South Tahoe Public Utility District

Tahoe Valley South Subbasin (6-005.01) Annual Report

Water Year 2021

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CERTIFICATION

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Contents

GLOSSARY

2012-2016 Event: Statewide drought emergency declared under the California Emergency Services Act

2014 GMP: Groundwater Management Plan prepared by the District in accordance with Assembly Bill 3030 pursuant to CWC Section 10750 et *seq*.

AF: Acre-feet

AFY: Acre-feet per year

Alternative Plan: Alternative to a GSP developed pursuant to Part 2.75 of the Water Code

Alternative Materials: Additional plans, reports and other documents related to the 2014 GMP

BMOs: Basin Management Objectives specified in the 2014 GMP

BHHRA: Baseline Human Health Risk Assessment

CASGEM: California State Groundwater Elevation Monitoring

Cleanup and Abatement Order: CAO

CMIP 5: Coupled Model Intercomparison Project Phase 5 (Taylor et al, 2012)

COC: Constituents of Concern

CSLT: City of South Lake Tahoe

CWC: California Water Code

CWS: Community Water System

District: South Tahoe Public Utility District

DDW: California Division of Drinking Water

DRI: Desert Research Institute

DWR: California Department of Water Resources

EDC: El Dorado County

EPA: Environmental Protection Agency

Feasibility Study or FS: Engineering feasibility study of remedial alternatives to mitigate PCE groundwater contamination in the South Y Area

GAC: Granular Activated Carbon

GMP: Groundwater Management Plan

GSA: Groundwater Sustainability Agency

GSP: Groundwater Sustainability Plan

GSP Regulations: California Code of Regulations Title 23. Waters; Division 2. Department of Water Resources; Chapter 1.5. Groundwater Management; Subchapter 2. Groundwater Sustainability Plans

GWMP: Groundwater Management Plan

IRAP: Interim Remedial Action Plan; this is the preferred alternative of the Feasibility Study

LBWC: Lukins Brothers Water Company

LPA: Lakeside Park Association

LRWQCB: Lahontan Regional Water Quality Control Board

LTBMU: US Forest Service, Lake Tahoe Basin Management Unit

LTLW: Former Lake Tahoe Laundry Works site, 1024 Lake Tahoe Boulevard, South Lake Tahoe, CA

MCLs: maximum contaminant levels

MDD: Maximum daily demand

MGD: Million gallons per day

Model Domain: Areal extent of the South Tahoe Groundwater Model encompassing the TVS Subbasin and the surrounding watersheds to the watershed divide.

MOU: Memorandum of Understanding

MT: Minimum Threshold; a minimum value, if exceeded, may cause an undesirable result

MtBE: Methyl tert-Butyl Ether

MT3DMS: Modular three-dimensional transport model

NRCS: National Resources Conservation Service

OW: Observation well

Parts per Billion: ppb, equivalent to micrograms per liter (µg/L)

Parts per Million: ppm, equivalent to milligrams per liter (mg/L)

PCA: Potential contaminating activity

PCE: Tetrachloroethylene

PDI: Groundwater investigation performed in support of the Feasibility Study

PTAS: Packed Tower Air Stripper

PWS: Public water system

RA: Recommended action; information that should be included in the first five-year update of the TVS Subbasin Alternative and recommendations for improvement (DWR, 2019a).

SAG: Stakeholders Advisory Group

SCWS: Small community water system is a public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 yearlong residents.

SGMA: Sustainable Groundwater Management Act

SMCLs: Secondary maximum contaminant levels

SNOTEL: NRCS snow telemetry station

South Y: Intersection of US Route 50 and California State Highway 89, in the City of South Lake Tahoe, CA

South Y Area: General area within a one-mile radius of the South Y

South Y Plume: Groundwater plume characterized by high concentrations of dissolved tetrachloroethylene contamination, above maximum contaminant levels, generally located between the South Y and the Tahoe Keys lagoon, in South Lake Tahoe, CA

STGM South Tahoe Groundwater Model: Groundwater flow model developed by DRI for the TVS Subbasin and its surrounding watersheds using MODFLOW-NWT

SWRCB: California State Water Resources Control Board

SWRCB-DFA: SWRCB Division of Financial Assistance

TKPOA: Tahoe Keys Property Owners Association

TKWC: Tahoe Keys Water Company

TRPA: Tahoe Regional Planning Agency

TVS Subbasin: Tahoe Valley South Subbasin (6-005.01) of the Tahoe Valley Groundwater Basin (6-005)

USGS: U.S. Geological Survey

UWMP: South Tahoe Public Utility District 2020 Urban Water Management Plan

Water Agency: El Dorado County Water Agency (aka El Dorado Water Agency)

WBZs: Water-bearing zones

WY: Water Year

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0 Executive Summary

The Tahoe Valley South Subbasin (6-005.01) of the Tahoe Valley Groundwater Basin (TVS Subbasin), is a discrete, highly productive sedimentary geologic basin located in the City of South Lake Tahoe (CSLT) and portions of El Dorado County, California (EDC). The 2021 Annual Report presents a management level summary of groundwater conditions within the TVS Subbasin using collected groundwater production and hydrologic data and results from numerical hydrologic models. District progress on implementation of Basin Management Objectives (BMOs) as described in the Alternative Plan (Kennedy-Jenks, 2014) is also reported.

In 2016, the South Tahoe Public Utility District (District) submitted the 2014 Groundwater Management Plan (2014 GMP) and Alternative Materials to the California Department of Water Resources (DWR) for assessment as an existing plan Alternative under section 10733.6(b)(1) of the Water Code. On July 17, 2019, DWR formally accepted the District's 2014 GMP and Alternative Materials as an approved Alternative to a Groundwater Sustainability Plan (Alternative Plan) for the TVS Subbasin, renaming the 2014 GMP.

This is the seventh annual report issued since adoption of the 2014 GMP and third annual report since DWR approval of the Alternative Plan for the TVS Subbasin in 2019. During Water Year (WY) 2021 the first five-year update to the Alternative Plan was prepared for formal adoption by the District and El Dorado Water Agency (Water Agency) Board of Directors. The adopted first five-year update of the Alternative Plan is planned to be resubmitted to DWR for periodic review during WY 2022.

Groundwater Conditions

This Annual Report provides hydrologic data for WY 2021, which is the 12-month period starting October 1, 2020 through September 30, 2021.

Water Year Classification. In terms of precipitation, WY 2021 was a below normal water year, which followed a dry water year (WY 2020), an above normal water year (WY 2019), a normal water year (WY 2018) and a very wet water year (WY 2017).

Groundwater Recharge. Groundwater recharge to the TVS Subbasin is the sum of areal recharge over the TVS Subbasin and the subsurface inflow of groundwater to the TVS Subbasin from the adjoining mountains [Mountain Block Recharge (MBR)] For WY 2021, total groundwater recharge to the TVS Subbasin is calculated at 18,992 acre-feet (AF). Of this amount, 16,8560 AF is from MBR and 2,131 AF is from areal recharge.

Groundwater Levels. WY 2021 groundwater elevations were generally within the normal range relative to the 10-year base period for groundwater levels (WY 2001 -WY 2010). May 2021 groundwater levels declined on average about -2.2 feet compared to May 2020 groundwater levels.

Degraded Groundwater Quality. Periodic evaluation of groundwater quality based on review of available water quality records collected over the past ten years (2011 – 2020) indicates the following.

- There were no drinking water supply wells with detections of regulated general constituents above primary and secondary maximum contaminant levels (MCLs).
- Inorganic constituents including aluminum, arsenic, iron, and manganese were detected in water samples collected from water supply wells above primary and secondary MCLs.
- Radioactive constituents including uranium and gross alpha activity were detected in water samples collected from water supply wells above primary MCLs.
- Regulated chemicals including 1,2-dichloroethane (1,2-DCA) and tetrachloroethylene (PCE) were detected in water samples collected from water supply wells above primary MCLs.

During WY 2021, the Lahontan Regional Water Quality Control Board (LRWQCB) continued regional plume characterization involving the installation of nine sentry wells to provide water purveyors advanced warning of PCE migration upgradient from drinking water supply wells. Initial sampling of sentry wells showed PCE detected at a maximum of 130 ppb in groundwater samples collected (148 – 151 ft depth) upgradient of LBWC #5; PCE detected at a maximum of 43 ppb in groundwater samples collected (145 – 148 ft depth) upgradient of TKWC #2; and PCE detected at a maximum of 99 ppb in groundwater samples collected (115 – 118 ft depth) upgradient of TKWC #1. PCE was not detected in groundwater samples collected upgradient of LBWC #1.

In response to impairment of water supply wells, TKPOA completed a long-range planning study to investigate options for providing a reliable water supply which would also serve as a long-term facility plan for TKWC (MC Engineering, 2021). In April 2021, TKPOA requested that the District determine what improvements were needed to the District's water system to provide sufficient water supply to meet TKWC peak hour demands through the Districts intertie with TKWC. A new intertie connection was constructed between the LBWC and TKWC water systems. TKPOA imposed water use restrictions to limit water demand below what could be met by water production from TKWC Well No. 1 (1,000-gpm) and the LBWC inter-tie (550-gpm), while limiting use of TKWC #3 due to uranium contamination. In July 2021 LBWC was able to return LBWC #5 to service following the installation of a Granular Activated Carbon well head treatment system, adding 0.893 MGD of source capacity for the LBWC water system.

Groundwater Production. Metered groundwater production from major community water system wells (District, TKWC, LBWC and LPA) accounts for more than 90% of groundwater extractions in the TVS Subbasin, totaled 6,402 AF. This is approximately 15% below average (WY 2005 – WY 2021). Groundwater extractions from these well is substantially less than sustainable yield (13,200 AFY).

Groundwater Storage. For WY 2021, the annual change of groundwater in storage for the TVS Subbasin is -4,127 AF. Since WY 2005, the cumulative change of groundwater in storage for the TVS Subbasin is +9,032 AF. The storage threshold for the TVS Subbasin is -32,050 AF relative to WY 2005.

Groundwater Supply. The current year available supply for WY 2021 is 41,082 AF. Since WY 2005, the groundwater supply has ranged from 31,858 AF (WY 2009) to 48,604 AF (WY 2019).

Basin Management Objectives

Groundwater management activities performed during WY 2021 included items required for ongoing compliance with SGMA and other efforts to address BMOs under the Alternative Plan. WY 2021 accomplishments included:

- Fulfilled the Alternative annual reporting requirements for the preceding water year for the TVS Subbasin.
- Fulfilled monitoring entity groundwater level elevation monitoring and reporting requirements for the TVS Subbasin under the CASGEM program.
- Continued conducting SAG workshops for collaboration around groundwater-related activities occurring within the TVS Subbasin.
- Reconciled projected water budgets between the Alternative Plan and the District's 2020 Urban Water Management Plan (UWMP).
- Updated the South Tahoe Groundwater Model (STGM) and used the updated model to
    - Develop a projected water budget over a 50-year planning and implementation horizon,
    - Assess potential climate change impacts,
    - Assess depletions of interconnected surface waters; and
    - Assessed current available groundwater supply.
- Developed sustainable management criteria for the assessment of undesirable results.
- Conducted administrative, technical, and public engagement tasks for preparation of the first five-year update of the Alternative Plan.

Comparison of current groundwater conditions to quantitative criteria defined for the TVS Subbasin, demonstrates that the sustainability goal for the TVS Subbasin is currently being met.

1 Introduction

The District has prepared this report for the TVS Subbasin. The WY 2021 Annual Report presents a management level summary to assess groundwater conditions and supplies within the TVS Subbasin, using groundwater production and hydrologic data and results from numerical hydrologic models. Progress on implementation of BMOs defined in the Alternative Plan is also reported.

The 2014 GMP was prepared in accordance with Assembly Bill 3030 (AB 3030) pursuant to CWC Section 10750 et *seq*. The 2014 GMP was adopted by the District and an accompanying Groundwater Ordinance was added as Division 7 to the District's Administrative Code on December 4, 2014. On December 28, 2016, the District concurrently submitted to DWR (1) its 2014 GMP and Alternative Materials as an existing plan Alternative pursuant to Water Code section 10733.6(b)(1) and (2) an analysis of basin conditions as an analysis Alternative pursuant to Water Code section 10733.6(b)(2) for public comment and DWR review and evaluation.[1] On July 17, 2019, DWR determined that the existing plan Alternative satisfied the objectives of SGMA and approved it as an Alternative Plan for the TVS Subbasin (DWR, 2019a), renaming the 2014 GMP.

This report was prepared in compliance with the annual reporting requirements of a Groundwater Sustainability Agency (GSA) to submit an annual report by April 1 of each year (CWC §10728). Since 2016, DWR has required GSAs which have submitted Alternatives to DWR for evaluation to also submit annual reports. As described in more detail in section 3.3.3.1 of this 2021 Annual Report, the District is the GSA for the majority of the TVS Subbasin, with the Water Agency acting as the GSA for the portions of the TVS Subbasin outside of the District's jurisdiction.

The WY 2021 Annual Report is the seventh annual report issued since adoption of the 2014 GMP and the third annual report issued since DWR approval of the Alternative Plan for the TVS Subbasin in 2019. Table 1-1 lists the components required for inclusion in annual reports submitted by a GSA to DWR. Also listed are the corresponding section(s) where this information is found in this report. Information about GSA Formation, development of the first five-year update of the Alternative Plan and outreach efforts are described in Section 3.3 BMO #3 – Building Collaborative Relationships of this report.

[1] As part of its submittals, the District indicated its preference to DWR that the review be sequenced in such a manner that its existing plan Alternative be reviewed first, and should DWR agree that the existing plan Alternative is functionally equivalent to a GSP, review of the analysis Alternative would not be necessary.

§ 356.2	ANNUAL REPORT COMPONENT	SECTION(s)
(a)	General information, including an executive summary and a location map depicting the basin covered by the report	Executive Summary; Section 1.1; Fig. 1-1; Fig. 1-2
(b)	A detailed description and graphical representation of the following conditions of the basin managed in the Plan:	
(1)	Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:	
(A)	Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.	Section 2.4.2; Fig. 2-6
(B)	Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.	Section 2.4; Fig. 2-4; Appendix A
(2)	Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.	Section 2.6; Table 2-4; Fig. 2-8, Fig. 2-9. All reported water use in Section 2.6 is for single-family and multi-family residential, commercial and landscape uses.
(3)	Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.	Not Applicable; surface water for recharge or in-lieu use is not used as a source of supply, except for Lakeside Park Association. The annual volume of surface water used by this system is not provided in this report.

§ 356.2	ANNUAL REPORT COMPONENT	SECTION(s)
(4)	Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.	Section 2.6.1; Table 2-4; The water use data provided in Section 2.6 is from the District's customer service database and is representative of more than 80% of the groundwater use in the TVS Subbasin. These data are presented in calendar years.
(5)	Change in groundwater in storage shall include the following:	
(A)	Change in groundwater in storage maps for each principal aquifer in the basin.	Section 2.7- The annual change of groundwater in storage is presented as a single value for the entire basin which is derived from the water budget calculated by the South Tahoe Groundwater Model (STGM). As the model calculates groundwater storage for all layers within the principal aquifer (e.g. Basin-fill Aquifer), a storage map is not provided. A graph depicting annual and cumulative change of groundwater in storage is provided as Figure 2-10.
(B)	A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.	Section 2.7; Fig. 2-10. All water use, in terms of groundwater production, shown in Figure 2-10 is for residential, commercial, and landscaping uses.
(c)	A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.	Section 3.0[2]

Table 1-1. Component requirements of Annual Reports submitted to DWR by GSAs (§356.2).

1.1 TVS Subbasin

The TVS Subbasin is part of the larger Tahoe Valley Groundwater Basin, which is located within the Lake Tahoe Hydrologic Basin and incorporates the sediment-filled basins bordering Lake Tahoe. The Tahoe

[2] The discussion in Section 3.0 of this Annual Report applies to the Alternative Plan.

Valley Groundwater Basin is subdivided into three sub-basins: the TVS Subbasin, the Tahoe Valley West Subbasin, and the Tahoe Valley North Subbasin (Figure 1-1). Of these three subbasins, the TVS Subbasin is the largest and most productive.

Elevations within the TVS Subbasin range from 6,225 feet at lake level, rising to above 6,500 feet within the groundwater basin. Elevations extend above 10,000 feet within the surrounding mountains along the Carson Range and Sierra Nevada Range. Portions of seven watersheds overlie the TVS Subbasin; the largest of these is the Upper Truckee River watershed. The Upper Truckee River flows north across the entire length of the TVS Subbasin and drains into Lake Tahoe after crossing the Upper Truckee Marsh. The Upper Truckee River is joined by Grass Lake and Big Meadow Creeks along the southern extent of its course, Angora Creek centrally, and Trout Creek near Lake Tahoe.

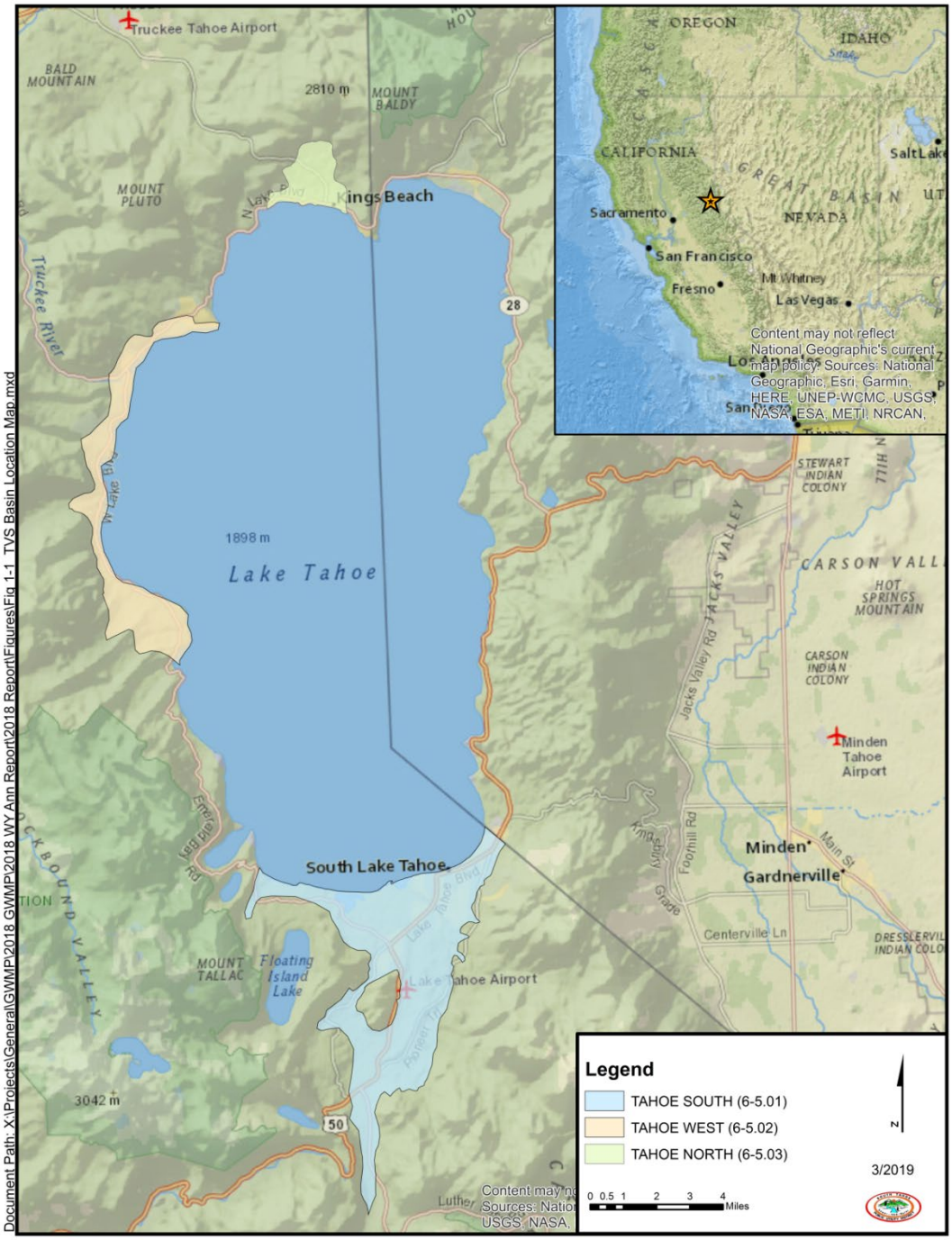

Figure 1-1. Lake Tahoe area regional map with DWR-designated groundwater subbasins.

The TVS Subbasin has an area of approximately 23 square miles (14,814 acres) and is in El Dorado County, California (Figure 1-2). The TVS Subbasin is roughly triangular-shaped, bounded on the southwest by the Sierra Nevada Range, on the southeast by the Carson Range, and on the north by the southern shore of Lake Tahoe. The TVS Subbasin generally conforms to the valleys of the Upper Truckee River and Trout Creek. The TVS Subbasin does not share a boundary with any other DWR groundwater basin or sub-basin. The City of South Lake Tahoe (CSLT) overlies the northern portion of the TVS Subbasin. The southern boundary extends about 3 miles south of the unincorporated town of Meyers. The northeast boundary of the TVS Subbasin is defined by the California-Nevada state line. For ease of description, the TVS Subbasin is subdivided into six geographically based sub-areas, referred to as the Tahoe Keys, South Lake Tahoe, Bijou, Angora, Meyers, and Christmas Valley sub-areas. The location and extent of these sub-areas are shown on Figure 1-2.

The TVS Subbasin includes the CSLT and portions of eastern EDC, which encompasses the unincorporated communities of Meyers, Angora Highlands and Christmas Valley. Within the greater South Lake Tahoe area, most of the land use is classified as Conservation area, followed by Residential, Recreation, Commercial and Public Service, and Tourist areas. Most of the Conservation areas are federal lands managed by the United States Forest Service - Lake Tahoe Basin Management Unit (LTBMU). Most of the federally managed land is located outside of the TVS Subbasin but does include large areas around the Camp Richardson/Fallen Leaf Lake area within the northwest portion of the TVS Subbasin; and along the basin margin on the east side of the TVS Subbasin.

Groundwater is the primary source of drinking water for the communities overlying the TVS Subbasin. Surface water for recharge or in-lieu use is not presently used, except by Lakeside Park Association (LPA). In January 2020 the District submitted Amended Application No. A023393 to the State Water Resources Control Board Division of Water Rights (SWRCB-DWR) to secure water rights based on a water demand analysis of future water needs for the greater South Lake Tahoe area (BHFS, 2020). This amended application is currently pending.

Most water wells drilled in the TVS Subbasin are completed in basin-fill deposits that generally consist of unconsolidated glacial, lake and stream sediments. These sedimentary deposits fill the lower reaches of the canyons that drain toward Lake Tahoe and underlie the relatively flat lying valley floors. These deposits can be over 1,000 feet thick in the deeper portions of the TVS Subbasin, but thin toward the basin margins where they cover shallow bedrock areas. Numerous water-bearing zones (WBZs) have been identified using lithologic and geophysical logs, and interpreted correlations to divide the basin-fill into multiple layers, representing regionally correlated units of high and low permeability. Units of relatively high permeability typically correspond to coarse-grained glacial outwash, fluvial and deltaic deposits forming the basin-fill aquifer. The laterally continuous fine-grained lacustrine (lake-bed) deposits form local confining layers or aquitards that affect groundwater flow between these higher permeability deposits.

Figure 1-3 is a conceptual hydrogeological cross section across the northern portion of the TVS Subbasin used to illustrate the WBZs. The different WBZ designations are informal and are based on the local

geographic area and the stratigraphic order in which the unit occurs. This is indicated as a subscript from deep to shallow depth (1 = lowermost zone; 5 = uppermost zone). The deepest zone (WBZ1) occurs in the deepest portions of the basin, generally at depths below 600 feet, and may act as a confined aquifer and show artesian conditions in some areas. The middle two zones (WBZ2 and WBZ3) represent the interval at depths between 200 to 600 feet and the shallowest two zones (WBZ4 and WBZ5) represent depths from 0 to 200 feet (Bergsohn, 2011).

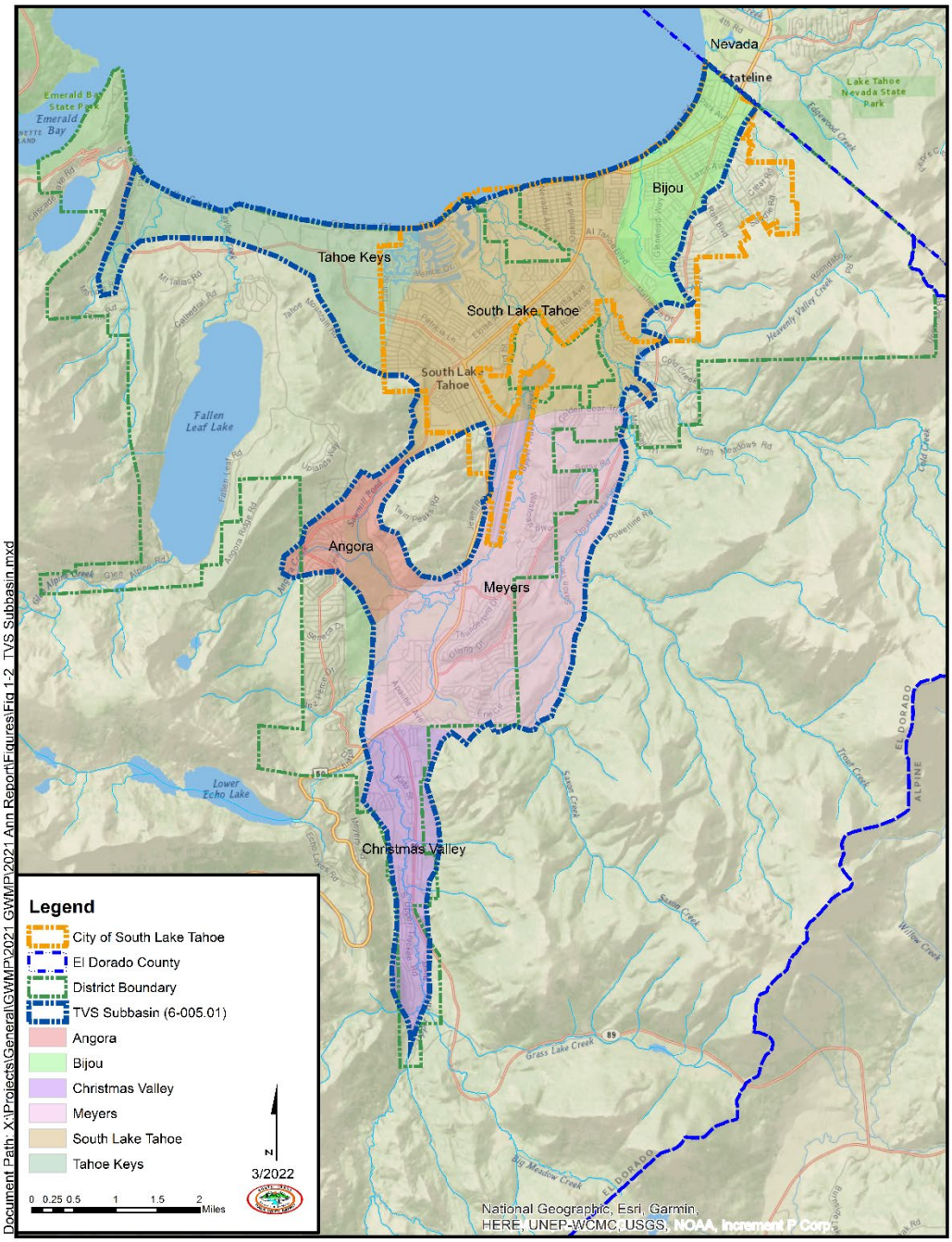

Figure 1-2. TVS Subbasin showing jurisdictional boundaries and geographically based sub-area designations used in this report.

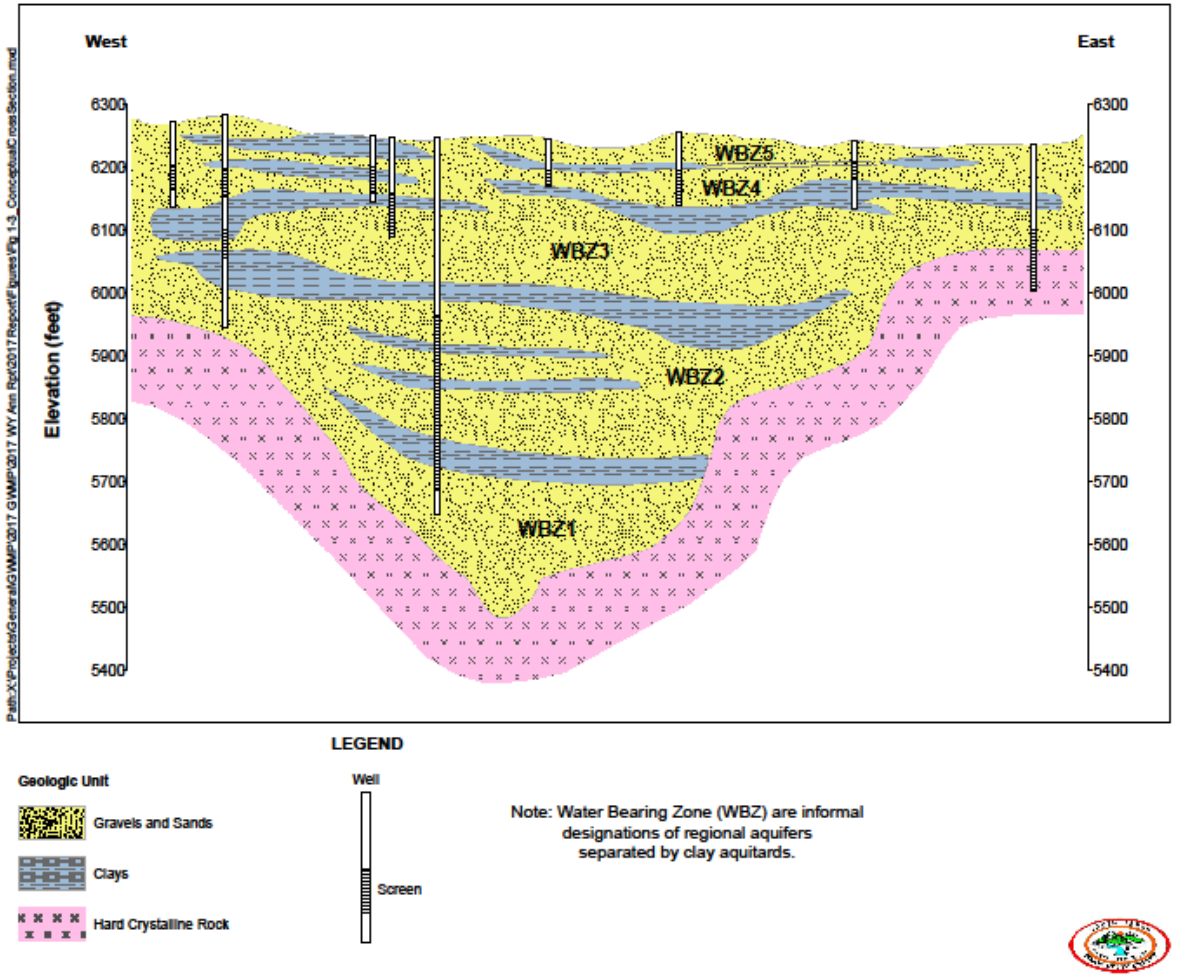

Figure 1-3. Conceptual geologic cross-section oriented east-west showing typical WBZs within the TVS Subbasin (Adapted from Kennedy-Jenks, 2014).

1.2 Water Year Classification

In terms of precipitation, WY 2021 was a below normal water year using the water year classification developed for the TVS Subbasin. Under the GSP Regulations, annual precipitation in a basin is required to be described in terms of water year type. DWR generally assigns water year type based on river flow indices or precipitation amounts and has developed water year classification systems for several hydrologic basins in California. For example, for the Sacramento Valley hydrologic basin, SWRCB developed five categories based on runoff forecasts and previous water year's index: 1) wet, 2) above normal, 3) below normal, 4) dry, and 5) critical (SWRCB, 1978).

The water year classification for the TVS Subbasin was created by the Desert Research Institute (DRI) following initial development of the STGM and a water budget for the TVS Subbasin. During development of the water budget, a strong linear correlation was identified between simulated precipitation from the Groundwater and Surface Water Flow (GSFLOW) Regional Model for the Truckee River Basin (GSFRM) and groundwater recharge to the TVS Subbasin. Linear correlation was also found between groundwater recharge to model calculated change of groundwater in storage. Using these relationships from the modeling analysis, total accumulated precipitation measured at four National Resources Conservation Service (NRCS) SNOTEL stations within the model domain were further evaluated to find the SNOTEL station with the best correlation to the simulated precipitation from the GSFRM. SNOTEL 508: Hagan's Meadow, CA was found to have the best correlation with model simulated groundwater recharge and change in groundwater storage. Therefore, NRCS precipitation records for this station were used as a reference station to classify water year type for the TVS Subbasin (Carroll et al., 2016b). The regression equation between annual total precipitations at SNOTEL 508: Hagan's Meadow, CA to groundwater recharge within the TVS Subbasin and surrounding watersheds is shown below in Figure 1-4.

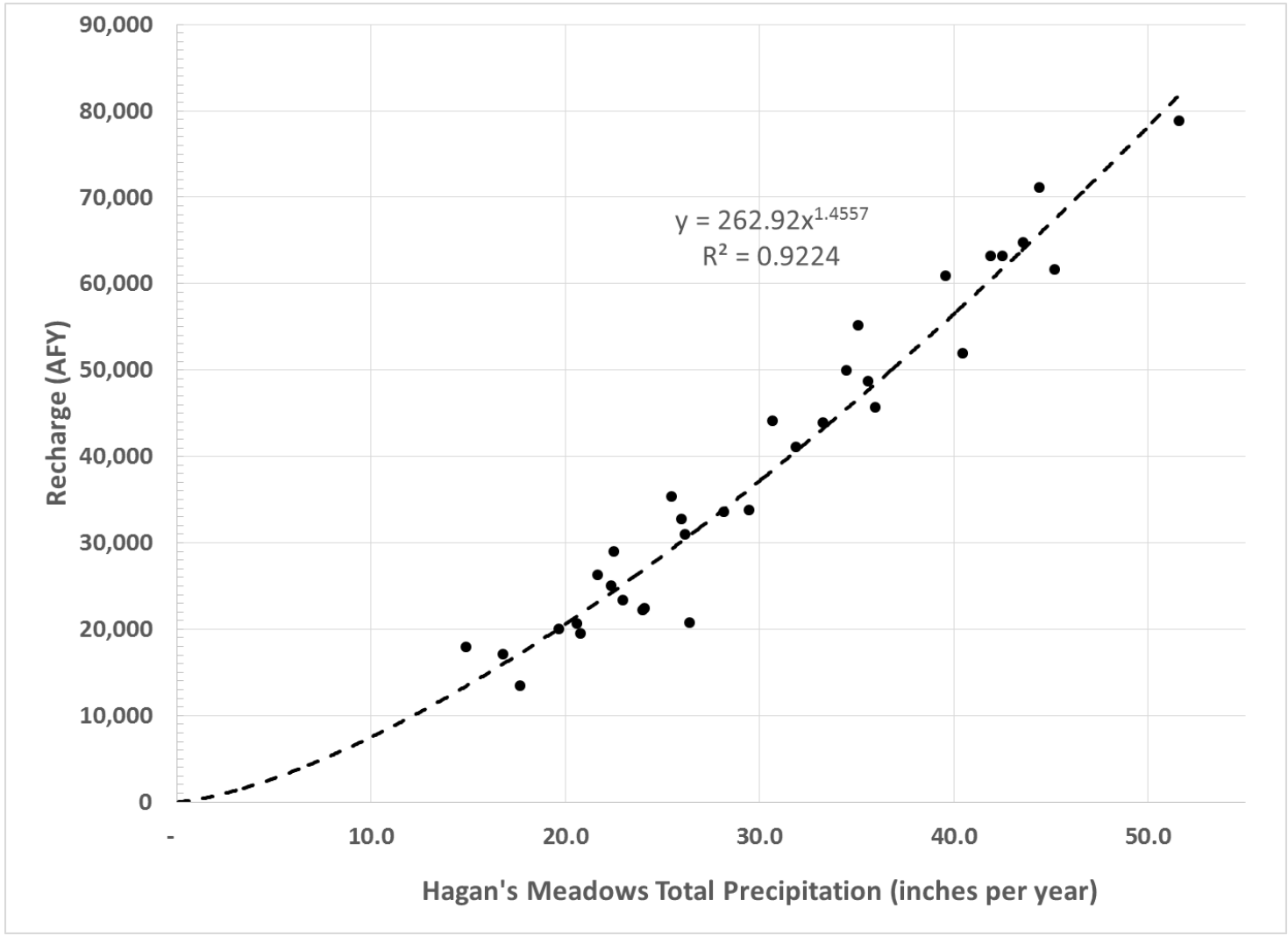

Figure 1-4. SNOTEL 508: Hagan's Meadow, CA annual precipitation versus modeled groundwater recharge within the model domain (G. Pohll et al., 2016)

For the TVS Subbasin, WY 1979 – WY 2017 was categorically defined by assuming a normal distribution in precipitation and establishing ranges based on the z-statistics in Table 1-2. To allow more flexibility in WY type, seven categories were established: 1) very wet, 2) wet, 3) above normal, 4), normal, 5) below normal, 6) dry, and 7) critical. The very wet periods are indicated by a z-statistic > 1.5 and occur in 1982 WY, 2011 WY and 2017 WY. The critical water year is indicated by a z-statistic – 1.5 and occurs when total accumulated precipitation is less than 14 inches. During the 2021 WY, total accumulated precipitation measured at SNOTEL 508: Hagan's Meadow, CA was 20.6 inches, which was the seventh driest water year on record. Table 1-2 shows the z-statistics, the calculated precipitation range for each water year type, and the number of each water year type (Count) occurring over the period of record (1979 – 2021) for this station. Figure 1-5 shows a graphical representation of this record.

WY Type	z (upper)	Precipitation (in) (WY 1979-WY 2017)		Count (1979 -2021)
		>	≤	
Very Wet	> 1.5	49	-	3
Wet	1.5	43	49	4
Above Normal	1.0	37	43	5
Normal	0.5	26	37	13
Below Normal	-0.5	20	26	13
Dry	-1.0	14	20	5
Critical	-1.5	0	14	0

Table 1-2. Classification system for Water Year (WY) Type based on observed WY accumulated precipitation at SNOTEL 508: Hagan's Meadows, CA. Upper bound of z-statistic and ranges in precipitation (inches) (Adapted from Carroll *et al.,* 2016b).

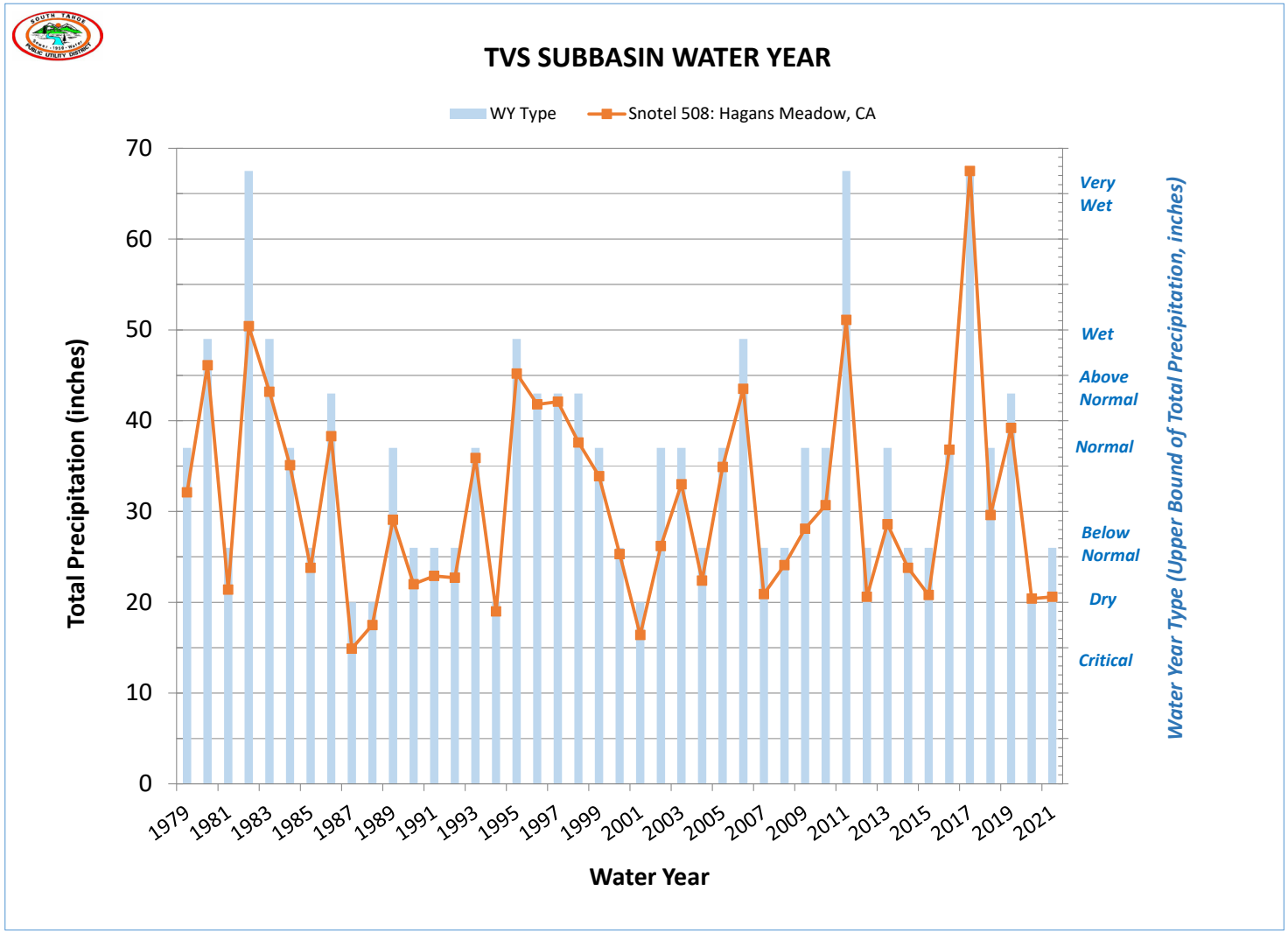

Figure 1-5. The annual accumulated precipitation measured at SNOTEL 508: Hagan's Meadow, CA and water year type indicated on the vertical axis along the right-side of the graph. Precipitation ranges for each water year type are listed in Table 1-2.

2 Groundwater Conditions

The following section presents data collected by the District and derived from numeric groundwater models to show the current state of the TVS Subbasin. Hydrographs showing groundwater elevation trends across the TVS Subbasin are provided in Appendix A.

2.1 South Tahoe Groundwater Model

The STGM was originally developed by DRI (Carroll, et al., 2016a; Carroll, et al., 2016b; Pohll, et al., 2018) to address BMOs identified in the 2014 GWMP. For use in this first five-year update of the Alternative Plan, it has since been updated to represent more recent years of the historical record and to extend predictive modeling scenarios further into the future. The model is used to quantify the TVS Subbasin conditions and is based on the U.S. Geological Survey (USGS) Newton-Rhapson formulation for MODFLOW -2005, referred to as MODFLOW-NWT (Niswonger et al., 2011) software. MODFLOW-NWT relies on an unstructured, asymmetric matrix solver to calculate groundwater head. MODFLOW-NWT is specifically designed to work with the Upstream Weighting Package to solve complex, unconfined groundwater flow simulations to maintain numerical stability during the wetting and drying of model cells.

The model grid is oriented north-south and contains 342 rows and 251 columns. Horizontal cell size is 100 meters (328 feet) and is based on the need to capture steep topography, narrow canyons, and potentially steep hydrologic gradients. The model is subdivided into four subsurface layers to maintain reasonable computation time. Layers are determined based on production well screen intervals. Land surface elevations are based on 30-meter (98 feet) Digital Elevation Model (DEM) aggregated to a 100-meter (328 feet) spatial resolution. Layer thicknesses are 40 meters (131 ft) for layer one and layer two, and 100 meters (328 feet) for layer three. Layer four bottom elevation is set to a constant 1,600 meters (5,248 feet) to produce variable thickness ranging from approximately 114 meters (274 feet) along the northern boundary with Lake Tahoe to 1,300 meters (4,264 feet) at watershed divides.

The model grid (i.e., model domain) covers an area of 99,907 acres commensurate with the South Lake Tahoe area (Figure 2-1). For ease of reporting the model domain is differentiated into two spatial zones (Zone 1 and Zone 10). Zone 1, referred to as the Mountain Block, covers an area of 85,093 acres encompassing the surrounding watersheds extending to the watershed divides, outside the TVS Subbasin. Zone 10 covers an area of 14,814 acres encompassing the TVS Subbasin as defined by DWR in Bulletin 118 (DWR, 2021). Organization of the model domain into spatial zones allows for comparison and reporting of discrete water budgets (including changes of groundwater in storage for the model domain (Zone 1 + Zone 10), the Mountain Block (Zone 1) and the TVS Subbasin (Zone 10). Reporting of water budgets specifically for the TVS Subbasin rather than the surrounding watershed area inclusive of

the TVS Subbasin was a recommended action identified by DWR for this first five-year update of the Alternative Plan.

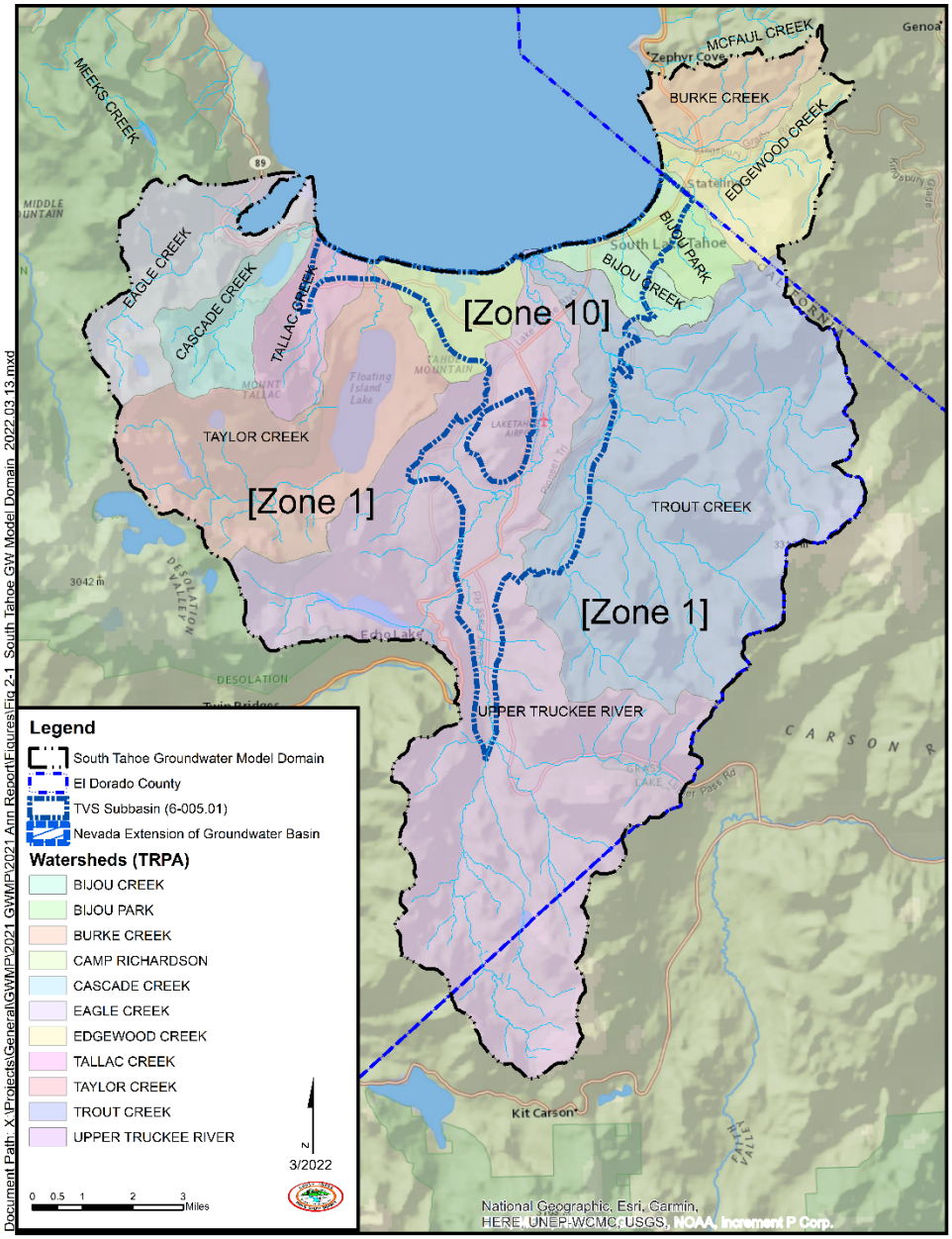

Figure 2-1. The model domain for the South Tahoe Groundwater Model encompasses the TVS Subbasin as defined by DWR (Zone 10) and the surrounding watersheds extending to the watershed divides (Zone 1).

2.2 Groundwater Recharge

Groundwater recharge to the TVS Subbasin is the sum of areal recharge over the TVS Subbasin (Zone 10) and the subsurface inflow of groundwater from the adjoining mountains (Zone 1) to the TVS Subbasin (Zone 10), referred to as Mountain Block Recharge (MBR). MBR is calculated in the water budget as the difference between the areal recharge within Zone 1 and the sum of the baseflow to streams plus discharge to Lake Tahoe within Zone 1.

Recharge for the TVS Subbasin was extracted from the transient model of the STGM. Figure 2-2 shows annual total recharge, areal recharge and MBR over the simulation period of the transient model (WY 1983 WY- WY 2021). For WY 2021, total groundwater recharge to the TVS Subbasin is calculated at 18,992 acre-feet (AF) or about 89% of average (21,325 AF) over the simulation period (WY 1983 WY – WY 2021). Of this total, about 11% (2,131 AF) is areal recharge and 89% (16,860 AF) is MBR.

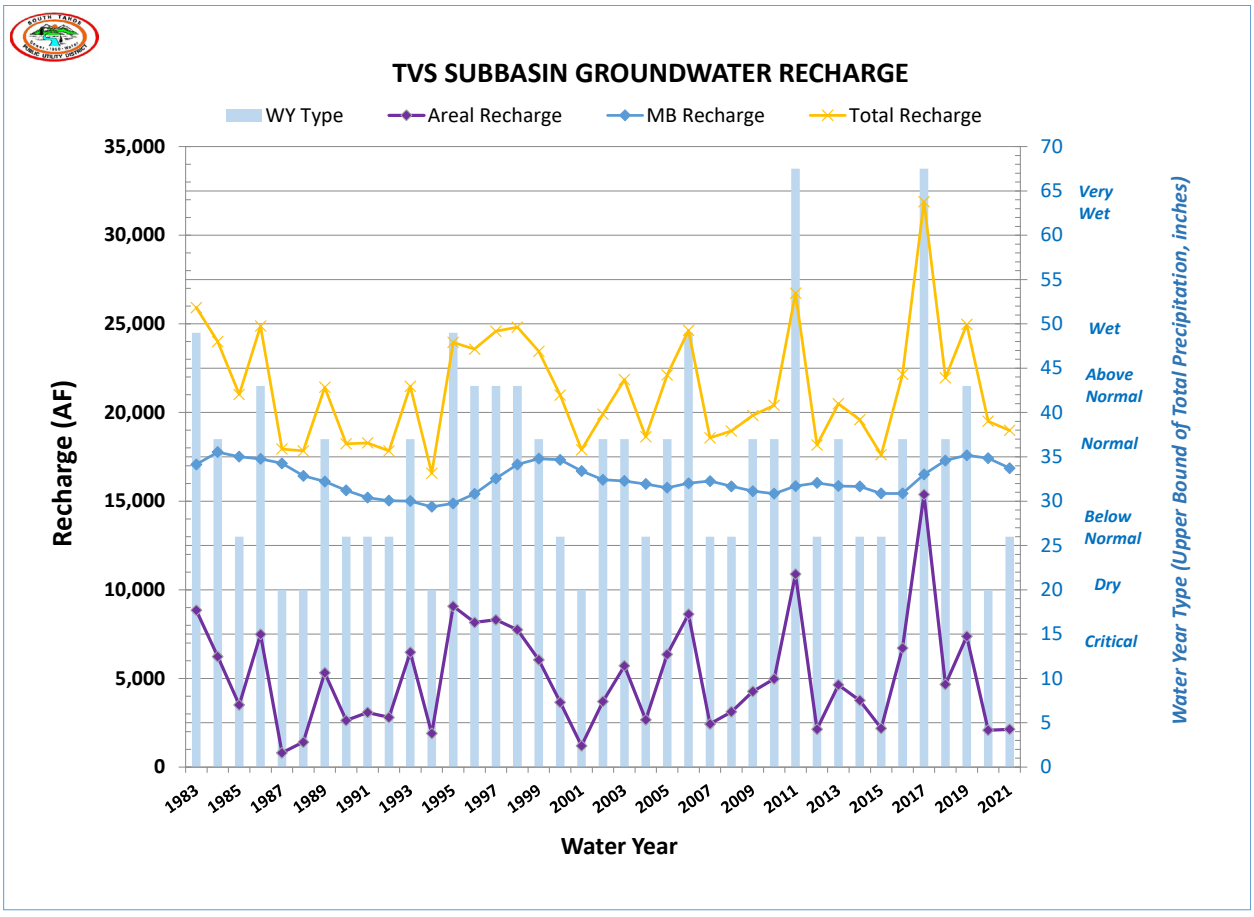

Figure 2-2. Areal, mountain block and total recharge (AFY) for the TVS Subbasin (WY 1983 – WY 2021). Water year type using the TVS Subbasin classification from total precipitation measured at SNOTEL 508 Hagan's Meadow, CA is indicated on the secondary vertical axis on the far right-side of the graph.

2.3 Groundwater Level Monitoring

The District is the designated monitoring entity for the TVS Subbasin under the CASGEM program. As such, groundwater level elevation monitoring data is reported semi-annually to DWR through the CASGEM online reporting system. For WY 2021, these data were reported to DWR in November 2020 and May 2021.

Groundwater levels are regularly measured in forty-seven (47) wells located throughout the TVS Subbasin. The District well network includes thirty-two (32) observation wells and fifteen (15) CWS wells (Figure 2-3). The majority of the CWS wells (11 of 15) are actively used for drinking water supply. Four of these wells are on stand-by status, used only for emergency purposes. The observation wells include monitoring wells, sentinel wells and test wells, as well as former drinking water supply wells that have been removed from service and are no longer connected to the District's water distribution system. Only the observation wells are used for reporting to the CASGEM program.

Construction details for selected wells for which hydrographs are provided (Appendix A) are set forth in Table 2-1. The sub-areas, shown in Table 2-1, are informal designations using the geographically based designations (Christmas Valley, Meyers, Angora, South Lake Tahoe, Tahoe Keys and Bijou) shown in Figure 1-2. The Christmas Valley sub-area is in the southernmost portion of the TVS Subbasin, south of Lake Valley and US Route 50. The Meyers sub-area is in the southern portion of Lake Valley from US Route 50 north to Twin Peaks. The Angora sub-area is in the northern portion of Lake Valley west of Twin Peaks. The South Lake Tahoe sub-area is located north of Lake Valley. The Tahoe Keys sub-area is located at the north end of the TVS Subbasin, west of the South Lake Tahoe sub-area, while the Bijou sub-area is located east of the South Lake Tahoe sub-area.

Basin monitoring generally involves the collection and evaluation of groundwater level, groundwater quality, groundwater production and climate data from numerous sources for the TVS Subbasin. A detailed description of the groundwater monitoring conducted in the TVS Subbasin is provided in Section 9.0 of the Alternative Plan. As part of the groundwater level monitoring effort, the District uses both hand and continuous readings to monitor groundwater elevation trends across the TVS Subbasin. Hand readings are collected from each of the TVS Subbasin groundwater elevation monitoring wells in the fall and spring of each water year. Hand readings from active CWS wells are collected a minimum of 12 hours after well pumps are turned-off for static water level measurements. A smaller number of observation wells (13) are fitted with dedicated water-level monitoring equipment. The data loggers are programmed to collect pressure head and temperature readings at 6:00 AM and 6:00 PM daily to provide a continuous record of groundwater levels in the TVS Subbasin.

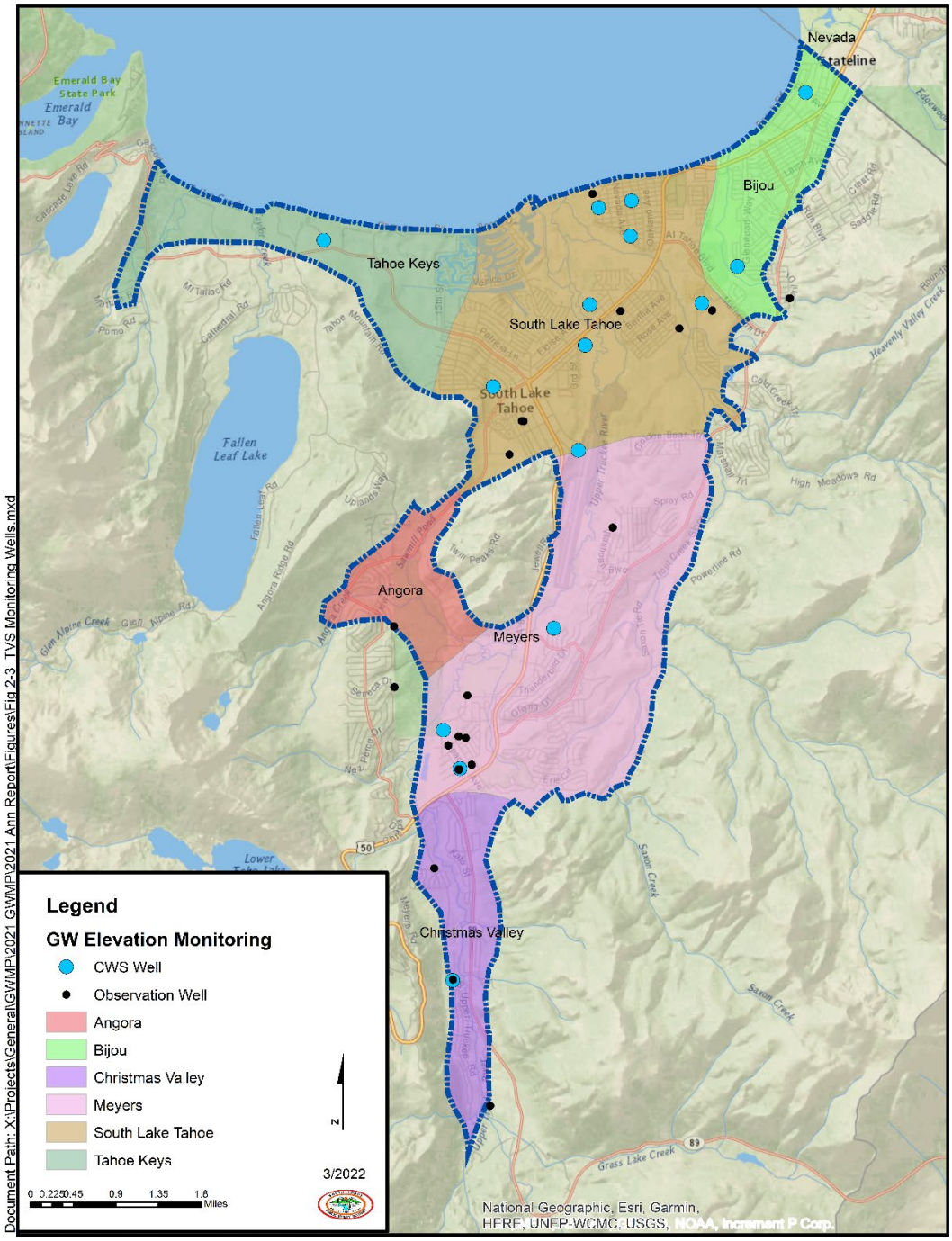

Figure 2-3. Locations of wells used for monitoring changes in groundwater elevation within the TVS Subbasin.

Well	Sub-Area	Reference Point Elevation (ft msl)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)
Mountain View	Angora	6313.14	95	164
Blackrock Well #1	Bijou	6242.72	168	180
Glenwood Well #3	Bijou	6261.68	112	192
Henderson OW	Christmas Valley	6369.78	79	100
			142	205
Bakersfield	Meyers	6310.50	130	170
			180	240
Elks Club Well #1	Meyers	6284.63	110	142
Washoan OW	Meyers	6307.84	102	144
			165	186
			207	228
			249	270
CL-1	South Lake Tahoe	6278.37	104	114
CL-3	South Lake Tahoe	6278.49	39	49
Paloma	South Lake Tahoe	6267.10	188	248
			268	408
Sunset	South Lake Tahoe	6249.00	275	430
Martin OW	South Lake Tahoe	6262.42	95	115
			125	145
			160	180
			200	240
USGS TCF-1-1	South Lake Tahoe	6296.48	325	340
USGS TCF-1-2	South Lake Tahoe	6296.47	245	260
USGS TCF-1-3	South Lake Tahoe	6296.65	158	163
USGS TCF-1-4	South Lake Tahoe	6296.63	130	140
USGS TCF-1-5	South Lake Tahoe	6296.63	88	98
Lily OW	South Lake Tahoe	6236.08	35	37.5
Valhalla	Tahoe Keys	6256.50	110	170

NOTES:
feet msl: Elevation in feet above mean sea level (NAVD88).
ft bgs: Depth in feet below ground surface.

Table 2-1. Screen intervals for selected groundwater elevation wells within the TVS Subbasin. Hydrographs for these wells showing groundwater level trends within each sub-area are provided in Appendix A.

2.4 Groundwater Levels

Hydrographs of continuous groundwater elevation readings collected from four observation wells across the TVS Subbasin are provided below in Figure 2-4. The Henderson Observation Well (OW) is located near the south end of the TVS Subbasin at the north end of the Christmas Valley sub-area. The Washoan OW is located near the center of the TVS Subbasin, within the north half of the Meyers sub-area. The Martin OW and Lily OW are both located at the north end of the TVS Subbasin, within the South Lake Tahoe sub-area. The Martin OW is located near the east margin of the TVS Subbasin within the south half of the sub-area; and the Lily OW is located nearest the south shore of Lake Tahoe within the north half of the sub-area.

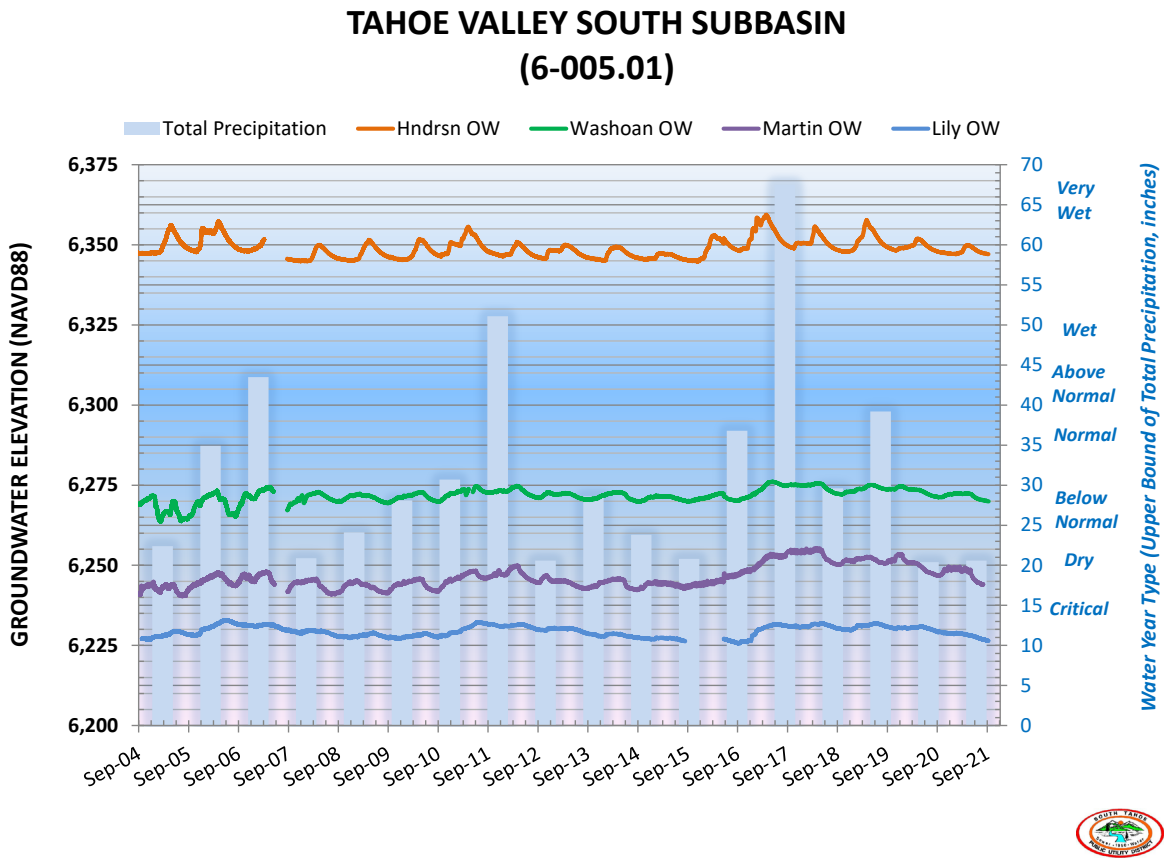

Figure 2-4. Continuous groundwater level readings collected from selected wells distributed across the TVS Subbasin.

Over the period of record (WY 2005 WY – WY2021), the continuous readings show that groundwater elevations have been relatively stable. During this period, there were one dry year, six below normal water years; six normal water years; one above normal water year; one wet water year; and two very wet water years (*see* Figure 1-5). Regular fluctuations representing seasonal changes in groundwater

elevations are most pronounced in the Henderson OW. This may be due to its remote location, away from the pumping influence of neighboring wells and away from the groundwater elevation influence of Lake Tahoe. Groundwater elevations tend to rise during the winter storm season when precipitation exceeds evaporation, plant transpiration (evapotranspiration) is at its lowest and groundwater production is at or near seasonal low water demands. As a result, seasonal high groundwater levels typically occur between early-April through mid-June. Groundwater levels then tend to decline during the summer and into the fall, when evapotranspiration exceeds precipitation and groundwater production is at or near seasonal high water demands. Seasonal low groundwater elevations typically occur at the end of this seasonal cycle, between mid-September through mid-November.

2.4.1 Basin Condition (Groundwater Levels)

Hand readings collected in May from the groundwater elevation monitoring wells of each water year are compared to hand readings collected during a ten-year period (WY 2001- WY 2010) prior to the statewide drought emergency declared in California during a five-year period spanning WY 2012 through WY 2016 (https://water.ca.gov/Water-Basics/Drought).

This analysis is used to ascertain the current condition of groundwater levels compared to the ten-year base period (WY 2001- WY 2010) selected for the TVS Subbasin. This base period was selected as groundwater level data for the basin monitoring wells are relatively complete and were collected prior to the 2012-2016 Event. During the base period accumulated precipitation measured at SNOTEL 508: Hagan's Meadow, CA averaged 29.3 inches, which is within the normal range of precipitation for the TVS Subbasin. During the base period for groundwater levels there were: one dry water year; three below normal water years; five normal water years; and one wet water year (see Figure 1-5).

Hand readings collected during WY 2021 were used to define current basin conditions as being either normal, above normal, or below normal with respect to the record of groundwater levels collected during the base period (Wy 2001 – WY 2010). The percentile rank of the groundwater elevation measured during the May 2021 monitoring event at each well was determined for more than thirty (30) of the groundwater elevation monitoring wells using the record of hand readings collected for that well during the base period. The percentile rank of the May 2021 groundwater elevation for each well was then plotted on a cumulative frequency diagram to show the current state of the TVS Subbasin in terms of groundwater levels (Figure 2-5).

Figure 2-5 shows the distribution of groundwater elevations measured in May over the past five water years (WY 2017 – WY 2021) using their respective percentile ranks within the record of groundwater levels measured for the same wells during the base period- (WY 2001 – WY 2010). During WY 2017, the median for the May groundwater elevations was at the higher end (far right) of the above normal range (97%) of the base period elevations and all wells were in the above normal range or within the normal range. During WY 2018 and WY 2019, the median for the May groundwater elevations was near the center of the above normal range (93%) of the base period elevations.

Over the past two water years (WY 2020 and WY 2021) the TVS Subbasin has been in severe drought (D2) experiencing consecutive dry and below normal water years. During WY 2020, the median for the May 2020 groundwater elevations was near the bottom of the above normal range (85%) of the base period elevations with two (2) wells in the below normal range (Sunset and South Upper Truckee #3); thirteen (13) wells in the normal range; and eighteen (18) wells in the above normal range. During WY 2021, the median for the May 2021 groundwater elevations was near the center of the normal range (64%) of the base period elevations with four (4) wells in the below normal range (Bayview, Al Tahoe, Sunset, and SW-1); twenty-four (24) wells in the normal range; and nine (9) wells in the above normal range. Groundwater elevations in the Bayview and Al Tahoe well decreased compared to the base period elevations to the middle of the below normal range (<15%); while groundwater elevations in the Sunset and SW-1 wells decreased compared to the base period elevations to near the upper part of the below normal range (27%) .

Between May 2017 and May 2021, the difference in groundwater elevations decreased an average of -5.09 feet. Between May 2017 and May 2018, the difference in groundwater elevations decreased an average of - 1.85 feet. Between May 2018 and May 2019, the difference in groundwater elevations increased by an average of 0.79 feet. Between May 2019 and May 2020, the difference in groundwater elevations decreased an average of -1.82 feet and between May 2020 and May 2021, the difference in groundwater elevations decreased an average of -2.21 feet. The annual changes in field measured differences in groundwater elevation readings are consistent with the annual changes in total precipitation measured at the TVS Subbasin reference station (SNOTEL 508); and the changes in groundwater recharge observed in the flow budgets derived from the STGM.

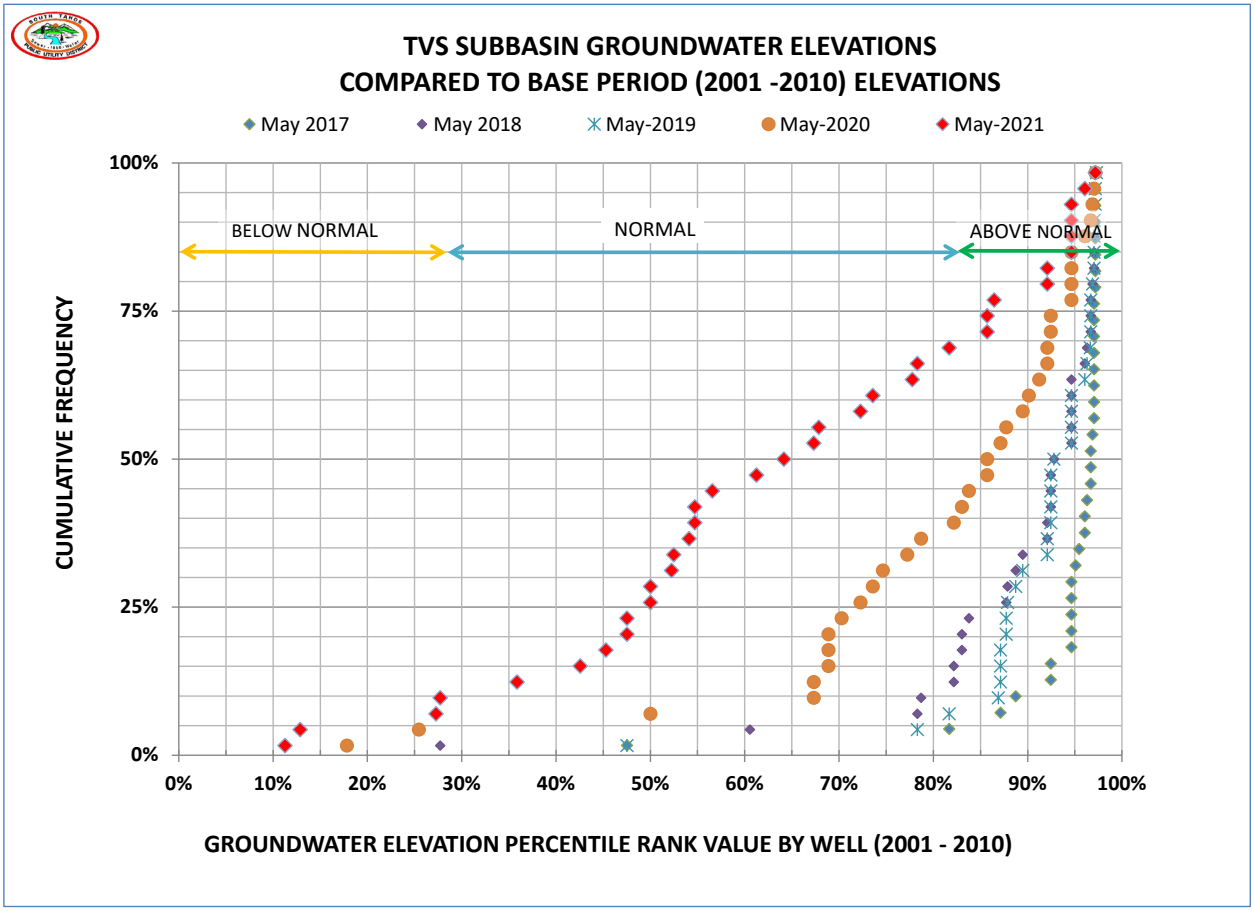

Figure 2-5. Hand readings collected during the May groundwater elevation monitoring event for WY 2017 through WY 2021 compared to the record of hand readings for the same wells collected during the base period for groundwater elevations (WY 2001 through WY 2010).

2.4.2 Groundwater Elevation Contours

Isocontours of groundwater elevations for October 2020 and May 2021 are presented in Figure 2-6 and represent seasonal low and seasonal high groundwater elevation conditions. The typical pattern is for seasonal low groundwater conditions to occur in the late summer and early fall due to low recharge following the relatively dry summer months and increased groundwater pumping to meet high water demands. Seasonal high groundwater conditions typically occur in the spring following the spring snowmelt and runoff and lower groundwater pumping needed to meet low water demands.

The STGM simulates the period WY 1983- WY 2021 to calculate changes in groundwater levels and flux due to variations in precipitation and groundwater extractions. Model simulated groundwater levels were used to generate the groundwater elevation contours presented in Figure 2-6. These contours are

considered appropriate to illustrate the general pattern of groundwater flow in the TVS Subbasin. Comparison of contours shows that the generalized pattern of groundwater flow remains very similar between October 2020 and May 2021. This is consistent with the hydrograph data (Appendix A) that shows the typical variation in groundwater levels is on the order of only a few feet.

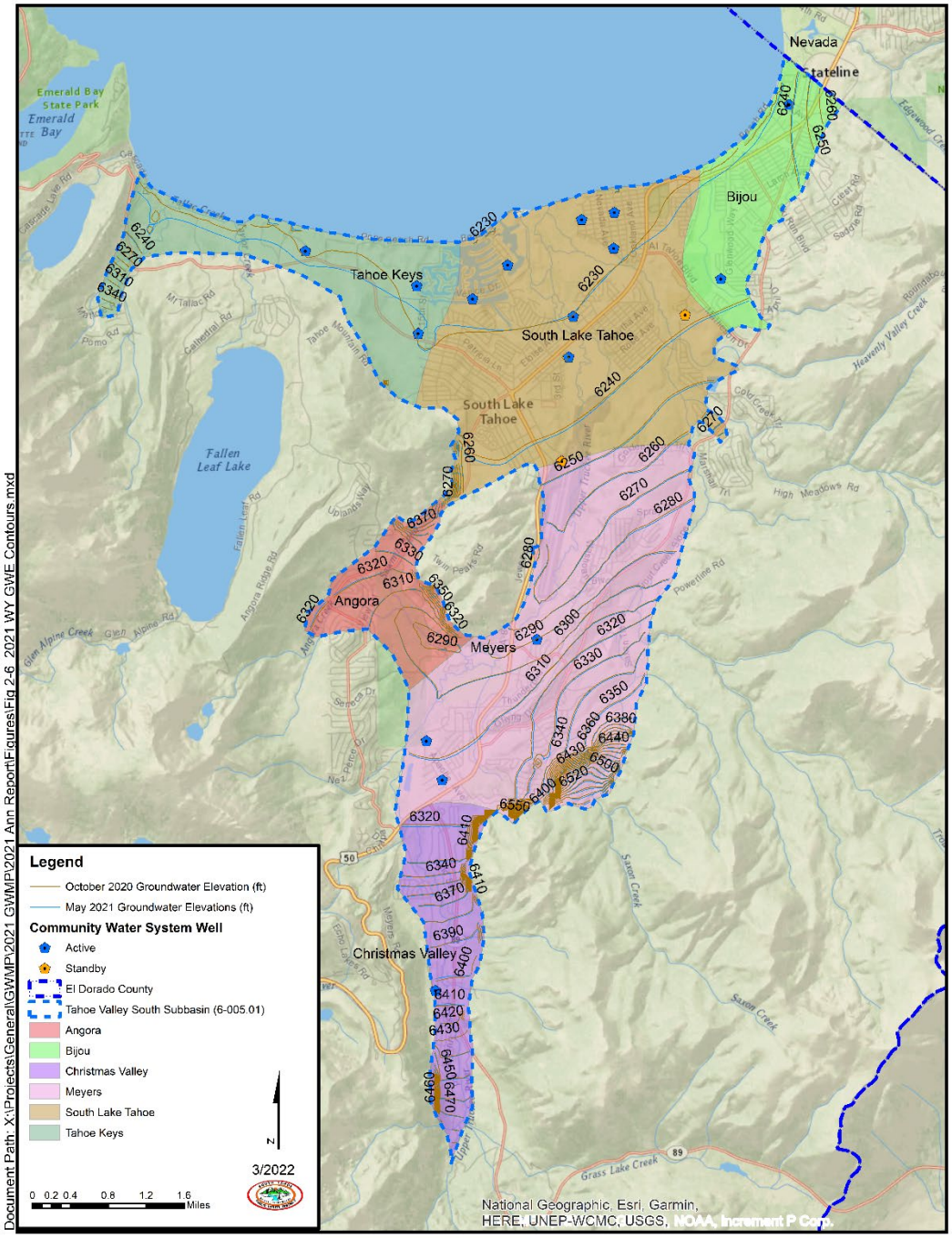

Figure 2-6. Model simulated groundwater elevations (upper 300 ft) for the TVS Subbasin, representing seasonal low (October 2020) and seasonal high (May 2021) groundwater conditions. Contour interval is 10 ft.

2.5 Degraded Groundwater Quality

Groundwater in the TVS Subbasin is typically of excellent quality; however, there is a history of groundwater contamination from both naturally occurring contaminants (for example arsenic , iron manganese and uranium) and regulated industrial and commercial chemicals (for example petroleum hydrocarbon and chlorinated hydrocarbon compounds). During WY 2021, an overview of groundwater quality, based on available water quality records collected over the past ten years (2011 – 2020) was completed for periodic evaluation of groundwater conditions (Rybarski et al, 2021). The following section summarizes important findings from this evaluation with an emphasis on the impact of degraded water quality on groundwater sources and beneficial use and users of groundwater (in terms of available source capacity) within the TVS Subbasin.

2.5.1 General Constituents

Groundwater from water supply wells is relatively low in total dissolved solids with typical values on the order of 100 milligrams per liter (MG/L). Average values for chloride and sulfate are very low at about 10.4 MG/L and 3.3 MG/L, respectively. Maximum nutrient concentrations for Nitrate (NO3 as N) and Nitrite (NO2 as N) are also low at 1.36 MG/L and 0.07 mg/L, respectively, well within MCLs for these constituents. There were no water supply wells with detections of regulated general constituents above primary and secondary maximum contaminant levels (MCLs).

2.5.2 Inorganic Constituents

Inorganic constituents detected in water samples collected from water supply wells above primary or secondary MCLs include aluminum (1 well); arsenic (5 wells), iron (8 wells), and manganese (3 wells). Arsenic has been detected in three wells within the District and TKWC water systems. Well head treatment (ferric-oxide adsorption) is presently used to remove arsenic from groundwater produced at one active District well (Arrowhead Well No. 3). A second District well with elevated levels of arsenic above MCLs (Airport Well) is an emergency stand-by source. Arsenic concentrations above MCLs have also been detected in TKWC No. 2. During WY 2021, there was no pumpage from both the Airport Well and TKWC No. 2. Of the eight wells with iron detected above secondary MCLs, two of these are currently active (LBWC No. 5 and LPA #3). During WY 2021, the only well with manganese above secondary MCLs (LBWC No. 2) was properly abandoned and destroyed.

2.5.3 Radioactive Constituents

Radioactive constituents detected in water samples collected from water supply wells above primary or secondary MCLs include total soluble uranium (3 wells) and gross alpha activity (twelve wells). Of the three wells with detections of uranium above MCLs, two of those wells are within the TKWC water

system (TKWC No. 2 and TKWC No. 3), the third well is a private well (CA0900673-001) no longer used for potable use. During WY 2021, elevated levels of uranium in the TKWC wells caused the Tahoe Keys Property Owners Association (TKPOA) to impose strict water use limitations, suspending irrigation by its customers within the TKWC service area (TKPOA, 2021a). TKWC added temporary well head treatment units (Ion Exchange) to remove uranium from groundwater produced by these wells.

Of the twelve wells with detections of gross Alpha particle activity above MCLs, eight of those wells are within the District water system, three are within the TKWC water system and one is a private well (CA0900673-001) no longer used for potable use. Of the eight wells within the District water system, four are active (Arrowhead Well #3, Bakersfield, Sunset, and South Upper Truckee Well No. 3), three are stand-by (Airport, Blackrock Well #2, and College) and one has been removed from service, converted to an observation well (Chris).

2.5.4 Regulated Chemicals

Regulated chemicals detected in water samples collected from water supply wells above primary or secondary MCLs include 1,2-Dichloroethane (1,2-DCA) (one well) and Tetrachloroethylene (PCE) (five wells). The one well with detections of 1,2-DCA above MCLs is an inactive well (Clement Well) in the District's water system. Of the five wells with detections of PCE above MCLs three of these wells are within the LBWC water system (LBWC #2, LBWC # 4 and LBWC #5), one is located within the TKWC water system (TKWC #2) and one is a private well (PW02909303). During WY 2020 and WY 2021, LBWC #4 and LBWC #2 were abandoned and properly destroyed. LBWC #5 was returned to service following construction of a well head treatment system [Granular Activated Carbon (GAC)] for the removal of PCE from groundwater. TKWC #2 is also fitted with a well head treatment system (GAC) installed in 2012. Each of these wells, except the private well are located within the South Y Plume (Figure 2-7).

In 2016, the District, in partnership with LBWC and TKWC, undertook renewed investigations to describe the extent of PCE contamination and identify remedial measures that may be used to remove PCE contamination from groundwater to protect existing groundwater sources used for drinking water supply. This included completion of an engineering assessment of an inactive water supply well (LBWC #4) for use as a potential extraction well (GEI, 2016a); compilation of historical data to show the spatial and temporal distribution of PCE contamination near the South Y (GEI, 2016b); and initial development of a modular three-dimensional transport model (South Y PCE Model) that could be used to evaluate the effectiveness of various remedial alternatives designed to mitigate contamination from the South Y Plume. During 2017, water quality data was collected to better understand the current extent of PCE contamination in CWS wells; the preliminary South Y PCE Model was completed, and negotiations were initiated with the SWRCB –DFA to conduct a Feasibility Study under a Proposition 1 Groundwater Planning Grant. An agreement with the SWRCB-DFA to conduct the Feasibility Study was executed in 2018 (Agreement D1712508). The Feasibility Study included performance of a groundwater investigation (referred to as the PDI) in the mid-section of the South Y Plume. Information from the PDI was used to inform the preliminary engineering design of extraction wells for the removal of PCE from groundwater.

As part of the Feasibility Study, water quality data collected during 2018 was used to update the South Y Fate and Transport Model and initial management scenarios were developed for evaluation.

During WY 2019, the District continued on-going activities to complete the Feasibility Study. Initial management scenarios were refined to define interim remedial alternatives to manage on-going contamination from the South Y Plume. Six interim remedial alternatives were developed and initially screened for effectiveness using the South Y Fate and Transport Model. The alternatives were also reviewed and screened for ease of implementation using input from the water purveyors. Based on this screening three interim remedial alternatives were selected for detailed analysis, including 20-year project life cost analysis, to select a preferred remedy. Technical reports presenting information from the PDI; Baseline Human Health Risk Assessment; and South Y Fate and Transport Modeling were completed and were posted on the District's website (https://stpud.us).

During WY 2020, the South Y Feasibility Study was completed. The Feasibility Study (FS) and an accompanying Interim Remedial Action Plan (IRAP) were issued and are posted on the District's website. The Feasibility Study/Interim Remedial Action Plan (FS/IRAP) Report is one of the principal technical documents prepared for the South Y Feasibility Study. The FS includes a description of historical and current studies used to describe hydrologic conditions, water systems infrastructure, groundwater production, groundwater quality and inferred extent of PCE contamination in the South Y Area. The FS also includes a description of the remedial alternatives developed and selected for detailed analysis, the selection criteria used for analysis and the results used to select a preferred interim remedial alternative. The preferred alternative involved construction of a new extraction well (R1) located at the former LBWC #4 location that could be used to increase PCE contaminant removal and equipped with wellhead treatment for potable reuse of contaminated groundwater (Kennedy Jenks, 2020).

In March 2019 the Lahontan Regional Water Quality Control Board (LRWQCB) was awarded a $4.6 million grant under the Site Cleanup Subaccount Program (SCAP) to investigate the South Y Plume (Figure 2-7). The South Y Plume is believed to have resulted from spills and releases associated with the use of commercial grade dry cleaning solvents in the South Y Area during the 1970's. During 2019 and 2020, the LRWQCB undertook a regional plume characterization that involved the drilling and sampling of seven-nine (79) borings to determine the lateral and vertical extent of PCE contamination; identify contaminant pathways; and using detailed graphics show the current distribution of PCE in groundwater.

During WY 2021, the LRWQCB continued regional plume characterization activities that involved the installation of nine sentry wells for 1) LBWC #1 (three wells total); LBWC #5 (two wells total); TKWC #1 (two wells total); and TKWC #2 (two wells total). The purpose of sentry well installation and monitoring are to provide water purveyors advanced warning of potential PCE migration upgradient from water supply wells. The siting and design of the sentry wells for LBWC #1, LBWC #5, TKWC #1, and TKWC #2 was based on lithology and PCE groundwater data from the 2019 and 2020 regional plume characterization investigation.

Following sentry well installation in July and August of 2021, the wells were developed, surveyed, and sampled for volatile organic compounds (VOC) including PCE. Groundwater samples were collected from the nine sentry wells using passive diffusion bags (PDBs) installed on September 24, 2021, and removed from the wells between October 19 and October 20, 2021. Two of the nine wells were sampled using the low-flow purge sampling method immediately after the PDBs were removed to confirm the sampling methods yield similar analytical results and validate the future use of PDBs for sentry well groundwater sampling events.

The groundwater sampling results from the 2021 well monitoring event are as follows:

- PCE was not detected in the three sentry wells installed for LBWC #1.
- PCE was detected at a maximum of 130 ppb in the deepest sentry well for LBWC#5 (approximate sample depth interval: 148.6 to 151.4 feet bgs).
- PCE was detected at a maximum of 43 ppb in the shallowest sentry well for TKWC #2 (approximate sample depth interval: 145.6 to 148.4 feet bgs).
- PCE was detected at a maximum of 99 ppb in the shallowest sentry well for TKWC #1 (approximate sample depth interval: 115.6 to 118.4 feet bgs).

The anticipated SCAP field tasks that will be completed during the 2022 field season include:

- Continue to develop a private and small-community water supply well inventory to identify additional supply wells to be sampled to ensure the water supply wells are providing water that is safe for human consumption.
- Conduct a soil gas investigation to evaluate the potential human health risks associated with potential soil vapor intrusion resulting from the PCE contamination. Soil gas samples will be collected downgradient from suspected source areas in locations where elevated concentrations of PCE have been detected in shallow groundwater. A Tier I human health risk evaluation will be conducted using the soil gas analytical data.
- Properly destroy priority municipal, private, and small-community water supply wells that have been identified as a vertical conduit(s) (e.g., responsible for the vertical migration of PCE in groundwater impacting deeper water-bearing unit[s]). Inactive wells, including monitoring wells installed for site-specific investigations that have not been properly destroyed, are included in the evaluation.
- Conduct two sentry well semi-annual groundwater monitoring events.

Regulatory activities and environmental data for the South Y Regional Contamination investigation (T10000007984) are available online through the SWRCB GeoTracker website at; https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T10000007984

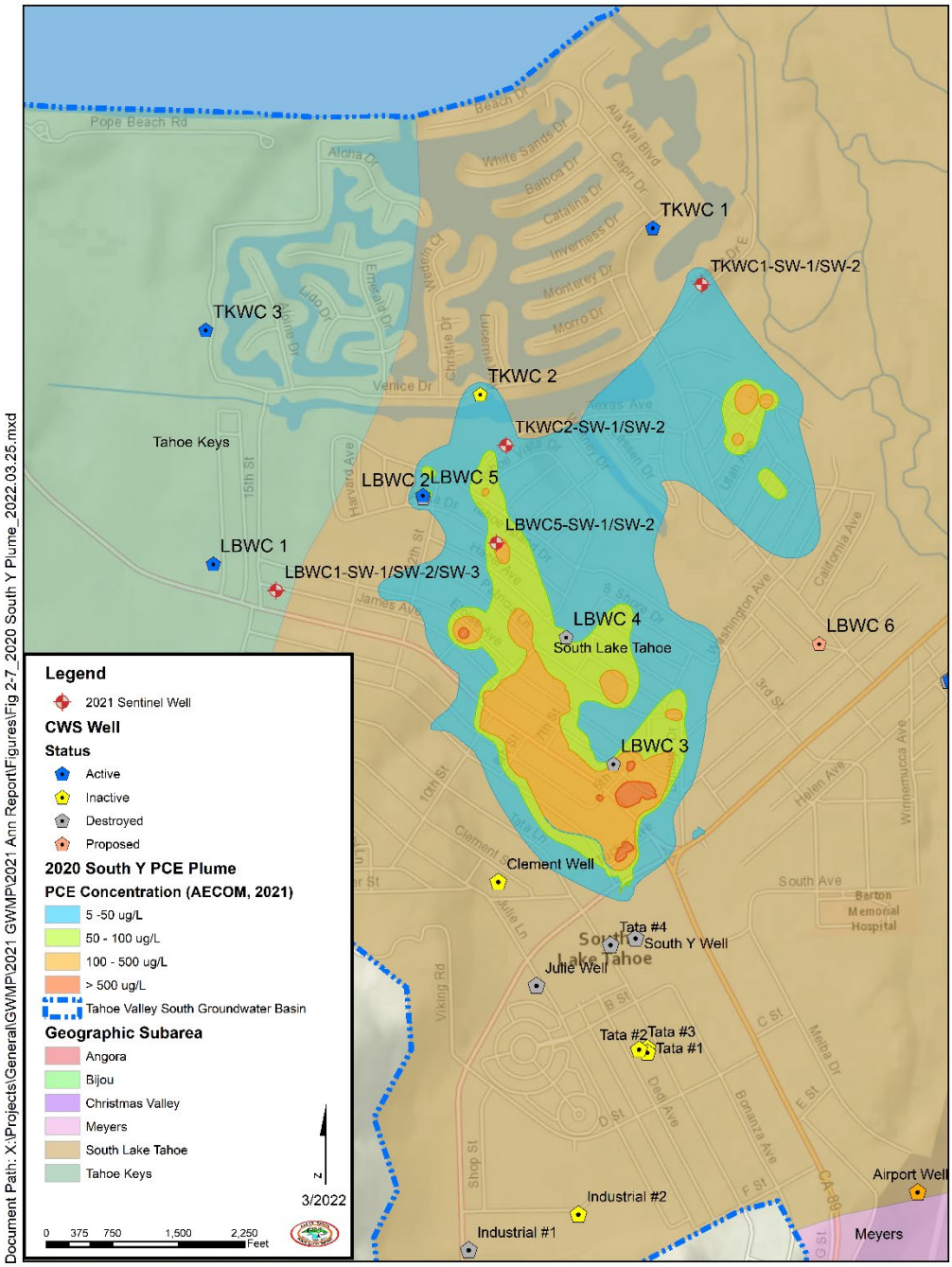

Figure 2-7. Location of the South Y Plume within the TVS Subbasin, as defined by PCE in groundwater detected above 5 micrograms per liter (µg/L), provisional data provided by LRWQCB.

2.5.4.1 Impact on Beneficial Users

High reliance on groundwater requires that CWS wells must have sufficient source capacity to meet water system demands. Because of this reliance and susceptibility of groundwater sources to contamination, the total source capacity of active CWS wells is used as an indicator to describe current basin conditions with respect to degraded groundwater quality (Pohll *et al.,* 2016; Rybarski et al., in preparation).

Table 2-2 shows the current WY 2021 source capacity and maximum day demands, in million gallons per day (MGD) for the District, TKWC and LBWC water systems. The source capacities are for active wells and does not include stand0by sources or wells that are currently offline. The maximum day demand (MDD) for the District, TKWC and LBWC water systems are calculated using the month with the highest water usage (maximum month) for each water system over the preceding 10-years (WY 2011 – WY 2020). The maximum month is divided by the number of days within that month to derive an average daily usage for the maximum month. This value is then multiplied by a peaking factor which is the quotient of the average daily use for the maximum month and the average daily use for that year. The difference between current source capacity and maximum day demand is shown as a surplus/deficit in the right end column of the table. The District, TKWC and LBWC water systems are inferred to account for more than 90% of the total groundwater pumpage extracted from the TVS Subbasin on an annual basis. To account for the beneficial users of groundwater not connected to these water systems, a 10 percent safety factor is added to the MDD derived for these water systems to determine the minimum threshold for the TVS Subbasin (Pohll *et al.,* 2016; Rybarski et al., in preparation).

Inspection of Table 2-2 shows that current WY2021 source capacity for the District, TKWC and LBWC water systems is sufficient to meet water system MDD and meet the MDD for all beneficial users in the TVS Subbasin (see Figure 3-1). However, the impairment of TKWC water system wells by inorganic (arsenic), radioactive (uranium) constituents and regulated chemicals (PCE) has severely limited this water systems source capacity which can only meet peak hourly demand when operating temporary wellhead treatment (ion exchange) for TKWC No. 3.

In response to impairment of TKWC wells, TKPOA completed a long-range planning study to investigate options for providing a reliable water supply which would also serve as a long-term facility plan for TKWC (MC Engineering, 2021). In April 2021, TKPOA requested that the District determine what improvements were needed to the District's water system to provide sufficient water supply to meet TKWC peak hour demands through its intertie with TKWC (TKPOA, 2021b). The District is currently developing the information needed to respond to this request. During WY 2021, a new intertie connection was constructed between the LBWC and TKWC water systems. TKPOA imposed water use restrictions to reduce water demand below what could be met by water production from TKWC Well No. 1 (1,000-gpm) and the LBWC inter-tie (550-gpm), while limiting use of TKWC #3, with temporary wellhead treatment (TKPOA, 2021c).

In July 2021 LBWC was able to return LBWC #5 to service following the installation of a GAC well head treatment system adding 0.893 MGD of source capacity for the LBWC water system. In January 2022, LBWC submitted a Drought Relief Assistance Application to DWR for grant funding to construct a new 500-gpm well outside the South Y Plume for source redundance. The District provided a letter of support for this project as the added pumpage from operation of the proposed well (500 GPM) would not cause total groundwater withdrawals to exceed the sustainable yield (see Figure 2-8).

Community Water System	Water System No.	Active Wells	Connections[1]	Population Served[1]	Source Capacity (mgd)[3]	Maximum Day Demand (mgd)[2]	(+) Surplus; (-) Deficit (mgd)[4]
South Tahoe Public Utility District (District)	CA0910002	10	14,235	33,124	17.9338	9.862	7.3518
Tahoe Keys Water Company (TKWC)	CA0910015	3	1,566	1,420	2.5920	2.383	0.2093
Lukins Brother Water Company (LBWC)	CA0910007	2	982	3,200	2.1888	0.634	1.5550
TVS SUBBASIN (6-005.01) TOTALS		15	16,783	37,744	22.7146	12.879	9.1160
Degraded Water Quality Minimum Threshold (110% of MDD)						**14.166**	**8.548**

Notes:

1) Source: SWRCB Drinking Water Branch Drinking Water Watch (https://sdwis.waterboards.ca.gov/PDWW/).

2) 10 Year (WY 2011 - WY 2020) Water System Maximum Day Demand, in million gallons per day (mgd), based on monthly water use as per CA Waterworks Standards (§ 64554).

3) Source capacity of active wells, in mgd (stand-by or offline sources not included).

4) (Source Capacity) – (Maximum Say Demand) in mgd.

Table 2-2. WY 2021 source capacity and maximum day demands for the District, TKWC and LBWC water systems, in millions of gallons per day (MGD).

2.6 Groundwater Production

Groundwater is the primary source of drinking water throughout the TVS Subbasin, provided primarily for residential and commercial water uses (see Section 2.6.1). More than ninety percent (90%) of groundwater produced from the TVS Subbasin is from drinking water wells operated by the District, TKWC, LBWC and Lakeside Park Association (LPA). The remaining balance of groundwater production is pumped from small community water system, state small water system, noncommunity water system, nontransient noncommunity water system and domestic wells. Pumpage from the District, TKWC, LBWC and LPA wells are metered using propeller or turbine type flowmeters with a register for total flow and a flow rate indicator. Totalizer readings are recorded daily by the District and monthly by TKWC, LBWC and LPA. Accuracy of measurement for these flow meters is typically on the order of +/- 2%. Pumpage from small community water system, state small water system, noncommunity water system, nontransient noncommunity water system and domestic wells are typically not metered.

Table 2-2 shows the monthly and total pumping volumes of groundwater produced by District, TKWC, LBWC and LPA wells during WY 2021. During this year, a total of sixteen (16) CWS wells were active, an additional four (4) wells were on stand-by status, but not used (restricted for emergency use only).

COMMUNITY WATER SYSTEM (CWS)	UNITS	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEPT	2021 WY
South Tahoe Public Utility District (District)	AF	513	363	385	378	314	323	333	563	684	739	674	535	5,802
Tahoe Keys Water Company (TKWC)	AF	20	13	10	16	14	16	14	18	24	29	39	33	245
Lukins Brothers Water Company (LBWC)	AF	10	5	5	14	13	15	18	36	46	55	50	51	316
Lakeside Park Association (LPA)	AF	0.76	0.17	0.04	0.17	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	1.2
TVS Subbasin CWS TOTALS		562	390	409	407	341	354	365	616	754	823	762	619	6,402

Table 2-3. Monthly pumping volumes for District, TKWC, LBWC and LPA wells in the TVS Subbasin during WY 2021, reported in AF.

Annual groundwater production from each of the CWS included in Table 2-3 above is shown below in Figure 2-8. The sustainable yield for the TVS Subbasin is 13,200 AFY which is the maximum quantity of

water calculated over a base period that is representative of long-term conditions in the basin and including any temporary surplus, that can be drawn annually from a groundwater supply without causing an undesirable result. Figure 2-8 shows that metered groundwater pumpage within the TVS Subbasin is significantly less than sustainable yield and was less than 50% of sustainable yield in WY 2021.

Since WY 2005 , metered groundwater production from the pumping of CWS wells has ranged from a low of approximately 6,306 AF (WY 2015) to a high of approximately 9,652 AF (WY 2007), with an average value of 7,512 AFY. During WY 2021, total groundwater production (6,402 AF) was about 15% below average. Community evacuations from the Caldor Fire are believed to have contributed to the historically low groundwater pumpage for District wells in September 2021. TKWC also imposed strict limitations on water use by its customers during WY 2021, resulting in a significant reduction in groundwater pumpage from TKWC wells which was 28% percent of average (WY 2005 – WY 2021).

Figure 2-9 shows the locations of the active District, TKWC, LBWC and LPA wells and their pumping volumes for WY 2021. Slightly more than 65% of the total pumpage from the TVS Subbasin is extracted from the South Lake Tahoe sub-area.

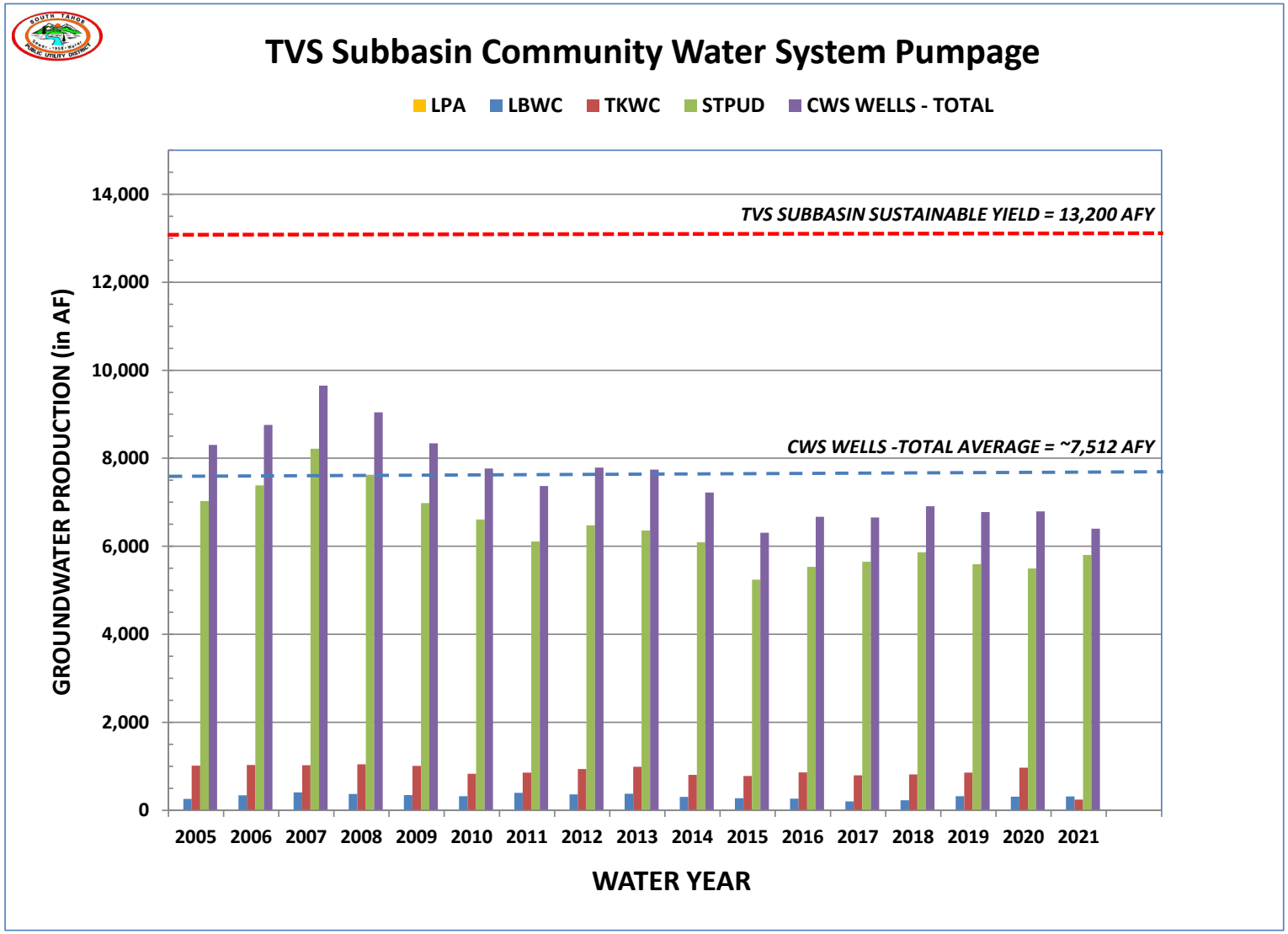

Figure 2-8. Groundwater production trends for major community water system wells in the TVS Subbasin since WY 2005, in AF.

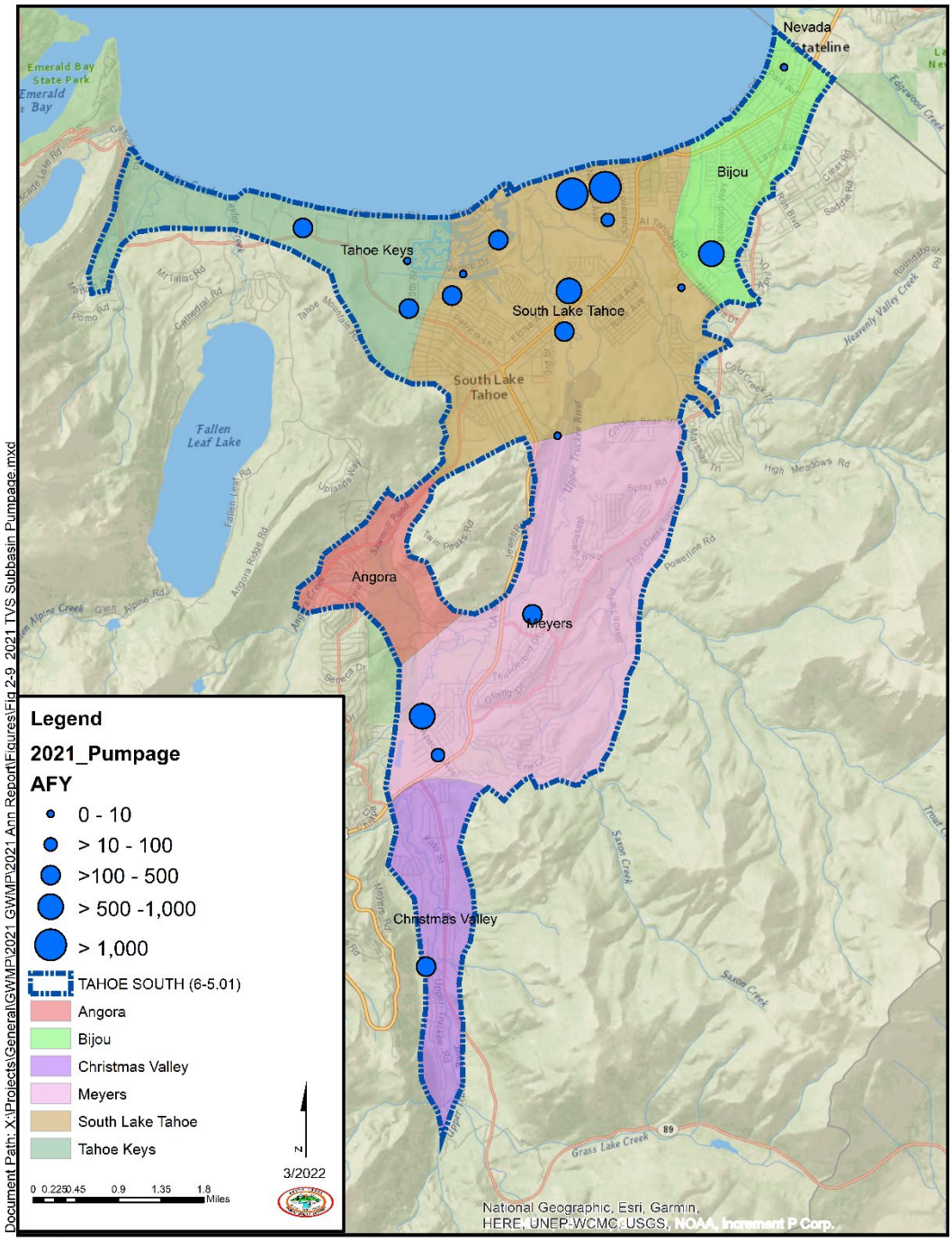

Figure 2-9. Groundwater pumpage from major CWS wells during WY 2021, in AF. Pumpage from major CWS wells accounts for more than 90% of the groundwater extracted from the TVS Subbasin.

2.6.1 Water Use

Water use information provided in this section is from the District's customer service database. As indicated in Table 2-3, the District produces most of the drinking water used within the TVS Subbasin, typically accounting for more than 80% of total groundwater production. Although not complete, information from the District's customer service database is believed to be adequate to show the general pattern of water use within the TVS Subbasin.

Table 2-4 shows water use by sector from metered data for the District's water system during the 2021 calendar year. The District is in the process of installing meters on all connections and is planned to be fully metered by 2022. The 2021 data captures about 98% of the total number of water accounts in the District's water system. The majority of the District's customers are residential. The District's commercial category includes office and retail, resorts including hotels, restaurants, and snowmaking and government customers. The "Other" category is for water transfers through the District's intertie to the LBWC and TKWC water system under its Mutual Aid and Assistance Agreements with these respective water systems. "Losses" are the non-revenue water system losses calculated from the difference between total groundwater production from District wells and consumption from the District meter data.

Use Type *(Add additional rows as needed)*	2021 Actual		
	Additional Description *(as needed)*	Level of Treatment When Delivered	Volume, AF
Single Family	RES	Drinking Water	2,699.6
Multi-Family	MFR	Drinking Water	802.3
Commercial	COM +MHT+ GOV	Drinking Water	1270.9
Other	Mutual Aid Transfers	Drinking Water	0.05
Losses	non-revenue water	Drinking Water	730.5
		TOTAL	**5,503**

Table 2-4. 2021 water use by sector for the District water system, in acre feet. The total volume accounts for about 98% of the Districts total water accounts which were metered in 2021. Losses are estimated as the difference between District groundwater production and consumption from the meter data.

Because use of recycled water within the Lake Tahoe basin is prohibited by the Porter-Cologne Act there is no recycled water use in the TVS Subbasin.

2.7 Groundwater in Storage

The annual change of groundwater in storage is the difference in the volume of water in an aquifer from one year to the next. Figure 2-10 shows the annual trends of groundwater production from District, TKWC, LBWC and LPA wells and the changes of groundwater in storage, as derived from the annual water budget calculated by the STGM from WY 2005 through WY 2021. The main components of the water budget include groundwater recharge; groundwater discharge to streams (baseflow); groundwater flux to Lake Tahoe; and groundwater pumping. Changes of groundwater in storage for the TVS Subbasin (Zone 10) are calculated from the differences in total inflow (recharge) and total outflows (baseflow, flux to Lake Tahoe and groundwater pumpage) over a specified period (Carroll, *et al.*, 2016a).

Groundwater in storage changes in response to changes in groundwater recharge (Figure 2-2) and groundwater production (Figure 2-8). Figure 2-10 shows that long-term reductions of groundwater in storage is not occurring. Since WY 2005 the annual change of groundwater in storage has ranged from -4,127 AF during a below normal water year (WY 2021) to +11,469 AF during a very wet water year (WY 2017). During WY 2021, the annual change of groundwater in storage for the TVS Subbasin was -4,127 AF. Groundwater levels respond to these annual changes of groundwater in storage, decreasing slightly when the annual change of groundwater storage is negative and increasing slightly when the annual change of groundwater in storage is positive (see Section 2.4). Since WY 2005, the cumulative change of groundwater in storage within the TVS Subbasin is +9,032 AF.

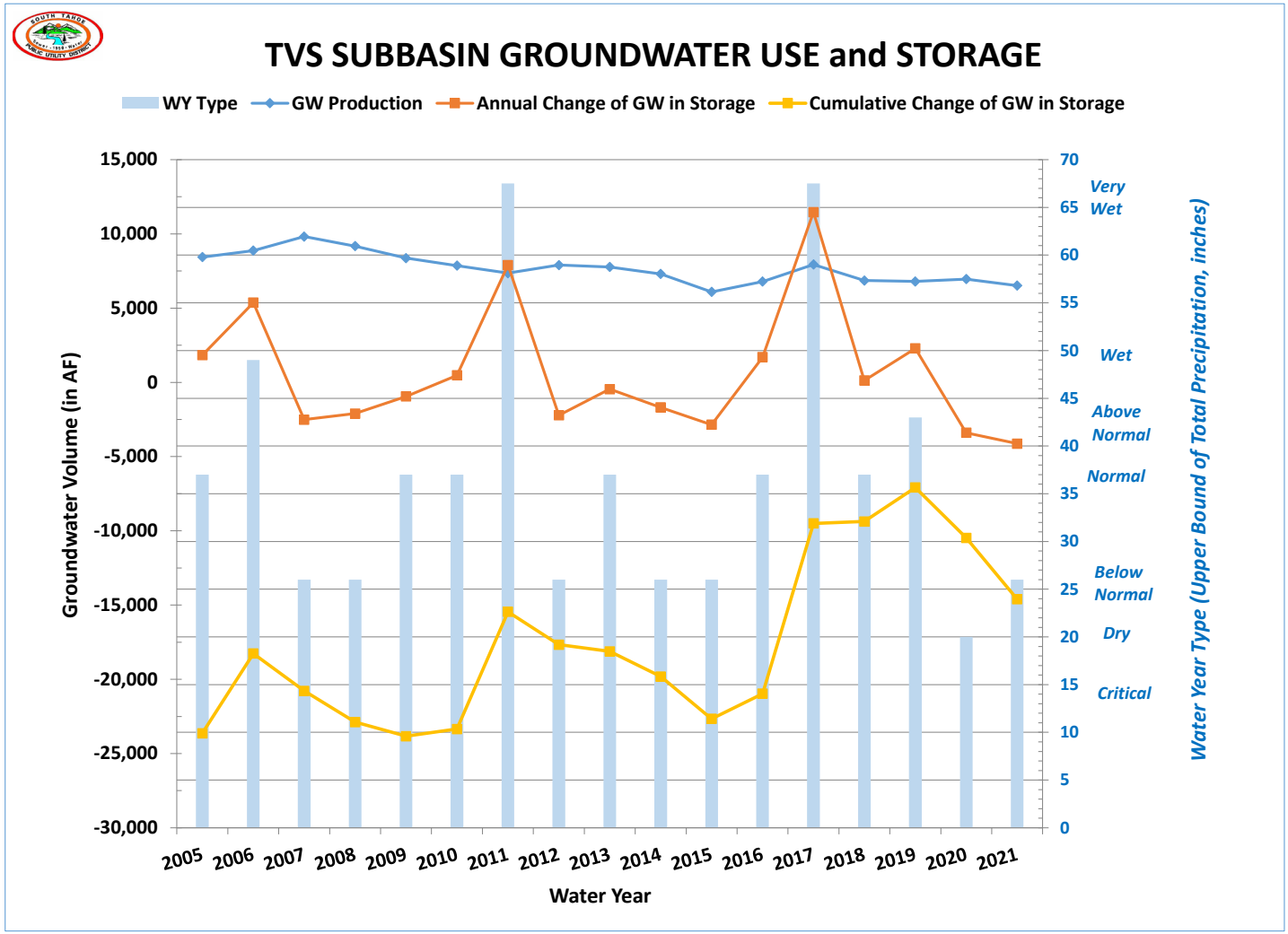

Figure 2-10. Annual groundwater production from community water supply wells and modeled annual and cumulative change of groundwater in storage, in AFY, for the TVS Subbasin (WY 2005 through WY 2021). Water year type using the TVS Subbasin classification is indicated on the vertical axis along the right-side of the graph. Positive annual changes in groundwater storage indicate periods of rising groundwater level.

2.8 Groundwater Supply

During WY 2021, the District reconciled different water demand projections between the first five-year update of the Alternative Plan and the 2020 UWMP. As part of this process, the District updated water budgets derived from the STGM and used the updated water budget to assess current year available groundwater supply. The current year available supply is needed to inform the annual Water Supply and Demand Assessment (WSDA) required of Urban Water Suppliers starting in 2022 (WCS §10632.1).

Figure 2-11 shows the available groundwater supply for the TVS Subbasin. The current year available supply for WY 2021 is 41,082 AF. Since WY 2005, available groundwater supply has ranged from 31,858 AF (WY 2009) to 48,604 AF (WY 2019). This is a conservative estimate as the change of groundwater in storage accounts for groundwater production from confirmed active public and private water wells operating within the TVS Subbasin. Under the reporting requirements for the WSDA, only groundwater production from water wells serving the District's water system need to be accounted.

Current year available supply is calculated as the difference between the current volume of groundwater in storage and the storage threshold for the TVS Subbasin. The storage threshold (-55,687 AF) is the minimum threshold for reductions of groundwater in storage in the TVS Subbasin, which is equivalent to a cumulative change of groundwater in storage of -32,050 AF relative to WY 2005 (Rybarski et al., in preparation). This reduction of groundwater in storage corresponds to a seven (7) foot basin-wide-decline in groundwater levels compared to WY 2005. The undesirable result from a basin-wide reduction of groundwater level elevations of this magnitude would cause the District to reduce well pumping rates to prevent pumping water levels to decline below top of screen intervals thereby inhibiting the District's ability to ensure a sustainable groundwater supply. Basin-wide groundwater level declines of this magnitude are not expected during interannual climate variations but may be expected during an extended long-term drought (Rybarski et al., in preparation).

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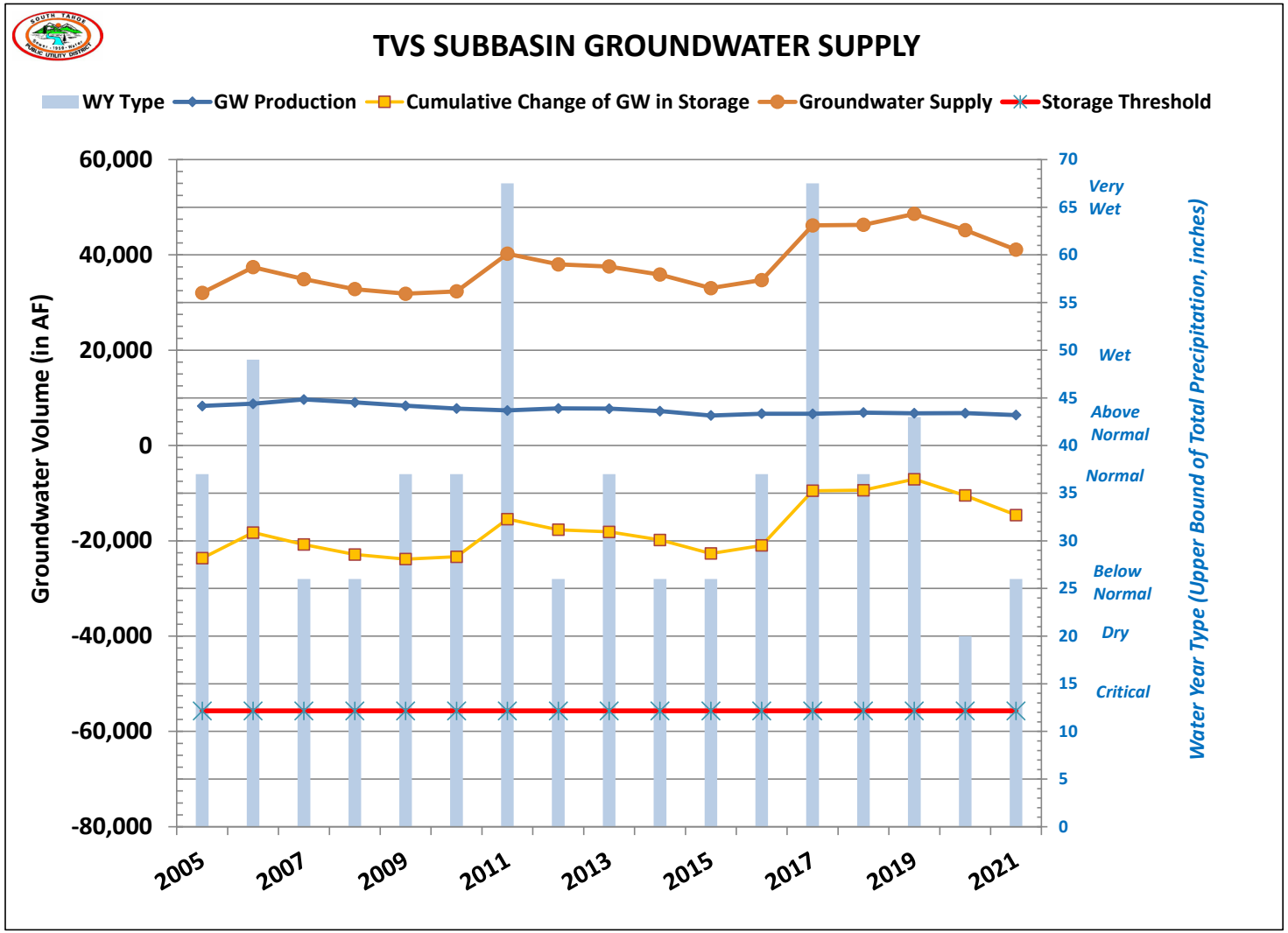

Figure 2-11. WY 2021 groundwater supply for the TVS Subbasin (41,082 AF) is calculated as the difference between the storage threshold and the current volume of groundwater in storage.

3 Basin Management Objectives

BMOs are flexible guidelines for the management of groundwater resources that describe specific actions to be taken by the District to meet locally developed objectives at the basin or sub-area scale. Under the Alternative Plan, eight BMOs are defined for sustainable groundwater management of the TVS Subbasin. Along with these BMOs sustainable management criteria and quantitative criteria are defined to objectively determine compliance of the Alternative Plan with the objectives of SGMA.

- BMO #1 – Maintain a sustainable long-term groundwater supply.
- BMO #2 – Maintain and protect groundwater quality.
- BMO #3 – Strengthen collaborative relationships with local water purveyors, governmental agencies, businesses, private property owners and the public.
- BMO #4 – Integrate groundwater quality protection into local land use planning activities.
- BMO #5 – Assess the interaction of water supply activities with environmental conditions.
- BMO #6 – Convene an ongoing Stakeholder's Advisory Group (SAG) as a forum for future groundwater issues.
- BMO #7 – Conduct technical studies to assess future groundwater needs and issues.
- BMO #8 - Identify and obtain funding for groundwater projects.

The following section describes current groundwater conditions using sustainable management criteria in accordance with SGMA. Comparison of current groundwater conditions to quantitative criteria defined for the TVS Subbasin, demonstrates that the sustainability goal for the TVS Subbasin is currently being met. Figure 2-8 shows that groundwater production from the TVS Subbasin is less than sustainable yield.

3.1 BMO #1- Maintain a Sustainable Supply

The purpose of BMO #1 is to implement measures to manage the groundwater levels for long-term sustainability and reliability of the water supply for all users within the TVS Subbasin. The measurable goal for tracking groundwater levels is to sustain groundwater levels within the range of historical data. If long-term groundwater levels show a consistent declining trend that falls below the historical range indicating a potential overdraft condition, then an assessment of the cause for the decline would be conducted. If excessive groundwater pumping is found to be the cause, then measures would need to

be taken to either redistribute the pumping to other portions of the basin or reduce pumping at the implicated well(s). No action would be required if the condition described above is not observed.

Sustainable management criteria (sustainability goals, undesirable results, sustainability indicators and minimum thresholds) for establishing quantitative criteria for chronic lowering of groundwater levels; reduction of groundwater storage and land subsidence are defined for the TVS Subbasin in the first five-year update of the Alternative Plan (Rybarski et al., in preparation).

3.1.1 Chronic Lowering of Groundwater Levels

- Sustainability Goal: To maintain a sustainable supply of groundwater by keeping groundwater water levels a safe distance above well screens.
- Undesirable Result: Regional water level declines such that water demands cannot be met.
- Sustainability Indicator: The total source capacity of community water supply wells
- Minimum Threshold: Having water levels above the screen intake at enough water supply wells such that the total source capacity meets or exceeds the Maximum Daily Demand (MDD).

A high reliance on groundwater necessitates those active wells have sufficient source capacity to meet water demands within the TVS Subbasin. As such groundwater levels must be sustained adequately above the top of the uppermost screen interval and pump intake to prevent operational problems that would lead to a loss of production. Minimum water level targets for individual wells are based on the depth to the top of screen plus an additional amount to account for drawdown while pumping at source capacity.

The MDD is accounted every five years as part of the periodic review for District, TKWC and LBWC wells operating in the TVS Subbasin to establish a current minimum threshold for chronic lowering of groundwater levels (Rybarski et al., in preparation). The MDD is calculated using the monthly water production data for the active wells in the District, TKWC, and LBWC water systems. The LPA is primarily reliant on surface water to meet its water system demands. LPA has one active well (LPA Well #3). This well is used as a back-up source to augment or help temporarily replace surface water supplies. As the LPA is generally regarded as a surface water system, production from the LPA Well #3 is not included in the MDD calculations as it is rarely used. Using the month with the highest water usage (maximum month) for the District, TKWC, and LBWC water system (WY 2011 – WY 2020) plus an added 10% to account for private wells which are not metered, the current minimum threshold for chronic lowering of groundwater levels in the TVS Subbasin is 14.166 MGD.

Table 3-1 shows the minimum water level targets and range of depth to water readings measured during WY 2021 in active District wells within the TVS Subbasin. Inspection of Table 3-1 shows that maximum water depths did not exceed minimum water level target depths for each active District well. The cumulative available source capacity for the active District wells (excluding the Paloma Well) is 17.124 MGD, which is greater than the current minimum threshold for chronic lowering of groundwater levels in the TVS Subbasin (14.166 MGD)

Well Name	Water System	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Average Depth to Water[1] WY 2022 - 2020) in ft bgs	Water Level Min Target[2] in ft bgs	Range of Depth to Water for WY 2021 Min (ft bgs)	Range of Depth to Water for WY 2021 Max (ft bgs)	Above Water Level Min Target (Y/N)	Source Capacity (MGD)	Cumulative Available Source Capacity (MGD)
Glenwood Well #5	District	150	180	32	39	18.2	21.8	Yes	1.493	1.493
Al Tahoe Well #2	District	110	140	33	61	30.75	36.98	Yes	3.600	5.093
SUT No. 3	District	70	90	19	47	17.35	22.41	Yes	1.224	6.317
LBWC No. 1	LBWC	132	182	**20**	50	nr	nr	nr	1.296	7.613
Elks Club Well #2	District	110	160	23	55	14.18	14.86	Yes	0.432	8.045
Valhalla Well	District	110	170	27	73	31.76	34.88	Yes	0.864	8.909
Helen Ave. Well #2	District	90	150	20	73	20.25	20.65	Yes	0.349	9.258
LBWC No. 5	LBWC	132	182	**20**	75	nr	nr	nr	0.893	10.151
Bakersfield Well	District	130	170	29	92	30.18	31.8	Yes	2.088	12.239
TKWC No. 2	TKWC	138	188	**20**	84	nr	nr	nr	0.576	12.815
TKWC No. 1	TKWC	125	312	**20**	86	nr	nr	nr	1.440	14.255
Paloma Well[3]	District	188	248	44	110	41.9	45.19	Yes	2.628	Off-Line
Bayview Well	District	180	300	29	106	25.93	34.5	Yes	5.184	19.439
Arrowhead Well #3	District	250	280	48	140	50.16	50.93	Yes	1.116	20.555
TKWC No. 3	TKWC	175	300	**20**	129	nr	nr	nr	1.152	21.707
Sunset Well	District	275	430	23	221	21.88	27.73	Yes	0.864	22.571

Notes

1. Based on average WY 2011-2020 measurements. Bold values are estimates based on nearby wells.
2. Water level minimum threshold based on top of screen - expected drawdown at full well capacity.
3. The Paloma Well is currently off-line for casing liner installation

ft bgs- feet below ground surface

nr- no reading

Table 3-1. Minimum water level targets and range of depth to water readings for WY 2021 measured in active production wells within the TVS Subbasin.

3.1.2 Reduction of Groundwater in Storage

- Sustainability Goal: To maintain groundwater levels storage reserves to ensure a sustainable supply of groundwater.
- Undesirable Result: A groundwater overdraft condition causing water levels to trend downward making it more difficult to extract sufficient groundwater for water supply purposes.
- Sustainability Indicator: Cumulative change of groundwater in storage.
- Minimum Threshold: Cumulative groundwater storage change of -32,050 AF relative to WY 2005, which indicates undesirable results.

During WY 2021, the annual change of groundwater in storage for the TVS Subbasin was -4,127 AF. The minimum threshold for reduction of groundwater in storage was not exceeded as the cumulative change of groundwater in storage relative to WY 2005 is +9,032 AF (see Figures 2-10 and 2-11).

3.1.3 Land Subsidence

- Sustainability Goal: To maintain groundwater level elevations within the historical range.
- Undesirable Result: A land subsidence of 1 foot due to a reduction of groundwater levels
- Sustainability Indicator: Change in groundwater levels measured in Basin Monitoring Network observation wells.
- Minimum Threshold: Negative change of more than 100 feet compared to groundwater elevations measured in Basin Monitoring Network observation wells in May 2015.

Table 3-2 shows the minimum and maximum groundwater elevations for observation wells within the Basin Monitoring Network with a negative change in May 2021 groundwater levels relative to May 2015 groundwater levels. For each of these wells the negative change of groundwater elevation is less than or equal to about -2.0 feet, significantly less than the minimum threshold value of -100 feet. The relative decline in groundwater levels is attributed to reduced groundwater recharge during WY 2020 and WY 2021 (see Figure 2-2).

	Period of Record	Groundwater Elevation (NAVD 88)				(May- 21) - (May-15)	WL Change > - 100 Feet
Well Name		Minimum	Maximum	May-15	May-21	(ft)	(Y/N)
Valhalla Well	2001 - 2021	6161.81	6248.18	6224.00	6221.99	-2.01	No
USGS TCF-5	2005 - 2021	6239.62	6249.43	6246.49	6245.11	-1.38	No
Al Tahoe Well #2	2001 - 2021	6214.53	6226.57	6219.62	6218.39	-1.23	No
Bayview Well	2004 - 2021	6220.19	6232.71	6222.19	6220.99	-1.20	No
EX-1	2010 - 2021	6467.79	6471.59	6470.74	6469.94	-0.80	No
Industrial Well #2	2001 - 2021	6257.99	6285.35	6270.75	6270.01	-0.74	No
Chris Ave. Well	2001 - 2021	6221.95	6231.99	6226.84	6226.11	-0.73	No
Helen Ave. Well #2	2001 - 2021	6211.65	6235.02	6229.81	6229.49	-0.32	No
Elks Club Well #1	2003 - 2021	6249.78	6276.03	6271.13	6271.05	-0.08	No

Table 3-2. Wells within the basin monitoring network with negative changes of groundwater elevation relative to May 2015 groundwater levels.

3.2 BMO #2 – Maintain and Protect Groundwater Quality

Groundwater in the TVS Subbasin is typically of excellent quality; however, there is a legacy of groundwater contamination from regulated industrial and commercial chemicals, which continues to impair water supplies (Section 2.5). The nature of the aquifer makes it highly vulnerable to groundwater contamination as evidenced by these impacts.

The purpose of BMO #2 is to implement measures to maintain and protect groundwater quality to sustain the beneficial use of groundwater within the TVS Subbasin. These measures would address contamination from manmade contaminants and not natural constituents intrinsic to the aquifer. This would include setting measurable goals and continuing proactive measures to protect groundwater quality.

Sustainable management criteria (sustainability goals, undesirable results, sustainability indicators and minimum thresholds) for establishing quantitative criteria for degraded water quality are defined for the TVS Subbasin in the first five-year update of the Alternative Plan (Rybarski et al., in preparation). As the TVS Subbasin is a headwater basin within the Sierra Nevada Region with elevations ranging from 6,223 feet at lake level rising to about 6,500 feet near the basin margin, significant and unreasonable seawater

intrusion is not an issue. Therefore, sustainable management criteria for this groundwater condition were not developed.

3.2.1 Degraded Quality

- Sustainability Goal: To ensure that groundwater quality is maintained to support continued extraction for water supply purposes.
- Undesirable Result: Degraded water quality threatens the ability to produce groundwater of sufficient quality and quantity to meet the demands of the community.
- Sustainability Indicator: The total source capacity of community water supply wells.
- Minimum Threshold: Degraded water quality concerns within the TVS Subbasin should not rise to a level that threatens the ability of groundwater sources to meet maximum daily demand (MDD).

The MDD is accounted every five years as part of the periodic review for all community water system wells operating in the TVS Subbasin to establish a current minimum threshold for degraded water quality in the TVS Subbasin (Rybarski et al., in preparation). The MDD is calculated using the monthly water production data for the active wells in the District, TKWC, and LBWC water systems. The LPA is primarily reliant on surface water to meet its water system demands. LPA has one active well (LPA Well #3). This well is used as a back-up source to augment or help temporarily replace surface water supplies. As the LPA is generally regarded as a surface water system, production from the LPA Well #3 is not included in the MDD calculations as it is rarely used. Using the month with the highest water usage (maximum month) for the District, TKWC, and LBWC water system (WY 2011 – WT 2020) plus an added 10% to account for private wells which are not metered, the current minimum threshold for degraded water quality in the TVS Subbasin is 14.166 MGD.

The source capacity for active community water system wells in the District, TKWC, and LBWC water systems. operating in the TVS Subbasin is provided in the first five-year update of the Alternative Plan (Rybarski et al., in preparation). For WY 2021, the source capacity of the District, TKWC, and LBWC water system wells is 23.291 MGD which exceeds the minimum threshold for degraded water quality, demonstrating that current groundwater sources are sufficient to meet water demands of all users within the TVS Subbasin (Figure 3-1).

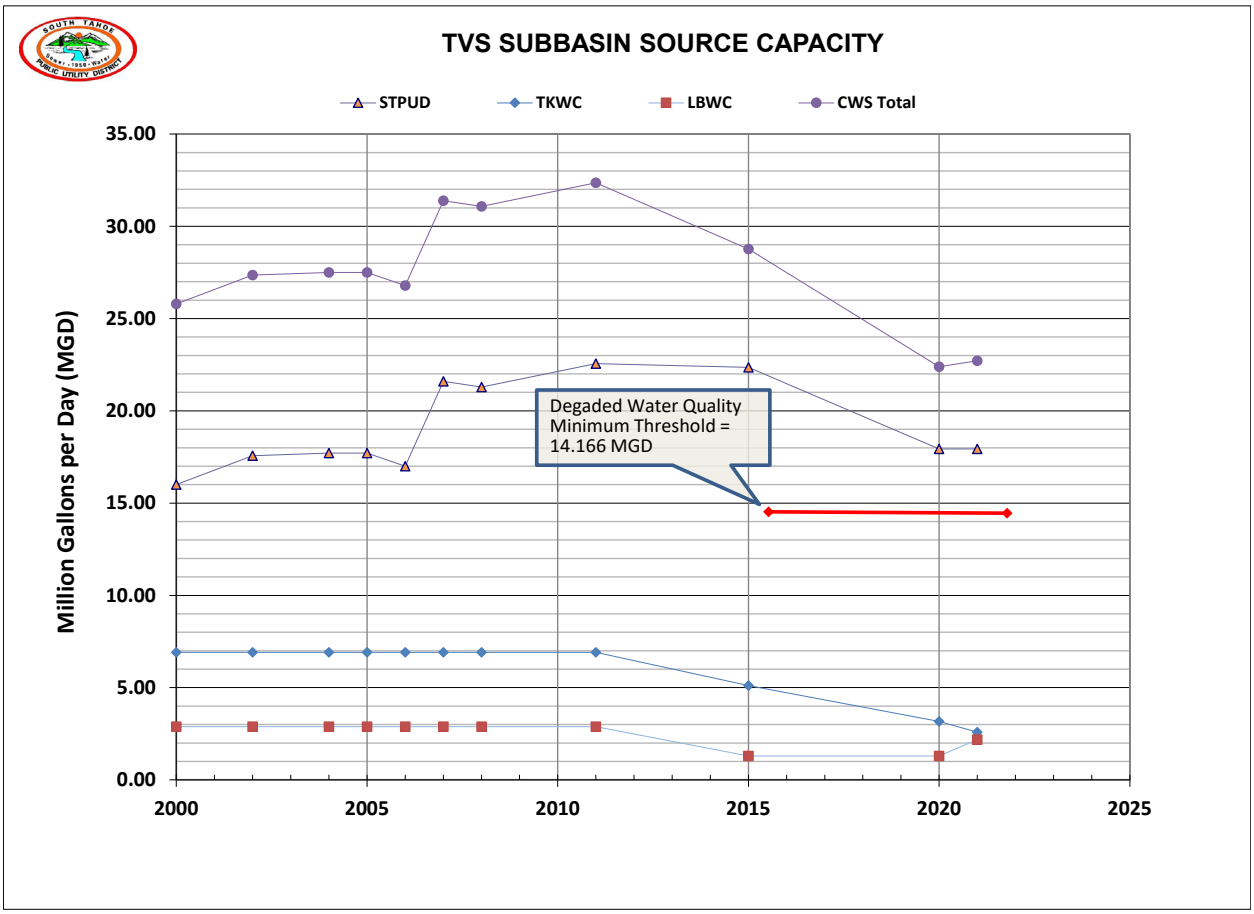

Figure 3-1. WY 2021source capacity (22.715) and degraded water quality threshold (14. 166) in million gallons per day for the TVS Subbasin.

3.3 BMO #3 – Building Collaborative Relationships

The TVS Subbasin includes a wide range of stakeholders in addition to the District, including private well owners and environmental users of groundwater. Government agencies, local business interests, environmental groups and private citizens also have interests in local groundwater management. Collaboration and coordination with other local agencies and stakeholders for implementation of the Alternative Plan is achieved through the Stakeholders Advisory Group (SAG). SAG members during WY 2021 are listed in Table 3-3.

Member	Title	Affiliation
Jason Burke	Storm Water Coordinator	City of South Lake Tahoe
Ken Payne, PE	General Manager	El Dorado Water Agency
Robert Lauritzen, PG	Geologist	El Dorado County Environmental Management Division
Brian Grey, PG	Engineering Geologist	Lahontan Regional Water Quality Control Board
Nicole Bringolf	Hydrologist	USFS-Lake Tahoe Basin Management Unit
Jennifer Lukins	Manager	Lukins Brothers Water Company
Daniel Larson	Water Systems Manager	Tahoe Keys Water Company
Nakia Foskett	Water Systems Manager	Lakeside Mutual Water Company
Scott Carroll	Environmental Planner	California Tahoe Conservancy/Real Property Owner
Michael Conger	Senior Long-Range Planner	Tahoe Regional Planning Agency
Harold Singer	Retired	Non-Business Community Rate Payer

Table 3-3. WY 2021 Stakeholder Advisory Group members.

3.3.1 GSA Formation

The TVS Subbasin lies entirely within EDC, and largely within the jurisdiction of the District. Since November 17, 2015, the District has been recognized as the exclusive GSA for the portion of the TVS Subbasin within its jurisdiction (South Tahoe Public Utility District GSA 1). During the summer of 2016, the El Dorado County Water Agency (Water Agency) and the District began discussing options to form a GSA in the portion of the TVS Subbasin outside of the District's jurisdiction. Pursuant to these discussions—as well as additional conversations with DWR—the Water Agency and the District determined that it would be appropriate for the District to become the GSA for the portion of the TVS Subbasin outside of its jurisdiction (i.e., within the Water Agency's jurisdiction). Concurrent with this decision, the Water Agency and the District drafted an MOU setting forth the Water Agency's and the District's agreement to cooperatively manage and coordinate implementation and enforcement of SGMA in this portion of the Basin. On September 16, 2016, the Water Agency and the District subsequently entered this MOU, the District elected to become a groundwater sustainability agency for the portion of the TVS Subbasin outside of its jurisdiction (Resolution No. 3040-16) and GSA formation notice was submitted to DWR (STPUD, 2016).

On December 28, 2016, the District was recognized as the exclusive GSA for the portion of the TVS Subbasin located outside of its service area jurisdiction (South Tahoe Public Utility District GSA-2). In March 2017, discussions with the SWRCB raised concerns about an agency forming a GSA outside of its jurisdiction. These concerns raised the risk that the South Tahoe Public Utility District GSA-2 may be considered invalid and that the TVS Subbasin could potentially be designated as "probationary" by the SWRCB and be put under state management. To ensure that the Water Agency and the District can retain local control of the TVS Subbasin's groundwater resources, the District agreed to rescind its 2016 GSA Formation Notice and the Water Agency agreed to act as the GSA for the portion of the TVS Subbasin covered by the District's 2016 GSA Formation Notice.

On May 4, 2017, the District adopted Resolution No. 3055-17 rescinding its 2016 GSA Formation Notice. The withdrawal notice had no effect on formation of the South Tahoe Public Utility District GSA -1 or its status as the exclusive GSA for the portion of the TVS Subbasin within its service area. On June 14, 2017, the Water Agency held a public hearing and elected to become the GSA for the portion of the TVS Subbasin outside of the District's service area; and the District submitted to DWR its notice of intent to withdraw the South Tahoe Public Utility District GSA-2 for the portion of the TVS Subbasin outside of its service area. On June 15, 2017, the Water Agency GSA formation notice for the El Dorado Water Agency GSA was posted on the DWR website through the SGMA Portal.

On June 4, 2017, concurrent with the Water Agency GSA formation notice for the Water Agency GSA and the District's notice of intent to withdraw the South Tahoe Public Utility District GSA-2, the District and Water Agency entered an Amended and Restated MOU to work collaboratively to sustainably manage groundwater resources and implement SGMA throughout the TVS Subbasin. With execution of the MOU, the TVS Subbasin is in full compliance with GSA formation requirements.

On June 4, 2020, the Amended and Restated MOU was amended a second time to acknowledge DWR's approval of the Alternative Plan; formalize the District's and EDWA's agreement to continue to manage groundwater resources cooperatively and sustainably within the TVS Subbasin; and to jointly implement the Alternative Plan in accordance with SGMA (District, 2020).

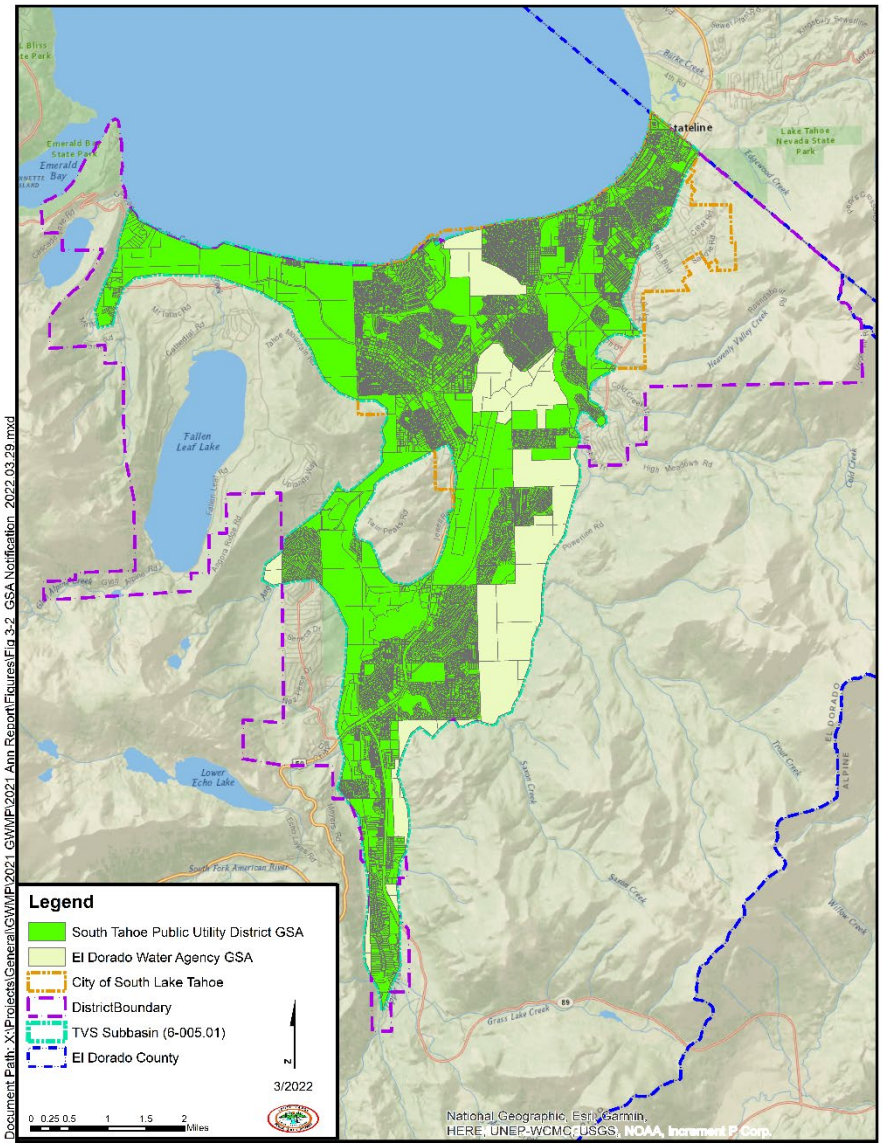

Figure 3-2. GSA boundaries for the TVS Subbasin. The District is regarded as the exclusive GSA for portions of the basin within its service area. The Water Agency is regarded as the exclusive GSA for portions of the basin outside the District' service area. Through an MOU, the District and Water Agency GSAs implement SGMA across the full extent of the TVS Subbasin.

3.3.2 Alternative Plan

Under SGMA, local agencies are authorized to submit an Alternative, in lieu of a GSP, for review by DWR. SGMA identifies the following three Alternatives to a GSP: (1) a GWMP developed pursuant to Part 2.75 of Division 6 of the Water Code (Section 10750 *et seq*.), (2) management pursuant to an adjudication action, or (3) an analysis of basin conditions (Wat. Code § 10733.6(b).)

To be eligible to submit any of the above Alternatives, the local agency must be able to demonstrate that (1) the Alternative applies to the entire basin, and (2) the basin is compliant with section 10733.6 of the Water Code. (23 Cal. Code Regs., § 358.2(a).) Additionally, the local agency must demonstrate that its Alternative is "functionally equivalent to the elements of a [GSP] required by Articles 5 and 7... [and is] sufficient to demonstrate the ability of the [Alternative] to achieve the objectives of [SGMA]." (23 Cal. Code Regs., § 358.2(d).)

On December 28, 2016, the District concurrently submitted (1) its 2014 GWMP and Alternative Materials to DWR as an existing plan alternative pursuant to Water Code section 10733.6(b)(1) and (2) an analysis of basin conditions pursuant to Water Code section 10733.6(b)(2) to DWR for evaluation and assessment.4F[3]

On July 17, 2019, DWR determined that the 2014 GWMP and Alternative Materials satisfied SGMA's requirements for an existing plan alternative and approved it as an Alternative Plan for the TVS Subbasin in compliance with Water Code section 10733.6(b). (DWR, 2019a.) In its approval of the Alternative Plan, DWR issued a set of Recommended Actions to be addressed in the Alternative Plan. These Recommended Actions are summarized below in Table 3-4.

During WY 2020, the District and EDWA started the procedural, technical and public outreach activities needed for the first five-year update of the TVS Subbasin Alternative. In April, the District and DRI met with DWR staff (conference call) to discuss RAs presented in the DWR Alternatives Assessment and approaches being considered by the District to address the RAs. On May 21,2020, the District adopted Resolution 3140-20 establishing its intent to draft an update to the 2014 GWMP (aka first five-year update of the Alternative Plan) for resubmittal to DWR. On June 25,2020, the District submitted a Notice of Intent (NOI) to draft an update to the 2014 GWMP to DWR (STPUD, 2020. On July 8, 2020, the Water Agency adopted its own Resolution WA-6-2020 establishing its intent to draft an update to the 2014 GWMP. On July 22, 2020, the Water Agency submitted an NOI to DWR informing DWR of its intent to draft an update to the 2014 GWMP (EDWA, 2020).

[3] As part of its submittals, the District indicated its preference to DWR that the review be sequenced in such a manner that its 2014 GWMP and Alternative Materials be reviewed first and should DWR agree that the 2014 GWMP and Alternative Materials are functionally equivalent to a GSP, review of the analysis of basin conditions would not be necessary.

Recommended Action	Description
RA-1	Provide water budget information in Tabular Form for historical, current and projected water budgets.
RA-2	Provide a projected water budget over the 50-year planning and implementation horizon, incorporating climate change effects.
RA-3	Reconcile the different future water demand projections between the Groundwater Management Plan (GMP) and Urban Water Management Plan (UWMP) and incorporate the reconciliation in the projected water budget.
RA-4	To understand change in groundwater storage for the Subbasin, the water budget calculated by the South Tahoe Groundwater Model should be calculated within the Subbasin boundary rather than the surrounding watershed area inclusive of the Subbasin.
RA-5	Provide additional explanation in the first five-year update for how pumping may impact plume migration or cause degraded water quality.
RA-6	Provide estimates of the quantity and timing of depletions of interconnected surface water; define what would cause depletions to become significant and unreasonable.
RA-7	Define quantitative criteria for groundwater levels, storage and depletion of interconnected surface water that can be used to objectively determine compliance of the Plan with the objectives of SGMA on an on-going basis.
RA-8	Provide a description of how the data gaps identified will be addressed; specifically the projects identified in Table 10-1 for BMO 5 - dependent upon District funding.

Table 3-4. Summary of Recommended Actions presented in the Alternative Assessment Staff Report for the Alternative Plan (DWR, 2019a).

During WY 2021, groundwater studies needed to develop new information to address recommended actions identified in the Department's Statement of Findings (Table 3-4) and periodic evaluation of groundwater conditions within the TVS Subbasin started during WY 2020 were completed, stakeholders were kept informed and public outreach was conducted for the first five-year update of the Alternative Plan. In September (Bergsohn, 2021a) and December 2021 (Bergsohn, 2021b), the District informed DWR of its need for an additional 120 days and provided an updated project schedule for resubmittal of the first five-year update of the Alternative Plan to DWR. The additional time was needed in response to scheduling impacts from the COVID-19 Public Health Emergency and the Caldor Wildfire. The proposed schedule received by DWR changed the resubmittal date for the first five-year update of the Alternative

Plan from January 1 ,2022 to April 29, 2022. On October 1, 2021, the District provided 90-day notice to the City of South Lake Tahoe and El Dorado County of its intent to hold public hearings to consider adopting the first five-year update of the Alternative Plan, pursuant to Water Code Section 10728.4 (STPUD, 2021). On February 9, 2022, Notice of Availability for the draft first five-year update of the Alternative Plan was provided to the City of South Lake Tahoe and El Dorado County (STPUD, 2022).

Groundwater studies conducted during WY 2020 and WY 2021 involved, but were not limited to, the following activities which are detailed in the first five-year update of the Alternative Plan (Rybarski et al., in preparation).

- Update of the STGM including extending the transient historic model through WY 2021.
- Differentiation of the STGM into spatial zones for reporting water budget terms specifically for the TVS Subbasin (Section 2.1).
- Addition of groundwater budget terms (pumpage from private wells, MBR, baseflow to streams and discharge to Lake Tahoe) to provide greater detail in reporting water budget.
- Development of projected 50-year water budgets for the TVS Subbasin.
- Estimation of sustainable yield.
- Development of model input terms to evaluate impacts of climate change on projected water budgets.
- Assessment of the interaction of water supply activities on interconnected surface waters and groundwater dependent ecosystems.
- Development of sustainable management criteria and definition of quantitative criteria to determine compliance of the Alternative Plan with SGMA.

Periodic evaluation of groundwater conditions conducted during WY 2020 and WY 2021 involved, but were not limited to, the following activities which are detailed in the first five-year update of the Alternative Plan (Rybarski et al., in preparation).

- Combined results of private well owner findings from surveys of private well owners conducted during WY 2017 and WY 2020.
- Updated groundwater elevation hydrographs through WY 2020
- Updated groundwater pumpage, well densities and groundwater demand projections.
- Reconciliated water budgets between the District's 2020 UWMP and the Alternative Plan
- Updated evaluation of groundwater quality (2011 – 2020)
- Updated evaluation of Potential Contaminating activity (PCA) sites and drinking water well source area zones.
- Updated Implementation Plan

3.3.3 Public Outreach

Over the past year, the District convened the following presentations, public hearings and/or workshops to inform the interested public and agencies of groundwater management activities being performed in the TVS Subbasin.

1. March 25, 2021: SAG Workshop No. 1.
2. April 1, 2021: Groundwater Management Plan Update – Staff Report
3. April 15, 2021: Public Hearing: Groundwater Management Plan Water Year 2020 Annual Report.
4. June 30, 2021: SAG Workshop No. 2
5. July 1, 2021: Groundwater Management Plan Update – Staff Report
6. October 1, 2021: 90-Day Notice to Cities and Counties (CWC Section 10728.4)
7. November 4, 2021: Groundwater Management Plan Update – Staff Report

In addition to these public meetings, the District regularly updates its website which includes a Groundwater Page used to post information about current groundwater management issues within the TVS Subbasin and activities being performed by the GSAs (https://stpud.us/groundwater/). Plan documents, workshop agendas, meeting materials and meeting notes are linked to this web page, which are available for download at http://stpud.us/news/groundwater-management-process/.

Plan notices posted on the Groundwater Management Plan webpage related to the first five-year update of the Alternative Plan include.

- Public Notice of Public Hearings to Adopt the First Five Year Update of the Alternative Plan for the Tahoe Valley South Subbasin (6-005.01) Pursuant to the Sustainable Groundwater Management Act of 2014 (03/17/2022)
- Notice of Availability South Tahoe Public Utility District Alternative Plan for the Tahoe Valley South Subbasin (01/31/2022)
- Public Notice of Opportunities to Participate in the Development of the 5-Year Update to the 2014 Groundwater Management Plan for the Tahoe South Subbasin (January 2021)
- 2014 Groundwater Management Plan Update Presentation (11/23/2020)
- Notice of Intent to Draft an Updated Groundwater Management Plan, Tahoe South Subbasin (6-005.01) (6/25/2020).

3.3.3.1 Survey of Well Owners

As part of its outreach efforts, the District conducted a survey of private well owners within the TVS Subbasin. The purposes of this well survey were to;

1. Inform private well owners of groundwater management planning and implementation efforts within the TVS Subbasin.
2. Encourage participation of private well owners in the SAG; and
3. Confirm the inferred location and use of private wells within the TVS Subbasin.

The initial phase of the well survey spanned a two-month period from August through October 2017. Planning for the survey involved the development of the survey questionnaire, survey team recruitment, preparation of outreach materials and compilation of available well owner lists from the District and SAG members, including El Dorado County and the United States Forest Service –Lake Tahoe Basin Management Unit (USFS-LTBMU). From these lists a total of 578 domestic and 56 small community water system wells were inferred to be located on parcels located within or surrounding the TVS Subbasin (Figure 3-3).

The well survey was advertised using local media, public service announcements, direct mail notification letters, door hangers and the District's website. Participation in the well survey was made available through a URL for direct access to the survey online, through paper copy on request from the District, and through direct door-to-door survey performed by a dedicated 3-member survey team. The well survey was successful in collecting information from a total of 370 respondents. Of these respondents, 247 confirmed the presence of a well on their parcel; 77 indicated that a well was not on the parcel; and 2 were uncertain if a well was located on their parcel. Figure 3-3 shows the locations of the inferred wells and the confirmed locations from the well survey. Results from this survey are provided in Appendix B of the WY 2017 Annual Report (STPUD, 2018a).

During WY 2018, a final report documenting the well survey was completed (Allegro Communications, December 2018); and made available to the public through the District's website (http://stpud.us/news/groundwater-management-process/).

Major findings from the *TVS Groundwater Basin Survey of Well Owners* report include.

- Private well geographic distribution reflects travel and settlement patterns of the one-hundred-year period prior to South Tahoe Public Utility District formation, from 1845 to 1950;
- Most respondents to the well survey were property owners (72%). Most of these properties were used as "secondary" residences.
- Most respondents (61%) indicated that the well on their property is currently in-use. Most of this use is either daily or more than 90 days out of the year.
- Private well owners overwhelmingly "like" perceived "purity" of well water. "Taste, color and odor" of well water are perceived favorably. Well owners enjoy features of private well water such as "cold temperature", "low cost", "quality" and "absence of chlorine". They highly value well water while the system consistently delivers high quality water; and

- Well owners indicating concern about well systems mention “pumps”, “wellhead connections”, “water production” and “system maintenance.

Recommendations developed based on the information gathered during this survey include.

1. Create capacity within the groundwater community to make technical support available to private well owners.
2. Complete the assessment of the status of private wells.
3. Assess risk to groundwater resources from private wells.
4. Cultivate capacity to create and maintain collaborative ties in the groundwater community.
5. Communicate with private well owners.
6. Collaborate with national and state programs that support source water protection; and
7. Share survey findings with Tahoe Basin partner agencies.

During WY 2019, the District started planning to complete the survey of private well owners started in 2017. During WY 2020, the District initiated the second phase of the Well Owner Survey to reach the nearly 300 Private Well Owners that were not contacted during the 2017 Survey. The Phase II Survey was started at the end of June with a direct mailer to property owners believed to have private wells on their property. Because of the COVID-19 Public Health Emergency, the Phase II Survey is dependent on Direct Mail with follow-up telephone calls and emails to encourage property owners to complete the well survey questionnaire. In appreciation for responding to the Phase II Well Survey, the District offered.

- Guidance on maintaining Private Wells through the El Dorado County Water Well Program website.
- Visual well checks to help property owners identify and prevent contamination from entering their well head; and
- General water quality testing to check well water quality.

Combined results of the survey of well owners conducted in WY 2016/2017 and WY 2020 are presented in the first five-year update of the Alternative Plan (Rybarski et al., in preparation).

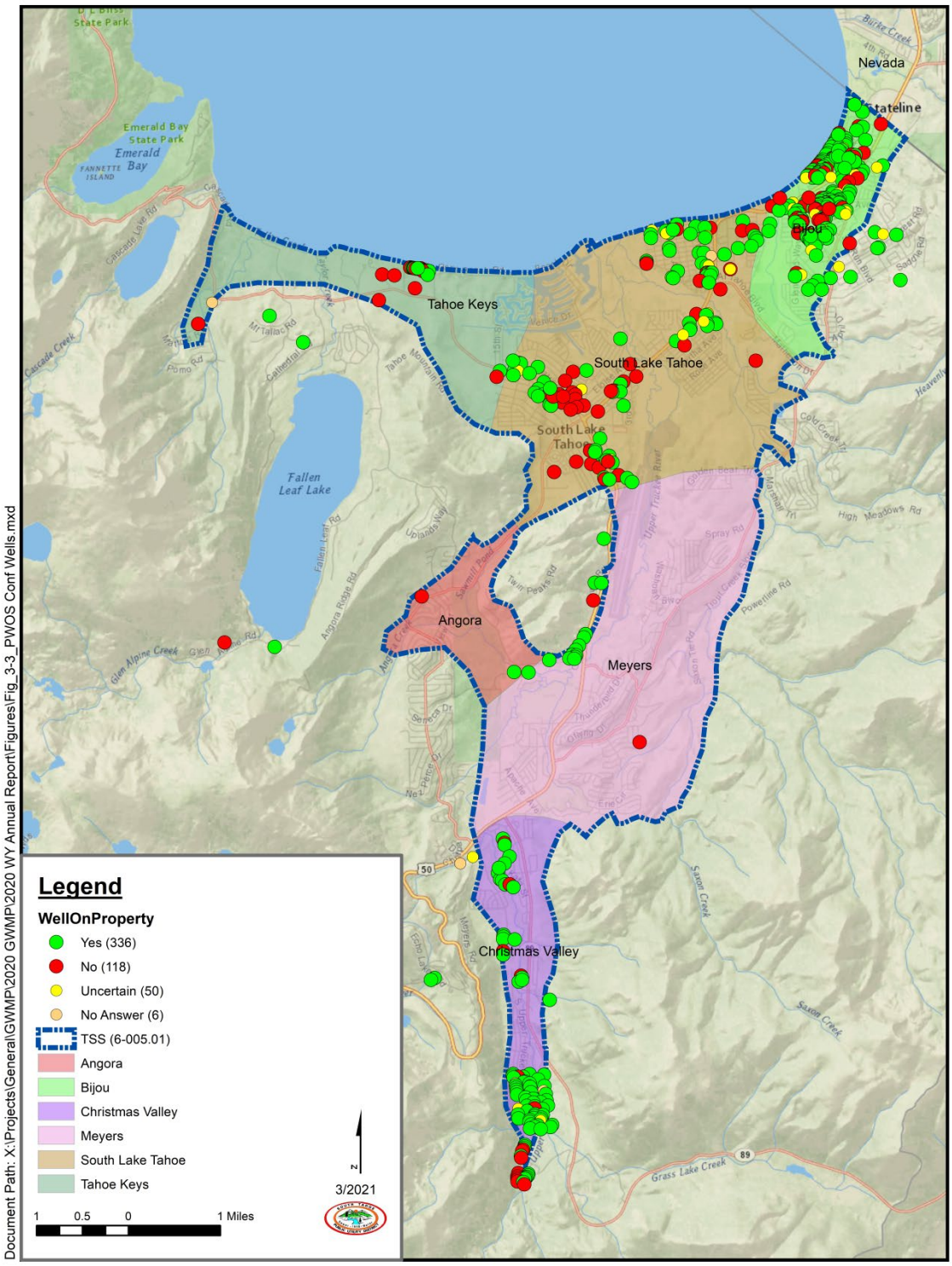

Figure 3-3. Confirmed locations of private wells identified by the 2017 and 2020 surveys of well owners.

3.4 BMO #4 – Integrating Groundwater Quality Protection and Land Use Planning

A key element of the Alternative Plan is an ongoing program of monitoring groundwater conditions and the potential threat of groundwater contamination within the TVS Subbasin. To better understand this potential threat, the locations of potential contaminating activity (PCA) sites operating within the TVS Subbasin were updated in WY 2017 and again in WY 2021 and compared to source water production zones surrounding active District, TKWC, LBWC and LPA wells, generated using the modified calculated fixed radius method (CDHS- DDW, 1999). Descriptions of these zones are as follows:

- **Zone A: Microbial/Direct Chemical Contamination Zone.** Protects the drinking water supply from viral, microbial, and direct chemical contamination and is defined by the surface area overlying the portion of the aquifer that contributes water to the well within a two-year time-of-travel.
- **Zone B5: Chemical Contamination Zone.** Prevents chemical contamination of the water supply, and to protect the drinking water source for the long term, encompassing the area between the two- and five-year time-of-travel. This zone provides for more response time for chemical spills.
- **Zone B10: Chemical Contamination Zone.** Prevents chemical contamination of the water supply, and to protect the drinking water source for the long term, encompassing the area between the five- and ten-year time-of-travel. This zone allows for some attenuation or remediation of contaminant sites, or if necessary, time to develop alternate sources of water supply.

The number and types of PCA found within each source water protection zone are summarized in Table 3-5. The 2021 Drinking Water Source Assessment and Protection (DWSAP) map for the TVS Subbasin is presented in the first five-year update of the Alternative Plan and is included in this report presented as Figure 3-4.

Possible Contaminating Activity Sites		
Number of Sites (Count)	**Type(s)**	**Possible Contaminants (DDWEM-CDHS, 1999)**
		Zone A
1	Apartments and condominiums	Swimming pool maintenance chemicals: pesticides for lawn and garden maintenance and cockroach, termite, ant, rodent, and other pest control wastes from on- site sewage treatment plants; household hazardous wastes.
1	Cellular Site	Diesel fuel (Diesel generator back-up); sulfuric acid (Battery back-up)
1	Clean-Up Program Site - Open	Diesel fuel; gasoline; kerosene
3	Clean-Up Program Site - Closed	Diesel fuel; gasoline; kerosene
2	Gas Stations/sumps	Soaps; detergents, waxes; miscellaneous chemicals, hydrocarbons
19	Injection Wells/ Dry Wells/ Sumps	Stormwater runoff; spilled liquids; used oils; antifreeze; gasoline; solvents; other petroleum products; pesticides; and a wide variety of other substances
1	Motor Pools	Automotive wastes: solvents; waste oils; hydrocarbons from storage tanks
3	Sewer Pump Station	Sewage, treatment chemicals
1	Utility Stations/ Maintenance Areas	PCBs from transformers and capacitors; oils; solvents; sludges; acid solution; metal plating solutions (chromium, nickel, cadmium); herbicides from utility rights-of-way

Possible Contaminating Activity Sites		
Number of Sites (Count)	**Type(s)**	**Possible Contaminants (DDWEM-CDHS, 1999)**
1	Wells	Storm water runoff; solvents; nitrates; septic tanks
	Zone B5	
2	Boat Services/repair/refinishing	Diesel fuels; oil; septage from boat waste disposal area; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes
1	Body Shops/repair shops	Waste oils; solvents; acids; paints; automotive wastes; miscellaneous cutting oils
2	Clean-Up Program Site - Closed	Diesel fuel; gasoline; kerosene
1	Gas Stations/sumps	Soaps; detergents, waxes; miscellaneous chemicals, hydrocarbons
10	Injection Wells/ Dry Wells/ Sumps	Stormwater runoff; spilled liquids; used oils; antifreeze; gasoline; solvents; other petroleum products; pesticides; and a wide variety of other substances
1	Sewer Pump Station	Sewage, treatment chemicals
	Zone B10	
1	Body Shops/repair shops	Waste oils; solvents; acids; paints; automotive wastes; miscellaneous cutting oils
1	Cellular Site	Diesel fuel (Diesel generator back-up); sulfuric acid (Battery back-up)

Possible Contaminating Activity Sites		
Number of Sites (Count)	**Type(s)**	**Possible Contaminants (DDWEM-CDHS, 1999)**
6	Clean-Up Program Site - Closed	Diesel fuel; gasoline; kerosene
2	Dry Cleaners	Solvents (perchloroethylene, petroleum solvents, Freon); spotting chemicals (trichloroethane, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)
1	Fire Station	General building wastes; hydrocarbons from test burn areas
1	Hardware/lumber/parts stores	Hazardous chemical products in inventories; heating oil and forklift fuel from storage tanks; wood-staining and treating products such as creosote; paints; thinners; lacquers; varnishes
3	Injection Wells/ Dry Wells/ Sumps	Stormwater runoff; spilled liquids; used oils; antifreeze; gasoline; solvents; other petroleum products; pesticides; and a wide variety of other substances

Table 3-5. The numbers and types of potential contaminating activity sites found within source water protection zones delineated within the TVS Subbasin (from Rybarski et al., in preparation).

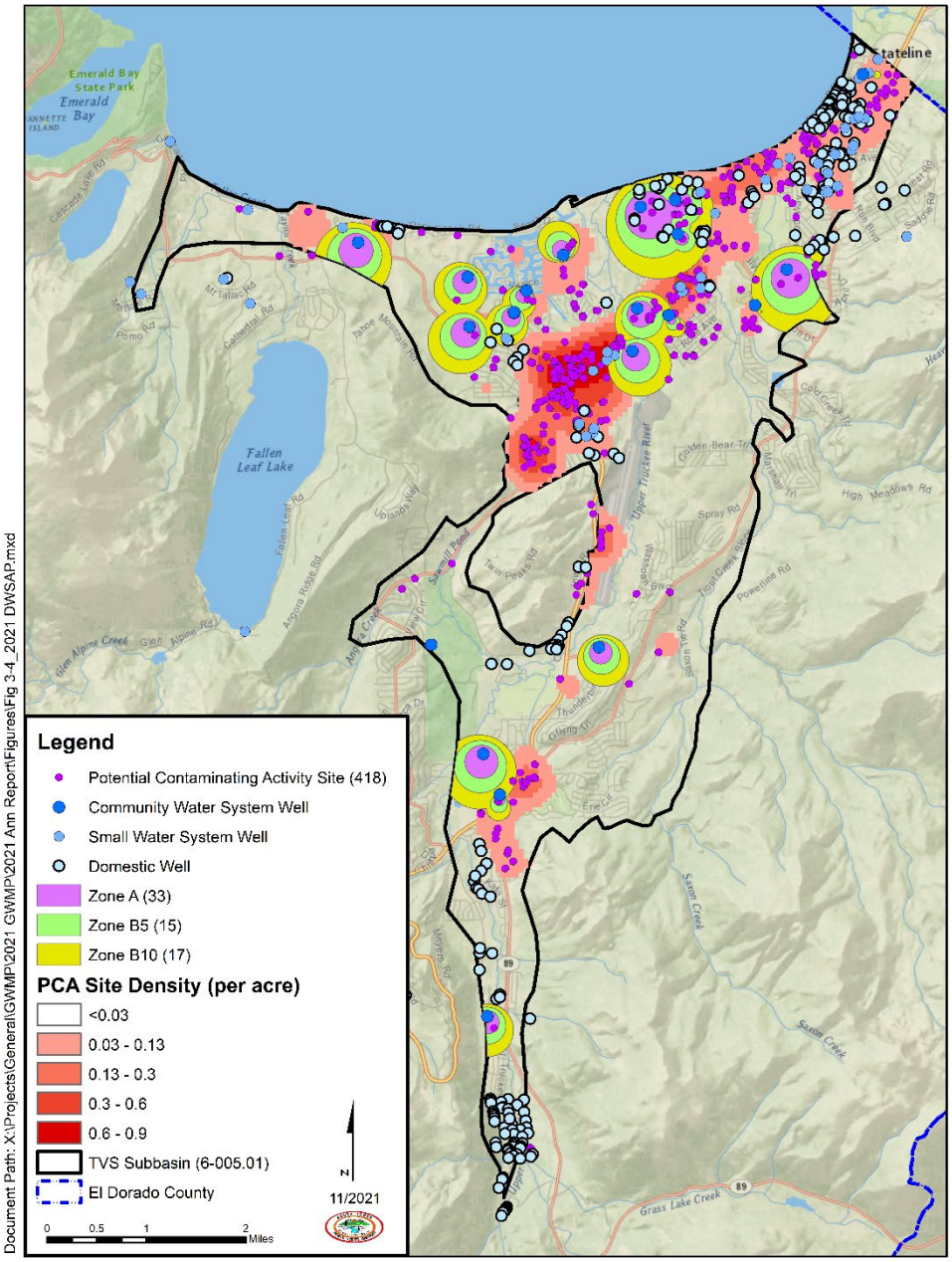

Figure 3-4. Well source area zones and potential contaminating activity sites within the TVS Subbasin. Well source area zones surrounding wells are generated using the modified calculated fixed radius method (CDHS- DDW, 1999) and the average groundwater production rate for each active well (WY 2011 -WY 2020) (from Rybarski et al., in preparation).

3.5 BMO #5 – Interaction of Water Supply Extractions on Environmental Conditions

Groundwater in the TVS Subbasin is inextricably linked to environmental conditions, and management of groundwater resources will affect both interconnected surface water (ISW) and groundwater dependent ecosystems (GDEs). The purpose of BMO #5 is to implement measures to maintain and protect the ecological communities – both plants and animals – that are dependent on in-stream surface flows and shallow groundwater.

Sustainable management criteria (sustainability goals, undesirable results, sustainability indicators and minimum thresholds) for establishing quantitative criteria for ISW and GDEs are defined for the TVS Subbasin in the first five-year update of the Alternative Plan (Rybarski et al., in preparation).

3.5.1 Interconnected Surface Water

- Sustainability Goal: To maintain spatial and temporal continuity of surface flows to support existing beneficial uses.
- Undesirable Result: Reduction of flow sufficient to negatively impact wildlife
- Sustainability Indicator: Current 10-year average stream discharge recorded at USGS Gage 103366092; 10336610 and 10336780 for Oct – May (winter)/Apr- Jly (peak)/ and Jly – Sept (late season) flows.
- Minimum Threshold: Both the 10-year average annual discharge and 10-year average late season (Aug-Sept-Oct) discharge are maintained within the range of historical variability (defined as ±25 percent of historical mean discharge), and statistically significant negative trends in discharge are not induced by groundwater pumping.

The sustainability indicator is the measured flow at three active USGS gages within the TVS Subbasin: the Upper Truckee River at Highway 50 above Meyers, CA (USGS Gage No. 103366092); the Upper Truckee River at South Lake Tahoe, CA (USGS Gage No. 10336610); and Trout Creek near Tahoe Valley, CA (USGS Gage No. 10336780) (Rybarski et al., in preparation). Salmonid species require cooler water temperatures (<79 °F; 26 °C) year-round (Rohde et al. 2019). Groundwater contributions to streams, i.e., baseflow, helps to maintain suitable temperatures for these species. The sustainability goal for ISW is therefore to maintain sufficient baseflow in streams to provide spatially and temporally continuous flows at the water temperatures required to support the needs of fish and wildlife species in the TVS subbasin.

Stream discharge in the TVS subbasin exhibits both high seasonality and high interannual variability. To account for the seasonality of measured discharge, multiple thresholds have been developed for each stream gage, representing in-stream flows occurring during different times of the year. To account for

the interannual variability of measured discharge, the minimum thresholds are based on a ten-year average (or thirty-year median) of discharge measurements rather than a single year (Table 3-6).

The ten-year average gaged discharge will be evaluated every five years as part of the periodic review of groundwater conditions. For each gage and each season, the 10-year mean discharge will be calculated and compared to the thresholds noted in Table 3-6. If the 10-year average discharge at any gage falls below the minimum threshold, the threshold has been exceeded.

Gage No.	Location	1 October – 31 March		1 April- 15 July		16 July – 30 September	
		Threshold	10-yr Mean	Threshold	10-yr Mean	Threshold	10-yr Mean
103366092	Upper Truckee River above Meyers	30	42.8	80	194.4	10	17.6
10336610	Upper Truckee River at South Lake Tahoe	40	61.3	140	226.8	10	19.3
10336780	Trout Creek	15	23.0	30	77.2	15	24.9

Table 3-6. Threshold discharges and current (WY 2011-WY 2020) 10-year average flows in cubic feet per second (cfs) for each season and gage (from Rybarski et al., in preparation).

Current (WY 2011 – WY 2020) 10-year average flows were evaluated as part of the periodic evaluation of groundwater conditions for the first five-year update of the Alternative Plan (from Rybarski et al., in preparation). Inspection of Table 3-6 demonstrates that the current 10-year mean flows remained above threshold values at each gage and for each season evaluated.

3.5.2 Groundwater Dependent Ecosystems

- Sustainability Goal: To maintain a shallow water table that supports riparian vegetation in areas where riparian vegetation currently exists
- Undesirable Result: Replacement of riparian vegetation by upland vegetation and loss of associated ecosystem services
- Sustainability Indicator: Water table elevation
- Minimum Threshold: Having average groundwater elevations within the interquartile range of historical variability

GDEs are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface (23 CCR, § 351 (m)). GSAs are responsible for identifying GDEs within a groundwater basin. Stream environment zones (SEZs) are defined in Chapter 90 of the Tahoe Regional Planning Agency (TRPA) Code of Ordinances as "Generally an area that owes its biological and physical characteristics to the presence of surface or ground water." As SEZs and GDEs are both dependent on the presence of groundwater there is substantial overlap in the spatial distributions of SEZs as defined by the TRPA and of GDEs as delineated by The Nature Conservancy in the TVS Subbasin. Because SEZ is an established term, commonly used in land planning and environmental resource management across regulatory and environmental agencies working within the TVS Subbasin, SEZ is used as a proxy for describing the spatial distribution of GDEs in the first five-year update of the Alternative Plan (Rybarski et al., in preparation). The spatial distribution of SEZs within the TVS Subbasin is depicted below in Figure 3-5.

Because GDEs are defined by their access to shallow groundwater, the sustainability indicator is the depth to groundwater. As groundwater levels exhibit interannual variability, this minimum threshold is based on a ten-year average of measurements rather than a single year. For each monitored GDE, the ten-year average groundwater elevation and the ten-year average late-season (Aug-Sept-Oct) groundwater elevation must be greater than 25th percentile of the historical record.

As there are few established monitoring wells with the long-term record needed to establish historical variability of the shallow groundwater that sustains GDEs, simulated groundwater levels from the updated historical STGM were evaluated to identify GDEs that may be vulnerable to declining groundwater levels for the first five-year update of the Alternative Plan. Findings from this evaluation show that negative trends in groundwater levels were not found in either a 30-year or 10-year time scale. Based on simulated groundwater levels, the GDEs within the TVS Subbasin currently appear to be stable or improving (from Rybarski et al., in preparation).

The findings presented in the first five-year update of the Alternative Plan are regarded as preliminary, as they are based on hydrologic modeling rather than on field observations. Local stakeholders, including the California Tahoe Conservancy (CTC) and USFS LTBMU, are actively monitoring groundwater levels in and around GDEs, and have provided monitoring data to the District. Data from these wells will be used to provide the initial basis for monitoring GDEs. Additional work is also planned to evaluate potential new locations for monitoring the impact of groundwater withdrawals on ISWs, with special emphasis on GDEs. This evaluation is planned to start in WY 2022 and will include both field evaluation and further hydrologic modeling.

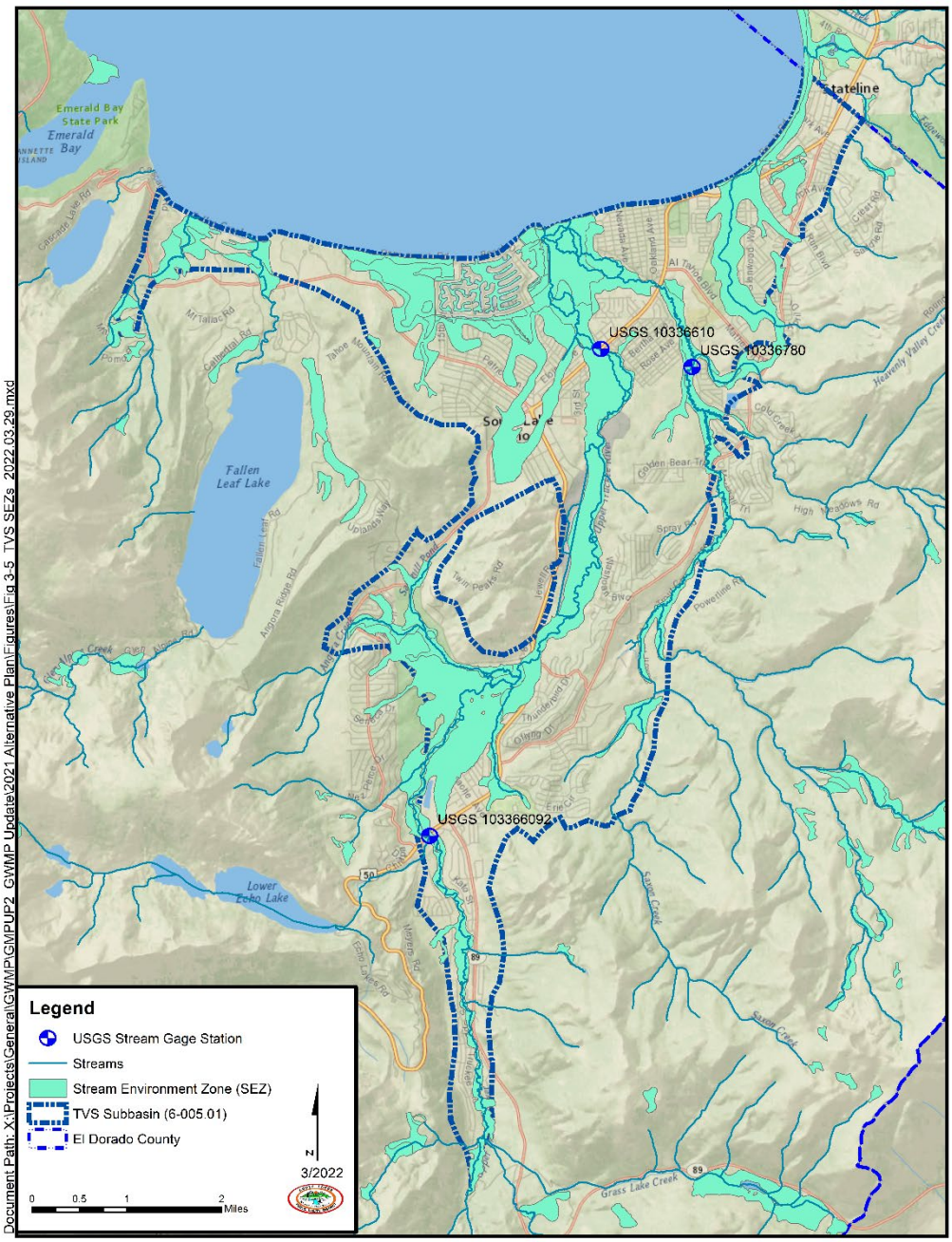

Figure 3-5. Stream Environment Zones as mapped by the Tahoe Regional Planning Agency using land capability. Mapping is for general use only, requiring verification at the individual parcel scale (from Rybarski et al., in preparation).

3.6 BMO #6 – Stakeholders Advisory Group (SAG)

The purpose of BMO #6 is to provide guidance regarding the role of the SAG in plan implementation. This includes hosting regular SAG workshops to provide a forum for discussion of groundwater management issues in the TVS Subbasin and receive a regional perspective from different members of the community (*see* Table 3-1). Other important functions of the SAG include:

1. Facilitation for interagency collaboration.
2. Assessing groundwater supply issues.
3. Assessing groundwater protection issues.
4. Data sharing; and
5. Developing regional support for groundwater projects.

During WY 2021, SAG workshops were convened in March and June. Major topics discussed during these workshops are listed in Table 3-7. Minutes from these workshops are provided in Appendix B.

WORKSHOP 1 (March 25, 2021)	**TOPICS**
	Alternative Plan for TVS Subbasin – Status Update
	Private Well Owners Survey – 2020 Results
	SCAP Regional Plume Investigation – 2020/2021 Update
	DRI Model Evaluation – Projected 50-Year Water Budget
WORKSHOP 2 (June 30, 2021)	**TOPICS**
	Sustainable Management Criteria
	Surface Water Depletions of Interconnected Surface Waters
	Alternative Plan for TVS Subbasin – Implementation Plan

Table 3-7. Major discussion topics for SAG Workshops convened during WY 2021.

3.7 BMO #7 – Technical Studies

Understanding the factors that control groundwater conditions in the TVS Subbasin is important to inform sustainable management. Table 3-8 provides a list of technical reports completed as part of studies used to inform groundwater management activities since 2014. All these reports are available for download through the District's Groundwater web page (https://stpud.us/groundwater/).

The list of technical reports is organized using several different subject matter categories as follows.

- Alternative Plan - technical studies which include detailed evaluation of groundwater conditions and/or provide information on groundwater use within the TVS Subbasin.

- Annual Reports – summaries of hydrologic conditions including groundwater elevation, groundwater extraction, total water use and change of groundwater in storage and groundwater management activities during the preceding water year in accordance with SGMA (§ 10728).
- South Y Plume – technical studies undertaken to address PCE groundwater contamination in the South Lake Tahoe subarea of the TVS Subbasin.
- STGM – technical studies which detail development of the South Tahoe Groundwater Model.

Subject	Name	Date	Author
Alternative Plan	Draft Alternative Plan for Tahoe valley South Subbasin (6-005.01) - First Five-Year Update	Feb-22	District
Annual Report	Tahoe South Subbasin (6-005.01) Annual Report 2020 Water Year	Mar-21	District
South Y Plume	Feasibility Study Report	May-20	Kennedy Jenks Consultants
South Y Plume	Interim Remedial Action Plan	May-20	Kennedy Jenks Consultants
Annual Report	Tahoe South Subbasin (6-005.01) Annual Report 2019 Water Year	Apr-20	District
South Y Plume	Groundwater Fate and Transport Modeling Report - Addendum	Sep-19	Desert Research Institute
South Y Plume	Pre-Design Investigation Report	Jul-19	Kennedy Jenks Consultants
South Y Plume	Groundwater Fate and Transport Modeling Report	Jun-19	DRI
Annual Report	Tahoe Valley South Subbasin (6-5.01) Annual Report 2018 Water Year	Mar-19	District
South Y Plume	Baseline Health Risk Assessment	Jan-19	Kennedy Jenks Consultants
Alternative Plan	TVS Groundwater Basin Survey of Well Owners	Dec-18	Allegro Communications
Annual Report	Tahoe Valley South Subbasin (6-5.01) Annual Report 2017 Water Year	Mar-18	District
Alternative Plan	Addressing Basin Management Objectives for the Tahoe Valley South (TVS-6.5.01) Groundwater Basin	Feb-18	DRI
Annual Report	Tahoe Valley South Subbasin (6-5.01) Annual Report 2016 Water Year	Mar-17	District

Subject	Name	Date	Author
Alternative Plan	Analysis of Basin Conditions Tahoe Valley South (6-5.01) Groundwater Basin, California	Dec-16	DRI
STGM	South Lake Tahoe Groundwater Model – Technical Memo Update	Aug-16	DRI
South Y Plume	South Y Extraction Well Suitability Investigation	Jun-16	GEI Consultants
Annual Report	Tahoe Valley South Subbasin (6-5.01) Annual Report 2015 Water Year	Mar-16	District
STGM	South Lake Tahoe Groundwater Model – Phase 1 Report	Feb-16	DRI
Alternative Plan	Tahoe Valley South Basin (6-5.01) 2014 Groundwater Management Plan	Dec-14	Kennedy Jenks Consultants

Table 3-8. Technical reports completed in support of sustainable groundwater management for the TVS Subbasin (https://stpud.us/groundwater/).

During WY 2021, groundwater studies were conducted to develop new information to address recommended actions identified in the Department's Statement of Findings (Table 3-4) and periodic evaluation of groundwater conditions within the TVS Subbasin for the first five--year update of the Alternative Plan (Section 3.3.2)

3.8 BMO #8 – Funding

Groundwater projects require funding. In addition to funding from local sources, there are state and federal grants and other funding programs available. These types of opportunities require effort to prepare, and process grant funding applications. Over the first-six-years of implementation, groundwater management actions under the Alternative Plan have been funded through the District's Water Enterprise Fund, the EDWA Cost Share Program and state funding through the Proposition 1 Groundwater Program.

3.8.1 Proposition 1 Groundwater Grant

On March 20, 2018, SWRCB-DFA and the District executed Agreement D1712508 funding a feasibility study of remedial alternatives to mitigate PCE contamination. The Proposition 1 Groundwater Planning Grant was used to evaluate whether existing and/or new wells can be used to provide hydraulic control and removal of PCE from groundwater in the TVS Subbasin.

The South Y Feasibility Study was completed during WY 2020. All grant requirements under Agreement D1712508 were completed to the satisfaction of the SWRCB-DFA. Copies of all technical documents prepared as deliverables for the South Y Feasibility Study are available for download from the Groundwater web page of the Districts web site: (https://stpud.us/groundwater/).

3.8.2 2021 Costs

Alternative Plan costs are accounted from the District's Water Enterprise Fund. Development and implementation costs for groundwater management activities have been supported by the County Water Agency under its Cost Share Grant program. Under this program, the County Water Agency assists projects eligible under Section 96-11 of the El Dorado County Water Agency Act and Board Expenditure Priority Policy (No. B-1003). Grants used for these projects are typically at a 50% matching fund level.

Figure 3-6 shows Alternative Plan costs expended during the calendar year ending December 31, 2021 Costs for groundwater management projects and activities totaled $374,270. Most costs expended during CY 2021 were on technical studies, public outreach and GSA administration required for preparation of the first five-year update of the Alternative Plan. Since 2015; the total cost to implement the Alternative Plan is $2,449,419.

3.8.3 Future Funding Opportunities

Future funding opportunities supporting groundwater management activities include the Sustainable Groundwater Management Program (SGM) Grant Program managed by the DWR Division of Regional Assistance, Proposition 68 grant funds and remaining Budget Act of 2021 funds. The following information is provided from the *SGM Grant Program SGMA Implementation Proposal Solicitation Package* (DWR, 2021b).

Under the SGM Grant Program, $114 million will be available for grant awards that will be directed to projects that benefit medium and high priority groundwater basins (including COD basins) that support implementation of SGMA. Priority in future funding grant solicitations will be given to applicants in basins that have not previously been awarded SGMA Implementation funding (DWR, 2021b). Proposition 68 authorizes the Legislature to appropriate a total of $120 million to DWR for drought and groundwater investments to achieve regional sustainability. After the administrative cost and previous funding awards, approximately $71.5 million is available for drought and groundwater investments to achieve regional sustainability through investments in groundwater recharge with surface water, stormwater, recycled water, and other conjunctive use projects, and projects to prevent or clean up contamination of groundwater that serves as a source of drinking water (Public Resources Code § 80146(a)). Of the approximately $71.5 million, a minimum of $15 million is reserved for projects located within and solely supporting a Severely Disadvantaged Community (SDAC) (DWR, 2021b).

The $114 million in future General Fund appropriations, the remaining $17 million in FY 2021/2022 General Fund appropriation, and the remaining $71.5 million in Proposition 68 grant funds will be combined in a single funding round (Round 2) for the medium and high priority basins. The minimum and maximum grant awards range from between $ 1 million to $20 million per basin. Round 2 Grant Solicitations for this funding is anticipated to open in September 2022. Eligible projects include those activities associated with the planning and implementation of a GSP or Alternative to a GSP and must also be consistent with the goals within the GSP or Alternative to a GSP (DWR, 2021b).

Projects presented in the Implementation Plan of the first-five-year update of the Alternative Plan which may be eligible for Round 2 funding are listed below (Table 3-9).

Basin Management Objective (BMO)	Potential Projects
BMO#1 Maintain a sustainable long-term Groundwater Supply	• Planning and development of groundwater sources to maintain a sustainable water supply
BMO #2: Maintain and Protect Groundwater Quality	• Update the South Y PCE Model using new data collected during the LRWQCB Regional Plume Investigation.
BMO #3: Strengthen Collaborative Relationships	• Conduct a third phase of the survey of private well owners. • Collaborate with local Storm Water Managers to develop outreach materials highlighting the detrimental impact of illicit discharges to storm water systems on groundwater.
BMO#5: Assess the interaction of water-supply activities with environmental conditions	• Refine monitoring protocols to detect potential changes in baseflow and GDEs due to groundwater pumping.
BMO #7: Conduct Technical Studies to assess future groundwater needs and issues	• Monitor degraded water quality in the South Y Regional Plume and near the Meyers Landfill. • Investigate the occurrence of PFOA and PFOS in stormwater within the TVS Subbasin. • Investigate the impact of wildfire on groundwater recharge within the TVS Subbasin

Table 3-9. Potential projects for SGM Grant Program Round 2 funding.

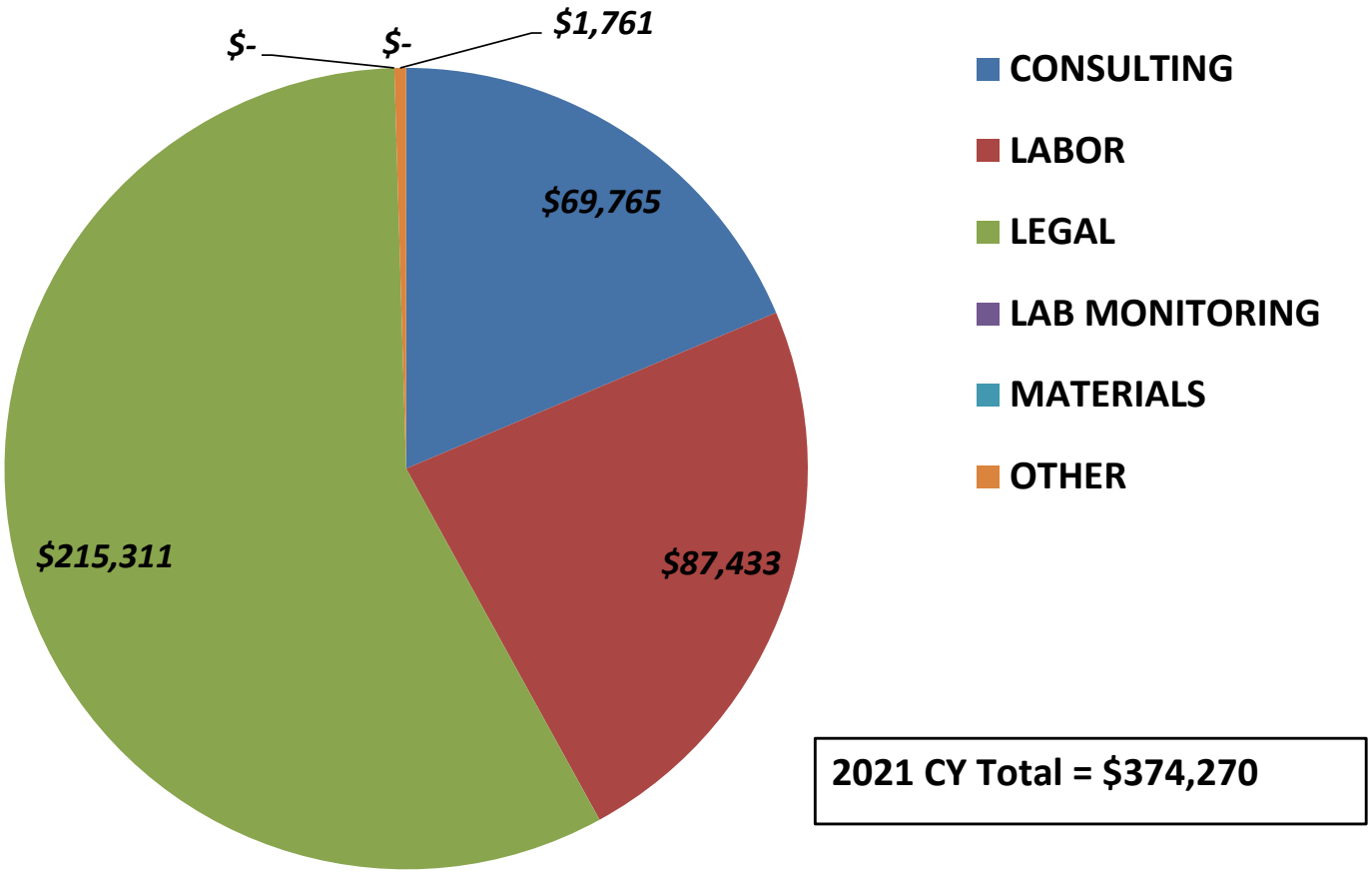

Figure 3-6. Alternative Plan costs for CY 2021.

4 Proposed Actions (WY 2022)

Groundwater management activities for WY 2022 will generally involve continuing the progress of on-going work from WY 2021 and the proposed actions listed below.

1. Continue to monitor new regulations and Basin Monitoring Program guidance issued by the DWR and SWRCB for implementation of SGMA.
2. Continue to monitor basin conditions and groundwater supplies.
3. Continue to update the SAG on the progress of Alternative Plan-related activities, seeking active participation of its members.
4. Continue to inform the public of groundwater management activities through public hearings, SAG workshops, notifications through its interested parties list, and the District's web page.
5. Maintain the contacts list of stakeholders interested in receiving notices regarding plan preparation, meeting announcements and availability of draft documents developed for the first five-year update of the Alternative Plan.
6. Prepare a public draft of the first five-year update of the Alternative Plan.
7. Prepare a NOA announcing the availability of the public draft for review and comment.
8. Notice and hold a Public Hearing to consider any protests.
9. Pending the outcome of the Public Hearing, adopt the first five-year update of the Alternative Plan.
10. Resubmit the adopted Alternative Plan to DWR for periodic review by April 29, 2022.
11. Develop consensus with stakeholders on applying for Round 2 SGM Grant funding.
12. Continue groundwater management actions and activities presented in the adopted Alternative Plan.

5 Alternative Plan Changes

Under SGMA, existing groundwater management plans remain in effect until a GSP or GSP Alternative is adopted (CWC § 10750.1). As DWR has determined that the 2014 GWMP and Alternative Materials satisfied the objectives of SGMA and was approved as an Alternative Plan for the TVS Subbasin, the District proceeded with preparing the first five-year update of the approved Alternative Plan during WY 2020 and WY 2021. The first five-year update of the Alternative Plan will be presented for adoption by the District and Water Agency Board of Directors, prior to resubmittal to DWR in April 2022.

The first five-year update of the Alternative Plan includes numerous changes, additions, and modifications compared to the approved existing plan Alternative, adopted in 2014. The most significant

changes occur in Section 8 of the first five-year update of the Alternative Plan. In the 2014 GWMP Section 8 provides a description of basin management objectives, strategies, and actions for qualitative management of groundwater resources within the TVS Subbasin. Under the first five-year update of the Alternative Plan, Section 8 has been updated using sustainable management criteria consistent with SGMA and developed for the TVS Subbasin within the framework of basin management objectives. The sustainable management criteria presented in the Alternative Plan provide quantitative criteria that are used to determine compliance of the first five-year update of the Alternative Plan with the objectives of SGMA. Other important changes presented in the first five-year update of the Alternative Plan include but are not limited to the following items.

- Section 1: Information has been updated and reorganized into Sections 1.1 Background, and Section 1.2 Development and Adoption Process. New Sections 1.3 Existing Plan and DWR Approval and 1.4 SGMA Compliance have been added.

- Section 2: A new Section 2.3 Soils and 2.5 Description of Basin Aquifers has been added. Surface Features and ecological resources are discussed under Section 2.6 Surface Water Features. All subsections have been updated.

- Section 3: Information has been updated and reorganized into new Sections 3.1 Population and Economy; and Section 3.2 Land Use. Water purveyors are discussed under new Section 3.3 Groundwater Uses and Users. A new Section 3.4 Demand Projections has been added.

- Section 4: Information has been updated and reorganized into new Section 4.2 Overlying Jurisdictions, Section 4.3 Regulatory Agencies, Section 4.4 Regulatory Programs and Policies, and Section 4.5 Analysis of Limits Imposed by Existing Water Resource Monitoring and Management Programs.

- Section 5: A new Section 5.5 Sustainable Yield has been added. All subsections have been updated.

- Section 6: Groundwater Contamination and Stormwater Infiltration Potential are discussed under new Section 6.3 Groundwater Quality Issues. All subsections have been updated.

- Section 7: Convene an Ongoing SAG has been updated and discussed under new Section 7.3 Future/Ongoing Stakeholder Involvement Opportunities.

- Section 8: Information has been updated and reorganized into new Sections 8.1 Maintain a Sustainable Long-Term Groundwater Supply; 8.2 Maintain and Protect Groundwater Quality; and 8.3 Assess the Interaction of Water Supply Activities with Environmental Conditions.

- Section 9: Information has been updated and reorganized into Sections 9.1 Groundwater Monitoring and Section 9.2. Identification and Description of Data Gaps.

- Section 10: Information has been updated and reorganized into Sections 10.1 Projects, Section 10.2. Funding the Alternative Plan and 10.3 Reporting.

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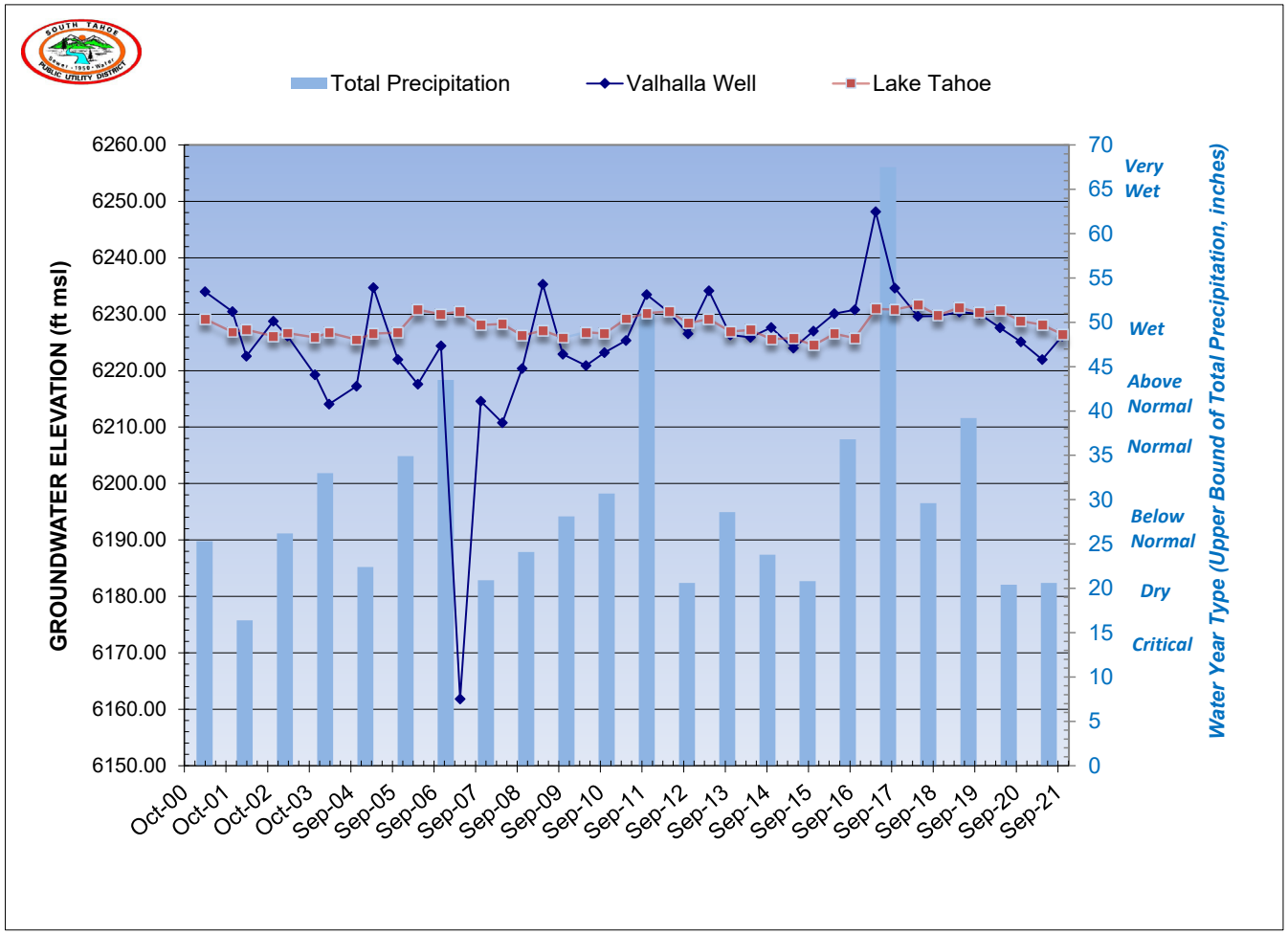
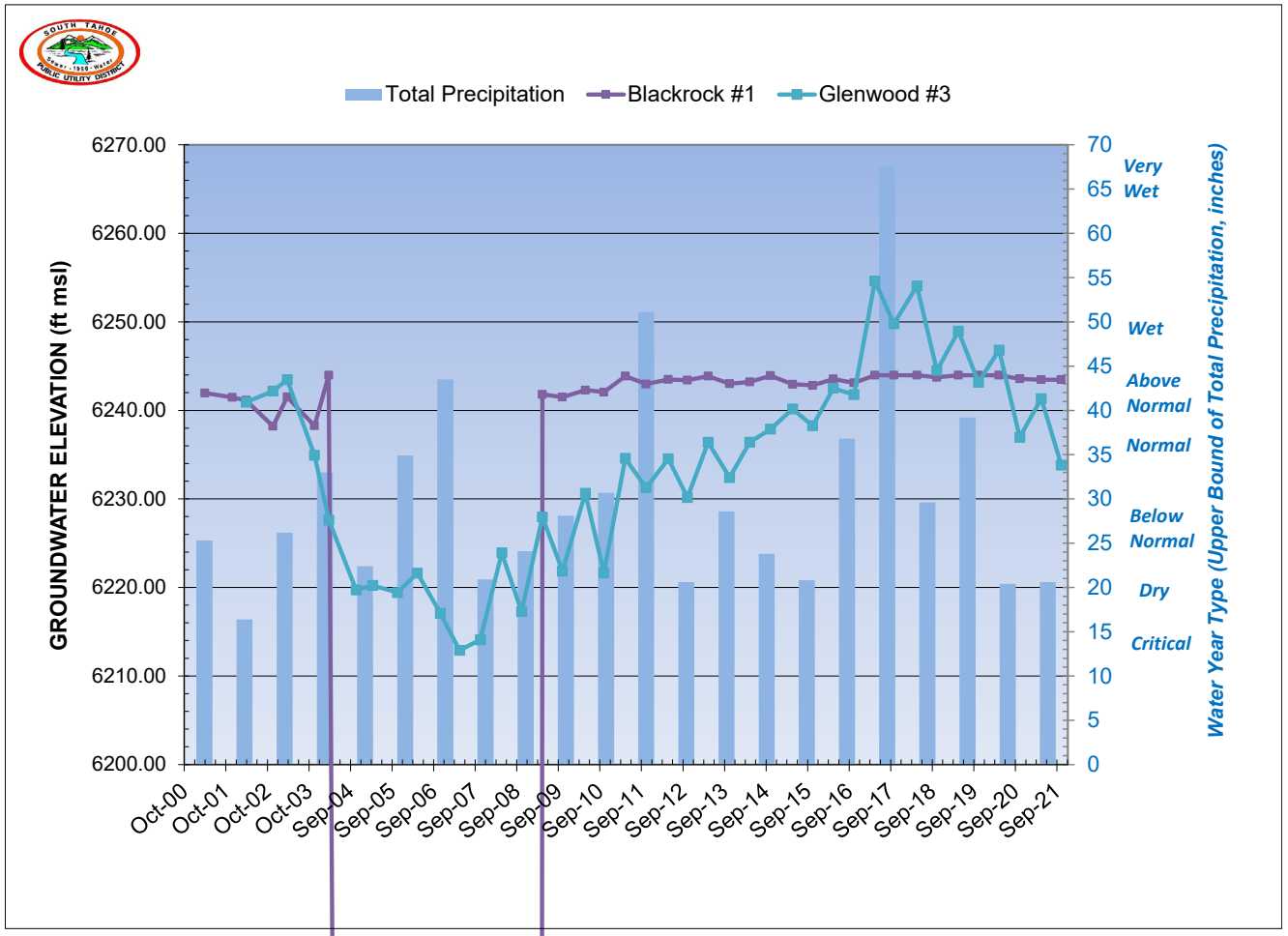
APPENDIX A

TVS Subbasin (6-005.01)

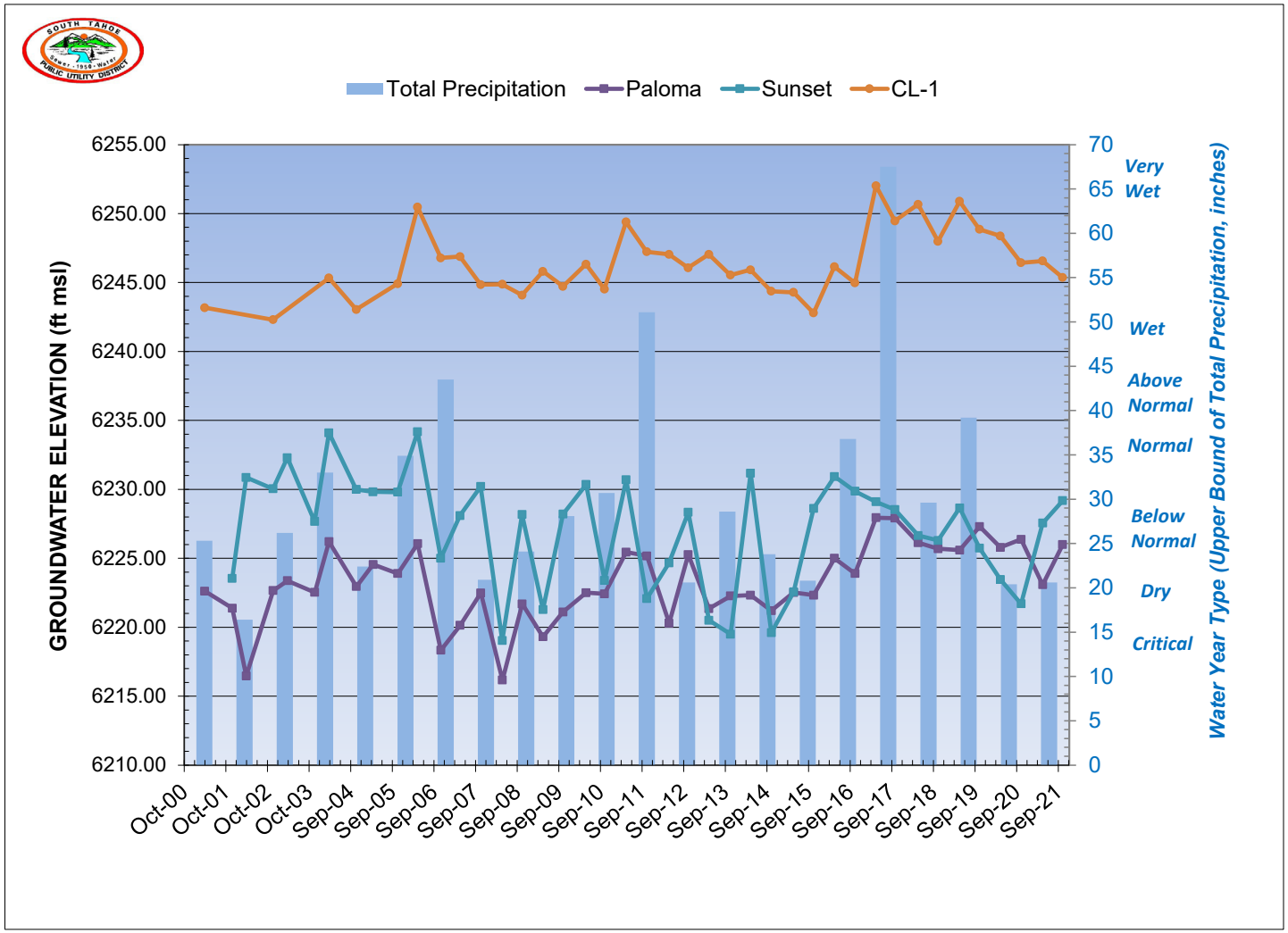
Hydrographs



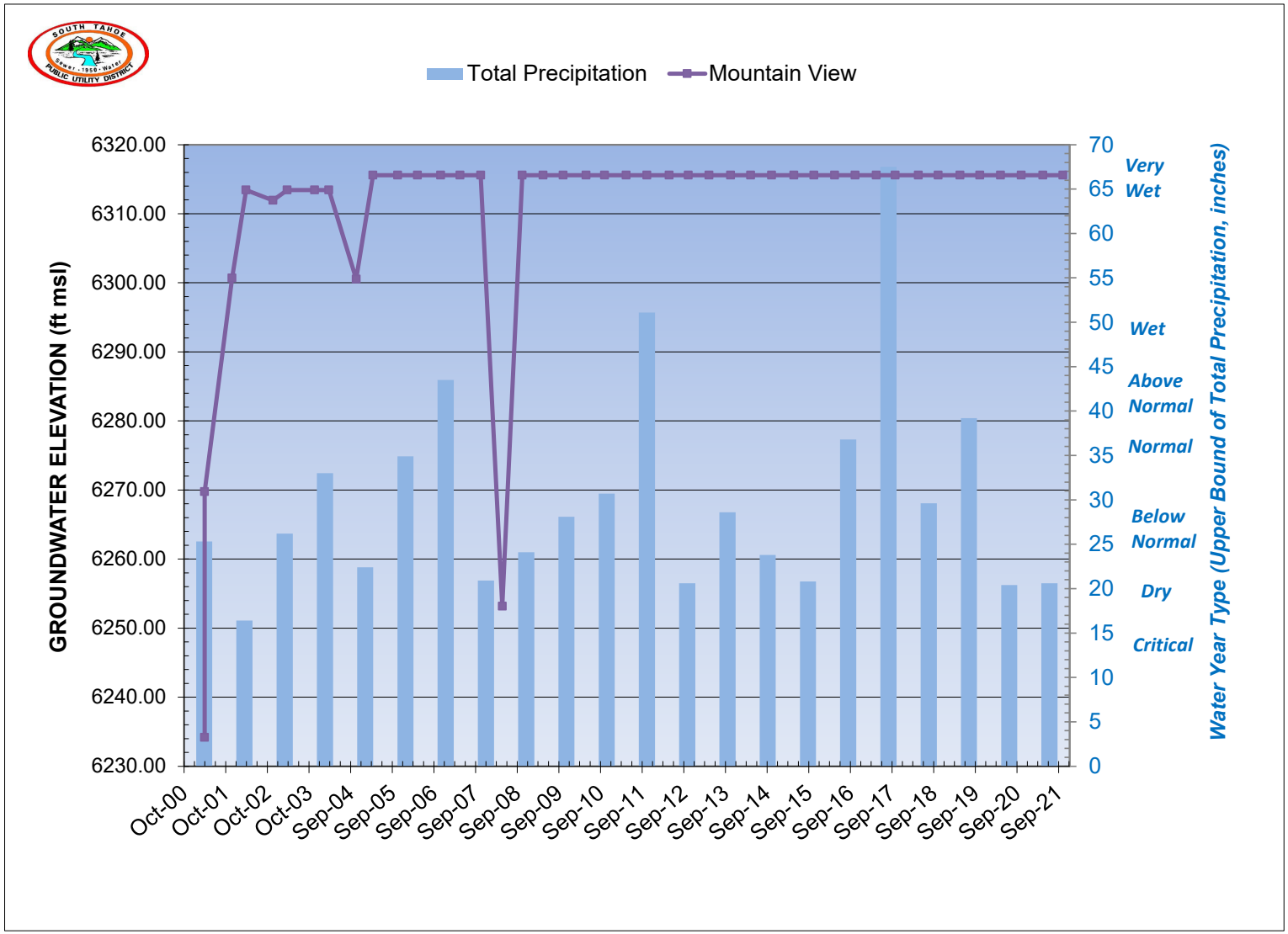
Appendix A – 1. Groundwater hydrograph for the Valhalla Well (6,257 feet msl) within the Tahoe Keys sub-area. Also shown is the water level (stage) of Lake Tahoe measured at USGS 10337000. All readings are static water levels collected following a minimum 12-hour recovery time, except for the May 2007 reading, which is a pumping water level measured at a well pumping rate of 700 gallons per minute(gpm). Water year type TVS Subbasin is indicated using the bar chart and upper bound of total precipitation displayed on the secondary-y axis.



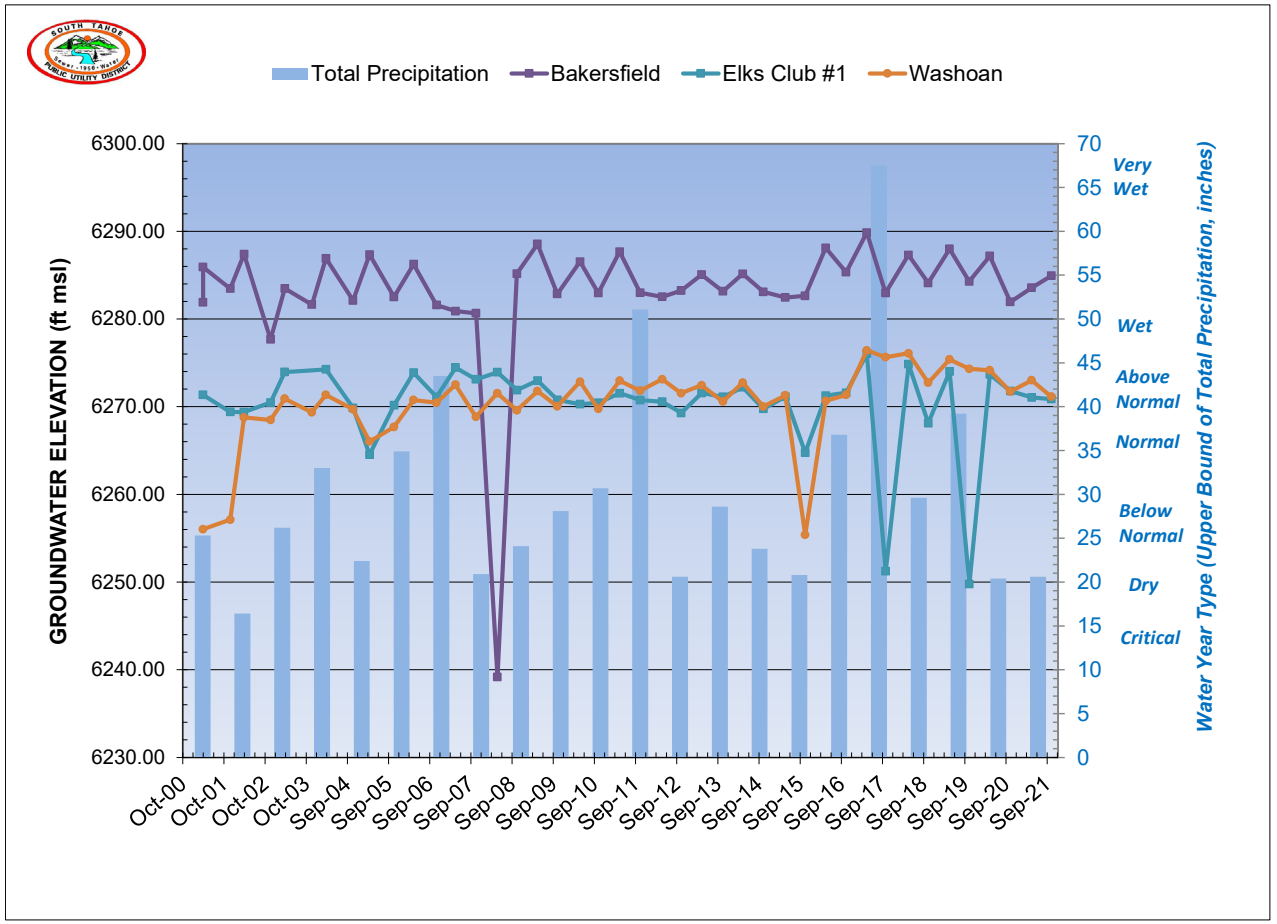
Appendix A – 2. Groundwater hydrograph for the Blackrock #1 (6,241 feet msl) and Glenwood #3 (6,260 feet msl) wells within the Bijou sub-area. Static water levels in the Blackrock #1 well are stable and slightly rise above ground surface (6,240 feet msl). The Glenwood #3 well is used to monitor water levels near an active CWS well (Glenwood #5). In 2007, the District restricted water production from Glenwood #5 to sustain groundwater production from this sub-area. The water level response in Glenwood #3 shows that this change in operation has been successful in allowing groundwater levels to recover to sustainable levels.



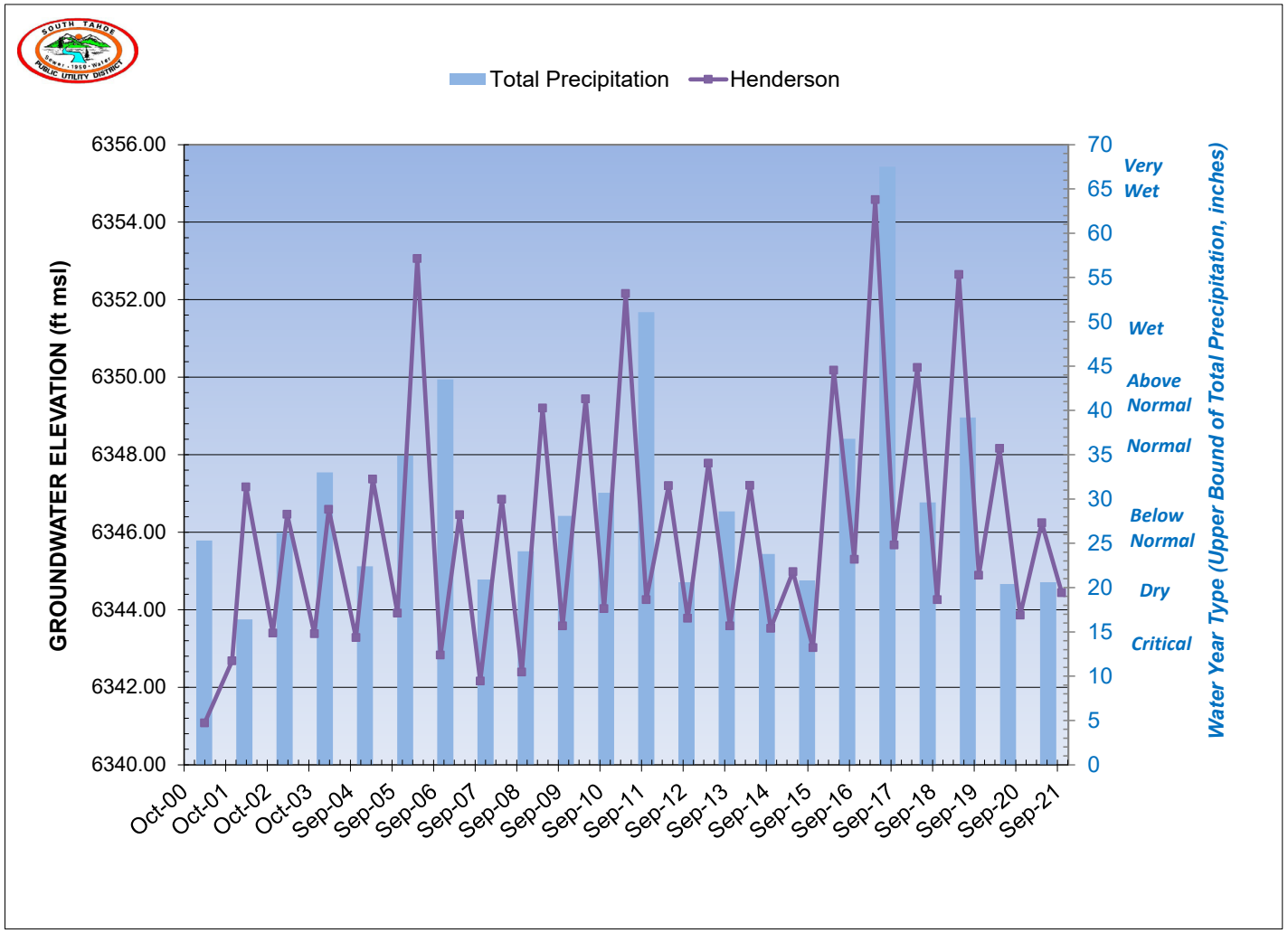
Appendix A – 3. Groundwater hydrograph for the Paloma (6,267 feet msl); Sunset (6,249 feet msl) and CL-1 (6,279 feet msl) wells in the South Lake Tahoe sub-area. Groundwater levels in these wells appear stable. Since 2017, groundwater production from the Sunset well has increased by about 59 million gallons per annum. Groundwater levels for the Sunset Well are on-watch for possible groundwater production restrictions.



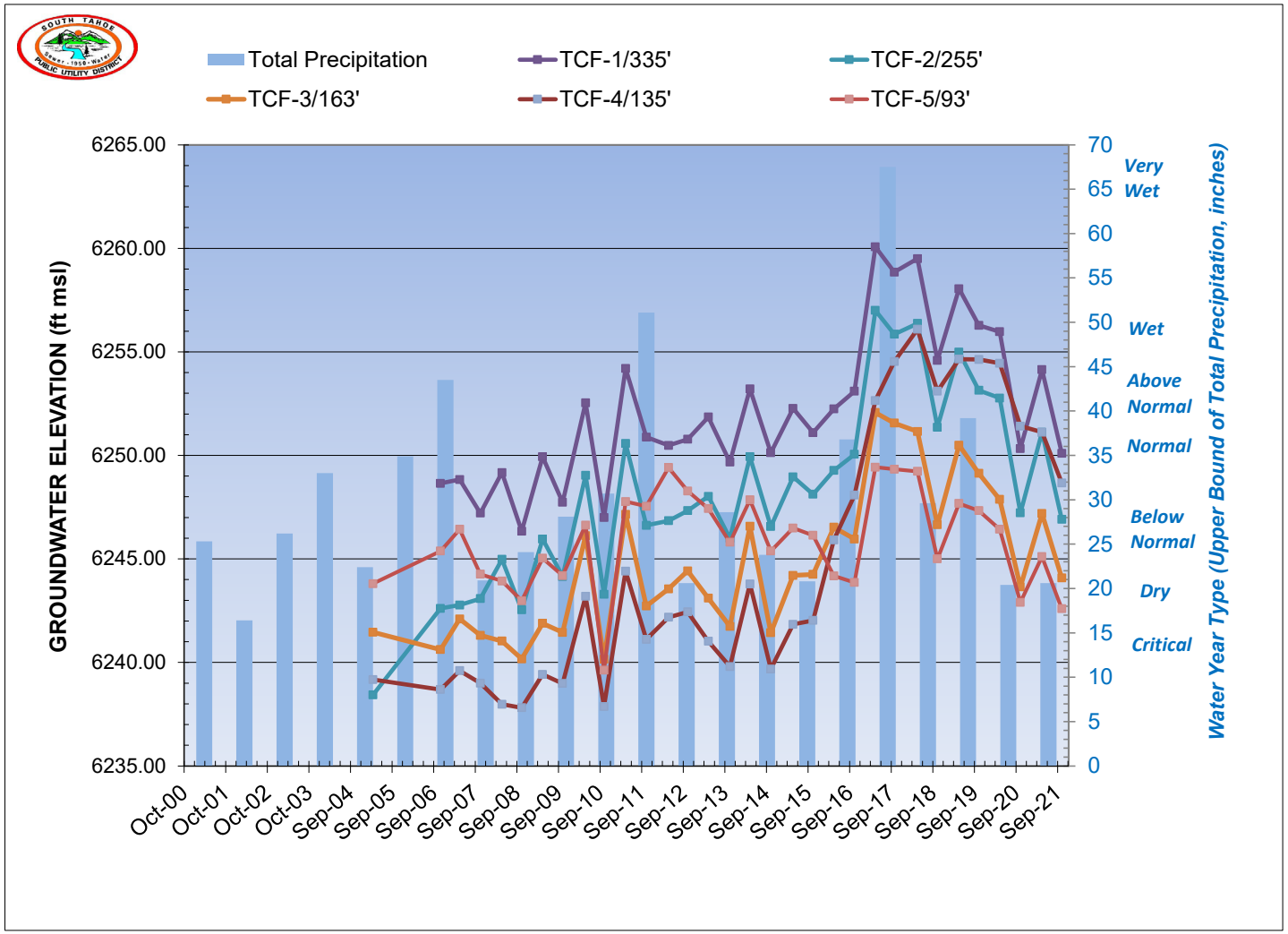
Appendix A – 4. Groundwater hydrograph for the Mountain View (6,313 feet msl) well (artesian flowing well) in the Angora sub-area.



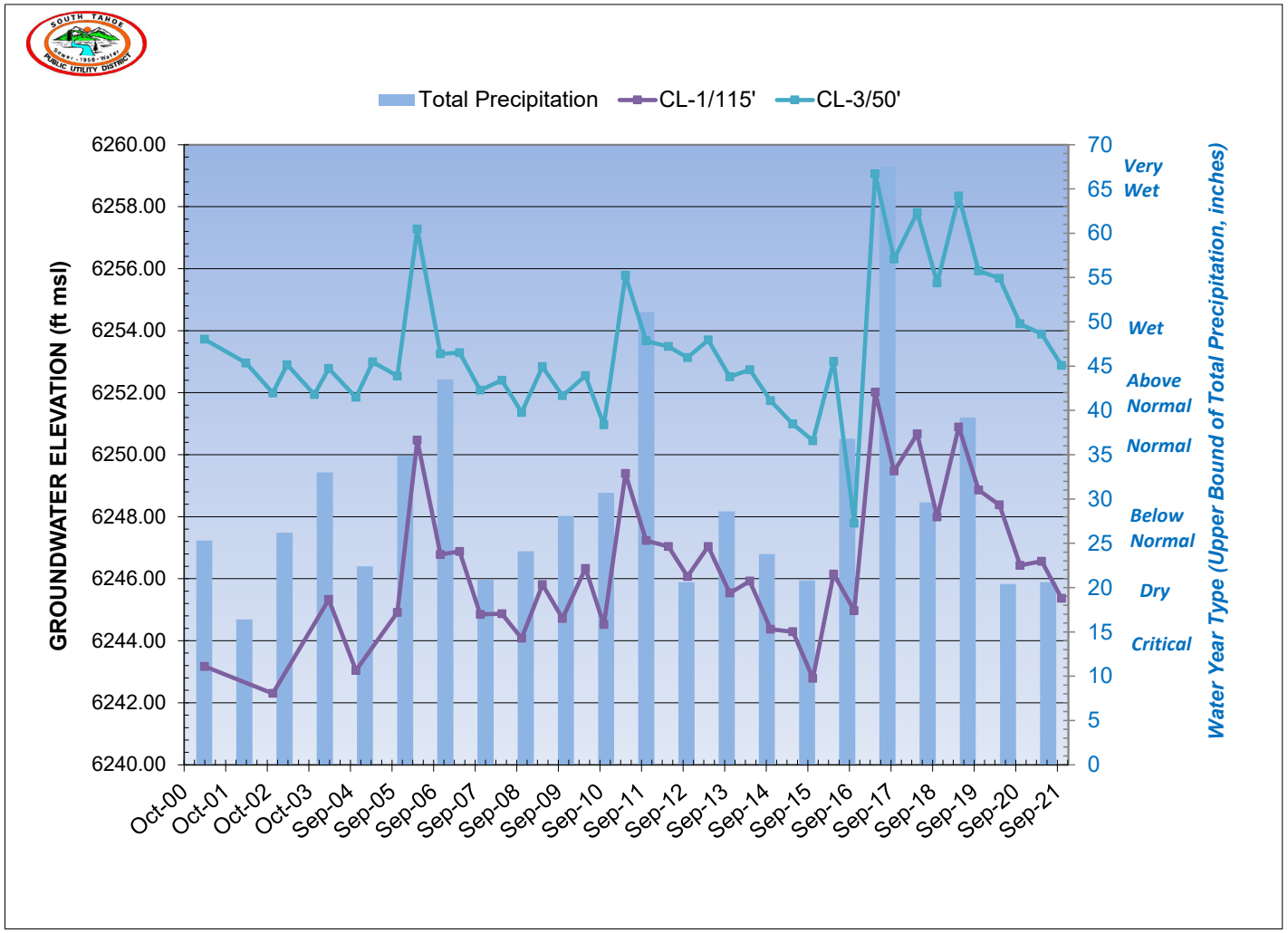
Appendix A - 5. Groundwater hydrograph for the Bakersfield (6,311 feet msl); Elks Club #1 (6,283 feet msl) and Washoan (6,308 feet msl) wells in the Meyers sub-area. Groundwater levels in the Meyers sub-area are relatively stable with short periods of declining water levels in response to increased pumping rates. Static water levels collected from the Bakersfield Well are following a minimum 12-hour recovery time, except for the May 2008 reading (pumping water level at 1,500 gpm). The Elks Club #1 Well is situated near an active pumping well (Elks Club Well #2). Static water levels collected from the Elks Club #1 are typically collected when the Elks Club Well #2 is off. The October 2017 and November 2019 readings are water levels measured when the Elks Club #2 Well was pumping at a rate of 310 gpm and 389 gpm, respectively.



Appendix A-6. Groundwater hydrograph for the Henderson Well (6,366 feet msl) within the Christmas Valley sub-area. Groundwater levels in this well are stable and do not exhibit a long-term downward trend.



Appendix A – 7. Groundwater hydrograph for the USGS TCF nested well (6,296 feet msl) within the South Lake Tahoe sub-area. Total well depths for the observation wells completed within the common borehole are as indicated. The complex vertical flow directions indicated by differences in groundwater levels in this well are believed to result from lowered head in WBZ 4 induced by pumping of the Glenwood #5 well.



Appendix A - 8. Groundwater hydrograph for the Clement Well cluster (6,279 feet msl) within the South Lake Tahoe sub-area. Total well depths for the observation wells comprising the well cluster are as indicated. Both CL-1 and CL-3 monitor groundwater levels from the uppermost water-bearing zone (TKZ5). Vertical flow is directed downward indicative of recharge adjacent to Tahoe Mountain.

APPENDIX B

SAG Workshop Minutes

Workshop 1 (March 25, 2021)

Workshop 2 (June 30, 2021)

AGENDA

DATE	Thursday, March 25th, 2021; 9:00 AM – 11:30 AM (PDT)
LOCATION	https://global.gotomeeting.com/join/481174597 ; Call-In #: 1 866 899 4679; Access Code: 481-174-597
STAKEHOLDER ADVISORY GROUP LIST	Ken Payne, P.E., (El Dorado Water Agency, Rick Lind (EN2R) ; Karen Bender, REHS, RD (El Dorado County -EMD); Jason Burke (City of South Lake Tahoe); Scott Carroll (CA Tahoe Conservancy); Andrea Buxton (Tahoe Resource Conservation District); Brian Grey, P.G. (Lahontan Regional Water Quality Control Board); Michael Conger (TRPA); Joey Keely, Nicole Bringolf (USFS – LTBMU); Nakia Foskett (Lakeside Park Water Co.); Jennifer Lukins (Lukins Brothers Water Co); Daniel Larson (Tahoe Keys Water Co.); Harold Singer (Community Rate Payer); and John Thiel, PE (South Tahoe PUD)
PLAN MANAGER	Ivo Bergsohn, PG, HG (South Tahoe PUD)

BASIN MANAGEMENT OBJECTIVES (BMO)

1. Maintain a sustainable long-term groundwater supply.
2. Maintain and protect groundwater quality.
3. Strengthen collaborative relationships with local water purveyors, governmental agencies, businesses, private property owners and the public.
4. Integrate groundwater quality protection into local land use planning activities.
5. Assess the interaction of water supply activities with environmental conditions.
6. Convene an on-going Stakeholders Advisory Group (SAG) as a forum for future groundwater issues.
7. Conduct technical studies to assess future groundwater needs and issues.
8. Identify and obtain funding for groundwater projects.

WORKSHOP OBJECTIVES

OBJECTIVES

1. Receive an update on current activities for the Tahoe South Subbasin Alternative.
2. Learn about recent and planned activities for the SCAP Regional Plume Investigation in the South Y Area.
3. Discuss results from the Survey of Private Well Owners Survey.
4. Learn about recent hydrologic modeling work for the 50-year water budget projections developed for the Tahoe South Subbasin Alternative.

SEE REVERSE FOR AGENDA

AGENDA

Time	Description	
9:00	**Roll call (5-Minutes)**	**SAG**
9:05	**TSS (6-005.01) - Open Forum (10-Minutes)** **Topics outside the subject matter of the SAG and not listed on the Agenda.**	**Round Robin**
9:15	**TSS Alternative - Progress Update** • **Outreach** • **TSS Alternative**	**I. Bergsohn, STPUD**
9:30	**Survey of Private Well Owners** • **Methods** • **Results** • **SAG Round Robin/ Q &A**	**J. Brand, STPUD**

9:45	**SCAP Regional Plume Investigation**
	• **Historical Database**
	• **Updated Subsurface Sections**
	• **Technical Report**
	• **2021 Field Work**
	  ○ **Inactive Monitoring Well Destructions**
	  ○ **Sentry Well Installations**
	  ○ **Soil Gas Investigations**
	• **SAG Round Robin/ Q &A**
		A. Shepard/ M. Novak, AECOM

10:25	**5-minute BREAK**	

10:30	**TSS (6-005.1) – 50-year Water Budgets Projections**
	• **Climate Scenario & Growth Assumptions**
	• **Model Results (preliminary)**
	• **Predicted Impacts**
	  ○ **PWS Wells**
	  ○ **Private Wells**
	• **SAG Round Robin/ Q &A**
		S. Rybarski/ M. Hausner DRI

11:15	**Adjourn**	

Tahoe South Subbasin (6-005.01) Alternative
MEETING NOTES
Thursday, March 25th, 2021; 9:00 am - 11:30 am
Location: On-Line Meeting
https://global.gotomeeting.com/join/481174597
Call-In #: 1 866 899 4679; Access Code: 481-174-597

SAG ATTENDEES:
John Thiel, PE; Ivo Bergsohn, PG, HG (STPUD); Ken Payne, PE (El Dorado Water Agency); Rick Lind (El Dorado Water Agency); Brian Grey, P.G., Abby Cazier (Lahontan Regional Water Quality Control Board); Michael Conger (Tahoe Regional Planning Agency); Jason Burke (City of South Lake Tahoe); Nicole Bringolf (USFS- Lake Tahoe Basin Management Unit); Andrea Buxton (Tahoe Resource Conservation District); Jennifer Lukins (Lukins Brothers Water Co); Daniel Larson (Tahoe Keys Water Co.); Nakia Foskett (Lakeside Mutual Water Company)

Participants: 32

BASIN MANAGEMENT OBJECTIVES:
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Roll Call
Roll-Call Sheet

Roll Call

South Tahoe Public Utility District

TVS SUBBASIN (6-005.01)
ALTERNATIVE

2021 STAKEHOLDERS ADVISORY GROUP
WORKSHOP No. 1

Thursday, March 25, 2021
(9:00 AM – 11:30 AM)

https://global.gotomeeting.com/join/481174597

Call-In #: 1 866 899 4679; Access Code: 481-174-597

NAME	AFFILIATION	PRESENT	ABSENT	NOTE
John Thiel, P.E.	STPUD	X		
Jason Burke	City of SLT	X		
Andrea Buxton	TRCD		X	Scheduling Conflict
Michael Conger	TRPA	X		
Ken Payne, P.E.	EDCWA	X		Rick Lind representing EDWA
Robert Lauritzen, PG	EDCEMD		X	
Karen Bender, REHS, RD	EDCEMD	X		
Brian Grey	LRWQCB	X		
Joe Keely	USFS - LTBMU		X	
Nicole Bringolf	USFS - LTBMU	X		
Jennifer Lukins	LBWC	X		
Daniel Larson	TKWC	X		
Nakia Foskett	LMWC	X		
Scott Carroll	CTC	X		
Harold Singer	Retired	X		
Ivo Bergsohn, PG, HG (Plan Mngr.)	STPUD	X		

Tahoe South Subbasin (6-005.01) Alternative
MEETING NOTES
Thursday, March 25th, 2021; 9:00 am - 11:30 am
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TVS Basin (6-5.01) - Open Forum (Group)
Current groundwater-related topics outside Agenda

I. Bergsohn, STPUD

- SGMO Office Items
  - DWR Household Water Supply Shortage System: On-line reporting system used to report Domestic Wells experiencing a water supply shortage; https://mydrywatersupply.water.ca.gov/report/
  - Draft California's Groundwater – Update 2020 (Bulletin 118) Released; Public Webinar on March 30, 2021, 12:00 PM to 1:30 PM; Fact Sheet included in Meeting Materials
- 2020 SAG Workshop 2 (December 17, 2020) Meeting Notes/Presentations posted on Groundwater Management Plan Web page;
- 2020 WY Annual Report Draft has been completed (Below Normal WY; GW Production > GW Recharge) – currently in-review; Due to DWR Thursday, April 1st;will be posted on GMP Webpage after April 1st
- 2021 WY; On trajectory for another Below Normal Water Year (Hagan's Meadow SNOTEL 508: 15.9" thru 3/23/2021)

TVS SUBBASIN ALTERNATIVE - PROGRESS UPDATE (I. Bergsohn, STPUD, 15 Minutes)

IB reported on progress in conducting the first 5-year update of the 2014 GMP, referred to as the Tahoe Valley South Subbasin (TVS Subbasin) Alternative (due to DWR by January 1, 2022). Current progress for the Alternative includes satisfying Public Notification Requirements, including identifying TVS Subbasin Stakeholders, development of Interested Parties Lists; and development of a Participation Notice describing how Stakeholders and Interested Parties may participate in the update process. A review and assessment of the 2014 GMP was also completed. The assessment involved re-evaluating the existing plan in light of current groundwater conditions and the need to incorporate groundwater information developed since adoption of the existing plan in 2014. Additional work is in-progress to address eight (8) Recommended Actions identified by DWR during assessment of the 2014 GMP. This new information will be used to address new groundwater management plan requirements added under SGMA which will also be incorporated into the Alternative. IB provided a slide showing the current status of this new work, as well as a quick look ahead to the work planned for the Alternative over the next three (3) months.

SURVEY OF PRIVATE WELL OWNERS (Jason Brand, STPUD, 15 Minutes)
Handouts: Well Owner Survey Combined (2/24/2021)

JB reported on the District's Survey of Private Well Owners and some findings from the survey results. The objectives of this work were to inform private well owners of the District as a Groundwater Sustainability Agency (GSA) and its role in groundwater management within the TVS Subbasin; encourage private well owners to participate in the SAG; and reach-out to private well owners to better understand private well ownership, well usage, well condition water quality and well owner concerns. The survey was conducted in two phases; PWOS I (August – October 2017) involved the survey of 370 well owners; PWOS II (June- September 2020) involved the survey of 134 well owners; including private CWS, NTNC, TNC, SSWS and Domestic well systems.

Through PWOS surveys, the locations of 335 private wells within the TVS Subbasin were confirmed; another 118 sites were confirmed to not have a private well; at 51 sites property owners were uncertain whether a well existed on the property. Major findings from the survey include; high majority of confirmed private wells are in use (292/335 responses); most of the properties were second homes (192/390 responses); the majority of private well owners use

their well on a daily basis (191/336 responses). Aesthetic water quality parameters (taste, color, odor) and purity were the top qualities well owners liked most; the majority of the well owners did not express any water quality concerns, of those that did, contaminants and " other" were the most common responses. A minority of respondents (56/336) were interested in receiving information about connecting to a public water system; and 135/336) were interested in joining the SAG. Recommendations from the PWOS include; continue updating well owners that have expressed interest in the SAG; continue working to contact the remaining ~160 private well owners (estimated) that have not been reached; and continue outreach to build positive relationships with private well owners.

Discussion (Group)

Has District been able to cross-reference confirmed well locations with EDC well construction information? How many wells are potential risks as vertical conduits for contamination? Good question, JB has not attempted to investigate private well construction information.

EDC would like to coordinate with District to identify the remaining ~160 well owners who have not been contacted. EDC does not regulate private wells, but does permit well construction, modification and destruction; question on well at 2717 Lake Tahoe Blvd (District checked it's PWOS records and found that the subject property is listed as a potential well site and is one of the remaining ~160 well owners which have not responded to the PWOS).

Vertical conduit evaluation is task within scope of current SCAP investigation

SCAP REGIONAL PLUME INVESTIGATION (A. Shepard, M. Novak, AECOM, 40 Minutes)

Michael Novak, Hydrogeologist reported on progress of the on-going Site Cleanup Subaccount Program (SCAP) Regional Investigation being performed by AECOM for LRWQCB. Primary objectives for this investigation include; 1) Improve Conceptual Site Model through better understanding of subsurface lithology; and lateral and vertical plume delineation; 2) Support next steps, sentry well siting and design; preferential pathway analysis (e.g., sewer line, surface water pathways) and feasibility of remedial options to protect well users and stakeholders.

Recent Work: 22 Sonic Borings (to 300 ft); 57 CPT borings (to 100 ft); groundwater samples (6 – 8 per location). Lithology data was logged in accordance with USCS and grouped based on associated permeability's (e.g. silt & clay -low to Sand & Gravels – High). Earth Volumetric Studio (EVS) modeling software was used both lithologic and groundwater sampling dataset (2017 – present; if multiple sample events at a location, max concentrations used) to develop an 3-D interpolated subsurface model of the PCE contaminant plume.

Cross-Sections: A-A' oriented South to North, parallel with direction of GW flow): Lithology's: new high resolution data shows that potential confining layers (clays) previously interpreted as continuous layers ; are likely to be discontinuous lenses (< 1 mile in extent); Aquifer is interpreted as single unit; ; confining layers do not sub-divide the aquifer into distinct units (e.g. shallow, intermediate, and deep). Chemical: diving plume, shallow in up-gradient area s(at south end), spreading vertically as it migrates in down-gradient direction. Plume dispersion may in part be influenced by lithologic heterogeneity; B-B'- similar to A-A' in terms of lithology; chemically- shallow not as deep as along west side of plume; uncertainty in interpolation between main body of plume and PCE detections found in TKWC #1.

Discussion (Group):

How will the plume delineation inform the source area investigation? Reply: Understanding plume geometry will help identify targets for future source investigation efforts; help with evaluation of source area inventory and planning of future soil-gas investigations.

Dashed perimeter- can you please speak to that? Dashes represent inferred extent of plume.

How strong an influence do the clay lenses have on the distribution of PCE in the subsurface? That is a plausible explanation; hesitant to make that determination-lacking vertical hydraulic gradient data within plume.

Next Steps: Sentry Well Program – allow for GW monitoring immediately up-gradient of threatened public water supply wells (planned for July/August 2021) – LBWC #1; LBWC #5 /TKWC #2; TKWC #1; TKWC #2. Vertical Conduit Destruction: private well locations will be added to EVS model to identify potential conduits and potential candidates for well decommissioning (June/July 2021); Soil-gas sampling- Chlorinated hydrocarbons – toxicity with respect to soil vapors released from plume; will collect soil gas samples at south end of plume to evaluate vapor-intrusion pathway (impacts to indoor air) (July/August 2021); Non-Municipal Well Sampling (June 2021).

Discussion (Group):

Will discrete vertical sampling be part of the Sentry Well Installation program? Yes- very interested in vertical distribution; could be part of program, still considering different screen designs for sentry well installation

Will sentry well installation be able to provide information to indicate single or multiple source areas? Sentry well installations would not directly address that question; sentry well installations would provide multi-depth water level data to calculate hydraulic gradients (vertical and horizontal). Sentry wells may also help to inform pathway analysis; for example; whether plume was influenced by sewer system.

What is being considered to reduce PCE in groundwater? Not a key objective for next season (2021); but is objective for long-term.

How fast is the plume moving? Current AECOM dataset is not adequate to assess plume migration rate; may be able to start addressing those questions as groundwater monitoring data is collected. (Note: available plume migration rates were estimated from data collected during the South Y Feasibility Study, both from field investigation and F&T Model results).

What are the other water quality parameters to be sampled during the Sentry Well Monitoring Program (naturally-occurring Ur and Arsenic is being detected in TKWC Wells); likely that Ur sampling would not be added to LRWQCB sampling program.

Is AECOM data being evaluated to justify interim clean-up (for example; spot clean-up in selected areas; installation of an up-gradient recovery well to reduce impact to TKWC #1)? May be potential opportunity for interim remedial clean-up; source area investigations that should be helpful to inform these decisions.

Has information from plume delineation changed LRWCB source inventory? No; source inventory has not changed; data is being used to inform planned source area investigations.

Tahoe South Subbasin (6-005.01) Alternative
MEETING NOTES
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TSS Alternative 50-yaer Water Budget Projections (S. Rybarski, M. Hausner, DRI, 45 Minutes)
Handouts: TSS Alternative Groundwater Model Evaluation

Susie Rybarski, Assistant Research Scientist reported on current progress of modeling work completed by DRI to address DWR Recommended Actions. Presentation focused on work being conducted to address RA-1, RA-2 and RA-3 (developing 50-year water budgets); RA-6 (evaluating depletions of Interconnected Surface Waters (ISWs)); and RA-7 (defining Sustainable Management Criteria (SMCs)).

50-year Water Budgets: goals- incorporate climate effects and changes in pumping; extend climate projections to 2099. Annual pumping rates projected using Ca Dept. of Finance long –term population growth rate (2010- 2060) for El Dorado County (0.37%). Projected recharge rates and lake stages were developed for a baseline model (average conditions) plus five (5) climate scenarios developed using global climate models (CMIP5) for 2075 – 2099; Q1 – warm and dry; Q2 – hot and dry; Q3- hot and wet; Q4- warm and wet; and Q5- increased temperature with no change in precipitation.

GW Recharge: used mean of GW recharge previously calculated by DRI (Pohl et all, 2018). Evaluation of mean and median recharge show earlier seasonal shift (from May to March) in timing of recharge for Q2 and Q4 scenario compared to baseline.

Groundwater Pumpage: projected from 2020 using 2007 WY pumping rates (maximum rates (1983 – 2019)); TKWC, LBWC and LPA were assigned future maximums defined by Kennedy Jenks in their water demand analysis for the District's service area (KJ, 2020); District's pumping was allowed to increase above its future maximum through 2099 (conservative model). Total pumpage was distributed to existing wells based on WY 2019 pumpage distribution and historical season pumping patterns; Pumping from LBWC #5 was started during WY 2021 to account for completion of wellhead treatment system to remove PCE from groundwater for this well. Added pumpage at private well locations were estimated based on District's private well owner survey results.

Lake Stage: lowest stage elevation based on submerged tree stump elevation (6214.9 ft) dated to 6,300 yrs BP (Lindstrom, 1990) used for Q2 scenario; and high stage elevation based on 1983 – 2015 average; were used to develop a two-point regression of lake stage elevation versus recharge to identify projected lake stages for the other climate scenarios. Decline rates were developed for a "composite drought" using observed declines in lake stage during recent drought periods (WY 2012 -2014; WY 1987 – 1994); the composite drought stage declines were then used to develop a "composite stage" decline for the Q2 scenario until the lowest stage elevation was reached. Lake Stage for Q3 and Q4 scenarios were set at the legal limit (6229.1 ft).

Private Well Impacts: projected model results were used to compare changes in groundwater level elevations across TVS Subbasin between historical (2019 WY) and projected baseline (2070 WY) and Q2 (2070 WY) scenarios. For the 332 private well locations identified; 38 sites had DTW > 50 ft under the baseline scenario; compared to 73 sites under the Q2 scenario; 34 sites are show to have DTW.50 ft for historical period. The average declines at private wells ranged from 3.7 ft (baseline) to 15 ft (Q2).

Community Supply Wells (District, TKWA, LBWC and LPA); compare projected groundwater pumping levels for Q2 scenario to top of well screen elevations for active community production wells. Model results show that pumping levels will not decline below top of screen elevations in all wells evaluated. The minimum predicted pumping level above the top of screen elevation is 46.5 feet at the South Upper Truckee Well No. 3.

Tahoe South Subbasin (6-005.01) Alternative
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ISWs: GW Management Area (GMA); area defined by model cells with >50% stream capture in any model layer. GMA delineation involved: 1) running a transient baseline model with no pumping (WY 2020 – 2099) for comparison to the baseline model (pumping only) and the five climate scenarios (pumping + climate effects) to produce monthly/annual depletion analysis; 2) spatial baseflow depletion analysis to show where depletion of baseflow is occurring in streams; and capture analysis to show where majority of pumping would capture flow directed toward streams versus directed to Lake Tahoe. General pattern in baseline, Q1, Q2 and Q5 shows initial depletion predominantly from storage until hydrologic system equilibrates to simulated climate conditions (recharge; lake stage). After equilibration, depletion is predominantly from streams (baseflow) or groundwater flow to Lake Tahoe. The relative differences in depletions between scenarios are controlled by the magnitude of reductions in recharge and differences in lake stage between the different scenarios. Q3 and Q4 (wet scenarios) show negative baseflow and storage depletion resulting in increased baseflow to streams and increased groundwater storage. Review of depletion distributed by month shows seasonal impact on groundwater storage; basin fills during winter months and depletes during summer. Capture analysis –shows where a hypothetical well would be expected to cause an increase in aquifer recharge due to losses in flow from ISWs. Results from models with and without the hypothetical well are then compared to see where water from the cell is captured from ISWs (i.e., lake vs. baseflow). Analysis run on both baseline and Q2 (worst-case) scenarios

Next Steps: develop SMCs for chronic lowering of GW levels; reductions in GW Storage; degraded GW quality; and depletions of ISWs; set sustainable thresholds within range of historic variability; identify data gaps and recommend methods to address; receive feedback from SAG on proposed SCMs.

Discussion (Group):

Model assumptions: Population growth based on County Average; land use planners believe there will be a much larger proportion of year-round homeowners in the future, was this taken into consideration? KJ water demand assessment considered water demand at total build-out; District pumpage used in 50-year water projections exceeded KJ water estimates, future pumpage projections are believed to be conservative.

Low lake stage level; did DRI also consider findings from study of submerged tree stumps found in Fallen Leaf Lake (FLL) - (mid-evil Drought)? DRI looked at it, but did not use as there were no elevations from that study for Lake Tahoe.

Baseline pumping used most conservative (highest historic pumping rates) from WY 2007, any reason why 2007? 2007 coincides with population peak before recession; and prior to subsequent movement of population away from South Lake Tahoe.

ADJOURN (11:30 AM)

TAHOE SOUTH SUBBASIN (6-005.01)
2021 SAG Workshop 1
March 25, 2021

TSS Alternative - Update

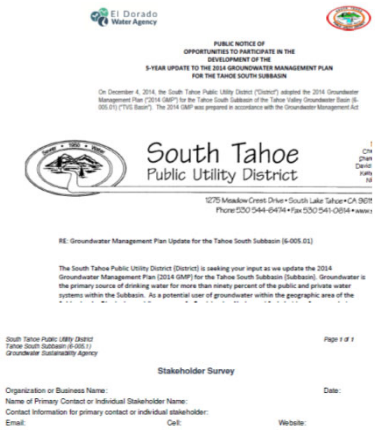
I. Bergsohn, PG, HG
South Tahoe Public Utility District

2014 GMP Update - Overview

- Public Notification (§ 10723.2; § 10723.4; § 10727.8)
- Periodic Review and Assessment (§ 10728.2)
  - Evaluate 2014 GMP
  - Assess Groundwater Conditions
  - Adjust Plan/Management Objectives
- Address DWR Recommended Actions
- Prepare Tahoe South Subbasin (TSS) Alternative

Public Notification

- Interested Persons List (§ 10723.4)
- Participation Notice (§ 10727.8)
  - https://stpud.us/news/groundwater-management-plan/
  - https://www.edwateragency.org/Pages/Water-Agency-Newsroom.aspx
  - Media Release
  - Tier I & II Stakeholders Mailers
  - Tier III Stakeholders Email



El Dorado Water Agency

PUBLIC NOTICE OF OPPORTUNITIES TO PARTICIPATE IN THE DEVELOPMENT OF THE 5-YEAR UPDATE TO THE 2014 GROUNDWATER MANAGEMENT PLAN FOR THE TAHOE SOUTH SUBBASIN

South Tahoe Public Utility District

RE: Groundwater Management Plan Update for the Tahoe South Subbasin (6-005.01)

The South Tahoe Public Utility District (District) is seeking your input as we update the 2014 Groundwater Management Plan (2014 GMP) for the Tahoe South Subbasin (Subbasin). Groundwater is the primary source of drinking water for more than ninety percent of the public and private water systems within the Subbasin. As a potential user of groundwater within the geographic area of the

Stakeholder Survey

Organization or Business Name: Date:
Name of Primary Contact or Individual Stakeholder Name:
Contact information for primary contact or individual stakeholder:
Email: Cell: Website:

Periodic Review and Assessment

- Evaluate 2014 GMP (100% Complete)
  - Identify new sections to address new GSP requirements under SGMA
  - Reorganize GMP to incorporate new information
- Assess Groundwater Conditions (<50% Complete)
  - Groundwater Conditions
  - Groundwater Storage
  - Groundwater Quality
  - Interconnected Surface Water (ISW) Interactions
  - Groundwater Dependent Ecosystems (GDEs)
  - Water Budget
  - Sustainable Yield
  - Assessment of Potential Overdraft Issues
  - Potential Climate Change Impacts
  - Characterization of Undesirable Results
- Adjust Plan/Management Objectives (20% Complete)
  - Incorporate new information
  - Identify data gaps, future groundwater management projects and activities
  - Update 2014 Implementation Plan

DWR Recommended Actions (RAs)

RA	Description
RA-1	Provide water budget information in Tabular Form for historical, current and projected water budgets.
RA-2	Provide a projected water budget over the 50-year planning and implementation horizon, incorporating climate change effects.
RA-3	Reconcile the different future water demand projections between the Groundwater Management Plan (GMP) and Urban Water Management Plan (UWMP) and incorporate the reconciliation in the projected water budget.
RA-4	To understand change in groundwater storage for the Subbasin, the water budget calculated by the South Tahoe Groundwater Model should be calculated within the Subbasin boundary rather than the surrounding watershed area inclusive of the Subbasin.
RA-5	Provide additional explanation in the first five-year update for how pumping may impact plume migration or cause degraded water quality.
RA-6	Provide estimates of the quantity and timing of depletions of interconnected surface water; define what would cause depletions to become significant and unreasonable.
RA-7	Define quantitative criteria for groundwater levels, storage and depletion of interconnected surface water that can be used to objectively determine compliance of the Plan with the objectives of SGMA on an on-going basis.
RA-8	Provide a description of how the data gaps identified will be addressed; specifically the projects identified in Table 10-1 for BMO 5 - dependent upon District funding.

Current Status

RA	Description	Status
RA-1, RA-2, RA-3	Updated water budgets for the 50-year planning horizon	Modeling Evaluation/ COMPLETED
RA-4	Water budget within the Subbasin boundary.	COMPLETED
RA-5	How pumping may impact plume migration or cause degraded water quality.	In-Progress (> 50% Complete)
RA-6	Quantity and timing of depletions of Interconnected Surface Waters (ISW)	In- Progress (<50% Complete)
RA-7	Quantitative criteria for groundwater levels, storage and depletion of ISW.	In- Progress (<25% Complete)
RA-8	Data gaps and recommend methods to address them.	In- Progress (<25% Complete)

Calendar

Date	Description
4/15/2021	Public Hearing: 2020 WY Annual Report
6/23/2021 (proposed)	2021 SAG Workshop 2

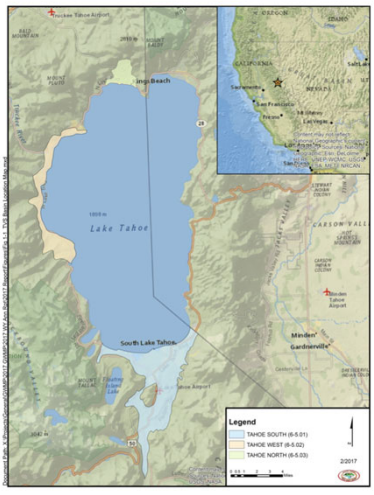
QUESTIONS/COMMENTS

TAHOE SOUTH SUBBASIN (6-005.01)
2021 SAG I WORKSHOP
March 25, 2021

Survey of Private Well Owners
Phase I & II Summary of Results

Jason Brand
South Tahoe Public Utility District

TAHOE SOUTH SUBBASIN
Survey of Private Well Owners



OBJECTIVES

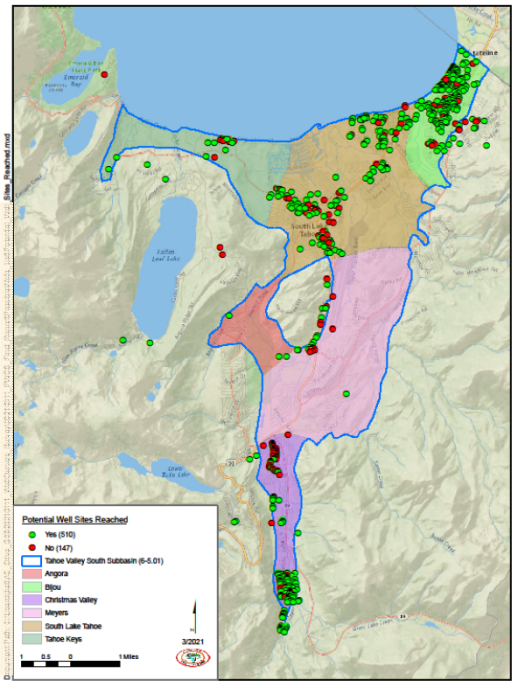
- Inform Private Well Owners of GSAs & Groundwater Management
- Encourage Private Well Owners to participate in the SAG
- Reach-out to Private Well Owners to better understand:
  - Well Ownership and confirm location
  - Water Usage
  - Well Condition
  - Water Quality
  - Well Owner Concerns

Private Wells

Wells - inferred (~ 670)

Survey conducted for 76% or 509 sites

Types
- Domestic
- CWS
- NTNC
- TNC
- SSWS



PWOS I

August – October 2017

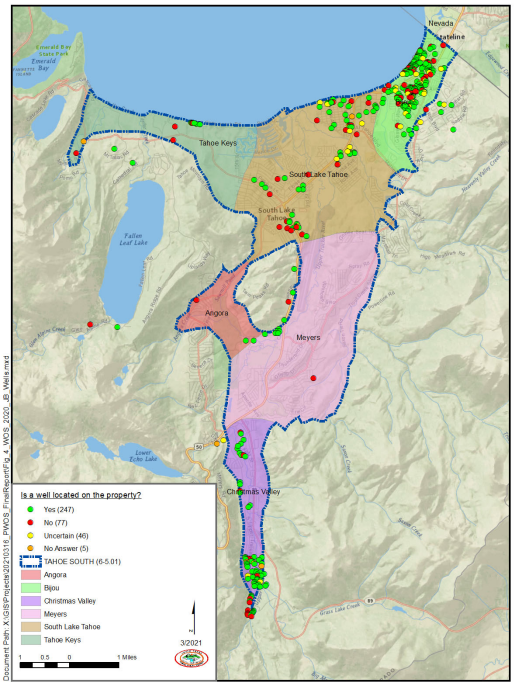
Methods

- Direct Mail
- Door to Door
- Online/Web Portal
- Telephone

Completed Well Survey (370)

- Yes (247)
- No (77)
- Uncertain (46)

TVS Groundwater Basin Survey of Well Owners (Allegro, 2018)



PWOS II

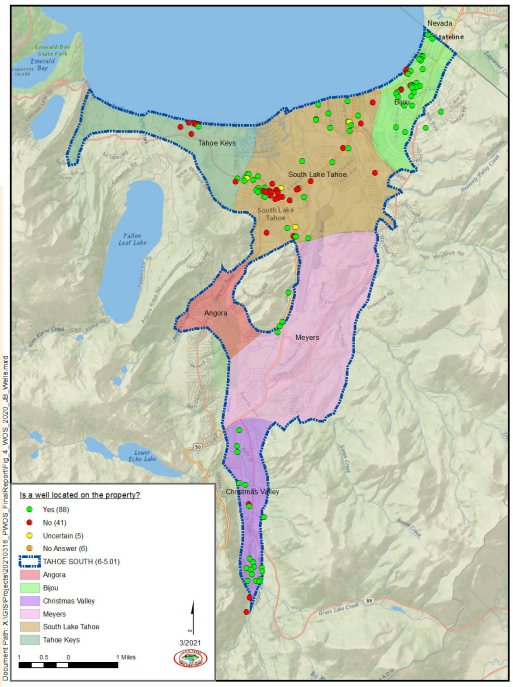
June – September 2020

Methods

- Direct Mail
- Email
- Online/Web Portal
- Telephone
- Incentives – Water quality test, well inspection, guidance

Completed Well Survey (134)

- Yes (88)
- No (41)
- Uncertain (5)



PWOS Combined

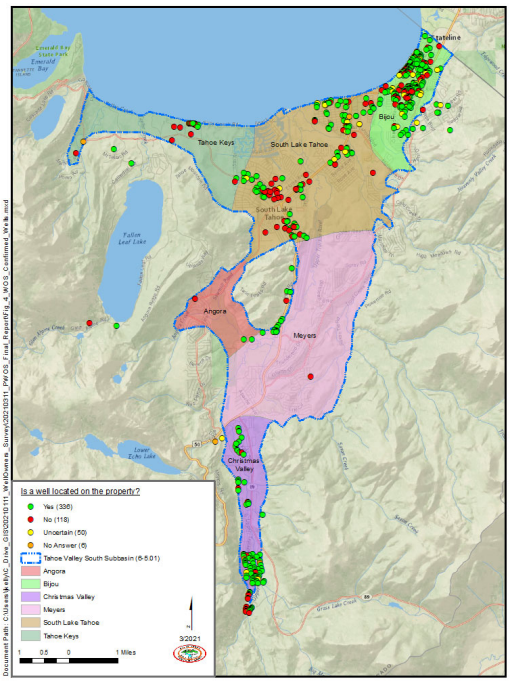
2017 and 2020

Possible Well Sites (670)

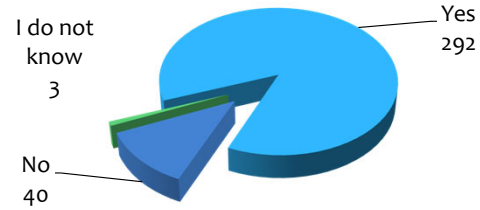
Completed Well Survey (509)

- Yes (335)
- No (118)
- Uncertain (50)

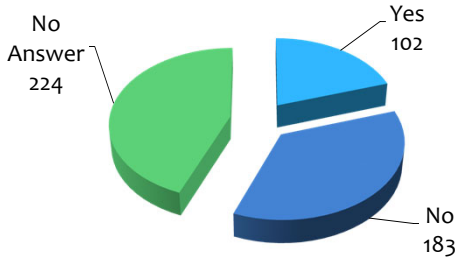
Final Report April 2021



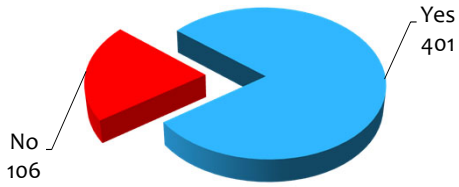
Is the well in use?



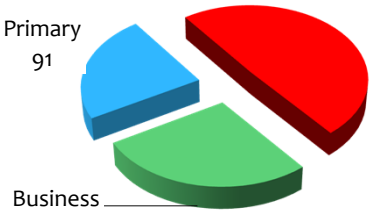
May I view the well?



Are you the owner?



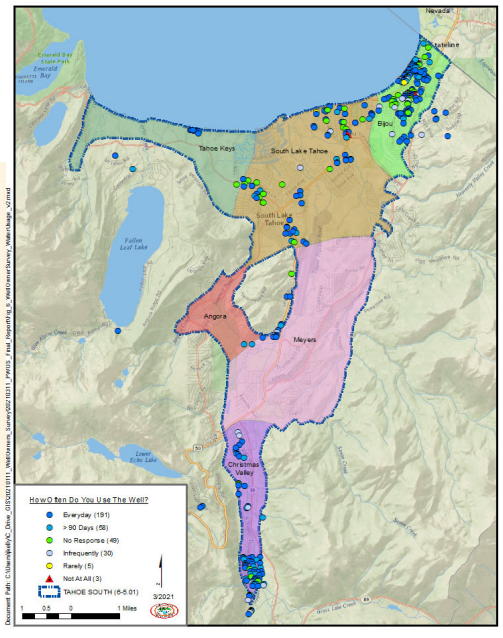
How do you use the property?

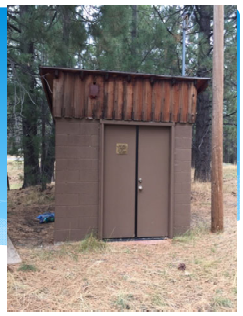


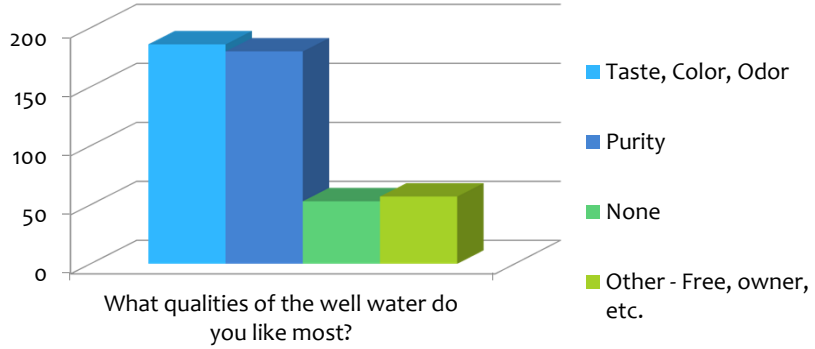
Well Use

How Often Do You Use the Well?

- Everyday (191)
- Less than 90 days (58)
- No Response (49)
- Infrequently (30)
- Rarely (5)
- Not at all (3)



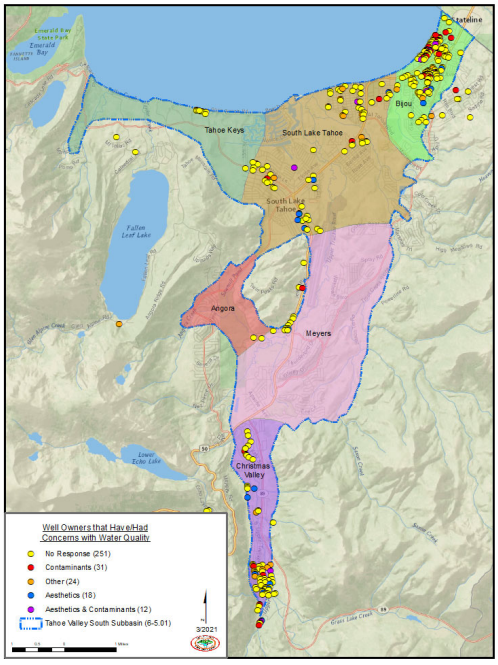




Water Quality

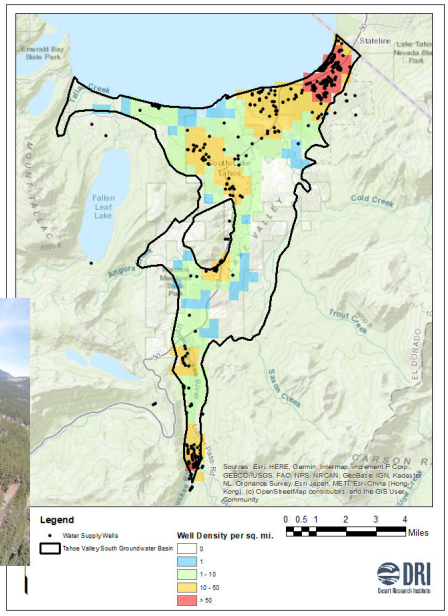
Well owners that have/had concerns with water quality

- No Response (251)
- Contaminants (31)
- Other (24)
- Aesthetics
- Aesthetics & Contaminants (12)



Well Density

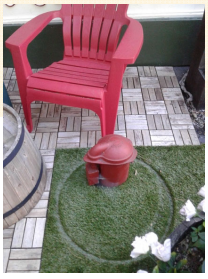
Well density per square mile

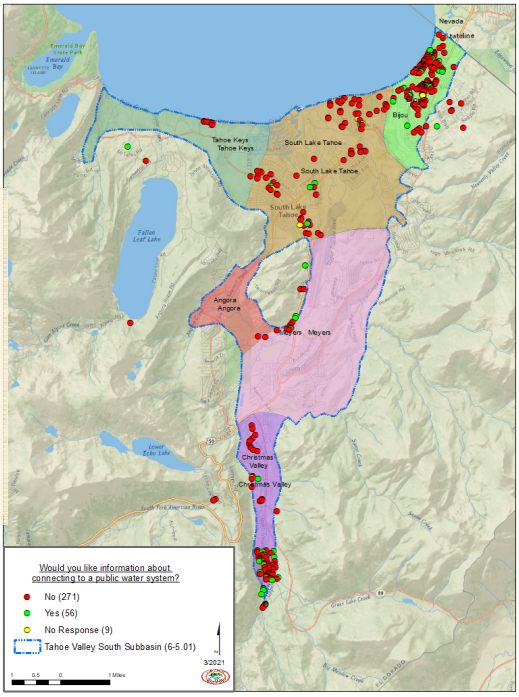


Connection ?

Would you like information about connecting to a public water system?

- Yes (56)
- No (271)
- No Response (9)

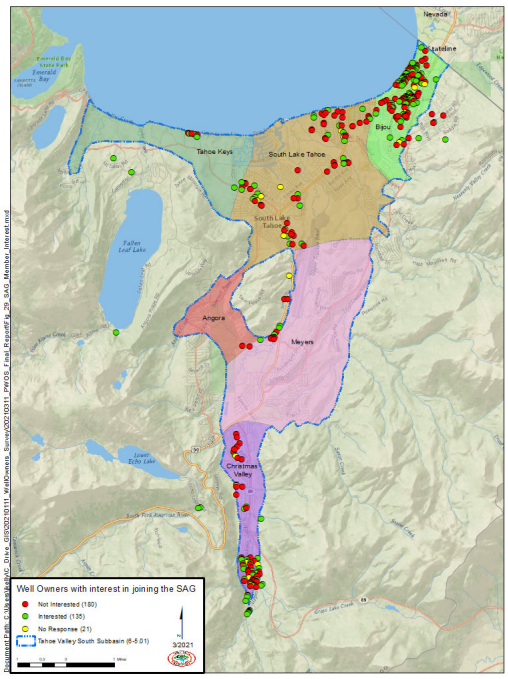




SAG Interest ?

Well owners with interest in joining the SAG

- Interested (135)
- Not interested (180)
- No Response (21)



PWOS Status

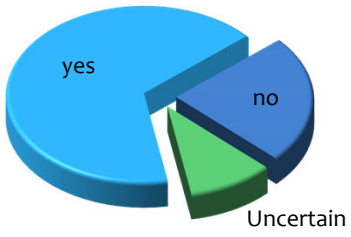
Goal to conduct survey and confirm well sites - **670**

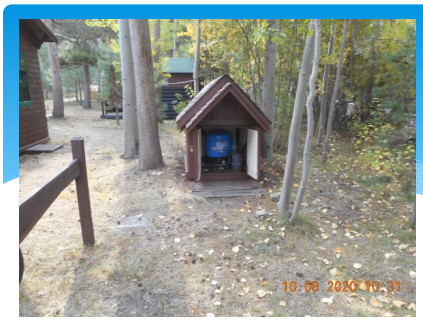
Surveys Conducted – **509** or **76%**

- Yes – **335**
- No – **118**
- Uncertain – **50**
- No response

Well sites not confirmed **~160**

Is there a well?





Recommendations

- Continue updating contacts of well owners that have expressed interest in being part of the SAG
- Continue working to contact properties that have not been reached ~160
- Work to create a positive relationship between Private well owners and other partner groups

South Tahoe Public Utility District

Survey of Private Well Owners

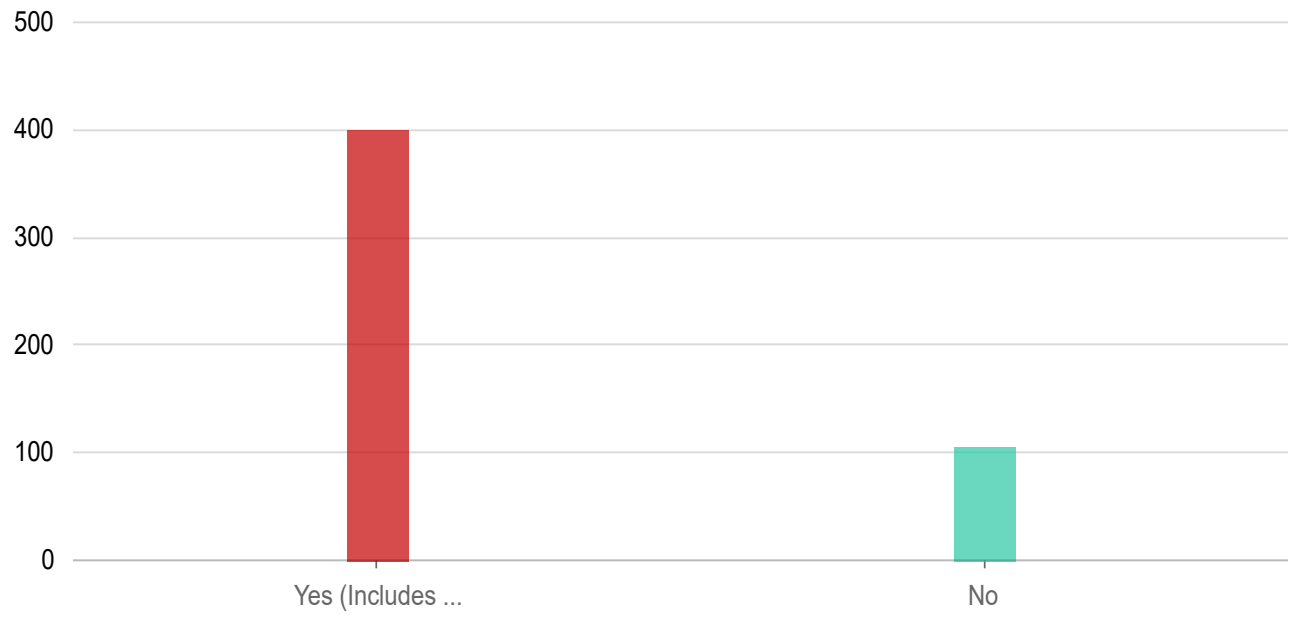
Questions

Jason Brand
South Tahoe Public Utility District

Well Owner Survey Combined

About Property Ownership and Usage

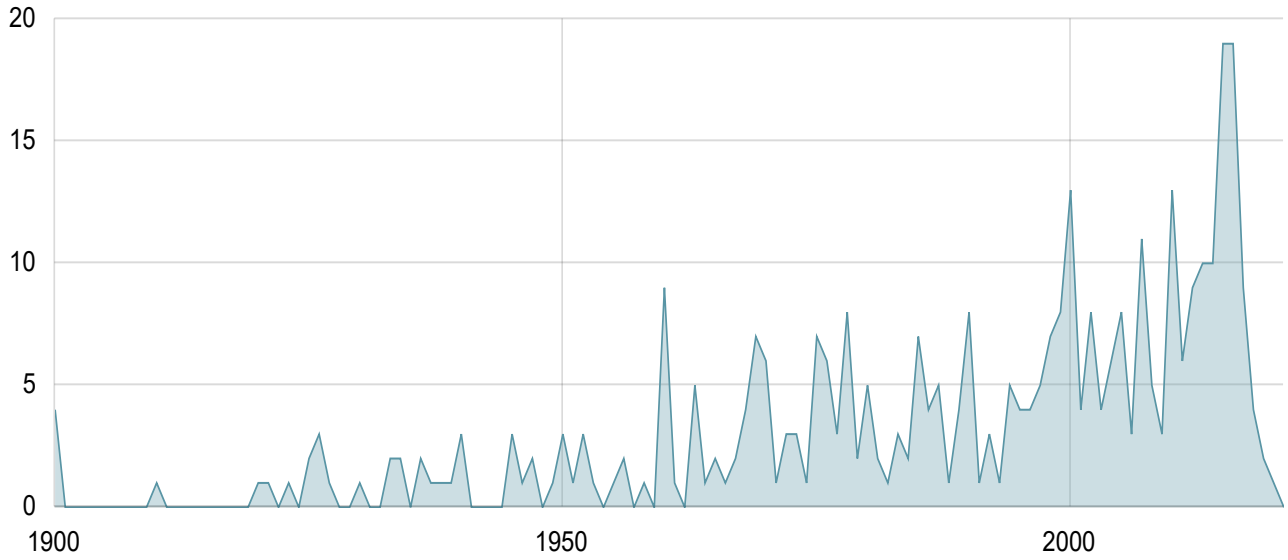
○ Are you the property owner at this address?



Answers	Count	Percentage
Yes (Includes Property Managers)	401	78.78%
No	106	20.83%

Answered: 507 Skipped: 2

○ Since when have you owned this property?



Date	Count
Jan 1, 1900 - Jan 1, 1901	4
Jan 1, 1910 - Jan 1, 1911	1
Jan 1, 1920 - Jan 1, 1921	1
Jan 1, 1921 - Jan 1, 1922	1
Jan 1, 1923 - Jan 1, 1924	1
Jan 1, 1925 - Jan 1, 1926	2
Jan 1, 1926 - Jan 1, 1927	3
Jan 1, 1927 - Jan 1, 1928	1
Jan 1, 1930 - Jan 1, 1931	1
Jan 1, 1933 - Jan 1, 1934	2
Jan 1, 1934 - Jan 1, 1935	2
Jan 1, 1936 - Jan 1, 1937	2
Jan 1, 1937 - Jan 1, 1938	1
Jan 1, 1938 - Jan 1, 1939	1

Jan 1, 1939 - Jan 1, 1940	1
Jan 1, 1940 - Jan 1, 1941	3
Jan 1, 1945 - Jan 1, 1946	3
Jan 1, 1946 - Jan 1, 1947	1
Jan 1, 1947 - Jan 1, 1948	2
Jan 1, 1949 - Jan 1, 1950	1
Jan 1, 1950 - Jan 1, 1951	3
Jan 1, 1951 - Jan 1, 1952	1
Jan 1, 1952 - Jan 1, 1953	3
Jan 1, 1953 - Jan 1, 1954	1
Jan 1, 1955 - Jan 1, 1956	1
Jan 1, 1956 - Jan 1, 1957	2
Jan 1, 1958 - Jan 1, 1959	1
Jan 1, 1960 - Jan 1, 1961	9
Jan 1, 1961 - Jan 1, 1962	1
Jan 1, 1963 - Jan 1, 1964	5
Jan 1, 1964 - Jan 1, 1965	1
Jan 1, 1965 - Jan 1, 1966	2
Jan 1, 1966 - Jan 1, 1967	1
Jan 1, 1967 - Jan 1, 1968	2
Jan 1, 1968 - Jan 1, 1969	4
Jan 1, 1969 - Jan 1, 1970	7
Jan 1, 1970 - Jan 1, 1971	6

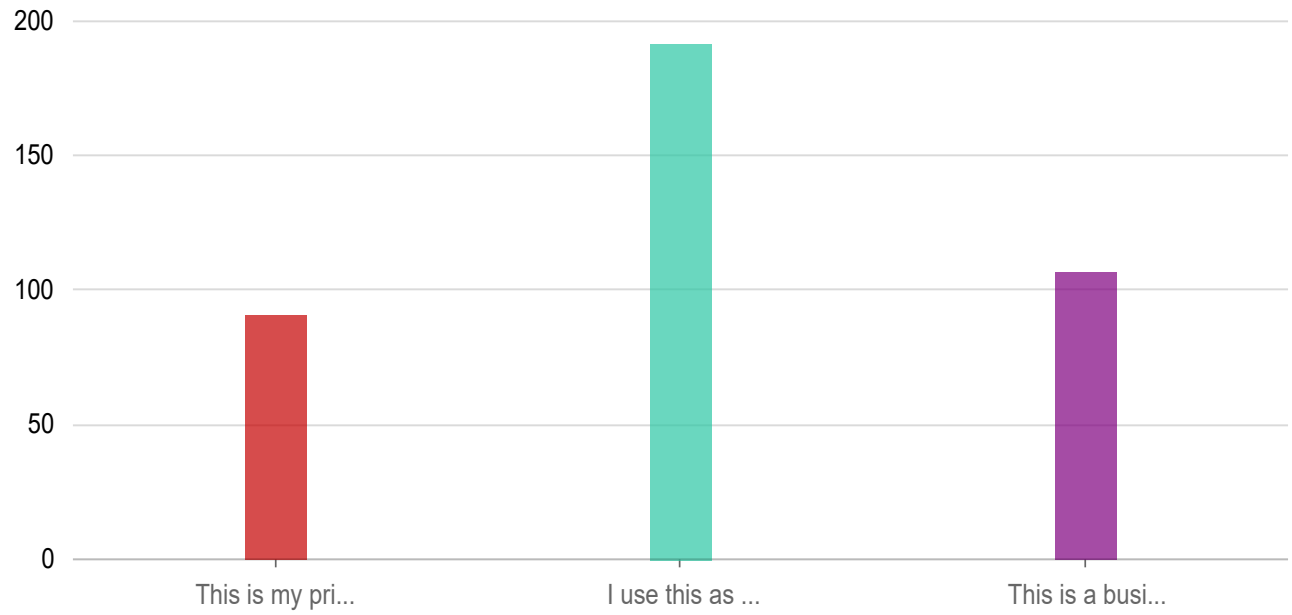
Jan 1, 1971 - Jan 1, 1972	1
Jan 1, 1972 - Jan 1, 1973	3
Jan 1, 1973 - Jan 1, 1974	3
Jan 1, 1974 - Jan 1, 1975	1
Jan 1, 1975 - Jan 1, 1976	7
Jan 1, 1976 - Jan 1, 1977	6
Jan 1, 1977 - Jan 1, 1978	3
Jan 1, 1978 - Jan 1, 1979	8
Jan 1, 1979 - Jan 1, 1980	2
Jan 1, 1980 - Jan 1, 1981	5
Jan 1, 1981 - Jan 1, 1982	2
Jan 1, 1982 - Jan 1, 1983	1
Jan 1, 1983 - Jan 1, 1984	3
Jan 1, 1984 - Jan 1, 1985	2
Jan 1, 1985 - Jan 1, 1986	7
Jan 1, 1986 - Jan 1, 1987	4
Jan 1, 1987 - Jan 1, 1988	5
Jan 1, 1988 - Jan 1, 1989	1
Jan 1, 1989 - Jan 1, 1990	4
Jan 1, 1990 - Jan 1, 1991	8
Jan 1, 1991 - Jan 1, 1992	1
Jan 1, 1992 - Jan 1, 1993	3
Jan 1, 1993 - Jan 1, 1994	1

Jan 1, 1994 - Jan 1, 1995	5
Jan 1, 1995 - Jan 1, 1996	4
Jan 1, 1996 - Jan 1, 1997	4
Jan 1, 1997 - Jan 1, 1998	5
Jan 1, 1998 - Jan 1, 1999	7
Jan 1, 1999 - Jan 1, 2000	8
Jan 1, 2000 - Jan 1, 2001	13
Jan 1, 2001 - Jan 1, 2002	4
Jan 1, 2002 - Jan 1, 2003	8
Jan 1, 2003 - Jan 1, 2004	4
Jan 1, 2004 - Jan 1, 2005	6
Jan 1, 2005 - Jan 1, 2006	8
Jan 1, 2006 - Jan 1, 2007	3
Jan 1, 2007 - Jan 1, 2008	11
Jan 1, 2008 - Jan 1, 2009	5
Jan 1, 2009 - Jan 1, 2010	3
Jan 1, 2010 - Jan 1, 2011	13
Jan 1, 2011 - Jan 1, 2012	6
Jan 1, 2012 - Jan 1, 2013	9
Jan 1, 2013 - Jan 1, 2014	10
Jan 1, 2014 - Jan 1, 2015	10
Jan 1, 2015 - Jan 1, 2016	19
Jan 1, 2016 - Jan 1, 2017	19

Jan 1, 2017 - Jan 1, 2018	9
Jan 1, 2018 - Jan 1, 2019	4
Jan 1, 2019 - Jan 1, 2020	2

Answered: 364 Skipped: 145

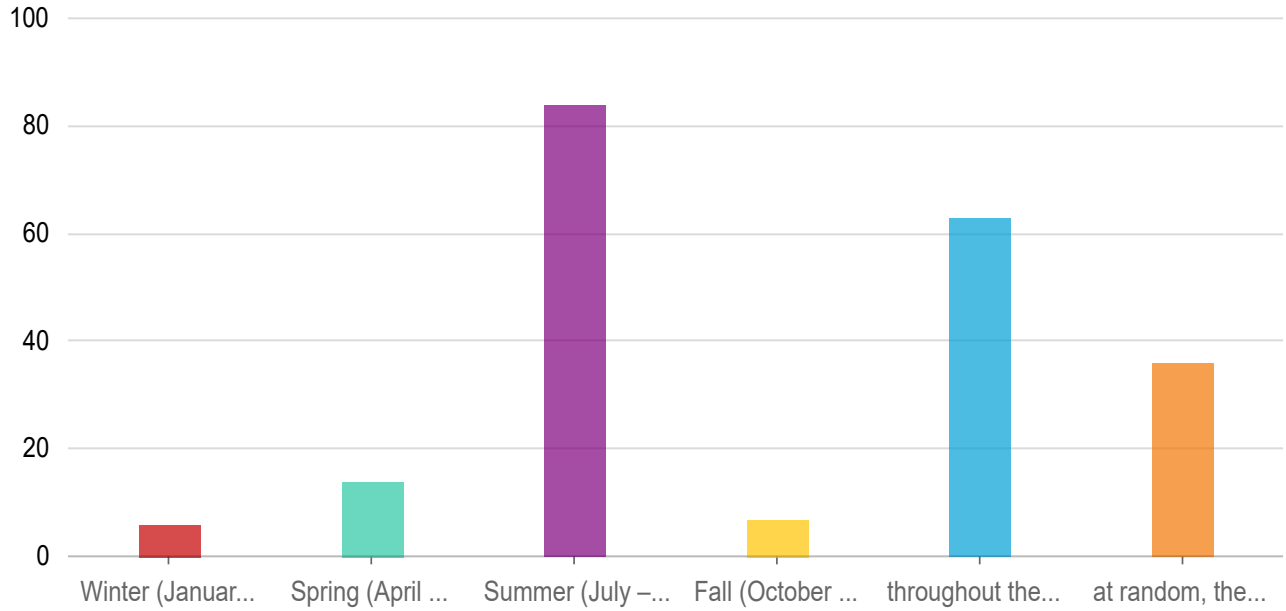
○ As owner, which best describes your relationship to this property?



Answers	Count	Percentage
This is my primary residence.	91	17.88%
I use this as a second home / vacation residence.	192	37.72%
This is a business property.	107	21.02%

Answered: 390 Skipped: 119

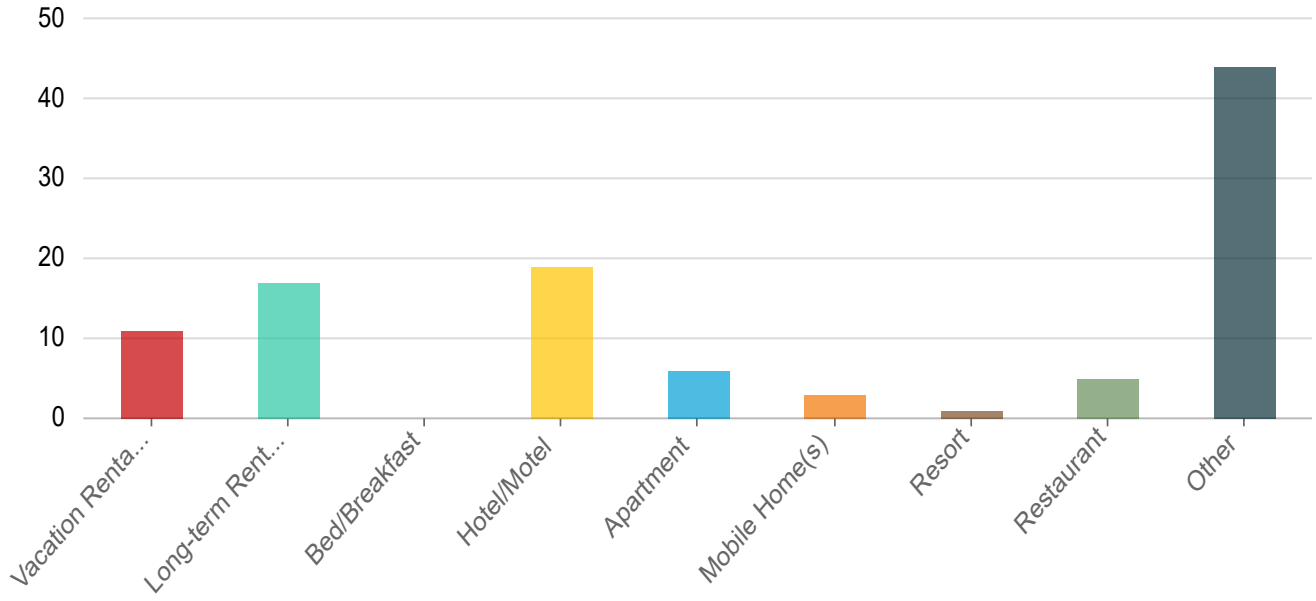
○ As a second home I use this property primarily:



Answers	Count	Percentage
Winter (January – March)	6	1.18%
Spring (April – June)	14	2.75%
Summer (July – September)	84	16.5%
Fall (October – December)	7	1.38%
throughout the year	63	12.38%
at random, there is no particular season I am here	36	7.07%

Answered: 178 Skipped: 331

○ **Please select the best description of the business(es) use of this address.**

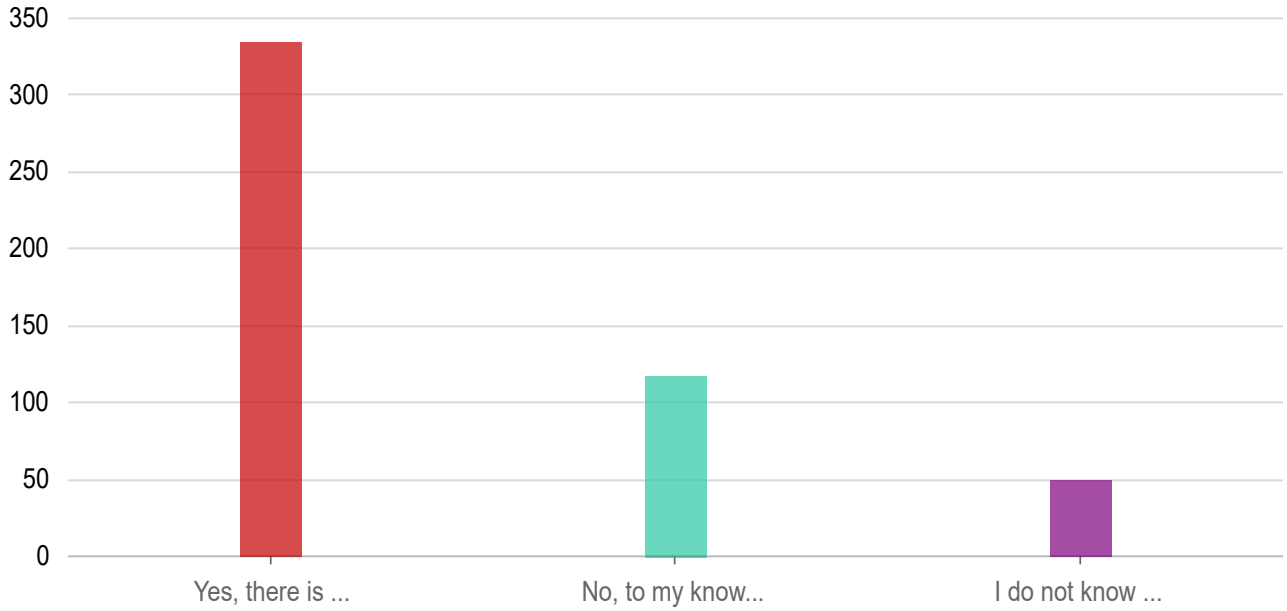


Answers	Count	Percentage
Vacation Rental	11	2.16%
Long-term Rental	17	3.34%
Bed/Breakfast	0	0%
Hotel/Motel	19	3.73%
Apartment	6	1.18%
Mobile Home(s)	3	0.59%
Resort	1	0.2%
Restaurant	5	0.98%
Other	44	8.64%

Answered: 106 Skipped: 403

About the Well and Water Use

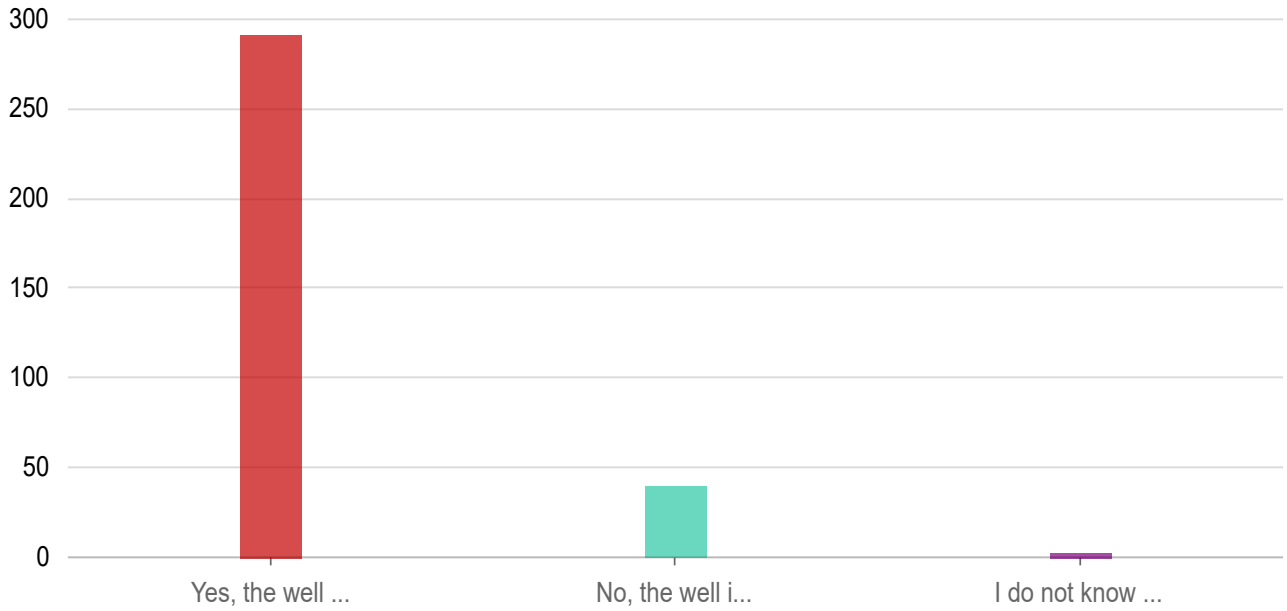
○ **Is there a well at this property?**



Answers	Count	Percentage
Yes, there is a well.	335	65.82%
No, to my knowledge there is not a well.	118	23.18%
I do not know if there is a well on this property.	50	9.82%

Answered: 503 Skipped: 6

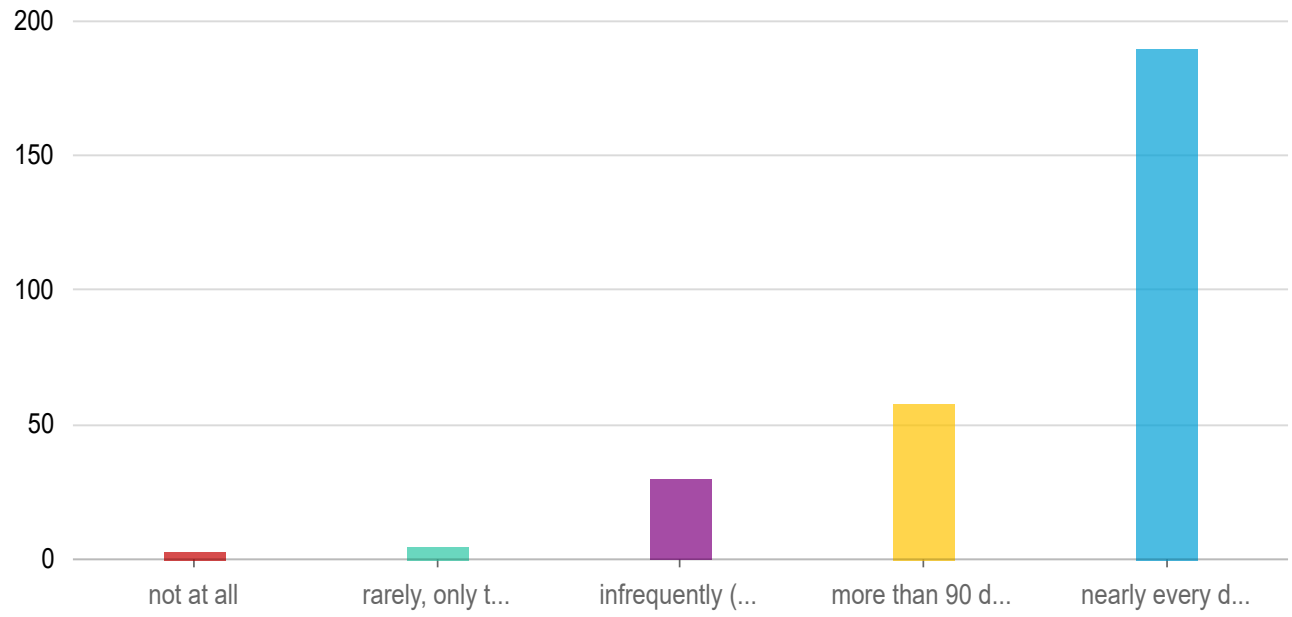
○ **Is the well in use?**



Yes, the well is used.	292	57.37%
No, the well is not used.	40	7.86%
I do not know whether the well is used.	3	0.59%

Answered: 335 Skipped: 174

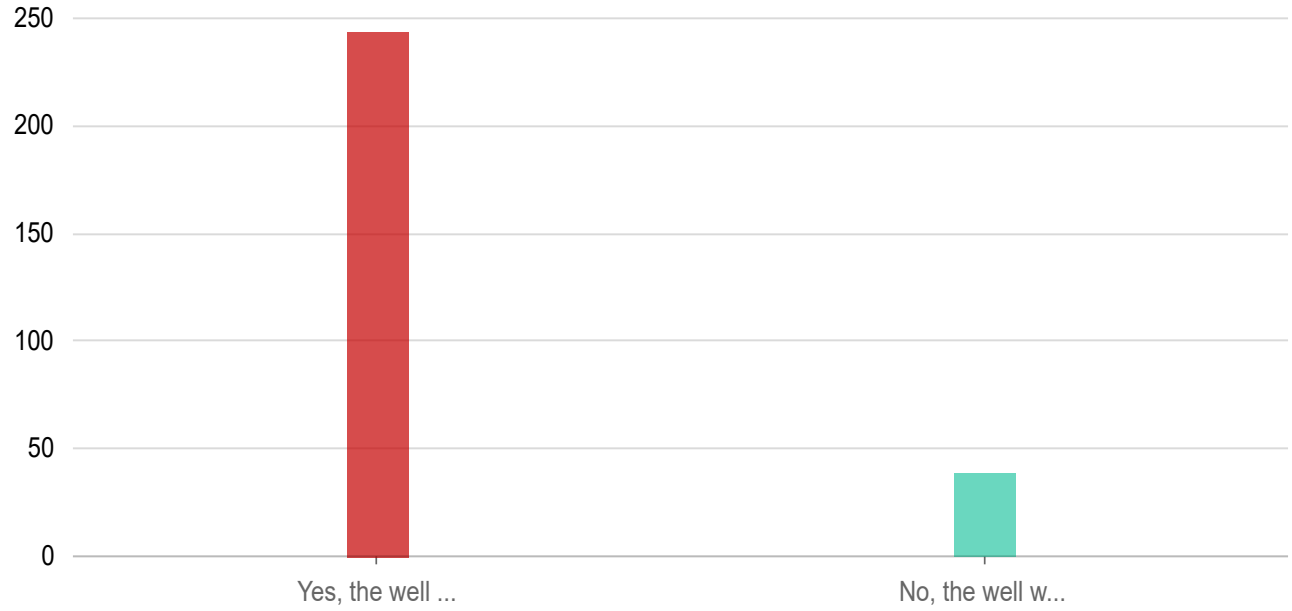
How often do you use the well?



Answers	Count	Percentage
not at all	3	0.59%
rarely, only to check or maintain it (less than 15 days a year)	5	0.98%
infrequently (approx. 15 to 90 days a year)	30	5.89%
more than 90 days a year (but not every day)	58	11.39%
nearly every day	190	37.33%

Answered: 286 Skipped: 223

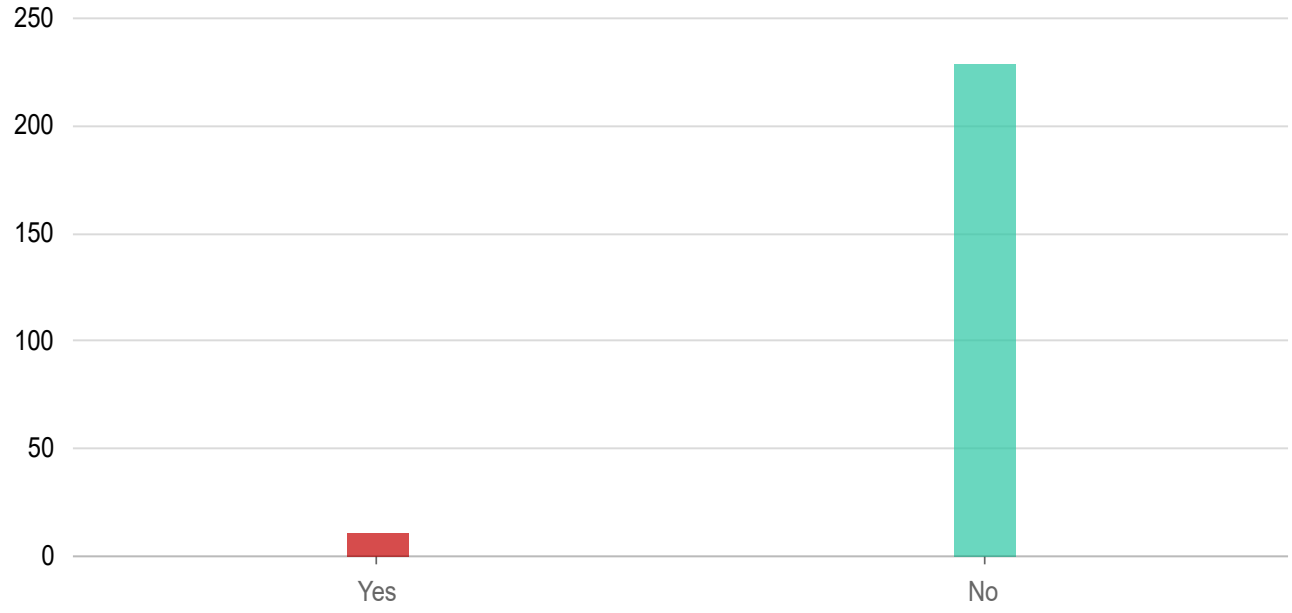
Is the well the primary source of household or business water?



Answers	Count	Percentage
Yes, the well is the primary source of water.	244	47.94%
No, the well water is not used for household or business purposes but is used solely for irrigation.	39	7.66%

Answered: 283 Skipped: 226

○ Is there a secondary, or backup, source of household water?

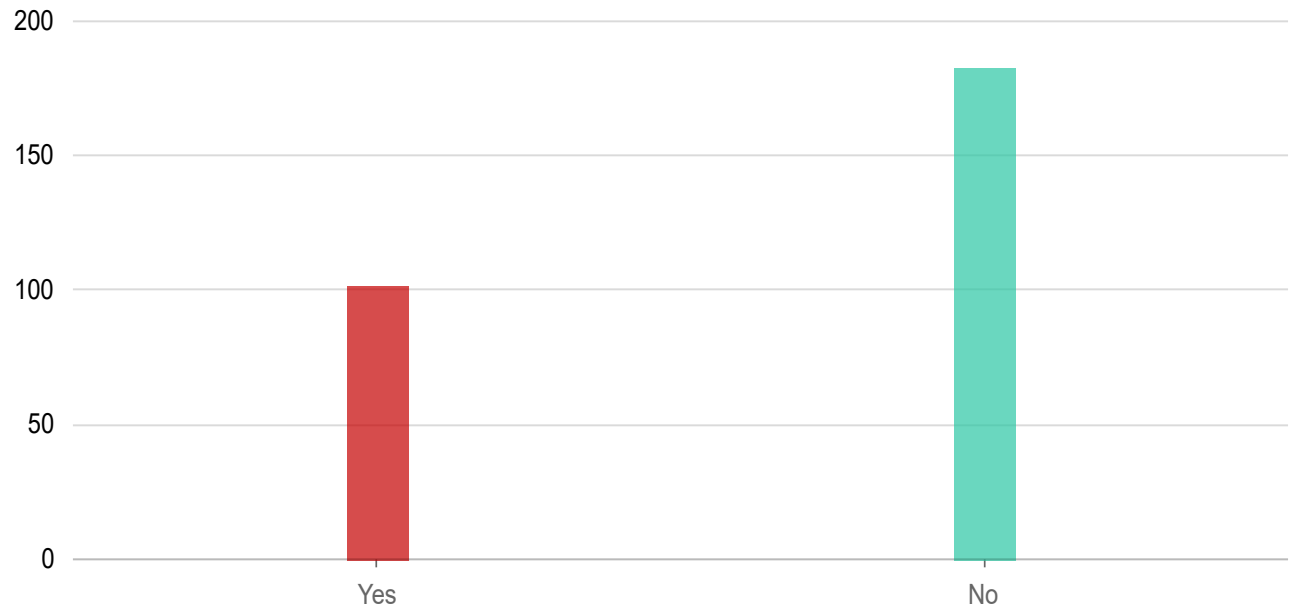


Answers	Count	Percentage

Yes	11	2.16%
No	229	44.99%

Answered: 240 Skipped: 269

○ **May [I/We] view the well?**

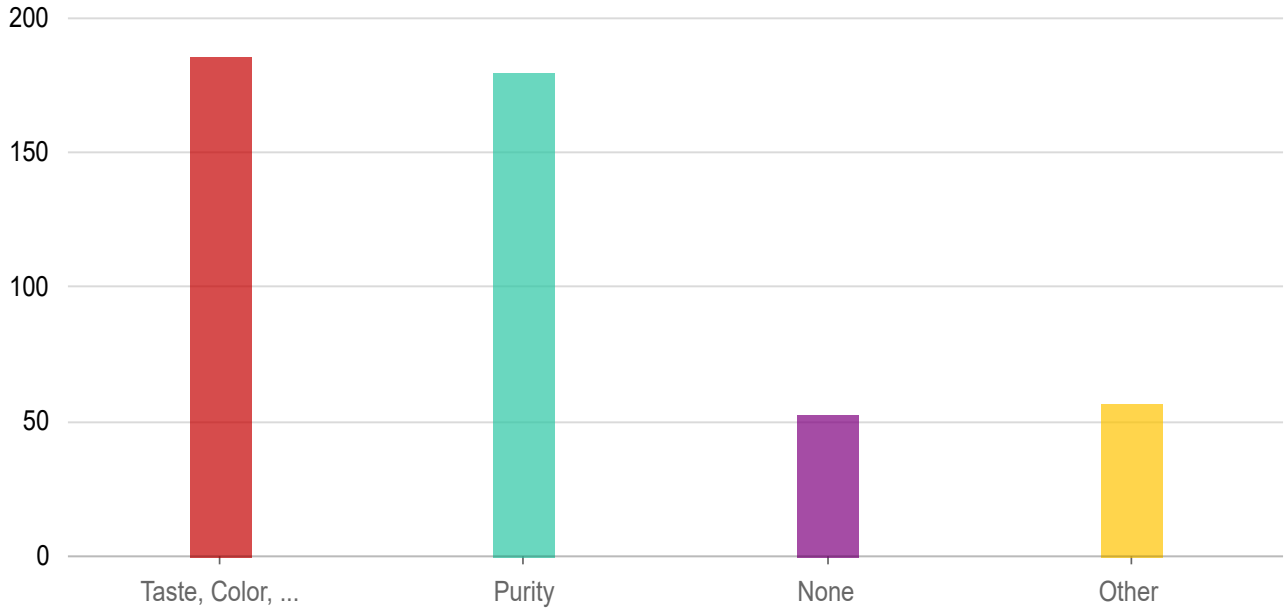


Answers	Count	Percentage
Yes	102	20.04%
No	183	35.95%

Answered: 285 Skipped: 224

About the Well Water Quality

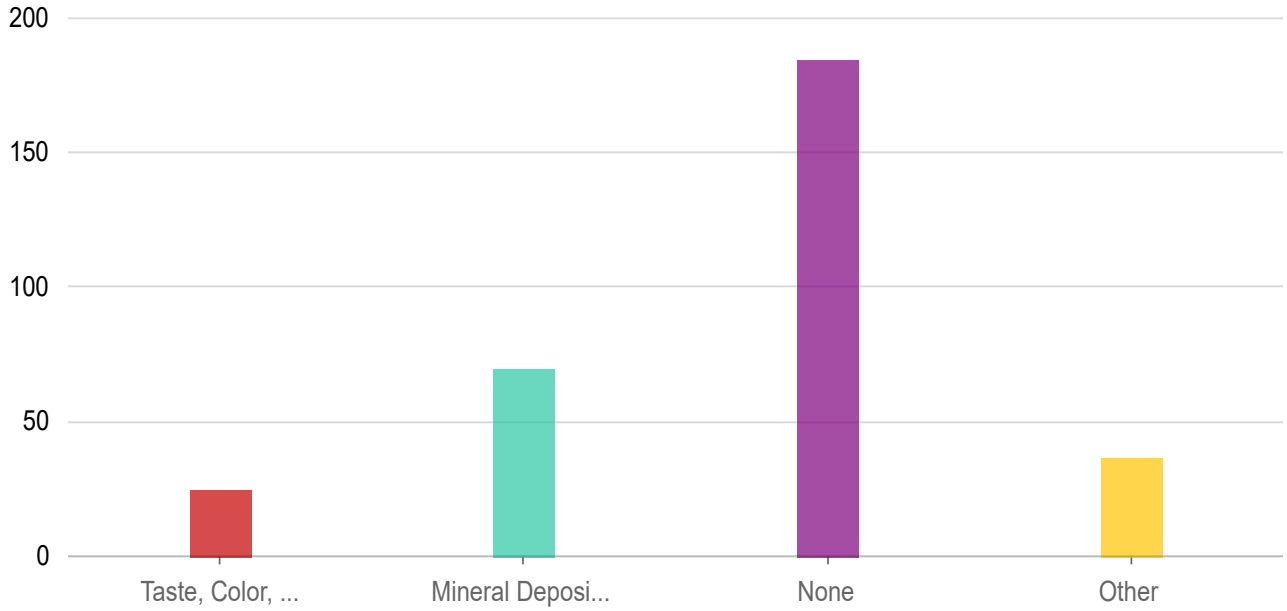
○ **What qualities of the well water do you most like?**



Answers	Count	Percentage
Taste, Color, Odor	186	36.54%
Purity	180	35.36%
None	53	10.41%
Other	57	11.2%

Answered: 302 Skipped: 207

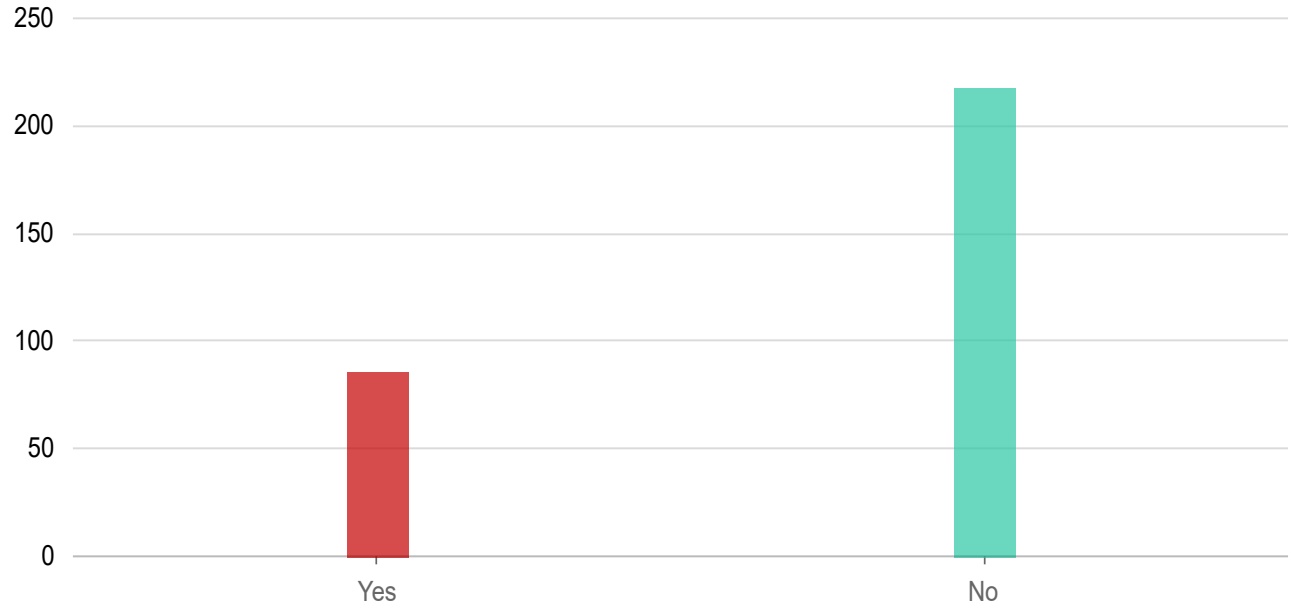
○ **What qualities of the well water do you most dislike?**



Answers	Count	Percentage
Taste, Color, Odor	25	4.91%
Mineral Deposits	70	13.75%
None	185	36.35%
Other	37	7.27%

Answered: 300 Skipped: 209

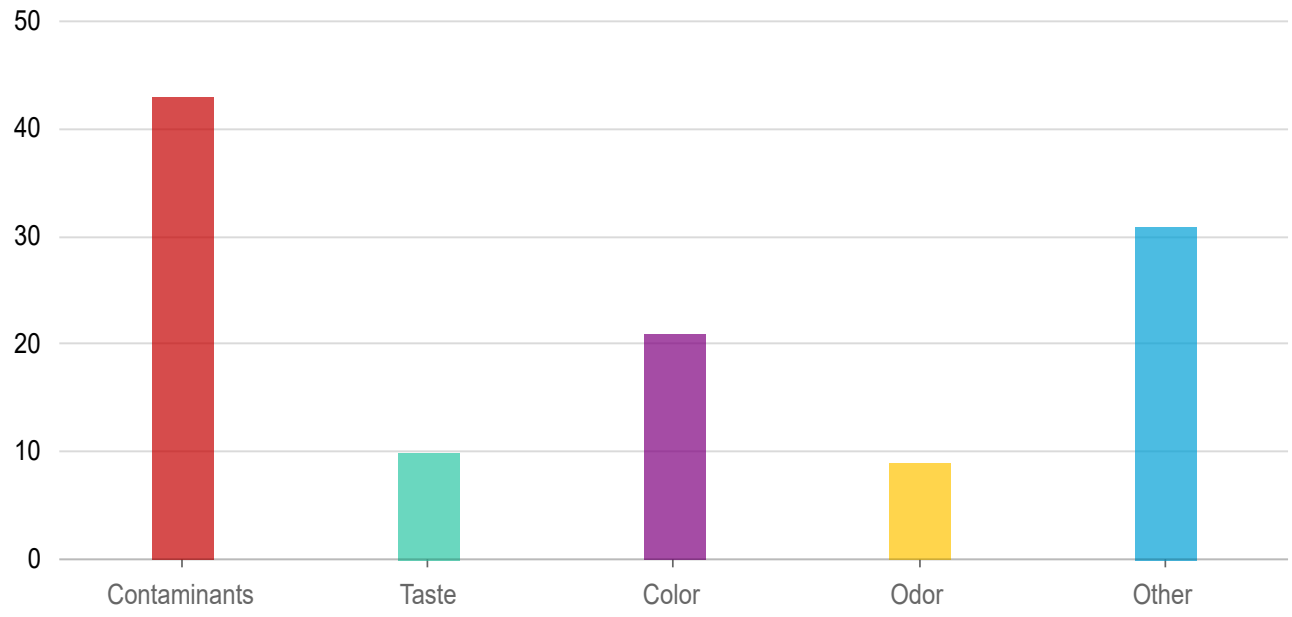
○ **Do you now or have you ever had any concern about the well water?**



Answers	Count	Percentage
Yes	86	16.9%
No	218	42.83%

Answered: 304 Skipped: 205

○ The well water concern is/was in regard to:



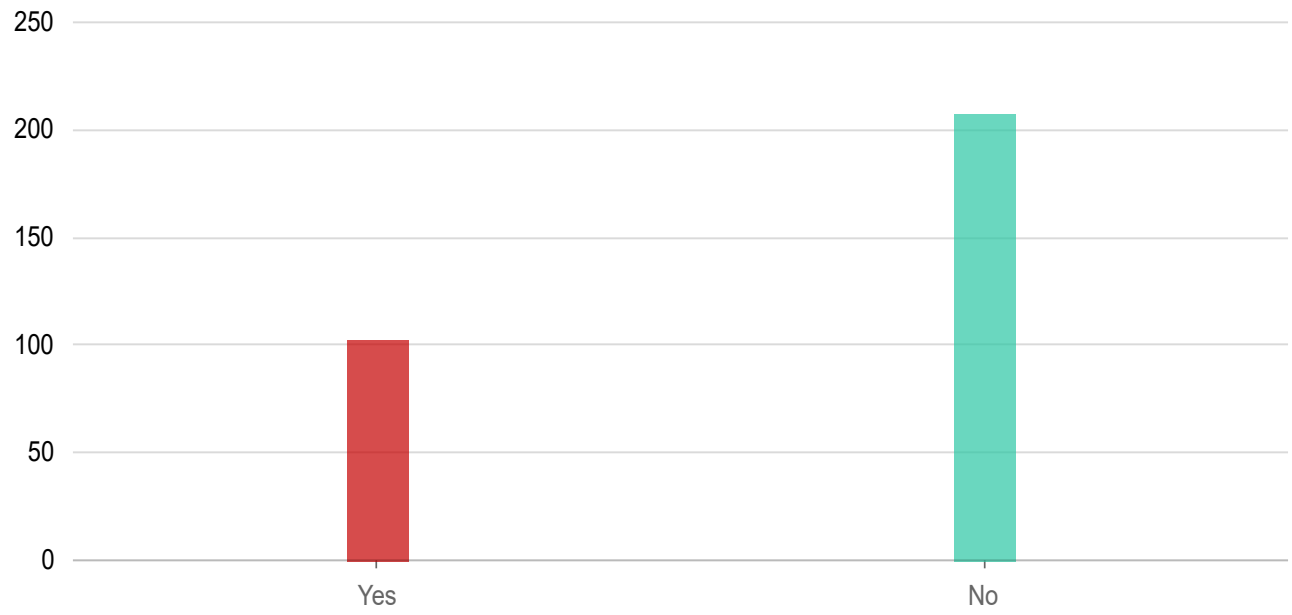
Answers	Count	Percentage

Contaminants	43	8.45%
Taste	10	1.96%
Color	21	4.13%
Odor	9	1.77%
Other	31	6.09%

Answered: 85 Skipped: 424

About the Water Well Condition

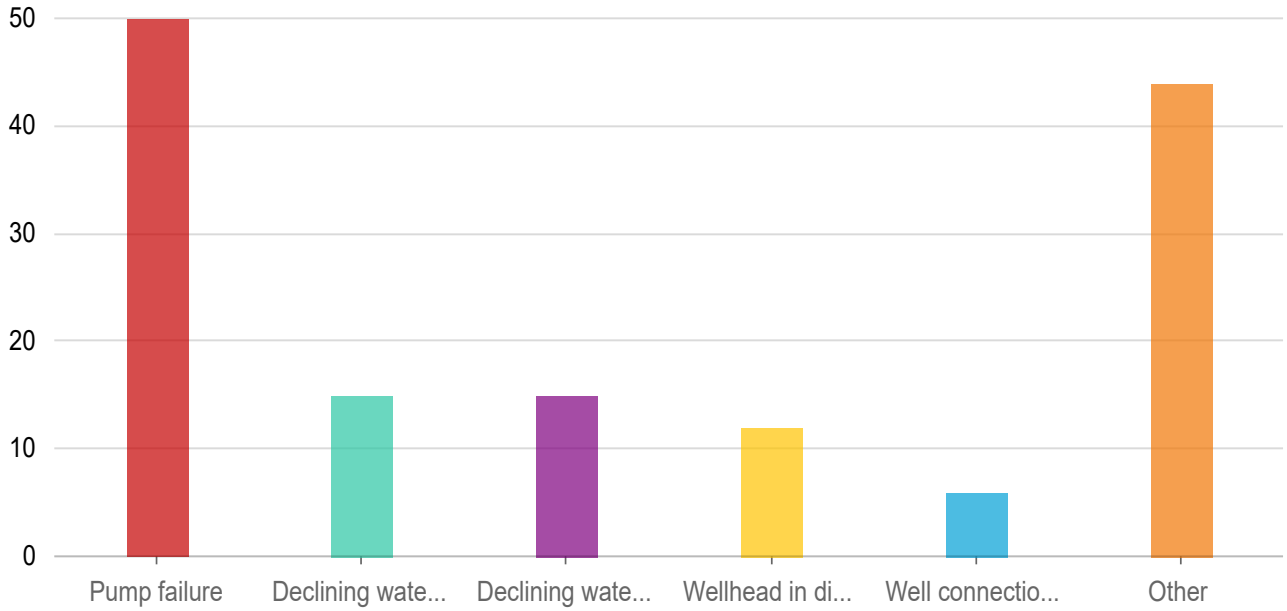
○ Do you now or have you ever had any concern about the well system?



Answers	Count	Percentage
Yes	103	20.24%
No	208	40.86%

Answered: 311 Skipped: 198

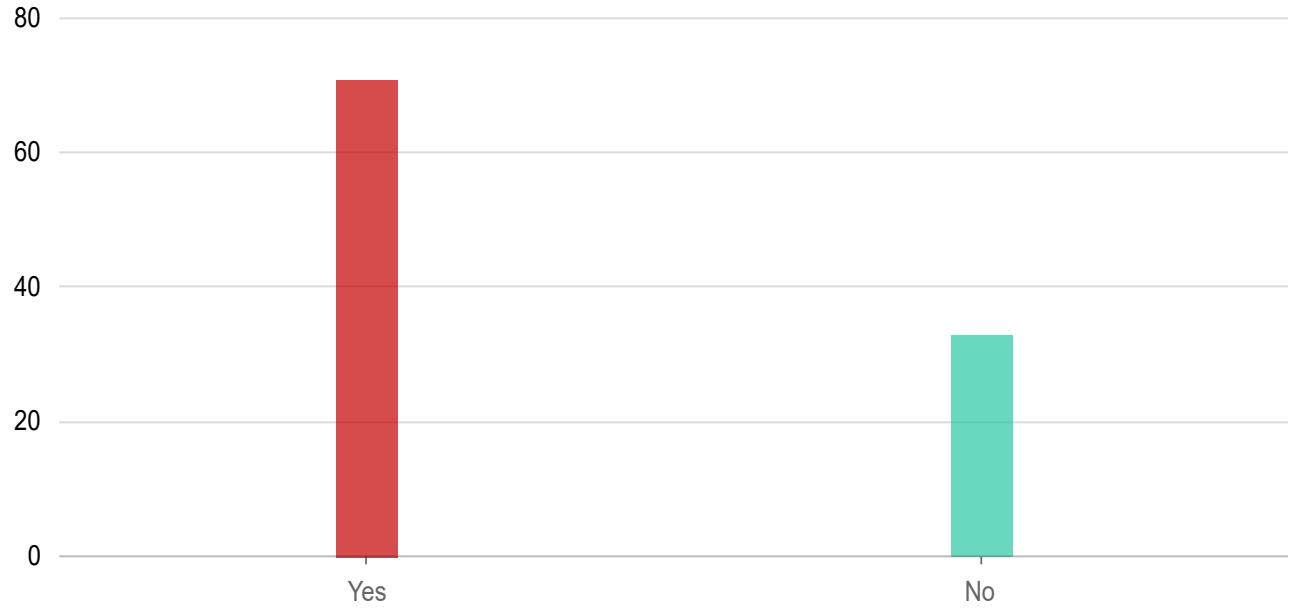
○ Well concerns:



Answers	Count	Percentage
Pump failure	50	9.82%
Declining water production	15	2.95%
Declining water quality	15	2.95%
Wellhead in disrepair or lacking tight seal	12	2.36%
Well connection to house	6	1.18%
Other	44	8.64%

Answered: 103 Skipped: 406

○ **Has the concern about the system been resolved?**

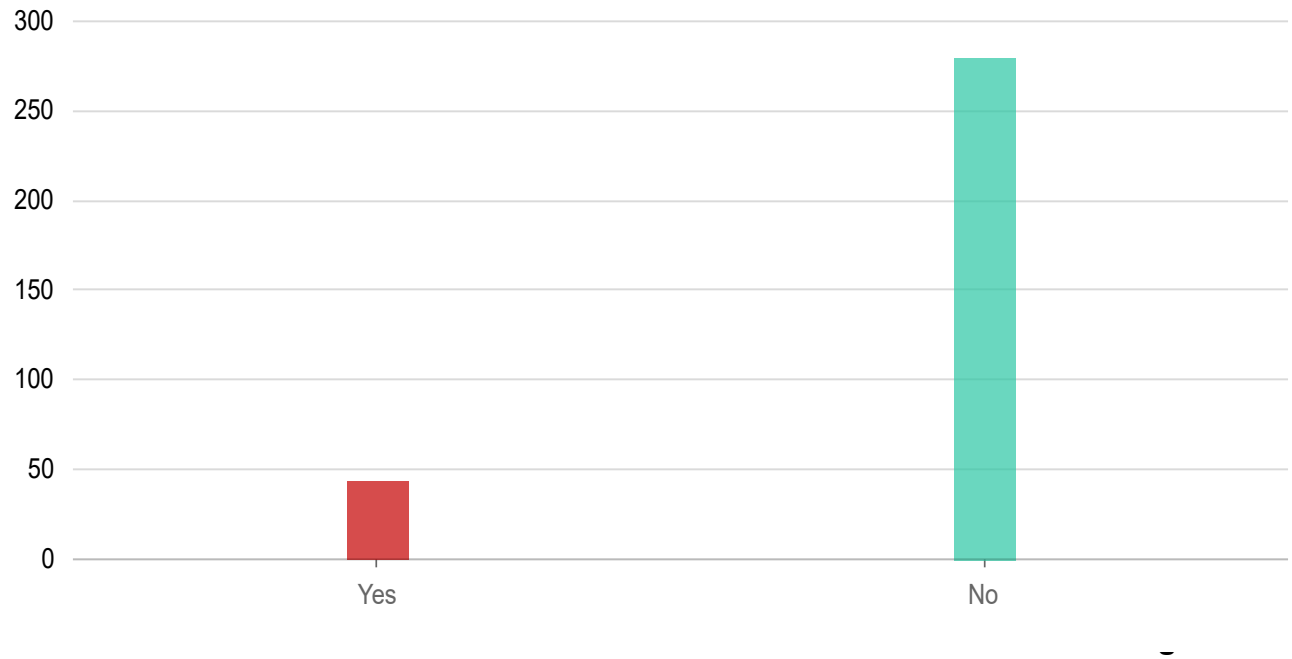


Answers	Count	Percentage
Yes	71	13.95%
No	33	6.48%

Answered: 104 Skipped: 405

About Support Available to Well Owners, Users and Managers

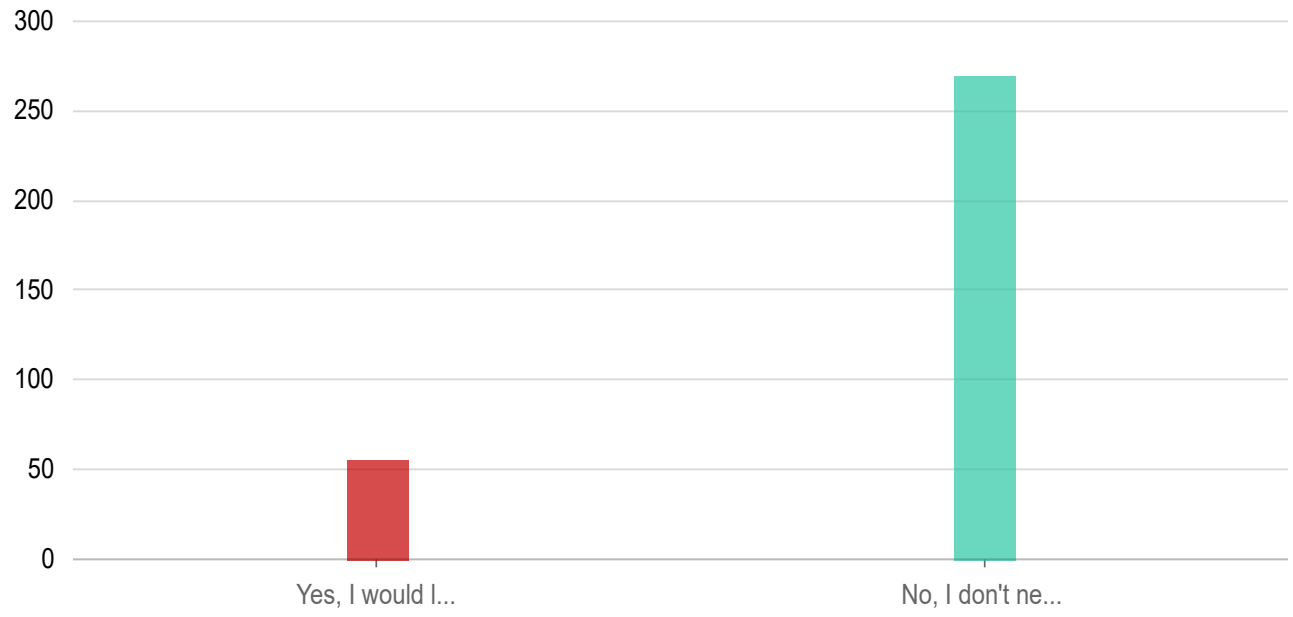
○ Are you interested in receiving information about County guidelines and requirements for well aban…



Yes	44	8.64%
No	280	55.01%

Answered: 324 Skipped: 185

○ Would you like information about connecting to a public water system?

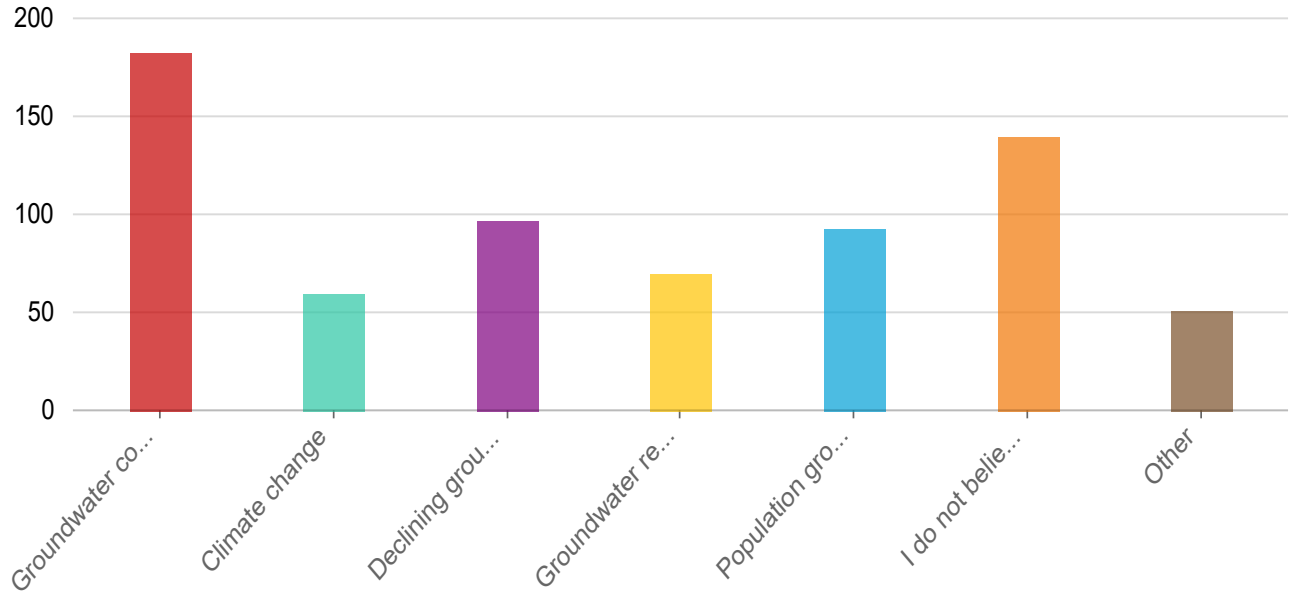


Answers	Count	Percentage
Yes, I would like to know more about connecting to the public water system.	56	11%
No, I don't need any information about connecting to the publi c water system.	270	53.05%

Answered: 326 Skipped: 183

About Groundwater

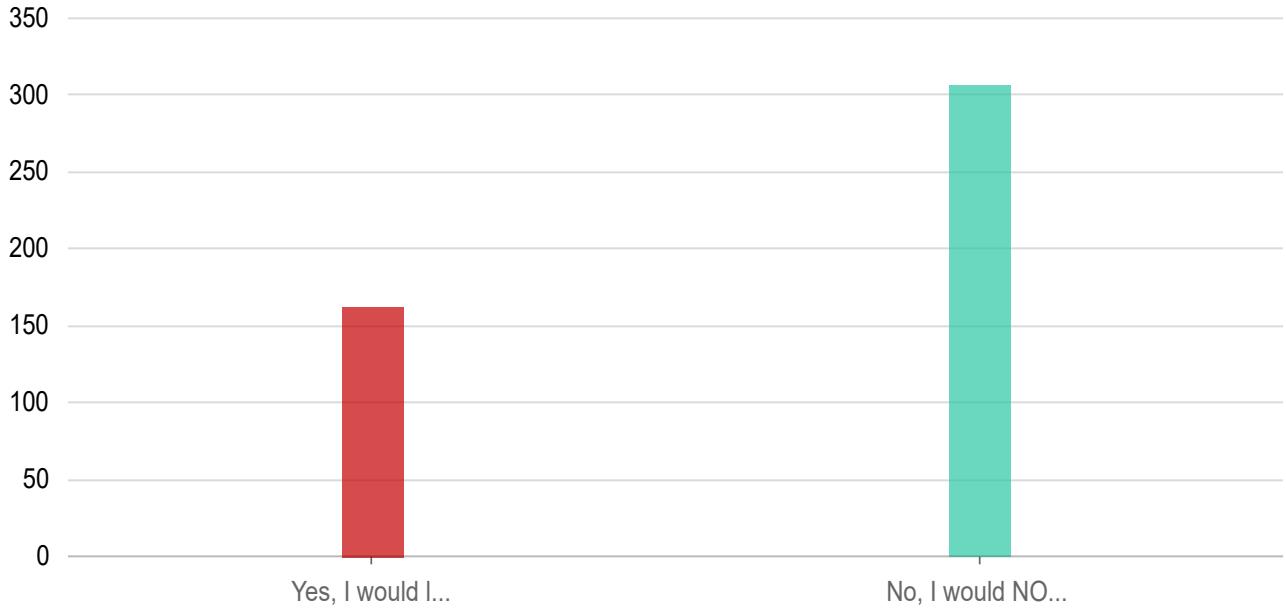
○ What do you consider the top three groundwater concerns in our South Tahoe community?



Answers	Count	Percentage
Groundwater contamination	183	35.95%
Climate change	60	11.79%
Declining groundwater levels	97	19.06%
Groundwater regulation	70	13.75%
Population growth; future water demands	93	18.27%
I do not believe there are any groundwater-related concerns in the South Shore area.	140	27.5%
Other	51	10.02%

Answered: 408 Skipped: 101

○ **Would you like to receive occasional District email updates about local groundwater management an…**



Answers	Count	Percentage
Yes, I would like to be on the District's groundwater email list	163	32.02%
No, I would NOT like to be on the District's groundwater email list	307	60.31%

Answered: 470 Skipped: 39

Tahoe Valley South Subbasin Groundwater Management Plan Stakeholder Advisory Group Workshop March 25, 2021

Site Cleanup Subaccount Program (SCAP) Regional PCE Investigation Update

Michael Novak, PG
AECOM

Introduction

- Site Cleanup Subaccount Program (SCAP) Regional Investigation Tasks
  - Records Review and Inventory Development
  - Regional PCE Plume Investigation
  - Vertical Conduit Evaluation and Destruction
  - Non-Municipal Water Supply Well Sampling
  - Soil Gas Sampling
  - Sentry Well Network Installation

2

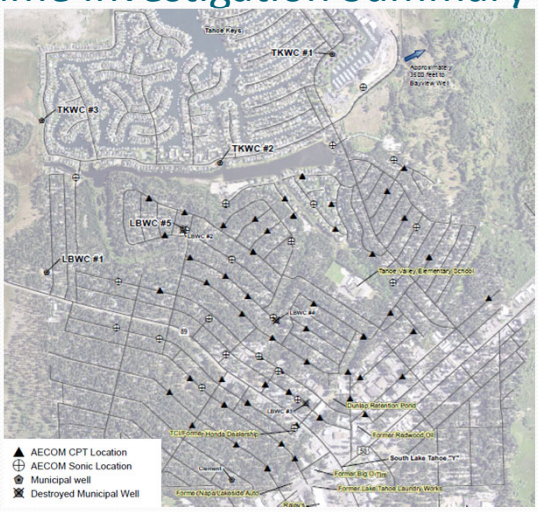
Regional PCE Plume Investigation Objectives

- Improve Conceptual Site Model
  - Develop understanding of regional subsurface lithology
  - Estimate lateral and vertical extent of PCE plume
- Support next steps
  - Design sentry wells (locations and depths of PCE near supply-well screen intervals)
  - Identify preferential pathways contributing to contaminant transport
  - Evaluate feasibility of potential remedial and receptor protection options

3

Regional PCE Plume Investigation Summary

- 22 sonic borings advanced to 300 feet bgs
- 57 Cone Penetration Test (CPT) borings advanced to 100 feet
- Approximately 6 - 8 groundwater samples collected per location



4

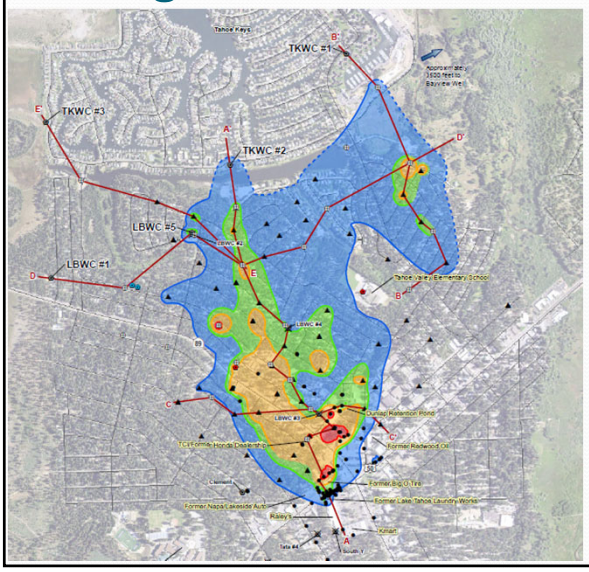
Lithology Groupings

- Continuous cores from the sonic borings were logged in accordance with the Unified Soil Classification System (USCS).
- CPT tip resistance and sleeve friction used to estimate soil type
- Earth Volumetric Studio™ (EVS) modeling software utilized to develop 3D lithologic model of the entire plume utilizing "Indicator Kriging".

USCS	Lithology
GP GW	Gravel
SM/SW-SM SW-SM SW-SP SP-SM SW/SP SP SW SW/SP-SM	Sand
SM SC SM/SP GM	Silty and clayey sand and gravel
SM/ML SP/CL SP/ML SP/ML/SM SP-SM/ML SW/ML CL/SP ML/SM ML/SP ML/SW	Interbedded sand, silt and clay
CL/ML CL-ML MH ML ML/CL CL	Silt and Clay

5

Boring and Cross Section Location Map



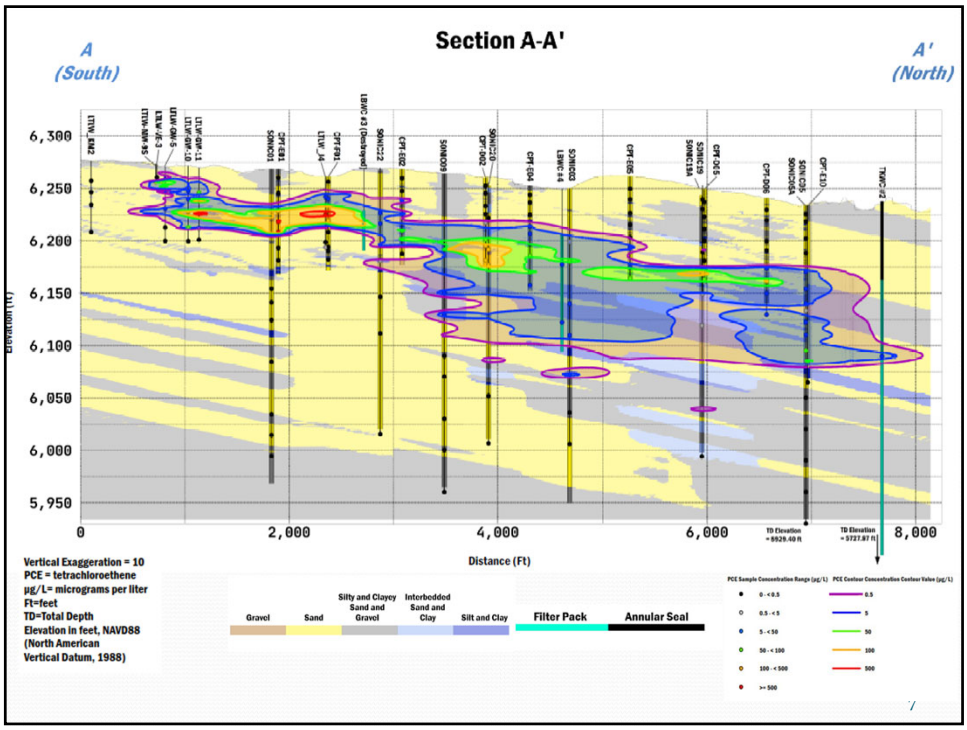
- AECOM CPT Location
- AECOM Sonic Location
- Historical Investigation Sample Location
- Municipal well
- Destroyed Municipal Well
- Private Well
- Small Community Well
- Cross Section Location

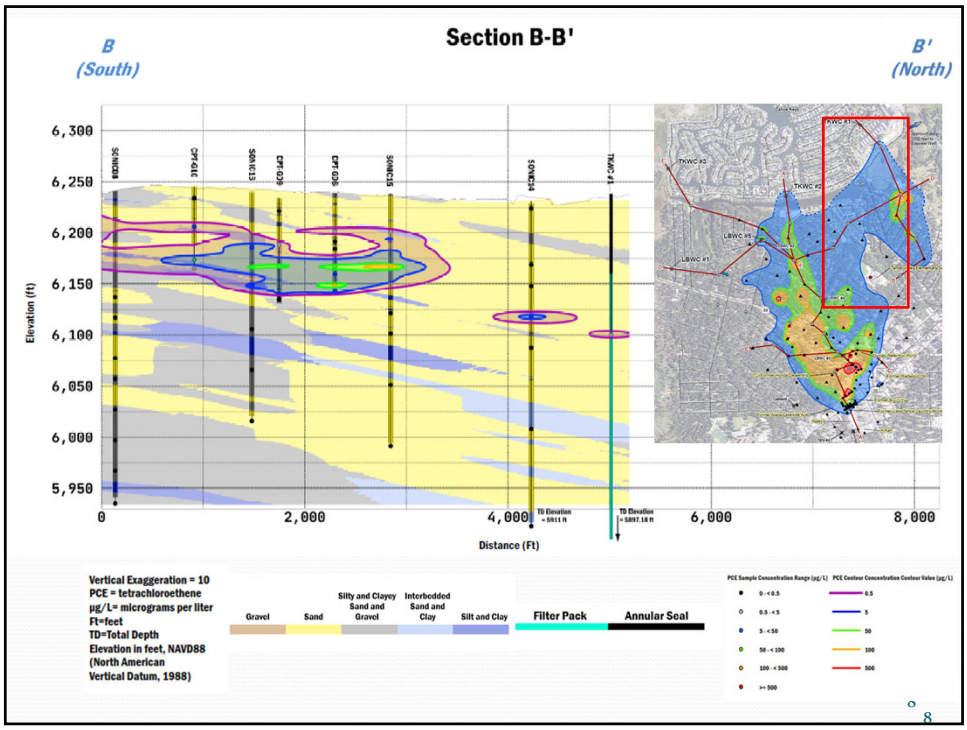
AECOM Sampled PCE Concentration Contours

- 5 - 50 µg/L
- 50 - 100 µg/L
- 100 - 500 µg/L
- >500 µg/L

PCE concentration data from January 1st, 2017 to present. Max concentration from 2018 to present was used if multiple sampling events were conducted over the past four years.

6


Section A-A'
A
(South)
A'
(North)
Elevation (ft)
Distance (Ft)
Vertical Exaggeration = 10
PCE = tetrachloroethene
µg/L= micrograms per liter
Ft=feet
TD=Total Depth
Elevation in feet, NAVD88
(North American
Vertical Datum, 1988)
Gravel
Sand
Silty and Clayey Sand and Gravel
Interbedded Sand and Clay
Silt and Clay
Filter Pack
Annular Seal


Section B-B'
B
(South)
B'
(North)
Elevation (ft)
Distance (Ft)
Vertical Exaggeration = 10
PCE = tetrachloroethene
µg/L= micrograms per liter
Ft=feet
TD=Total Depth
Elevation in feet, NAVD88
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Gravel
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Silty and Clayey Sand and Gravel
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Filter Pack
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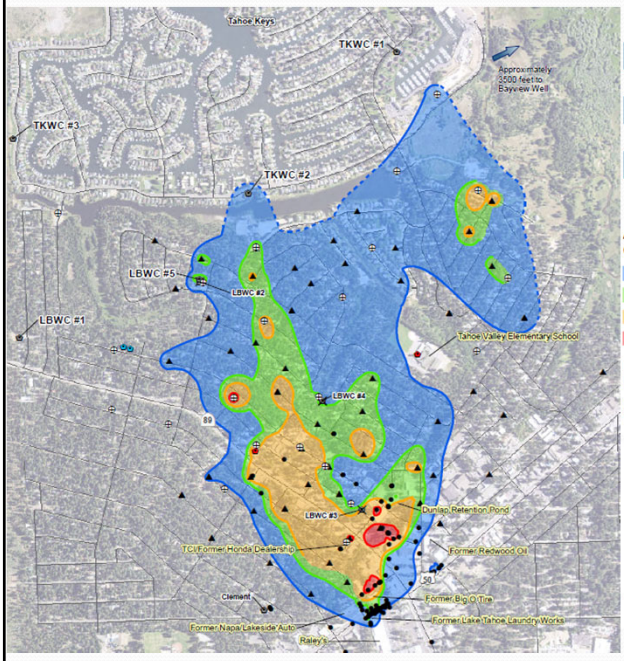

PCE Isoconcentration Map

AECOM Sampled PCE Concentration Contours

- 5 - 50 µg/L
- 50 - 100 µg/L
- 100 - 500 µg/L
- >500 µg/L

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- AECOM CPT Location
- AECOM Sonic Location
- Historical Investigation Sample Location
- Municipal well
- Destroyed Municipal Well
- Private Well
- Small Community Well
- Cross Section Location

9

2021 SCAP Schedule Summary

- **Sentry Well Installation and Sampling**
  - Evaluate receptor inventory against lithology and PCE plume
  - Work with stakeholders to finalize location and construction details
  - Well Installation, Development and Sampling – July/August 2021
- **Vertical Conduit Destruction**
  - Evaluate vertical conduit inventory against lithology and PCE plume to identify potential vertical conduits
  - Well Decommissioning (if warranted) of select, prioritized vertical conduits – June/July 2021

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2021 SCAP Field Schedule Summary (continued)

- **Soil Gas Sampling**
  - Identify proposed sampling locations based on Source Area Inventory, evaluation of shallow groundwater contamination, and potential vapor-intrusion receptors
  - Complete soil gas investigation and risk screening
  - Fieldwork July/August 2021
- **Non-Municipal Well Sampling**
  - Identify proposed new sampling locations based on receptor inventory and participant response
  - Sampling June 2021

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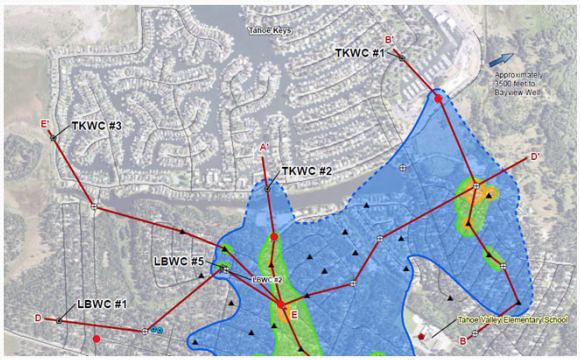
Sentry Well Network Installation

- Task Objective: Install sentry well network upgradient from threatened/impacted receptors



- Sentry well network installation anticipated to occur in July/August 2021
- Contract task includes four semi-annual monitoring events

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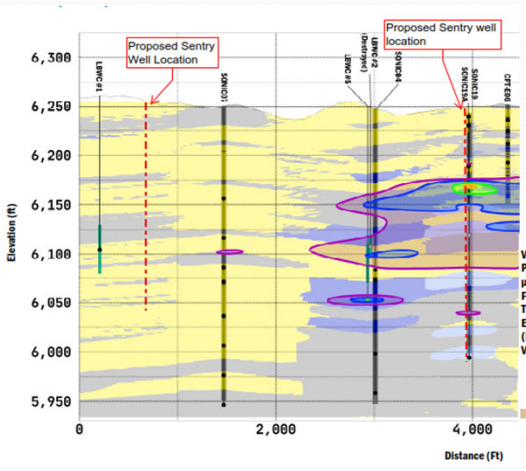
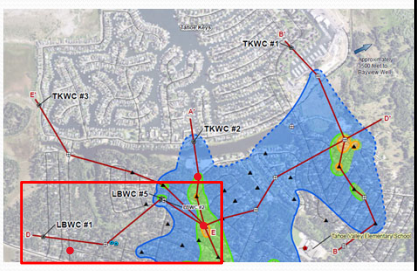
LBWC #1 and LBWC #5 Cross Section





Vertical Exaggeration = 10
PCE = tetrachloroethene
µg/L= micrograms per liter
Ft=feet
TD=Total Depth
Elevation in feet, NAVD88
(North American
Vertical Datum, 1988)

PCE Sample Concentration Range (µg/L): 0 - < 0.5; 0.5 - < 5; 5 - < 50; 50 - < 100; 100 - < 500; >= 500
PCE Contour Concentration Contour Value (µg/L): 0.5; 5; 50; 100; 500

Gravel | Sand | Silty and Clayey Sand and Gravel | Interbedded Sand and Clay | Silt and Clay

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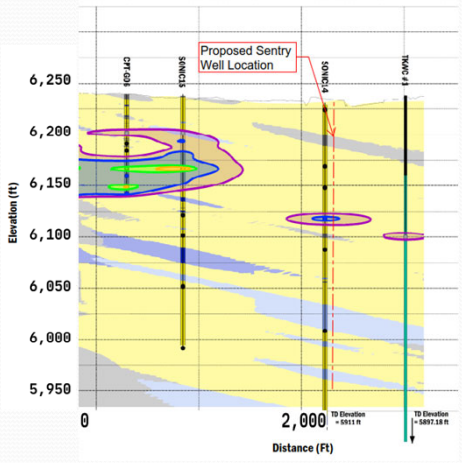
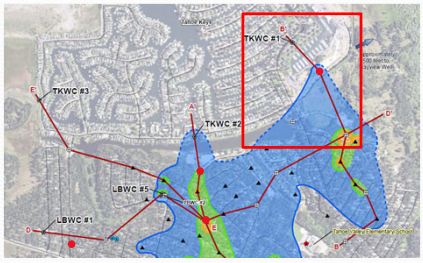
TKWC#1 Cross Section





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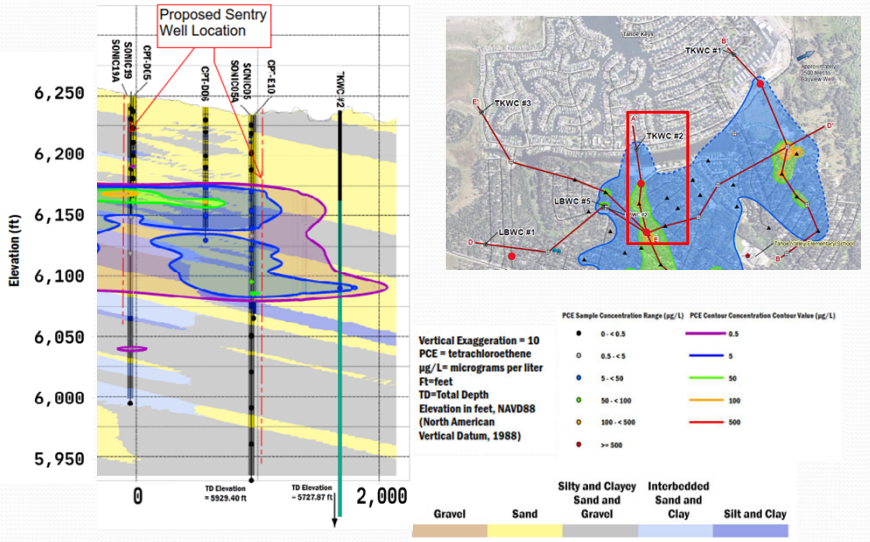
PCE Contour Concentration Contour Value (µg/L): 0.5; 5; 50; 100; 500

Gravel | Sand | Silty and Clayey Sand and Gravel | Interbedded Sand and Clay | Silt and Clay

14

TKWC #2 Cross Section



15

Soil Gas Sampling

- Task Objective: Evaluate potential threat to human health from vapor intrusion
  - Install shallow (5 ft) and deeper (10 ft) soil gas probes
  - Soil vapor samples will be collected in accordance with the Active Soil Gas Investigation Advisory
  - Conduct a Tier 1 Human Health Risk Assessment using soil gas investigation data
- Soil gas sampling anticipated to occur in August/September 2021

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Non-Municipal Water Supply Well Sampling

- Task Objective: Identify and sample domestic wells
  - 8 domestic wells sampled in October 2019
  - PCE was not detected above the RL of 0.5 ug/L in the 7 active wells and detected at 0.5 ug/L in the inactive well at Tahoe Valley Elementary
  - Two active wells were identified and property owners did not allow access
- Second round of sampling scheduled for June 2021
  - Re-sample 8 original wells sampled in 2019 plus any other identified threatened receptor wells

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Questions?

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GWMP 5-Year Update
Groundwater Model Evaluation

Susie Rybarski
Mark Hausner

DRI
Desert Research Institute

DWR Recommended actions To be addressed

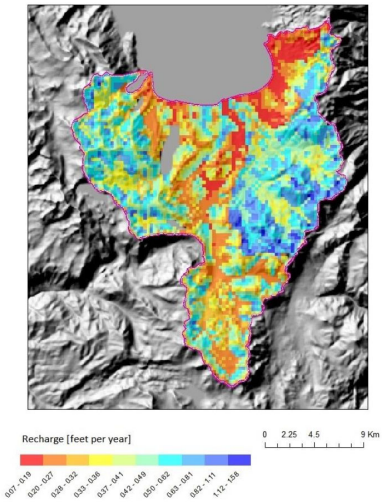
- **RA-1:** Provide water budget information in tabular form for the historical, current, and projected water budgets.
- **RA-2:** Provide a projected water budget incorporating climate change over the planning and implementation horizon of 50 years. Address the apparent discrepancy between the Groundwater Management Plan indicating a shift from snow to rain and the Urban Water Management Plan indicating no detrimental effects on the Subbasin.
- **RA-3:** Reconcile the differing future water demand trend projections between the Groundwater Management Plan, Urban Water Management Plan, and incorporate the reconciliation into the projected water budget.
- **RA-5:** Provide additional explanation for how pumping may impact plume migration or cause degraded water quality.
- **RA-6:** Provide estimates of the quantity and timing of depletions of interconnected surface water and further define what would cause depletions to become significant and unreasonable for the Subbasin.
- **RA-7:** Define quantitative criteria for groundwater levels, storage, and depletion of interconnected surface water that can be used to objectively determine compliance of the Plan with the objectives of SGMA on an ongoing basis.
- **RA-8**: Provide a description of data gaps and how they will be addressed

DRI tasks to address recommended actions

- **Task 1:** Develop updated water budgets for the 50-year planning horizon, including climate change and population growth (Addresses RA-1, RA-2, RA-3).
- **Task 2:** Summarize findings from the South Y PCE Model for inclusion in the plan (Addresses RA-5).
- **Task 3:** Delineate a Groundwater Management Area (GMA) based on the capture of water from streams and develop area-specific sustainability indicators and minimum thresholds for the undesirable results "depletion of interconnected surface water" (Addresses RA-6).
- **Task 4:** Recommend for the entire basin a set of quantitative sustainability indicators, representative monitoring sites, and minimum thresholds designed to prevent the undesirable results:
  - Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
  - Significant and unreasonable reduction of groundwater storage
  - Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
  - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water
- **Task 5:** Identify data gaps that arise in addressing these issues and make recommendations on how to address those gaps (Addresses RA-8).

Task 1: Develop 50-year water budgets

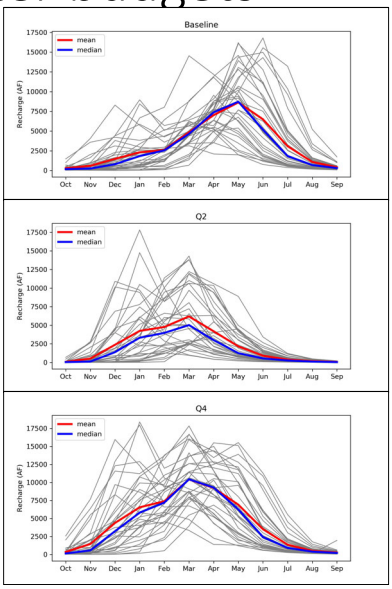
- Predictive water budgets must incorporate climate effects and changes in pumping
- Extended climate projections previously developed to address 2014 GWMP BMOs to 2099
- Projected annual pumping rates according to projections of population growth and water demand (California Dept of Finance, 2020) following historical seasonal distribution
- Existing South Tahoe groundwater model has been updated with revised recharge rates, projected pumping, and projected lake stages for a baseline model and 5 projected climate scenarios; models run through 2099



Task 1: Develop 50-year water budgets

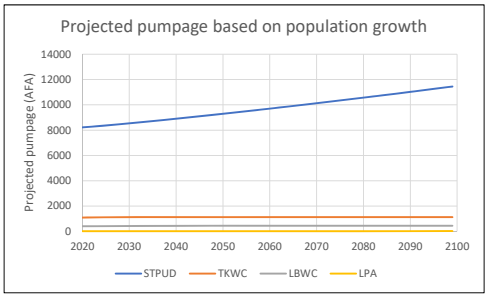
- Five climate scenarios previously developed using global climate models (CMIP5) for 2075-2099
  - Q1 – warm and dry
  - Q2 – hot and dry
  - Q3 – hot and wet
  - Q4 – warm and wet
  - Q5 – hot with no change in precipitation
- GW recharge calculated in GSFLOW for each climate scenario allows for spatial and temporal variability in recharge rates based on precipitation and temperature
- Climate scenarios assume warming/precipitation changes begin immediately; compare to historical baseline to create an envelope for predicted changes to flow budgets

Simulation	Mean (AF)	Median (AF)
Baseline	38790	34282
Q1 (warm/dry)	29206	24249
Q2 (hot/dry)	26026	19040
Q3 (hot/wet)	48254	41174
Q4 (warm/wet)	52303	46839
Q5 (warm)	36564	31119



Task 1: Develop 50-year water budgets

- Projecting pumping to future demand
  - Population projections (El Dorado County, 2020)
    - Estimated El Dorado County population growth rate for 2010-2060 = 0.37%
- Baseline (initial) pumping defined by 2007 pumpage (most conservative), future maximums defined by KJ, 2020 estimates.
- Total estimated pumpage distributed across wells in each system according to the ratio of use in 2019, and according to historical seasonal distribution to allow for monthly stress periods (LBWC 5 assumed to be online starting 10/2021).
- Pumpage at private well locations estimated based on PWOSI and PWOSII survey results



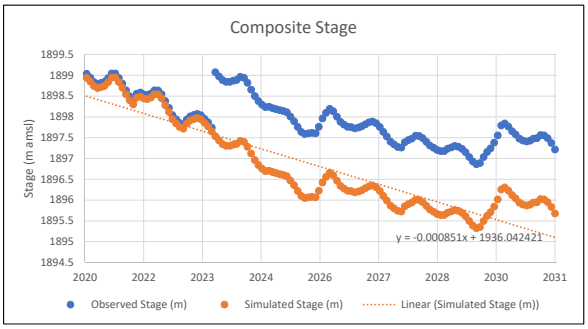
System	Future Maximum (AFA) 2007 rates + future requirement from KJ, 2020
STPUD	9241
LBWC	441
TKWC	1121
LPA	77

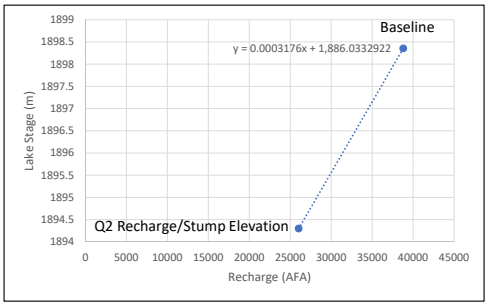
Lake Stage

- Lowest elevation submerged tree stump in Lake Tahoe at 6,214.9 ft dated to 6,300 yrs BP (Lindstrom, 1990) (compare to average of 6,228.2 ft for 1983-2015).
- Corresponding middle Holocene temperature increase of 3-5C, and reduction of runoff to Tahoe of >30% (Benson et al, 2002).
- Dry scenarios assume reduction of precipitation of 17%, temperature increase of 3-5C.
- Use 6,214.9 as low stage for Q2 (hot and dry) scenario

Lake Stage

- Generated a 'composite drought', using observed declines in stage for WY 2012-2014 and 1987-1994
- Used rate declines for Q2 (hot and dry), until mid-Holocene tree stump elevation was reached
- For all other scenarios, use stage/recharge regression to estimate equilibrium stage





Scenario	Recharge (AFA)	Lake Stage (ft)	WY Simulated	Notes
Baseline	38,790	6,228.2	2020-2099	Stage from mean of 1983-2015
Q1 (warm/dry)	29,206	6,218.2	2020-2099	Stage estimated from baseline and Q2 recharge/stage slope
Q2 (hot/dry)	26,026	6,214.9	2020-2099	Stage from submerged mid-Holocene tree stump elevation
Q3 (hot/wet)	48,254	6,232.0	2020-2099	Stage at legal limit
Q4 (warm/wet)	52,303	6,232.0	2020-2099	Stage at legal limit
Q5 (warm)	36,564	6,225.9	2020-2099	Stage estimated from baseline and Q2 recharge/stage slope

DRI tasks to address recommended actions

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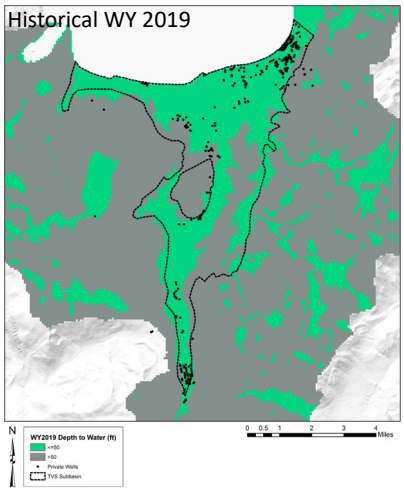
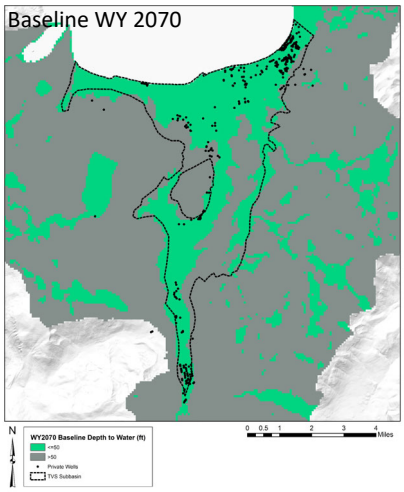
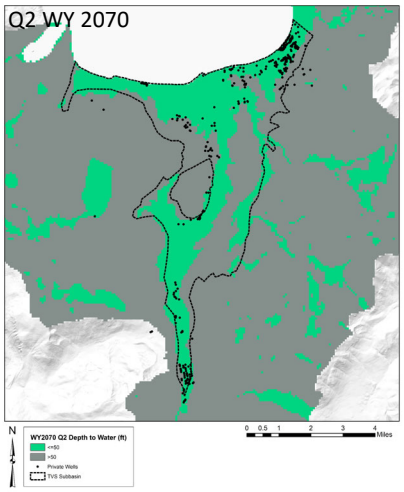
Private Well Impacts







Private Well Impacts

- 332 private wells
- Baseline WY2070 average decline in water levels at private wells = 3.7 ft
- Q2 WY2070 average decline in water levels at private wells = 15 ft

Scenario	Number of wells at DTW > 50 ft	Mean DTW (ft)	Median DTW (ft)
Historical WY 2019	34	20.90	13.12
Baseline WY2070	38	24.59	19.69
Q2 WY 2070	73	35.90	32.81

Production well drawdown/screened interval comparison

- Simulated drawdown assessed for Q2 (hot & dry) scenario from beginning of model run to end of WY 2070
- Predicted water levels adjusted to measured 11/2019 water levels where available

Well	Surface Elevation	Screen Top (ft)	Screen Bottom (ft)	WY 2070 Q2 Predicted WL Elevation (ft)	WY 2070 Q2 Predicted Height Above Screen (ft)
ALTAHOE2	6,255.37	6,145.44	5,855.44	6,201.59	56.15
ARROWHEAD3	6,343.10	6,088.97	6,058.97	6,283.99	195.02
BAKERSFIELD	6,313.74	6,183.10	6,003.09	6,273.99	90.89
BAYVIEW	6,255.49	6,071.59	5,711.59	6,212.79	141.19
COLLEGE	6,283.75	6,033.21	5,923.21	6,229.13	195.92
EIKSCLUB2	6,286.88	6,143.65	6,025.65	6,243.77	100.12
GLENWOOD5	6,259.00	6,143.65	6,025.65	6,219.25	75.59
HELEN2	6,250.18	6,160.27	6,100.26	6,206.87	46.61
LPA Well 3	6,244.31	6,075.31	5,903.31	6,219.17	143.86
LUKINSBROTHERS1	6,245.00	6,113.07	6,063.07	6,209.85	96.78
LUKINSBROTHERS2	6,245.00	6,113.07	6,089.07	6,211.79	98.72
LUKINSBROTHERS5	6,240.00	6,099.07	6,060.07	6,211.79	112.72
PALOMA	6,268.27	6,080.40	5,860.40	6,202.82	122.42
SUNSET	6,249.43	5,975.60	5,820.60	6,203.46	227.86
TAHOEKEYS1	6,235.00	6,110.07	5,923.07	6,210.55	100.47
TAHOEKEYS2	6,240.00	6,102.07	5,749.07	6,211.09	109.02
TAHOEKEYS3	6,237.00	6,062.07	5,937.07	6,207.57	145.50
UPPERTRUCKEE3	6,403.71	6,326.08	6,086.07	6,372.58	46.50
VALHALLA	6,256.87	6,143.65	6,025.65	6,206.83	63.18

DRI tasks to address recommended actions

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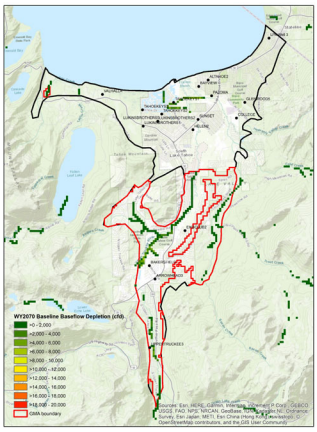
- **Task 5:** Identify data gaps that arise in addressing these issues and make recommendations on how to address those gaps (Addresses RA-8).

Task 3: Delineate a groundwater management area/develop sustainability indicators and minimum thresholds for this area

- Ran a groundwater model with no pumping (i.e. dynamic steady-state) for comparison with climate scenarios to produce monthly/annual depletion analyses.
- Spatial baseflow depletion analysis.
- GMA delineated using a capture map analysis, defined by cells expressing greater than 50% stream capture in any model layer.

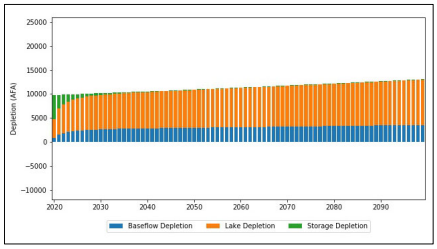


Depletion Analysis

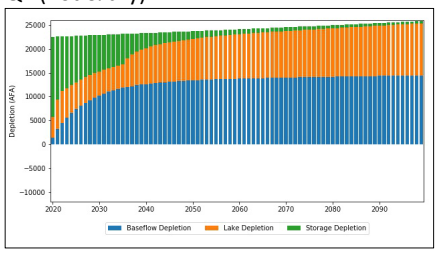
- Transient baseline model (WY2020-2099) with no pumping run for depletion analysis.
- Depletion of each flow budget component is calculated as the difference between the scenario flow budget and the no-pumping baseline model.
- For the baseline model, total system depletion is equal to the pumping rate; for climate models, total system depletion differs from the pumping rate with changes in recharge and lake stage.
- For Q3 and Q4 (wet scenarios), negative baseflow and storage depletions indicate an increase in those flows compared to the no-pumping transient simulation.

Depletion Analysis

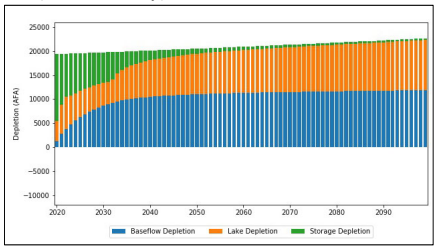
Baseline



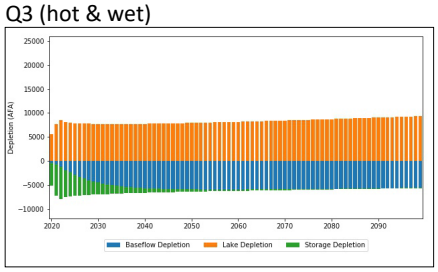
Q2 (hot & dry)



Q1 (warm & dry)

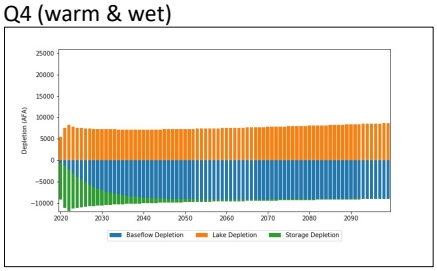


Q3 (hot & wet)

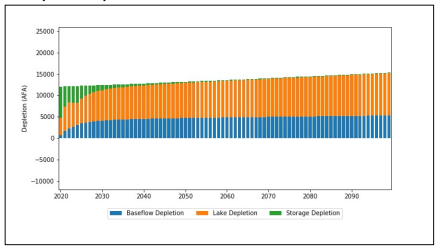


Depletion Analysis

Q4 (warm & wet)

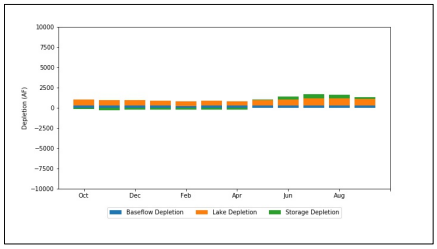


Q5 (warm)

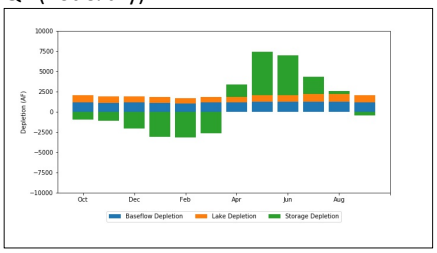


WY 2070 Monthly Depletion Analysis

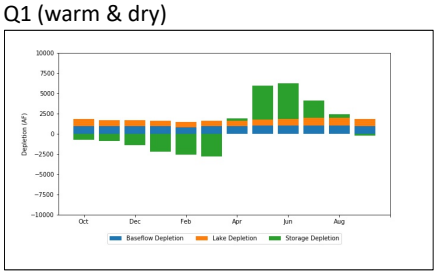
Baseline



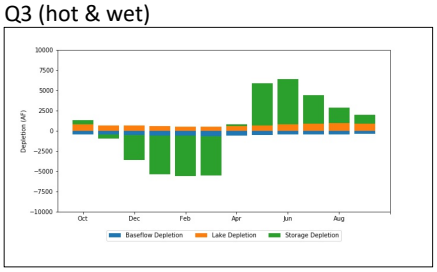
Q2 (hot & dry)



Q1 (warm & dry)

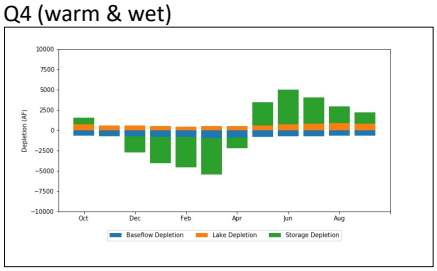


Q3 (hot & wet)

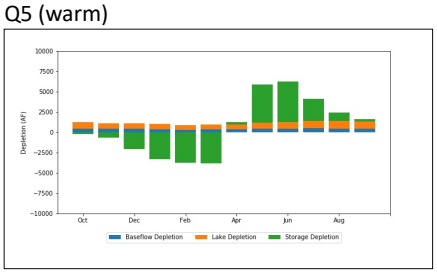


Depletion Analysis

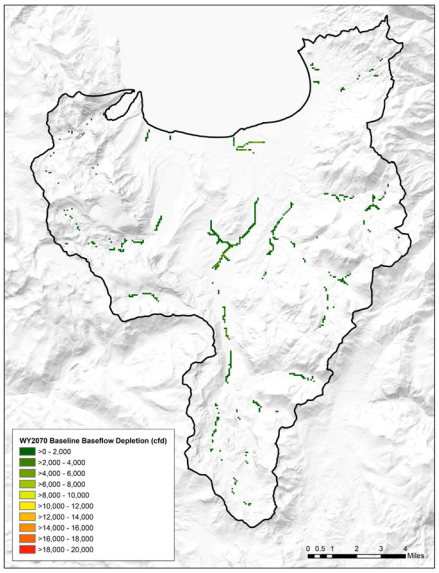
Q4 (warm & wet)

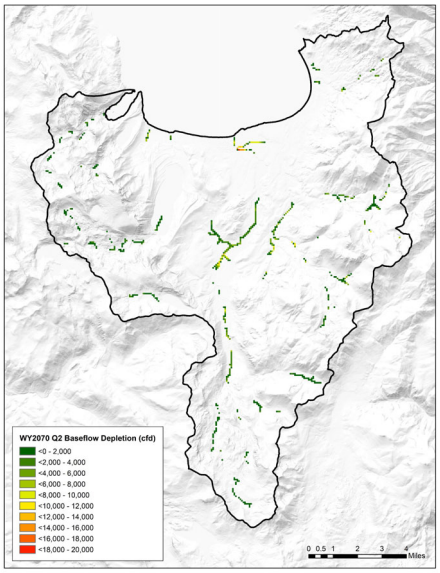


Q5 (warm)



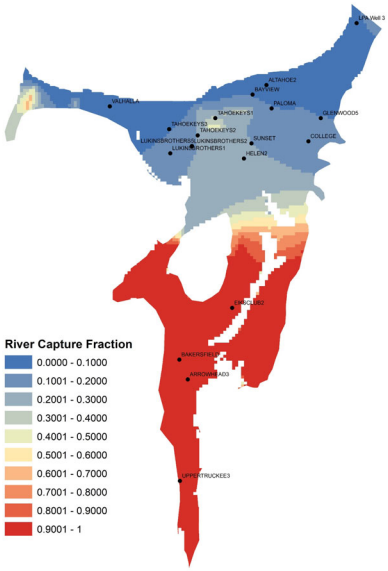
Baseflow Depletion Maps



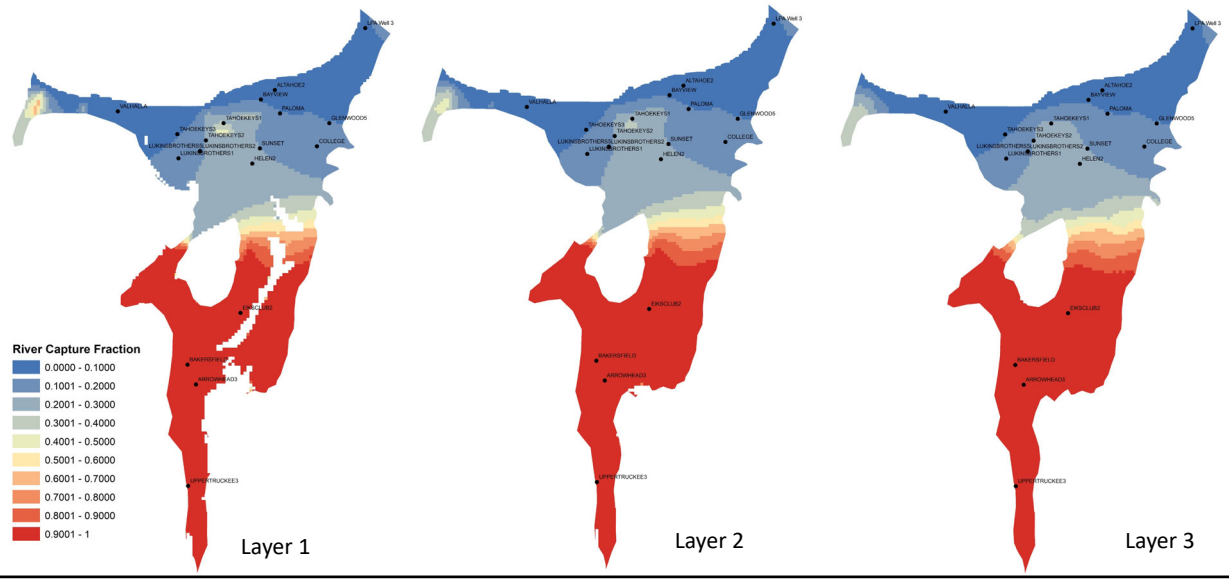


TASK 3: DELINEATE A GROUNDWATER MANAGEMENT AREA/DEVELOP SUSTAINABILITY INDICATORS AND MINIMUM THRESHOLDS FOR THIS AREA

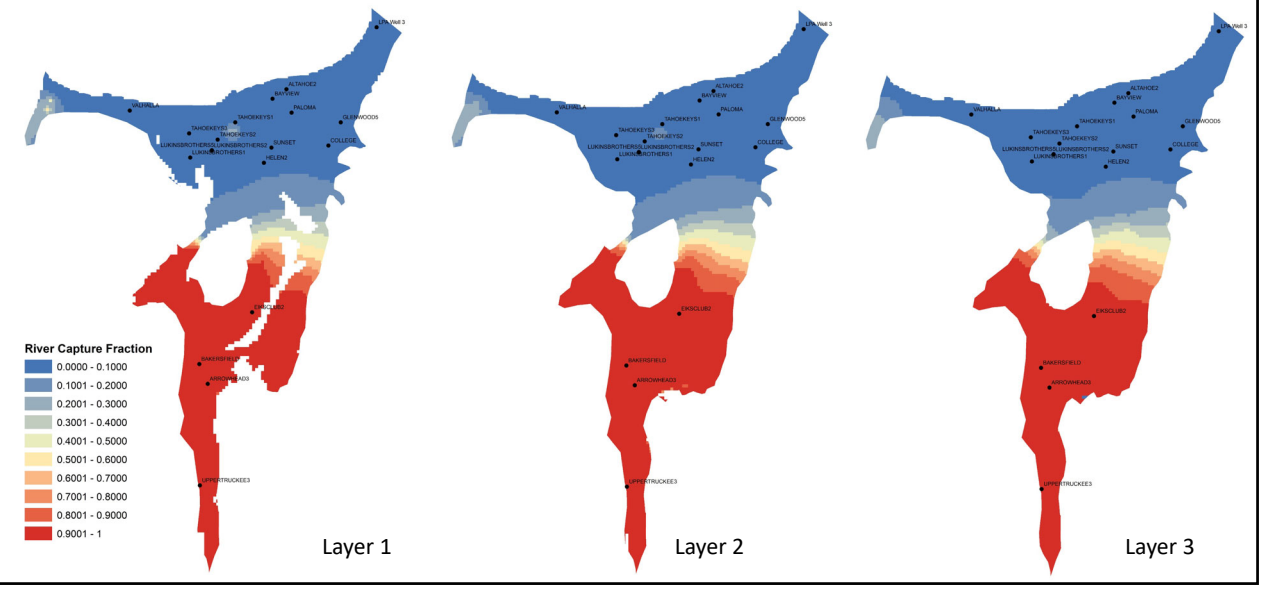
- Used to show spatially where a hypothetical well would be expected to cause an increase in aquifer recharge due to losses from interconnected surface-water features (capture).
- Capture analysis run on the steady-state model, with all municipal wells pumping at their most conservative (i.e. highest) rate from future projected rates.
- The same analysis was run on a steady-state model with the recharge rates defined by the most conservative climate scenario (hot/dry) to provide a worst-case end member.
- GMA is defined by any cells expressing greater than 50% stream capture in any model layer



Baseline Capture

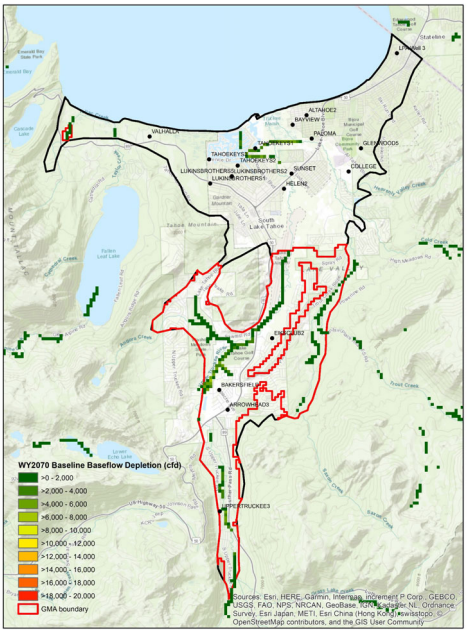


Q2 Capture



GMA

- Defined by area with greater than 50% river capture.
- Baseline GMA is more conservative.



NEXT STEPS

- Recommend for the entire basin a set of quantitative sustainability indicators, representative monitoring sites, and minimum thresholds designed to prevent the undesirable results:
  - Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
  - Significant and unreasonable reduction of groundwater storage
  - Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
  - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water
- Goal is to set thresholds within the range of historic variability; dependent on model results.
- Identify data gaps and recommend methods to address them
- Proposed thresholds/indicators will be presented to stakeholders to solicit feedback prior to finalization of recommendations to the District.

Tahoe Valley South Subbasin (6-005.01) Alternative
MEETING NOTES
Wednesday, June 30th, 2021; 2:00 pm - 4:00 pm
Location: On-Line Meeting
https://global.gotomeeting.com/join/501536749
Call-In #: 1 866 899 4679; Access Code: 501-536-749

SAG ATTENDEES:

John Thiel, PE; Ivo Bergsohn, PG, HG (STPUD); Rick Lind (El Dorado Water Agency);Karen Bender, REHS (El Dorado County – EMD); Brian Grey, P.G., Abby Cazier (Lahontan Regional Water Quality Control Board); Jason Burke (City of South Lake Tahoe); Jennifer Lukins (Lukins Brothers Water Co); Harold Singer (Retired)

Participants: 16

BASIN MANAGEMENT OBJECTIVES:

1. Maintain a sustainable long-term groundwater supply.
2. Maintain and protect groundwater quality.
3. Strengthen collaborative relationships with local water purveyors, governmental agencies, businesses, private property owners and the public.
4. Integrate groundwater quality protection into local land use planning activities.
5. Assess the interaction of water supply activities with environmental conditions.
6. Convene an on-going Stakeholders Advisory Group (SAG) as a forum for future groundwater issues.
7. Conduct technical studies to assess future groundwater needs and issues.
8. Identify and obtain funding for groundwater projects.

WORKSHOP OBJECTIVES

1. Consider sustainable management criteria being developed for the TVS Subbasin Alternative.
2. Learn about recent hydrologic work considering surface water depletions within the TVS Subbasin.
3. Discuss the Implementation Plan and potential projects for the TVS Subbasin Alternative.

Roll Call

Roll-Call Sheet

Tahoe Valley South Subbasin (6-005.01) Alternative
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TVS Basin (6-5.01) - Open Forum (Group)

Current groundwater-related topics outside Agenda

J. Lukins, LBWC

- LBWC #5 GAC Wellhead Treatment Facility – update:
  - LBWC #5 out of service since 2014; Drilled 1983-1985; Largest producing well;
  - Jenn described improvements completed at LBWC #5 Well site; installed new casing liner; constructed 98,000-gallon Welded Steel Storage Tank over former LBWC #2 location (Destroyed); constructed steel building around two x 8,800-gallon GAC Treatment Vessels (Calgon); took 1-week to install and backwash GAC; 4- Booster Pump Station (2 x 15 Hp; 2 x 30 HP); and 250 kW emergency power generator (w/sound attenuation)
  - Operating permit; on-going, submitted in March; awaiting DDW approval.

I. Bergsohn, STPUD

- Groundwater Sustainability Plan Reviews (DWR Press Release)
  - First round of DWR Assessments of GSPs submitted for Critically Over-Drafted (COD) Basins are available; Consultation Letters were issued by DWR outlining the deficiencies identified in the submitted GSPs for four COD Basins.; these reviews are available through the link provided in the press release included in the Meeting Materials.
- TRPA Greenhouse Gas Inventory (Infographic)
  - Inventory includes estimates an emissions inventory and estimates of carbon stored in natural ecosystems (2014-2018); and Projected future emissions Inventory for Lake Tahoe Basin (2018 – 2045)
- 2020 California Groundwater Conditions Report
  - DWR released a report and accompanying maps showing groundwater level changes across California between Spring 2019 and Spring 2020 .
  - Stable conditions are regarded as water level changes on the order of +/- 5 feet
  - Between May 2019 (Normal) and May 2020 (Below Normal) groundwater levels fell an average of -1.82 feet across the TVS Subbasin.
  - Between May 2020 (Below Normal) and May 2021 (Below Normal) groundwater levels fell an average of -2.21 feet across the TVS Subbasin.
- 2021 SAG Workshop 1 Meeting Notes and Presentations are posted on District's Groundwater Page

Tahoe Valley South Subbasin (6-005.01) Alternative
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TVS SUBBASIN ALTERNATIVE – Sustainable Management Criteria (S. Rybarski, DRI, 30 Minutes);

Handouts: Item 5: Sustainable Management Criteria

Susie Rybarski, DRI (SR) reported on progress in developing Sustainable Management Criteria (SMC) for the TVS Subbasin Alternative. SR explained SMCs as per SGMA and explained the SMCs being developed for Chronic Lowering of GW Levels; Reduction of GW Storage; Degraded Water Quality; and Land Subsidence applicable to the TVS Subbasin.

[**Note:** SMCs for Interconnected Surface Waters (ISWs) to be discussed more fully in next presentation by Mark Hausner.]

Chronic Lowering of GW Levels:
- Sustainability Goal; maintain sustainable supply of groundwater by maintaining pumping levels above top of well screen(s);
- Undesirable Result: Regional Water level decline such that water system demands can no longer be met;
- Sustainability Indicator: Total source capacity of Community Water System (CWS) wells; Total source capacity currently estimated at 19,155 (gpm) or 27.5832 (mgd) - may be modified.
- Minimum Threshold: Total Source Capacity ≥ 110% of Maximum Day Demand (MDD); MDD over past 10-years with 10% buffer = 14.166 mgd; current surplus =13.42 mgd

Minimum Threshold is source capacity > 110% MDD (14.166 mgd); DTW at well (from 2005 WY); Freeboard = expected drawdown when pumping at Specific Capacity (SC); For example Valhalla Well when pumping will have 7 feet of water above top of well screen. If water levels dropped below 7 feet would lose source capacity thereby reducing cumulative total source capacity for the CWS Wells. Based on this analysis groundwater levels can drop a total of 31 feet across basin before total source capacity would be reduced below total MDD for all drinking water users.

Reduction of GW Storage:
- Sustainability Goal; maintain groundwater storage reserves to ensure a sustainable supply of GW;
- Undesirable Result: GW Overdraft Condition – downward trend in groundwater levels;
- Sustainability Indicator: Cumulative changes in groundwater storage relative to WY 2005 (Baseline Normal WY)
- Minimum Threshold: Decrease in Storage of 32,050 AF relative to WY 2005 (equals GW Storage water loss from 7 feet of dd across Subbasin).

Degraded Water Quality:
- Sustainability Goal; maintain groundwater quality to support continued use of CWS wells for water supply;
- Undesirable Result: Degraded water quality impairs CWS reducing total Source Capacity < 110% of MDD;
- Sustainability Indicator: Total Source Capacity of CWS Wells
- Minimum Threshold: Total Source Capacity ≥ 110% of Maximum Day Demand (MDD); MDD over past 10-years with 10% buffer = 14.166 mgd; surplus =13.42 mgd

Land Subsidence:
- Sustainability Goal; maintain GW levels as needed to prevent land subsidence;
- Undesirable Result: GW Overdraft Condition to extent that significant compaction of fine-grained layers occurs;
- Sustainability Indicator: Measured static GW levels at CWS wells;
- Minimum Threshold: Decline in GW levels at each CWS well estimated to result in 1- ft. of land subsidence. Land Subsidence Estimate: 1 foot of Subsidence = ~ 100-ft. GW Level Decline (calculated from modified Terzaghi's equation – for 1-Dimensional compaction of porous media).

Discussion (Group): No questions/comments were received from the group

TVS SUBBASIN ALTERNATIVE – Interconnected Surface Waters (M. Hausner, DRI, 30 Minutes);

Handouts: Item 6: Interconnected Surface Waters

Mark Hausner, DRI (MH) reported on progress in developing quantitative thresholds for ISWs in the TVS Subbasin. Focus on sufficient water supply for ecosystems. MH presented slides discussing Climate Adaptation/Mitigation Strategies, SMCs for ISWs; ISW Archetypes; and establishment of minimum thresholds for groundwater levels within SEZs/GDEs and In-stream flows.

Guidance used for development of thresholds followed SGMA Requirements; California 4th Climate Change Assessment, Sierra Nevada Region, Ca DFW Planning Considerations; and TNC guidance on thresholds and GDEs. Climate Adaptation/Mitigation Strategies include: Resistance – ward off the effects of climate change (applicable to existing infra-structure, not applicable to ISWs); Resilience – increase capacity of systems to resist climate change impacts; Orderly Response – assist transitions to avoid most undesirable outcomes; and Realignment-facilitate transition to most desirable new condition. For ISWS will look at Resilience and Orderly Response as main strategies for ISWs. ISWs are coincident with SEZs; use TRPA SEZ mapping to define boundaries; and follow guidance from TNC on monitoring GW declines. Looked at Quantitative Benchmarks: Historical Variability in GW Levels within GDEs; Baseline Simulations to identify potential undesirable results; and Pumping vs. No-Pumping Model Simulations to determine whether effects are management-driven or climate driven.

ISWs
- Sustainability Goal; maintain shallow water table that supports riparian vegetation where currently exists;
- Undesirable Result: Succession of riparian vegetation by upland vegetation (with loss of Groundwater Dependent Ecosystems (GDEs)) ;
- Sustainability Indicator: Water Table Elevation;
- Minimum Threshold: Maintain average groundwater elevations within the interquartile range of historical variability.

Archetypes;

1. SEZs where simulated heads lie within 25% - 75% interquartile range projected over next 50 years (2021 – 2071): Example: Upper Truckee Marsh – West Side; Does Not Require extensive ongoing monitoring.
2. SEZs where simulated heads fall below 25% - 75% interquartile range due to climate change; Example: Tallac Meadows : Baseline Model simulated head fall below allowable 25% – 75% interquartile range after about 30 years (~ 2050) ; with or with-out pumping; apply Orderly Response mitigation strategy (example- ensure riparian vegetation has seed bank population with deeper root zones (outside scope of GMP).
3. SEZs where simulated heads fall below 25% - 75% interquartile range due to groundwater pumping; Example: Osgood Creek- Baseline Model simulated head fall below allowable 25% – 75% interquartile range after about 30 years (~ 2035) with groundwater pumping; apply Resilience mitigation strategy (example - redistribute pumping allocation between wells).

Identifying most vulnerable GDEs/SEZs: prioritize archetypes where simulated heads fall below 25% - 75% interquartile range due to groundwater pumping by predicted year of exceedance. Focus on SEZ/GDE areas where responses are expected over next 20 years (by 2040) and proximity to active CWS wells – located in north area of Subbasin (South Lake Tahoe, Tahoe Keys Subarea) and outside Groundwater Management Area (south portion of Subbasin (Meyers, Angora, Christmas Valley subareas).

Establishing thresholds: consider using particle tracking and model simulations to identify pumping influence from wells on GDE/SEZs and available remote sensing data to identify representative GDE/SEZs for potential monitoring; also looking at existing monitoring well networks with time series data for comparison to historical simulations; establish a delta between observed and simulated 25% quartiles; and apply deltas to observed hydrographs for establishment of quantitative threshold for area. For areas without existing groundwater monitoring data, new monitoring wells may need to be installed.

SMCs for Instream flows- compare available records from USGS Gage Stations to model simulated base flows at each station.

In-Stream Flows

- Sustainability Goal; maintain spatial and temporal continuity of surface flows to support existing beneficial uses;
- Undesirable Result: reduction of flow that negatively impacts wildlife and/or recreational uses;
- Sustainability Indicator: USGS discharge records;
- Minimum Threshold: 10-year average annual and 10-year average late-season (Aug, Sept, Oct) flows within range of historical variability.

P-values from Kendall's tau evaluation indicate strong correlation between late-season discharge and model simulated baseflow. Apply correlation to average late season flows from projected (2070) model baseflow simulations. Evaluation of records from continuous Gage Stations on Upper Truckee River and Trout Creek suggest that instream flows for these streams are within range of 10-year average annual and 10-year average late season flows.

Discussion (Group)

Was any consideration given to potential changes in groundwater quality over 50-year planning horizon? Not explicitly in GDEs or in-stream flows.

How will future movement of PCE plume affect water quality at seepage face to Lake Tahoe? Would not be fully evaluated as part of this update to the 2014 GMP, but could be added as an item to consider for future work in the implementation plan.

Population numbers for TKWC water system presented in water system demand tables (1,400 vs. 1,520) should be verified; these will be double-checked.

TVS SUBBASIN ALTERNATIVE – Implementation Plan (Section 10) (I. Bergsohn, STPUD, 40 Minutes);

Handouts: Item 7 TVS Subbasin Implementation Plan- 2 page per slide handouts); Item 8 TVS Subbasin Implementation Plan Draft (2021.06.23)

Ivo Bergsohn, STPUD (IB) reported on progress in developing the Implementation Plan for the TVS Subbasin Alternative. IB presented introductory slides to provide a bit of context when considering the draft Implementation Plan. These included a high-level view of the groundwater management work; and the accomplishments achieved since adoption of the current Groundwater Management Plan in 2014; the costs expended for this work; and a description of the funding sources used to support this work. IB also presented several slides describing the Sustainable Groundwater Management (SGM) Grant Program to inform the SAG on the types of projects which may be eligible for future funding.

IB presented a substantial list of accomplishments achieved by the District in collaboration with the EDWA and the SAG with respect to Basin Monitoring, Hydrologic Modeling, Groundwater Investigations, Public Outreach and Reporting. Over the past five years (2015 – 2020), the total costs for this work exceeded $2 million dollars;. The majority of funding support for this works was from the District's water enterprise fund, the EDWA cost share program and State Grants. The base cost of this program is projected to approach $6 million dollars to as high as $16.7 million over 50 years. Over the next 5-year planning cycle, the priorities for this program are expected to include: the management of naturally-occurring and manmade contaminants on groundwater sources; the increased engagement of private well owners in groundwater management; and increased understanding distinguishing between the effects of groundwater pumping and climate change on ISWs. IB believes the draft Implementation Plan recognizes these priorities.

IB provided a brief overview of the draft Implementation Plan. The draft plan is organized into, On-Going; activities needed to continue groundwater management in accordance with current regulations; Short-Term: activities identified for work over the next five years; and Long-Term: activities that are likely to require longer time frames (> 5years) to achieve and is seeking comment from the SAG by the end of July.

Discussion (Group):

SAG recognizes work accomplished through implementation of the 2014 GMP and support seeking of funding opportunities for future projects.

ADJOURN (3:40 PM)

GWMP 5-Year Update
Sustainable Management Criteria

Susie Rybarski
Mark Hausner

DRI
Desert Research Institute

Sustainable Management Criteria: Best Management Practice

- SGMA defines *sustainable groundwater management* as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (DWR, 2017).

- Sustainable management criteria include:
  - **Sustainability Goal**
  - **Undesirable Results**
  - **Sustainability Indicators**
  - **Minimum Thresholds**

Sustainable Management Criteria: Best Management Practice

- **Recommend for the entire basin a set of quantitative sustainability indicators, representative monitoring sites, and minimum thresholds designed to prevent the undesirable results:**
  - **Chronic lowering of groundwater levels** indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
  - Significant and unreasonable **reduction of groundwater storage**
  - Significant and unreasonable **degraded water quality**, including the migration of contaminant plumes that impair water supplies
  - Significant and unreasonable **land subsidence** that substantially interferes with surface land uses
  - **Depletions of interconnected surface water** that have significant and unreasonable adverse impacts on beneficial uses of the surface water (Mark Hausner)

Sustainable Management Criteria: Chronic Lowering of Groundwater Levels

- **Sustainability Goal:** Maintain a sustainable supply of groundwater by keeping groundwater levels a safe distance above well screens
- **Undesirable Result:** Regional water level declines such that water demands cannot be met
- **Sustainability Indicator:** The total source capacity of community water supply wells
- **Minimum Threshold:** Having water levels above the screen intake at enough water supply wells such that the total source capacity meets or exceeds the MDD

Sustainable Management Criteria: Chronic Lowering of Groundwater Levels

- Quantify available water supply as total source capacity of all active public supply wells

		SOURCE CAPACITY		
Well I.D.	**WATER SYSTEM**	**(gpm)**	**(mgd)**	**STATUS**
Al Tahoe Well #2	STPUD	2792	4.0205	Active
Bakersfield Well	STPUD	1450	2.0880	Active
Bayview Well	STPUD	3000	4.3200	Active
Elks Club Well #2	STPUD	508	0.7315	Active
GlenWood Well #5	STPUD	1037	1.4933	Active
Helen Ave. Well #2	STPUD	242	0.3485	Active
Paloma Well	STPUD	1825	2.6280	Active
Sunset Well	STPUD	650	0.9360	Active
SUT No. 3	STPUD	858	1.2355	Active
Valhalla Well	STPUD	597	0.8597	Active
Arrowhead Well #3	STPUD	775	1.1160	Active - Treated
	STPUD SUB-TOTAL	**13,734**	**19.7770**	
TKWC No. 1	TKWC	1000	1.4400	Active
TKWC No. 2	TKWC	400	0.5760	Active-Treated (LP GAC; IX (Temporary), 400 gpm anticipated 7/2021)
TKWC No. 3	TKWC	800	1.1520	Active - Treated (IX (Temporary), 800 gpm anticipated 7/2021)
	TKWC SUB-TOTAL	**2,200**	**3.1680**	
LBWC No. 1	LBWC	900	1.2960	Active
LBWC No. 5	LBWC	620	0.8928	Inactive-Treated (LP GAC; 620 gpm; anticipated start 7/2021)
	LBWC SUB-TOTAL	**1,520**	**2.1888**	
COMMUNITY WATER SYSTEMS TOTAL		**17,454**	**25.1338**	

Sustainable Management Criteria: Chronic Lowering of Groundwater Levels

- Quantify water demands to be met as MDD over the past 10 years with a 10% buffer

Community Water System	Ca Water System No.	Active Wells	Connections[1]	Population Served[1]	Source Capacity (mgd)[3]	Maximum Day Demand (mgd)[2]	(+) Surplus; (-) Deficit (mgd)[4]
South Tahoe Public Utility District	910002	11	14,168	33,124	19.7770	9.862	9.9150
Tahoe Keys Water Company	910015	3	1,566	1,420	3.1680	2.383	0.7853
Lukins Brother Water Company	910007	1	982	3,200	1.2960	0.634	0.6622
TVS SUBBASIN (6-005.01) TOTALS		**15**	**16,716**	**37,744**	**24.241**	**12.879**	**11.3624**
			Lowering of Groundwater Levels Threshold (110% of MDD)			**14.166**	

NOTES

1) Source: SWRCB Drinking Water Branch Drinking Water Watch (https://sdwis.waterboards.ca.gov/PDWW/).
2) 10 Year (WY 2011 - WY 2020) Water System Maximum Day Demand, in million gallons per day (mgd), based on monthly water use as per CA Waterworks Standards (§ 64554).
3) Source capacity of active wells, in mgd (stand-by or offline sources not included).
4) (Source Capacity) - (Maximum Day Demand), in mgd.

Sustainable Management Criteria: Chronic Lowering of Groundwater Levels

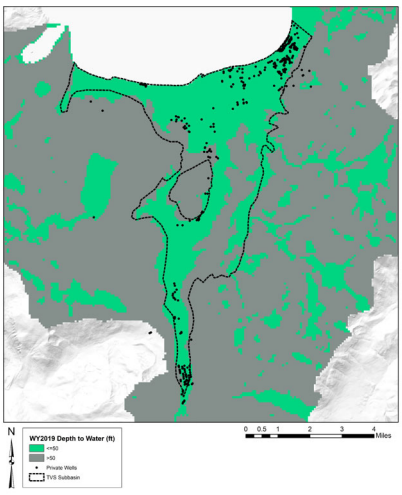
- Minimum threshold is cumulative reduced source capacity greater than 110% MDD (14.166 mgd)

Well I.D.	Water System	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Depth to Water[1] (ft bgs)	Transmissivity (gpd/ft)	Expected Drawdown (ft)	Specific Capacity[2] (gpm/ft)	Water Level Min Target[3] (ft bgs)	Freeboard[4] (ft)	Source Capacity (MGD)	Cum. Red. Source Cap. (MGD)
Valhalla Well	STPUD	110	170	31	14,713	72	9	38	7	0.8597	24.2741
Al Tahoe Well #2	STPUD	110	140	34	67,649	65	39	45	11	4.0205	20.2536
SUT No. 3	STPUD	70	90	18	18,805	37	38	33	15	1.2355	19.0181
LBWC No. 1	LBWC	132	182	20	12,342	97	7	35	15	1.2960	17.7221
Elks Club Well #2	STPUD	110	160	19	3,652	60	5	50	31	0.7315	16.9906
Paloma Well	STPUD	188	248	45	39,996	112	22	76	31	2.6280	14.3626
GlenWood Well #5	STPUD	150	180	39	25,544	75	15	75	36	1.4933	12.8693
Helen Ave. Well #2	STPUD	90	150	18	15,237	29	9	61	43	0.3485	12.5208
TKWC No. 2	TKWC	138	188	20	12,342	74	7	64	44	0.5760	11.9448
Bakersfield Well	STPUD	130	170	29	55,569	52	29	78	49	2.0880	9.8568
TKWC No. 3	TKWC	175	300	20	30,855	100	18	75	55	1.1520	8.7048
TKWC No. 1	TKWC	125	312	20	46,159	39	26	86	66	1.4400	7.2648
Bayview Well	STPUD	180	300	25	65,308	77	47	103	78	4.3200	2.9448
Arrowhead Well #3	STPUD	250	280	49	14,534	92	9	158	109	1.1160	1.8288
Sunset Well	STPUD	275	430	20	31,506	36	18	239	219	0.9360	0.8928
LBWC No. 5	LBWC	141	180	20						0.8928	0.0000

Notes
1. Based on average WY 2005 measurements. Bold values are estimates based on nearby wells.
2. Bold values represent directly measured specific capacity at well capacity. Other values are calculated using Cooper and Jacob (1946) equation.
3. Water level minimum threshold based on top of screen - expected drawdown at full well capacity.
4. Freeboard is defined as Water level target - depth to water.

Sustainable Management Criteria: Reduction of Storage

- **Sustainability Goal:** Maintain groundwater storage reserves to ensure a sustainable supply of groundwater
- **Undesirable Result:** A groundwater overdraft condition causing water levels to trend downward making it more difficult to extract sufficient groundwater for water supply purposes
- **Sustainability Indicator:** Cumulative changes in groundwater storage relative to WY 2005 (baseline normal year)
- **Minimum Threshold:** Decrease in storage of **32,050 AF** relative to WY 2005 (equivalent storage loss from 7 feet of drawdown over subbasin)



Sustainable Management Criteria: Degraded Water Quality

- **Sustainability Goal:** Maintain groundwater quality to support continued extraction for water supply purposes
- **Undesirable Result:** Degraded water quality threatens the ability to produce groundwater of sufficient quality and quantity to meet the demands of the community
- **Sustainability Indicator:** The total source capacity of community water supply wells
- **Minimum Threshold:** Degraded water quality concerns within the TVS Basin should not rise to a level that threatens the ability of groundwater sources to meet 110% MDD (14.166 mgd)

		SOURCE CAPACITY	
Well I.D.	WATER SYSTEM	(gpm)	(mgd)
Al Tahoe Well #2	STPUD	2792	4.0205
Bakersfield Well	STPUD	1450	2.0880
Bayview Well	STPUD	3000	4.3200
Elks Club Well #2	STPUD	508	0.7315
GlenWood Well #5	STPUD	1037	1.4933
Helen Ave. Well #2	STPUD	242	0.3485
Paloma Well	STPUD	1825	2.6280
Sunset Well	STPUD	650	0.9360
SUT No. 3	STPUD	858	1.2355
Valhalla Well	STPUD	597	0.8597
Arrowhead Well #3	STPUD	775	1.1160
	STPUD SUB-TOTAL	**13,734**	**19.7770**
TKWC No. 1	TKWC	1000	1.4400
TKWC No. 2	TKWC	400	0.5760
TKWC No. 3	TKWC	800	1.1520
	TKWC SUB-TOTAL	**2,200**	**3.1680**
LBWC No. 1	LBWC	900	1.2960
LBWC No. 5	LBWC	620	0.8928
	LBWC SUB-TOTAL	**1,520**	**2.1888**
COMMUNITY WATER SYSTEMS TOTAL		**17,454**	**25.1338**

Sustainable Management Criteria: Land Subsidence

- **Sustainability Goal:** Maintain water levels as needed to prevent land subsidence that substantially interferes with surface land uses
- **Undesirable Result:** A groundwater overdraft condition causing water levels to trend downward to the extent that significant compaction occurs in fine-grained layers
- **Sustainability Indicator:** Measured water levels at public supply wells
- **Minimum Threshold:** Decline in water levels at each public supply well estimated to result in 1 foot of land subsidence

Sustainable Management Criteria: Land Subsidence

- TVS Basin is largely composed of coarse glacial deposits with limited potential for compaction
- Compaction due to a decrease in pore fluid pressure can be estimated as:

$$-(dz) = -\alpha z p_w g(dh)$$

  - dz = compaction
  - α = sediment compressibility
  - z = saturated thickness
  - $p_w g(dh)$ = reduction in hydrostatic pressure

- To generate 1 foot of subsidence, a sustained static water level drop of ~100 feet would required, far exceeding the minimum thresholds for chronic lowering of groundwater levels.

Questions?

Quantitative Thresholds: Interconnected Surface Waters

Mark Hausner
Susie Rybarski

DRI
Desert Research Institute

Interconnected Surface Waters

- SEZs and GDEs
- Instream Flow Requirements
- Depletions: Quantity and Timing
- Undesirable Results
- SAG Round Robin/Q&A

Interconnected Surface Waters

- General approach
- SEZs and GDEs
  - Undesirable Results
  - Establishing thresholds
- Instream Flow Requirements; Quantity and Timing of Depletions
  - Undesirable Results
  - Establishing thresholds
- SAG Round Robin/Q&A

Guidance followed

- SGMA requirements
- California's 4th Climate Change Assessment, Sierra Nevada Region Report (Dettinger et al. 2018)
- California DFW "Fish & Wildlife Groundwater Planning Considerations"
- TNC guidance on quantitative thresholds and GDEs

Climate Adaptation/Mitigation Strategies

- **Resistance:** trying to ward off the effects of climate change
- **Resilience:** increasing the capacity of systems to resist and bounce back from climate change impacts
- **Orderly response:** assisting transitions to avoid at least the most undesirable outcomes
- **Realignment:** facilitating major transitions to the most desirable new conditions

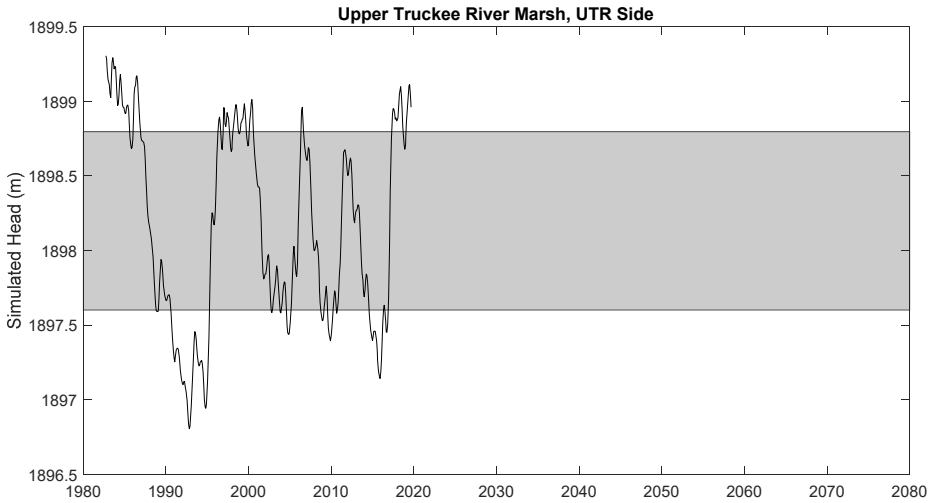
SEZs and GDEs

- Use TRPA's Stream Environment Zones as the geographical boundaries
- Follow guidance from The Nature Conservancy on monitoring declines in water level
- Quantitative benchmarks
  - Historical variability determines acceptable range
  - Baseline simulations used to identify potential undesirable results
  - Pumping vs. no-pumping simulations considered

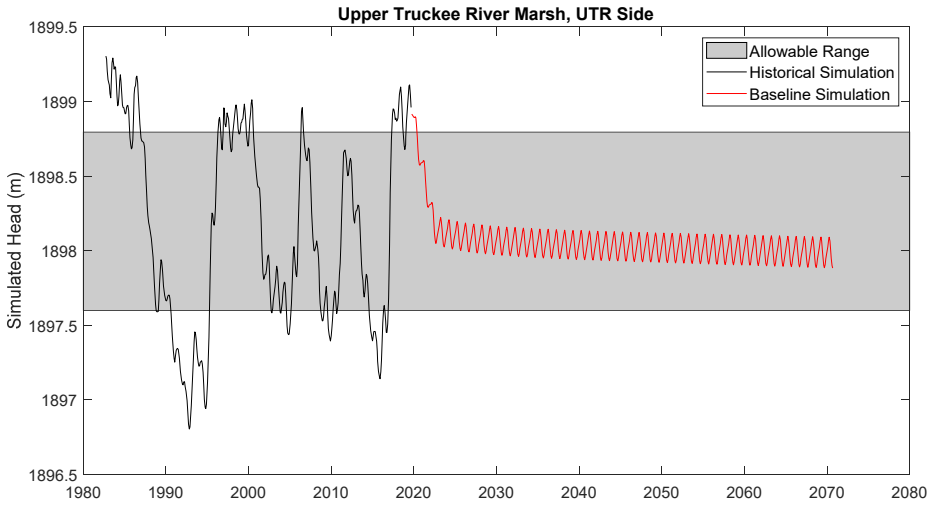
Sustainable Management Criteria: Groundwater-Dependent Ecosystems

- **Sustainability Goal:** Maintain shallow water table that supports riparian vegetation in areas where riparian vegetation currently exists
- **Undesirable Result:** Replacement of riparian vegetation by upland vegetation and loss of associated ecosystem services
- **Sustainability Indicator:** Water table elevation
- **Minimum Threshold:** Having average groundwater elevations within the interquartile range of historical variability

SEZs and GDEs: Examples



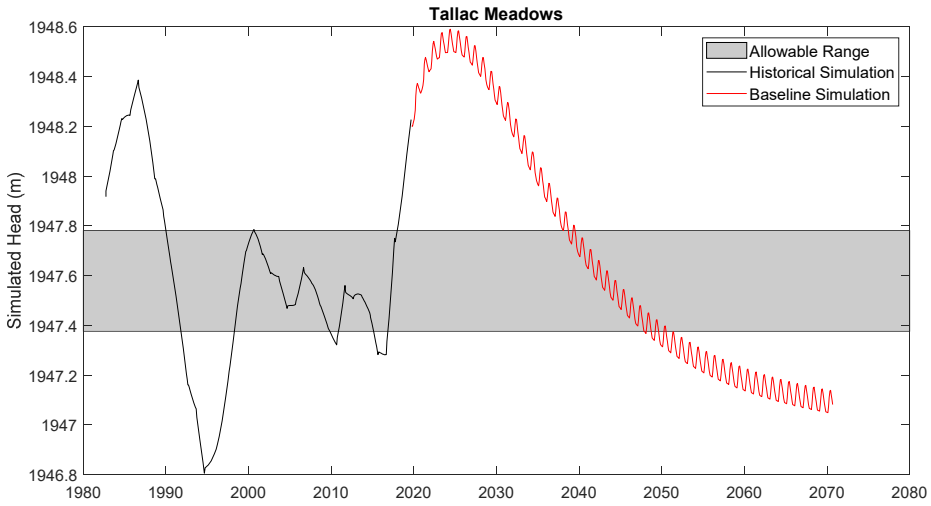
SEZs and GDEs: Examples



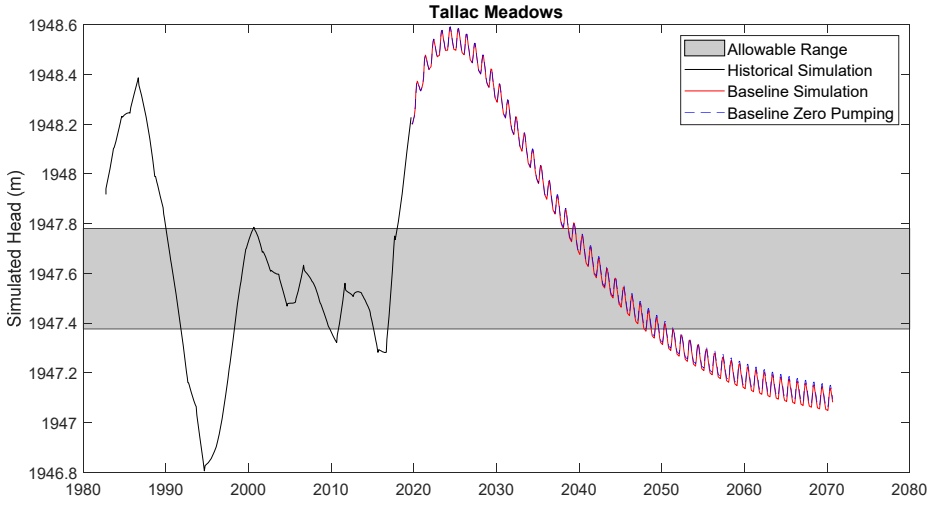
SEZs and GDEs: Examples

- Upper Truckee River Marsh, UTR side
  - Simulated heads fall within historical variability
  - Does not require ongoing monitoring

SEZs and GDEs: Examples



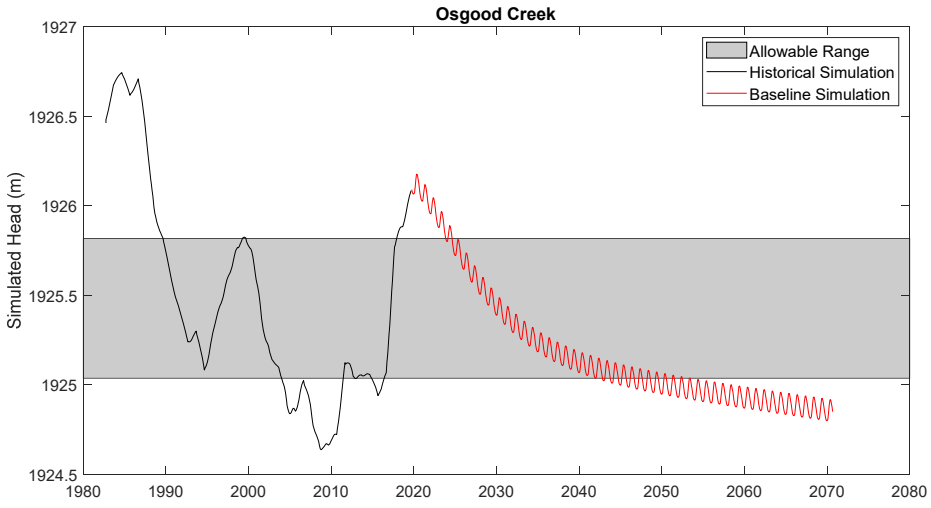
SEZs and GDEs: Examples



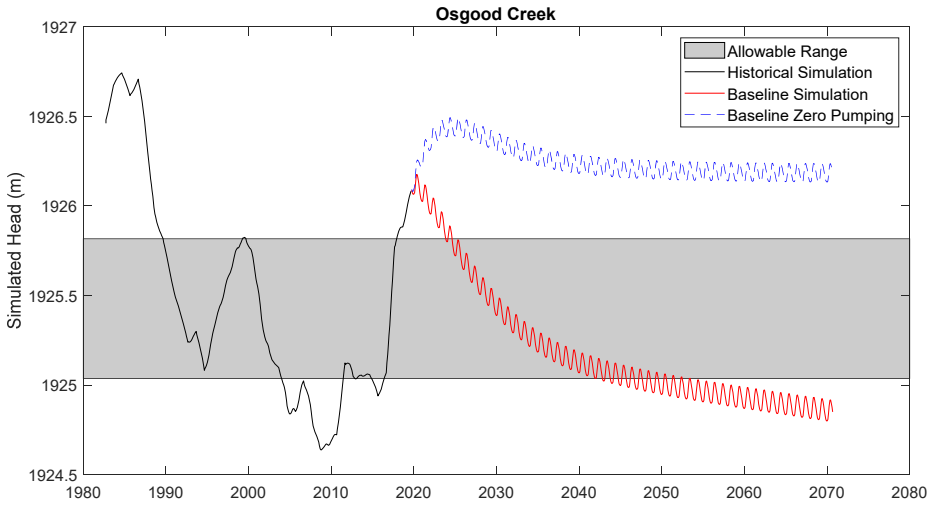
SEZs and GDEs: Examples

- Upper Truckee River Marsh, UTR side
  - Simulated heads fall within historical variability
  - Does not require ongoing monitoring
- Tallac Meadows
  - Simulated heads fall outside of historical variability regardless of pumping
  - Orderly response (assist transitions to avoid the most undesirable effects)

SEZs and GDEs: Examples



SEZs and GDEs: Examples

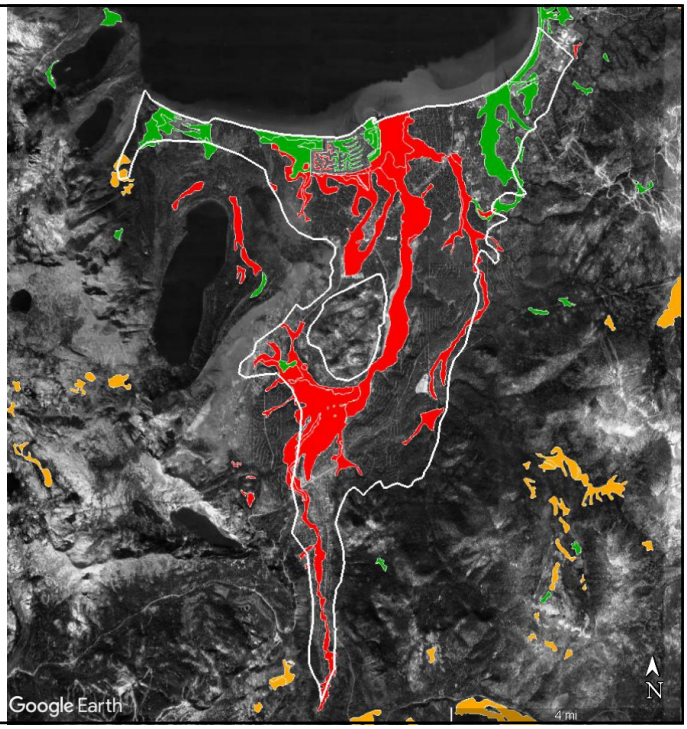


SEZs and GDEs: Examples

- Upper Truckee River Marsh, UTR side
  - Simulated heads fall within historical variability
  - Does not require ongoing monitoring
- Tallac Meadows
  - Simulated heads fall outside of historical variability regardless of pumping
  - Orderly response (assist transitions to avoid the most undesirable effects)
- Osgood Creek
  - Simulated heads fall outside of historical variability with pumping, but are acceptable without pumping
  - Resilience (increase capacity to resist and recover from climate impacts)

SEZs and GDEs

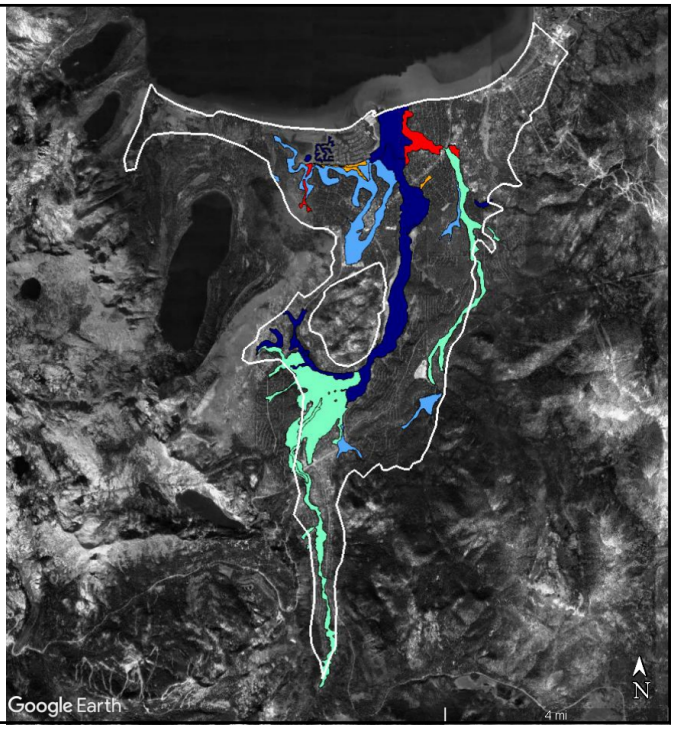
- Green: within historical bounds
- Orange: outside historical, but not affected by pumping (orderly response)
- Red: outside historical and affected by pumping (resilience)

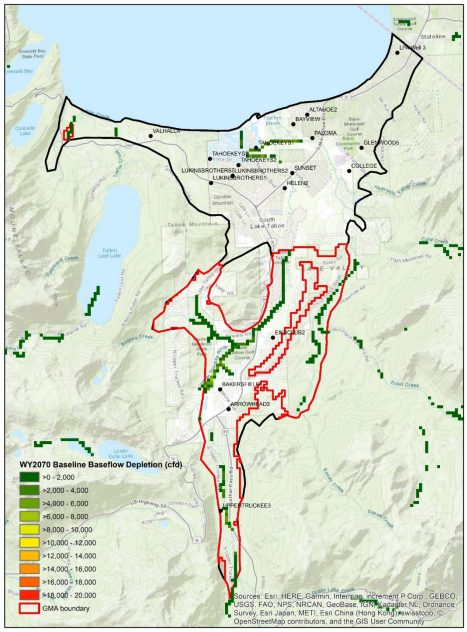


SEZs and GDEs

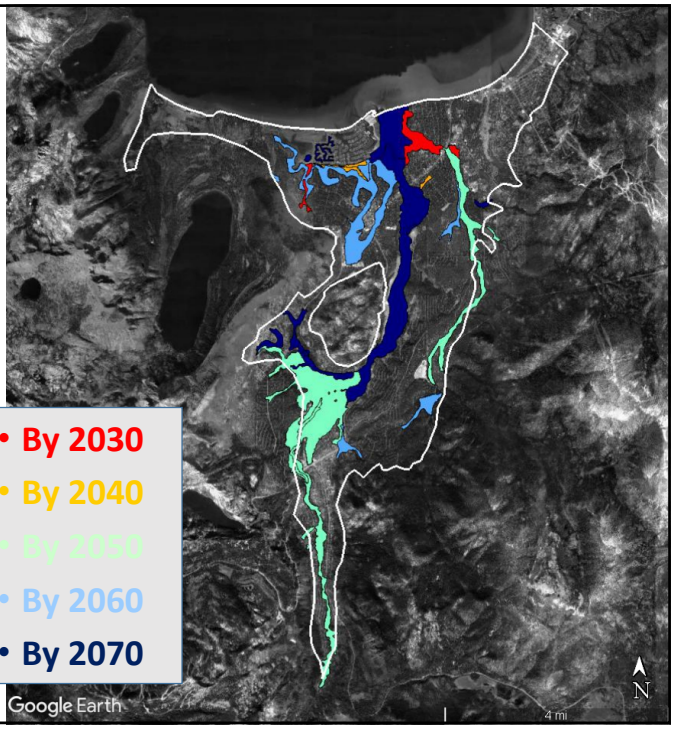
Year of Exceedance

- **By 2030**
- **By 2040**
- **By 2050**
- **By 2060**
- **By 2070**





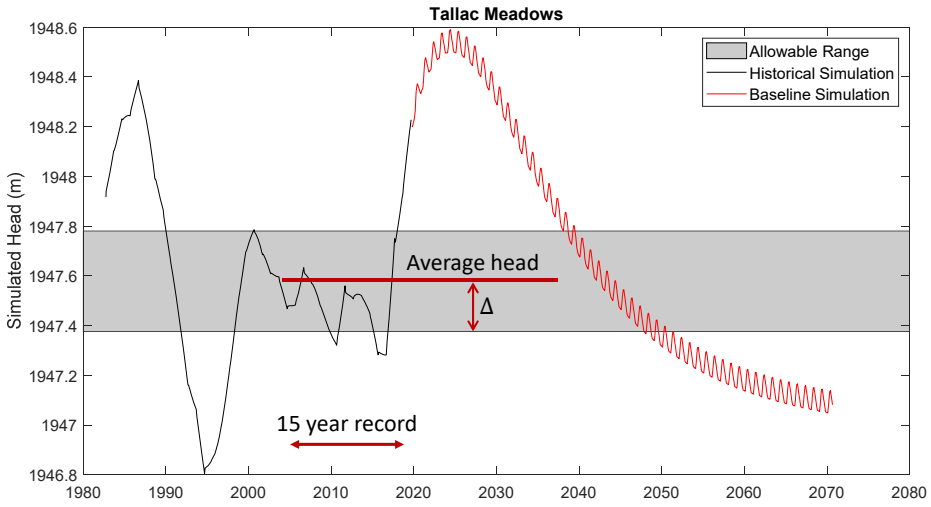
Previously identified Groundwater Management Area



SEZs and GDEs: Establishing Thresholds

- Identify indicator SEZs/GDEs for continuous monitoring
- Are there existing monitoring wells with time series of data?
  - Compare the average water level over the period of record to historical simulations
  - Establish a delta between historical simulations and the 25th percentile of the historical record
  - Apply that delta to the observed water level to obtain the quantitative threshold

SEZs and GDEs: Establishing Thresholds

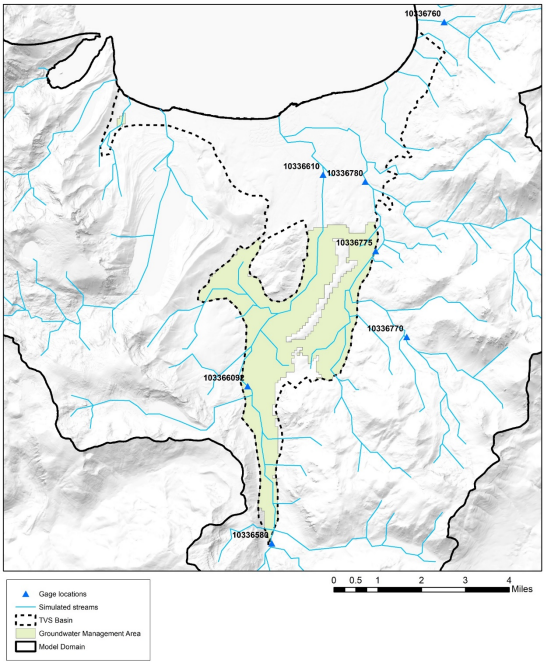


SEZs and GDEs: Establishing Thresholds

- Identify indicator SEZs/GDEs for continuous monitoring
- Are there existing monitoring wells with time series of data?
  - Compare the average water level over the period of record to historical simulations
  - Establish a delta between historical simulations and the 25th percentile of the historical record
  - Apply that delta to the observed water level to obtain the quantitative threshold
- Do we need to drill a new monitoring well?
  - Establish a delta between the current water level and the 25th percentile threshold

Instream Flows

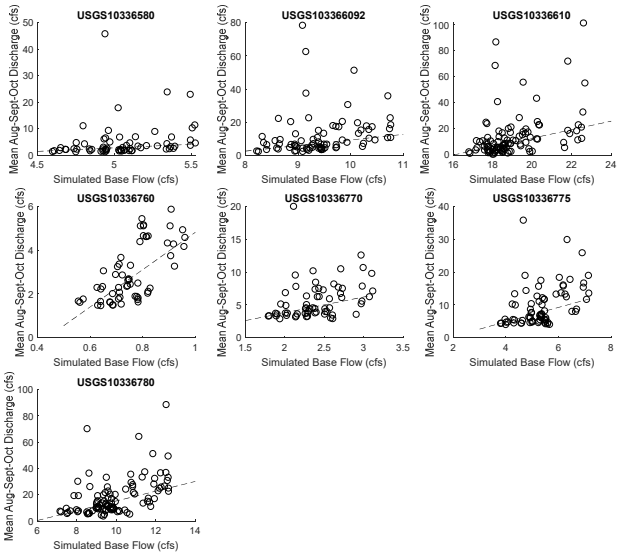
- Seven USGS Gages in the model domain
- Compared simulated baseflows at each USGS gage to historical observations



Sustainable Management Criteria: Instream Flows

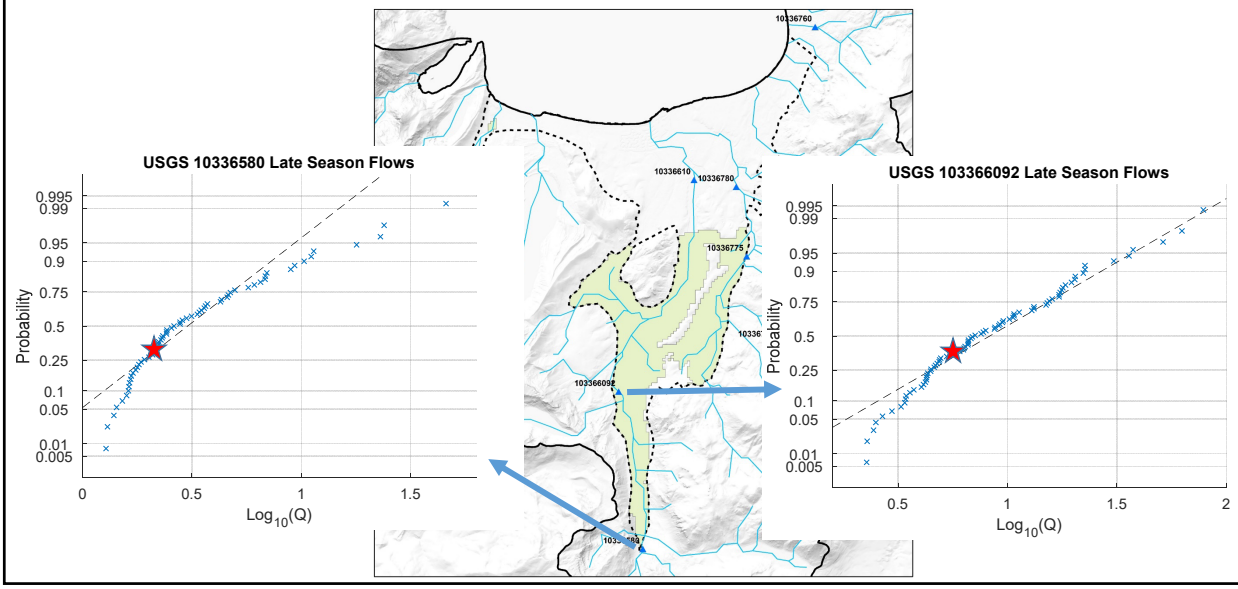
- **Sustainability Goal:** Maintain spatial and temporal continuity of surface flows to support existing beneficial uses
- **Undesirable Result:** reduction of flow sufficient to negatively impact wildlife and/or recreational use of streams
- **Sustainability Indicator:** USGS gaged discharge
- **Minimum Threshold:** Having 10-year average annual discharge and late season (Aug-Sept-Oct) discharge within the range of historical variability

Instream Flows

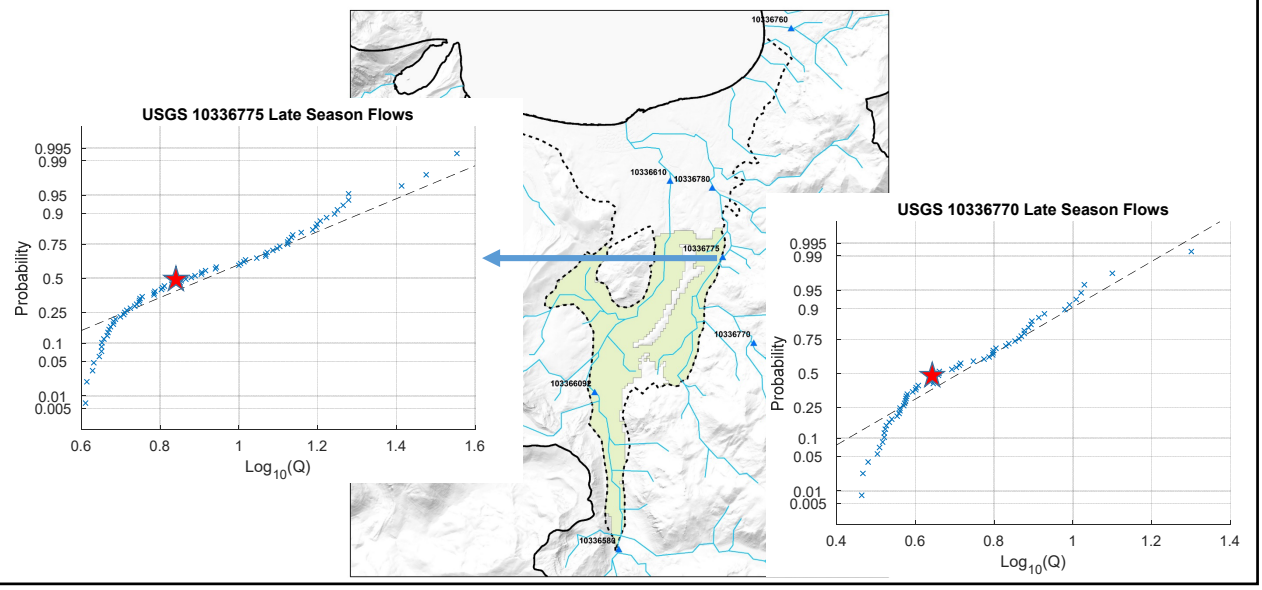


Aug-Sept-Oct Correlations		
Kendall's tau	p	Sen slope
-0.284	8.4E-04	2.689
-0.277	2.8E-04	3.382
-0.336	5.6E-07	3.263
-0.463	2.4E-07	8.520
-0.304	4.5E-04	2.396
-0.319	5.9E-05	2.200
-0.371	3.4E-08	3.709

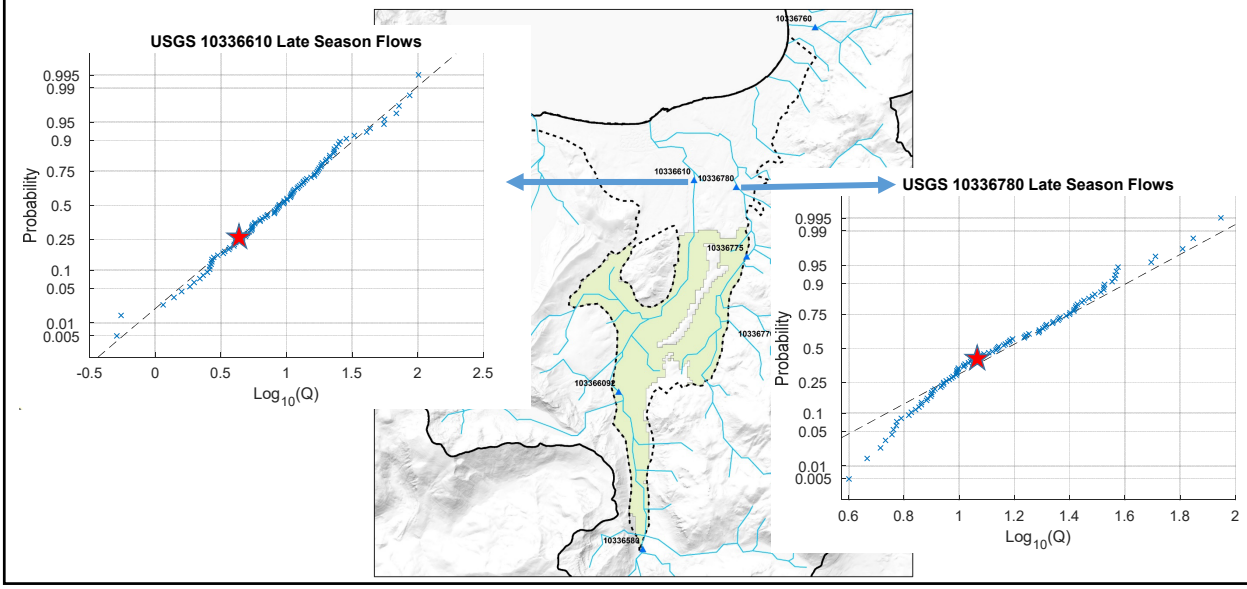
Depletions: 2070 Quantity and Timing



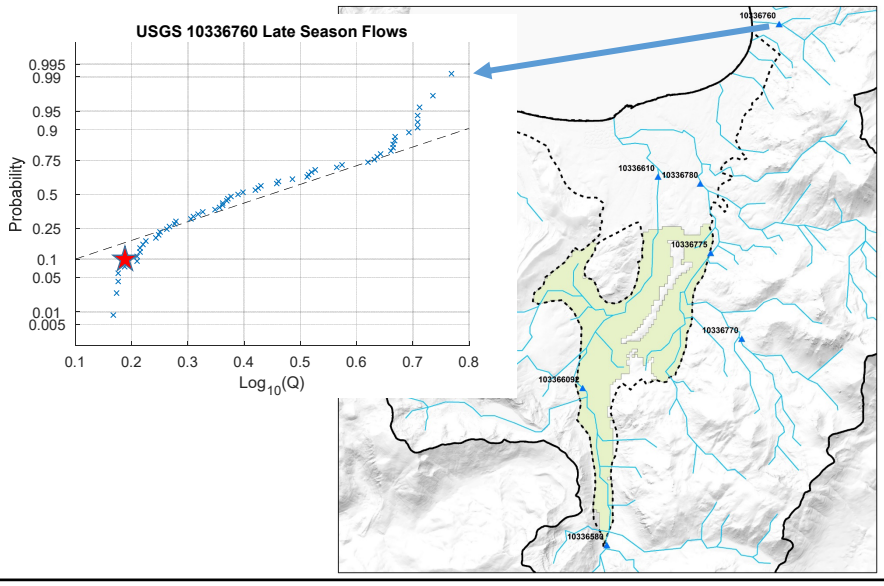
Depletions: 2070 Quantity and Timing



Depletions: 2070 Quantity and Timing

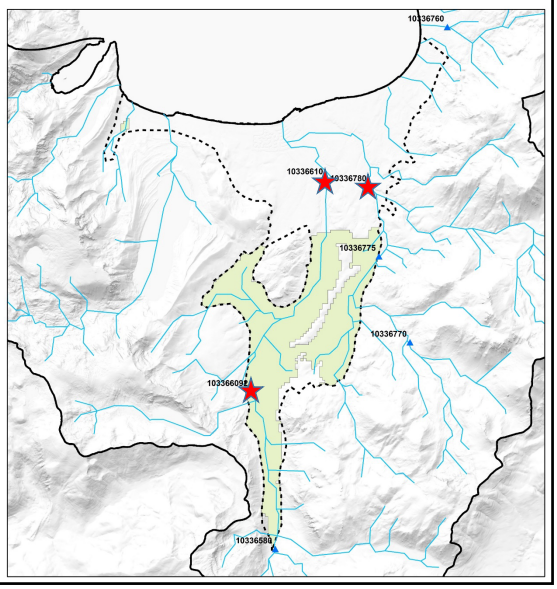


Depletions: 2070 Quantity and Timing



Depletions: Establishing Thresholds

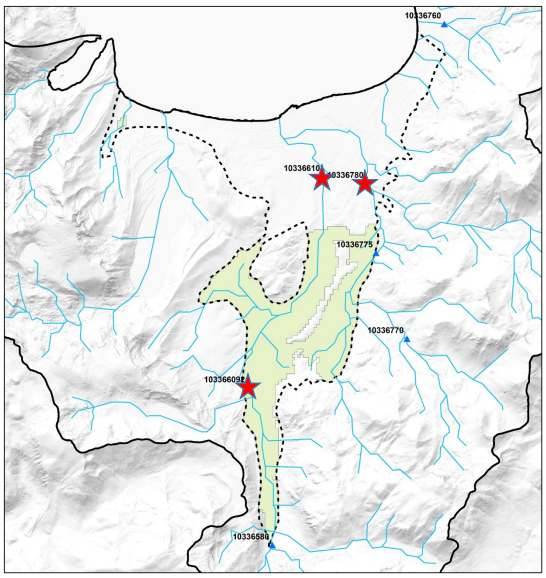
- Continuous monitoring at USGS Gages
  - Upper Truckee River at Hwy 50 above Myers
  - Upper Truckee River at South Lake Tahoe
  - Trout Creek near Tahoe Valley
- Compare recent discharge to historical variability
  - Total annual discharge
  - Late-season discharge (Aug-Sept-Oct)



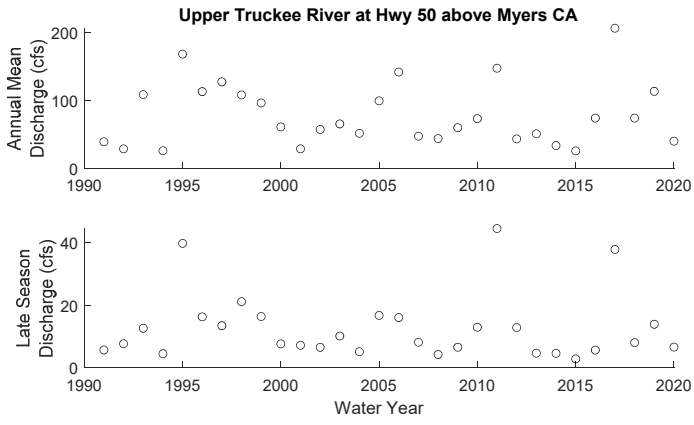
Depletions: Establishing Thresholds

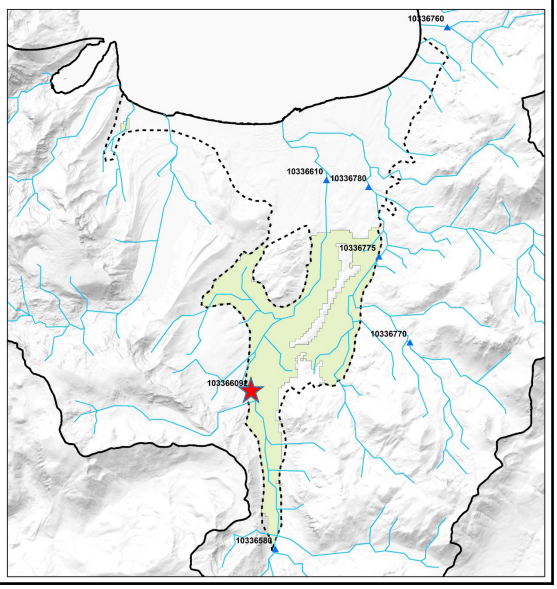
Annual Flows (cfs)				
Gage No.	Location	25th Percentile	10-Year Mean	5-Year Mean
66092	UTR above Myers	43.47	81.1	101.8
6610	UTR at South Lake	45.83	102.7	129.9
6780	Trout Creek	19.92	39.2	50.3

Late Season Flows (cfs)				
Gage No.	Location	25th Percentile	10-Year Mean	5-Year Mean
66092	UTR above Myers	5.71	14.2	14.5
6610	UTR at South Lake	6.08	14.3	13.5
6780	Trout Creek	11.15	19.7	23.1

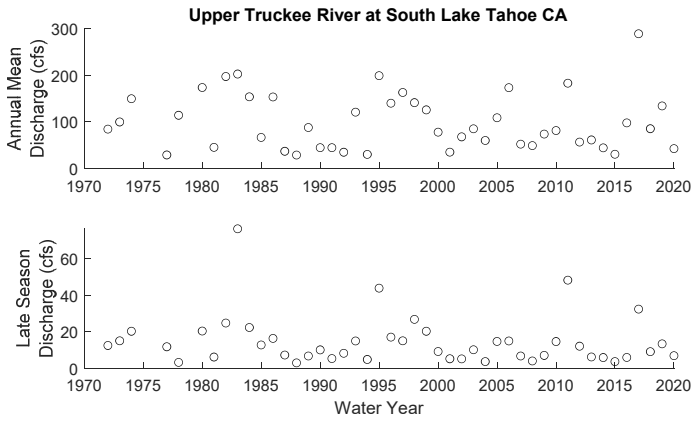


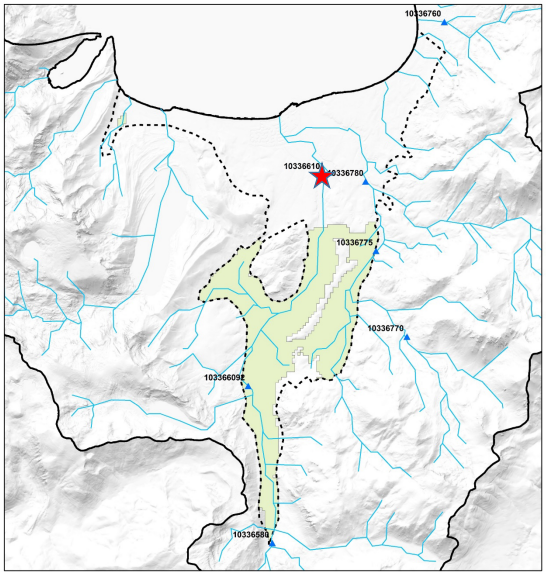
Depletions: Establishing Thresholds



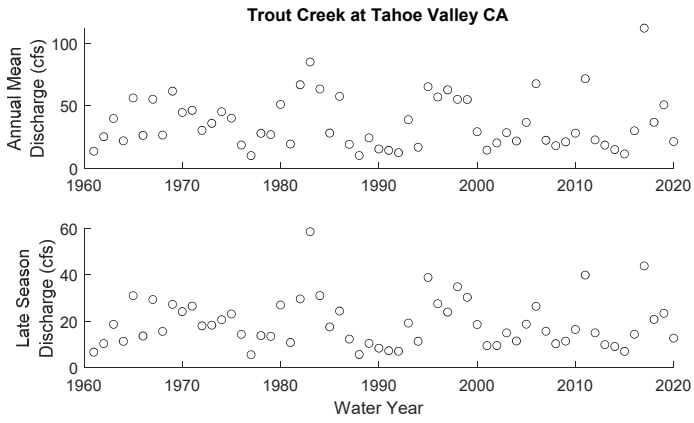


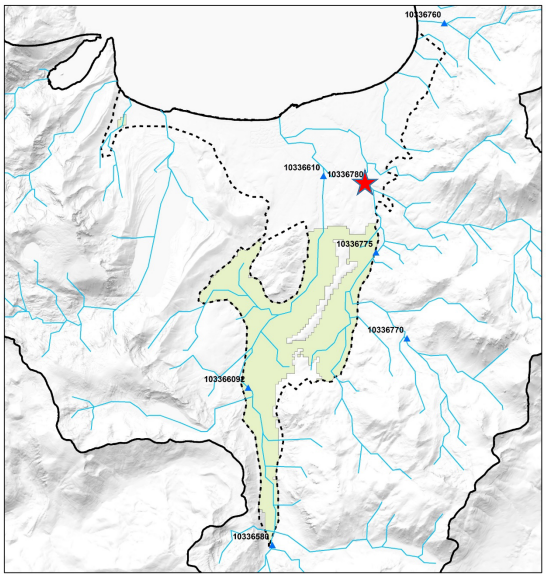
Depletions: Establishing Thresholds





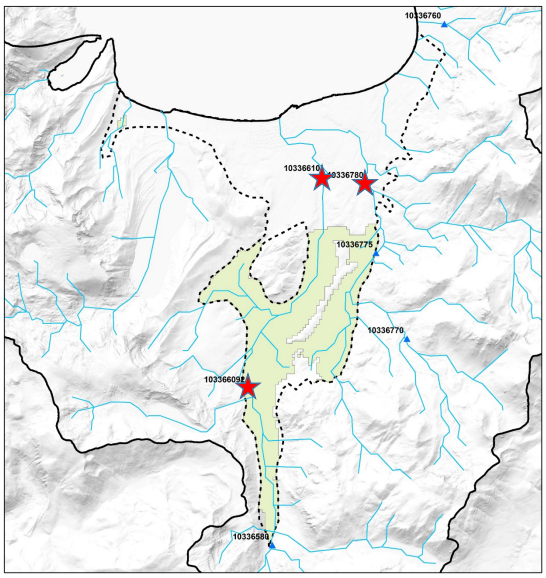
Depletions: Establishing Thresholds





Depletions: Establishing Thresholds

- Warning signs: Trends in discharge
  - Update at end of each water year
  - Look for trends in annual and late-season discharge
- Currently, no long-term (30-year) or short-term (10-year) trends



Questions?

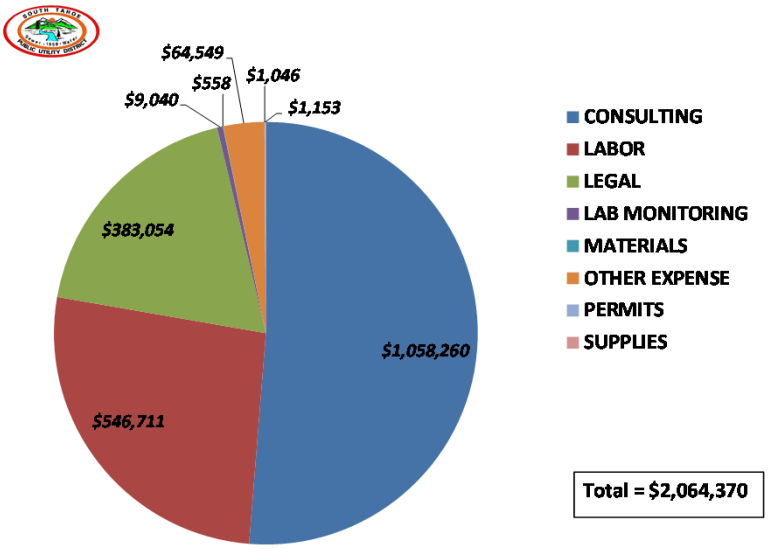
TVS SUBBASIN (6-005.01)
2021 SAG Workshop 2
June 30, 2021

SECTION 10: Implementation Plan

Ivo Bergsohn, PG, HG
ibergsohn@stpud.dst.ca.us

ACCOMPLISHMENTS (2015 – 2020)	
BASIN MONITORING	• Groundwater Monitoring- precipitation, elevations, groundwater pumpage, recharge, storage
HYDROLOGIC MODELING	• Phase 1 Hydrologic Models– Water balance, future conditions • Phase II Hydrologic Models – Recharge areas, capture zones, baseflow depletion analysis and capture maps, climate change impacts, monitoring network evaluation • Updated Phase 1 Groundwater Model • South Y Fate & Transport Model
INVESTIGATIONS	• South Y Extraction Well Suitability Investigation • Basin Management Objectives Analysis • Analysis of Basin Conditions • Survey of Private Well Owners • South Y Feasibility Study – Baseline Health Risk Assessment, Pre-Design Investigation, Feasibility Study, Interim Remedial Action Plan
PUBLIC OUTREACH	• SAG Workshops • South Y FS Workshops • PWOS I – Groundwater Well Survey • PWOS II – Groundwater Well Survey • Groundwater Web Page
REPORTING	• GSA Formation • DISTRICT – EDWA MOU • CASGEM Reporting • SGMA Annual Reporting • GSP Alternative

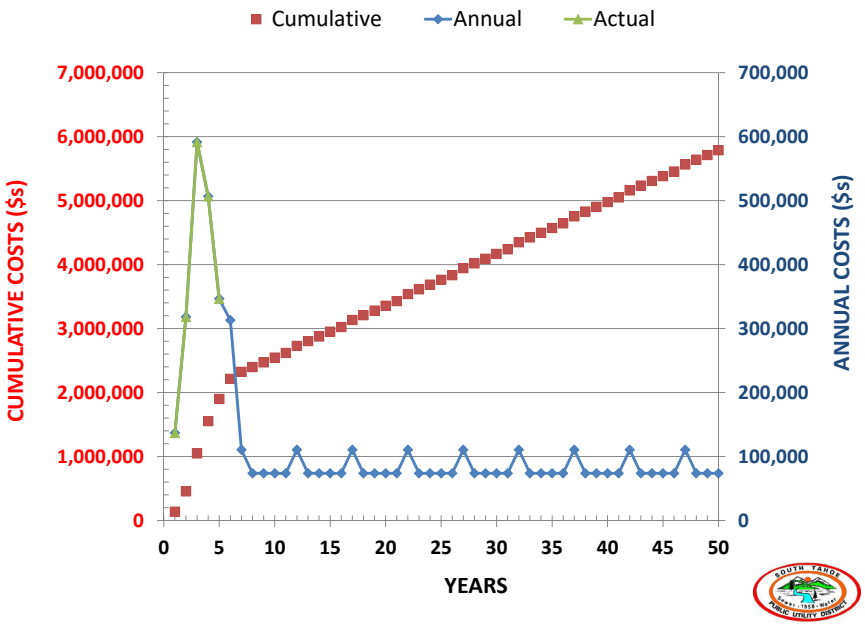
COSTS (2015 – 2020)



FUNDING (2015 – 2020)

SOURCE	AMOUNT
EDWA COST SHARE	$681,000
STATE GRANTS	$430,000
DISTRICT	$953,000
TOTALS	$2,064,000

50-Year PROJECTED



TVS Alternative Priorities (the next 5 years)

- Groundwater Contamination
- Small Water System & Domestic Wells
- Interconnected Surface Waters

FUNDING

- SGM Grant Program
  - SGM Implementation Grants
    - Confirmed: 2nd Round Funding - $77 M for medium and high-priority basins
    - Potential:
      - Governor's Budget (May Revised): $300 M for SGM Implementation including infrastructure, tech. assistance, support for DACs (e.g., DAC Involvement Program)
      - Legislature Budget (June Approved): $60 M for CODs
  - Eligible Project Types
    - Prop 68 Preference
    - Other Eligible
    - Implementation Plan
    - Multiple Benefits
  - Cost Share
    - 25% of local cost share (includes in-kind services)

Proposition 68 Preference

- "….activities and/or tasks that consist of the development of groundwater recharge projects with surface water, stormwater, recycled water, and other conjunctive use projects; and/or projects that prevent or clean up contamination of groundwater that serves as a source of drinking water (Public Resources Code § 80146(a)

Other Eligible

- Projects and programs that support water supply reliability, water conservation, and water use efficiency and water banking, exchange, and reclamation.

Implementation Plan

- Activities associated with the implementation of an adopted GSP or approved Alternative; listed within an adopted GSP or approved Alternative; and consistent with SGMA Guidance and BMPs.

Multiple Benefits (MB)

- Meet benefits of multiple planning documents (e.g., Stormwater Resources Plans (SWRP), Integrated Regional Water management (IRWM) Plans, Draft Water Resiliency Portfolio, etc.)

MB Examples

- Addresses impacts of current and future droughts and other water shortages;
- Community involvement, engagement, and education
- Habitat enhancement and/or creation;
- Stream or riparian enhancement and/or instream flow augmentation
- Upgrade and/or expansion of a wastewater treatment plant(s) to augment local water demand
- Water conservation
- Surface water, or dry weather runoff capture and reuse, treatment, and/or infiltration

Eligible Project Activity Examples

- Groundwater contaminant remediation or prevention projects for groundwater that serves as a source of drinking water
- Stormwater and runoff capture projects that support groundwater recharge
- Groundwater recharge projects that address groundwater dependent ecosystems (GDEs)
- Planning, design, and environmental documentation only as a task of a Project or Component of an overall project (not a standalone task).

SCHEDULE

- Spring 2022 – Solicitation Opens
- Summer 2022 – Public Review of Draft Funding List
- Fall 2022 – Final Awards