Bear Valley Basin Groundwater Sustainability Plan

Prepared for
Bear Valley Basin Groundwater Sustainability Agency

January 2022

Thomas Harder & Co.
Groundwater Consulting

In Association with:

WSC

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1. Introduction to the Bear Valley Basin Groundwater Sustainability Plan

1.1 Purpose of the Sustainable Groundwater Management Act

In September 2014, the Sustainable Groundwater Management Act (SGMA) was signed into law, with an effective date of January 1, 2015, and codified in the California Water Code, Section 10720 et seq. The legislative intent of SGMA is to, among other goals, provide for sustainable management of alluvial groundwater basins and subbasins defined by the California Department of Water Resources (CDWR), to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide specified local agencies with the Agency and the technical and financial assistance necessary to sustainably manage groundwater. To comply with and satisfy the requirements of SGMA, the following activities are mandated:

- Formation of a Groundwater Sustainability Agency (GSA) by June 30, 2017.
- Development of a Groundwater Sustainability Plan (GSP) by January 31, 2022.
- Implementation of the GSP to achieve quantifiable objectives and sustainability within 20 years (by 2042).
- Annual reporting of groundwater conditions in the basin to the CDWR.
- Periodic (every five years) evaluation of the GSP implementation by the GSA.

This document fulfills the GSP development requirement for the Bear Valley Basin. Specifically, the GSP provides the geographical and managerial context of the Bear Valley Basin, summarizes the groundwater basin setting (including groundwater conditions, water budget, and management areas), describes the criteria used to measure and demonstrate sustainability, reviews the existing groundwater monitoring and management programs, and defines how those actions will be incorporated into the Bear Valley Basin GSP to achieve and maintain sustainability in the future.

1.2 Description of the Bear Valley Groundwater Basin

This GSP covers the entire Bear Valley Groundwater Basin identified as Basin No. 8-009 in the CDWR Bulletin 118 (see Figure 1-1). The groundwater basin underlies the Big Bear Valley and covers approximately 30 square miles within the San Bernardino Mountains in southern San Bernardino County, California. The Big Bear Valley is an east-west trending valley that extends from Big Bear Lake Dam on the west to the eastern portion of Baldwin Lake on the east. The valley is surrounded by a series of local mountain ranges which rise to approximately 7,000 to 8,000 feet above sea level. Average annual precipitation ranges from approximately 35 inches on the western edge of the valley and in the mountains south of Baldwin Lake to 18 inches on the eastern edge of the valley (Flint and Martin, 2012). Big Bear Lake and Baldwin Lake are the

primary surface water features within the Bear Valley Groundwater Basin, and the basin is within the watershed areas of the Big Bear Lake and Baldwin Lake surface water drainage basins. These drainage basins are composed of multiple subbasins which are defined by surface water divides. The numerous creeks within these subbasins drain into Big Bear and Baldwin Lakes; the only significant surface water outflow from the valley is through Bear Valley Dam. Urban areas within the Bear Valley Groundwater Basin include the cities of Big Bear Lake, Fawnskin, Sugarloaf, and Big Bear City. Highways 18 and 38 are the primary driving routes within the valley.

The Bear Valley Basin is generally composed of alluvial deposits which are bound by pre-Tertiary crystalline (basement) rocks of the San Bernardino Mountains. Groundwater is produced from three primary geologic formations: unconsolidated or semi-consolidated alluvial sediments, fractures and weathered zones in granitic bedrock, and fractures and cavities in carbonate bedrock. Groundwater production wells that typically have the highest yields are constructed within the aquifers of the alluvial sediments. Currently, the entire municipal water supply in Big Bear Valley is from groundwater as there is no means of importing water into the area. The perennial yield (i.e. safe yield or sustainable yield) of the Bear Valley Basin has been estimated to be approximately 5,300 acre-feet/year. To date, annual groundwater production has never exceeded the perennial yield estimate and groundwater levels periodically recover to historical high conditions during wet periods. However, due to relatively limited aquifer storage in the basin, groundwater levels can vary widely between periods of relatively high precipitation and periods of low precipitation. As such, it is critical to monitor and manage groundwater levels to ensure adequate supplies during periods of prolonged drought. Since 2003, local agencies have implemented groundwater monitoring and management programs that have been successful at managing groundwater supplies to address periodic drought conditions, including the recent dry period between 2011 and 2017.

1.3 Basin Prioritization

CDWR’s Bulletin 118 – Interim Update 2016 (CDWR, 2018) defined 515 groundwater basins and subbasins in California. CDWR is required to prioritize these groundwater basins and subbasins as “high,” “medium,” “low,” or “very low” priority. The SGMA 2019 Basin Prioritization process was conducted to reassess the priority of the groundwater basins following the 2016 basin boundary modification, as required by the Water Code. For the SGMA 2019 Basin Prioritization, DWR followed the process and methods developed for the CASGEM 2014 Basin Prioritization, adjusted as required by SGMA and related legislation. CDWR is required to prioritize basins for the purposes of SGMA, which was enacted, among other things, to provide for the sustainable management of groundwater basins. This reprioritization entailed a reassessment of factors that had been utilized in the CASGEM program to prioritize basins based on groundwater elevation

monitoring. SGMA also required CDWR to continue to prioritize basins based on a consideration of the requirements specified in Water Code Section 10933(b):

1. The population overlying the basin or sub-basin.
2. The rate of current and projected growth of the population overlying the basin or sub-basin.
3. The number of public supply wells that draw from the basin or sub-basin.
4. The total number of wells that draw from the basin or sub-basin.
5. The irrigated acreage overlying the basin or sub-basin.
6. The degree to which persons overlying the basin or sub-basin rely on groundwater as their primary source of water.
7. Any documented impacts on the groundwater within the basin or sub-basin, including overdraft, subsidence, saline intrusion, and other water quality degradation.
8. Any other information determined to be relevant by the department, including adverse impacts on local habitat and local streamflow.

CDWR incorporated new data, to the extent data was available, and the amended the language of Water Code Section 10933(b)(8) (component 8) to include an analysis of adverse impacts on local habitat and local streamflow as part of the SGMA 2019 Basin Prioritization. Evaluation of groundwater basins at a statewide scale does not necessarily capture the local importance of groundwater resources within the smaller-size or lower-use groundwater basins. For many of California's low-use basins, groundwater provides close to 100 percent of the local beneficial uses. Thus, when reviewing the SGMA 2019 Basin Prioritization results, it is important to recognize the findings are not intended to characterize groundwater management practices or diminish the local importance of the smaller-size or lower-use groundwater basins; rather, the results are presented as a statewide assessment of the overall importance of groundwater resources in meeting beneficial uses.

The following information was deemed relevant and considered as part of component 8 for the SGMA 2019 Basin Prioritization based on SGMA:

- Adverse impacts on local habitat and local streamflows
- Adjudicated areas
- Critically overdrafted basins
- Groundwater-related transfers

Additional information about how each of these components were analyzed can be found in the process section of the 2019 SGMA Basin Prioritization Process and Results document.

The Bear Valley Groundwater Basin (Basin Number 8-009) was initially designated by the CDWR as a medium priority basin not subject to conditions of critical overdraft, requiring the formation

of the Bear Valley Basin Groundwater Sustainability Agency (BVBGSA) and preparation of a GSP for the GSA area. Given the fact that natural precipitation is the only source of recharge and water supply to the valley, the BVBGSA member agencies have already been proactive in implementing many of the groundwater monitoring and management elements required by SGMA in an effort to protect this critical resource. As such, the BVBGSA applied for and received a grant from CDWR to fund the preparation of the GSP. Following award of the grant, CDWR reclassified the Bear Valley Basin as a very low priority basin, but encouraged the BVBGSA to continue with the planned preparation of the GSP. Medium priority basins that are not in critical overdraft are scheduled to submit a GSP to CDWR by January 31, 2022.

1.4 Agency Information

The BVBGSA is a "local agency" comprised of the Big Bear City Community Services District (BBCCSD), the City of Big Bear Lake Department of Water and Power (BBLDWP), the Big Bear Regional Wastewater Agency (BBARWA) and the Big Bear Municipal Water District (BBMWD), each a member with water management responsibilities within the Bear Valley Groundwater Basin.

In 2017, the BBCCSD, BBMWD, BBARWA and BBLDWP elected to form a joint powers authority (JPA) to serve as the exclusive GSA for the entire Bear Valley Basin through a joint powers agreement. The Agency was created primarily to fulfill the role and legal obligations of a GSA for the Bear Valley Basin required by SGMA. The Agreement and Agency will continue to serve this role in full force until the governing bodies of the members unanimously elect to terminate the Agreement. Figure 2-1 shows the service area boundaries of each of the Agency parties and the GSA area.

1.4.1 Agencies Names and Mailing Addresses

The following contact information is provided for each member of the Bear Valley Basin Groundwater Sustainability Agency, pursuant to California Water Code §10723.8.

Big Bear City Community Services District
139 E. Big Bear Boulevard
P.O. Box 558
Big Bear, CA 92314
Attention: General Manager

City of Big Bear Lake Department of Water and Power
41972 Garstin Drive
P.O. Box 1929
Big Bear Lake, CA 92315

Attention: General Manager, Department of Water and Power

Big Bear Area Regional Wastewater Agency
121 Palomino Drive
Big Bear, CA 92314
Attention: General Manager

Big Bear Municipal Water District
40524 Lakeview Drive
P.O. Box 2863
Big Bear Lake, CA 92315
Attention: General Manager

1.4.2 Agency Organization and Management Structure

The JPA established the BVBGSA as a single GSA for the entire Bear Valley Basin to provide for the commitments reasonably anticipated to be necessary of ensuring that the Basin is sustainably managed in accordance with the timelines established by SGMA. The BVBGSA is governed by a Board of Directors which is composed of one (1) representative from BBCCSD, one (1) representative from BBARWA, one (1) elected representative from BBMWD and one (1) appointed commissioner from BBLDWP. Each BVBGSA Board member shall be entitled to one vote. A simple majority of the quorum (i.e. two-thirds) is required for any adoption of a motion, resolution, contract authorization or other action of the Board, except that:

1) A majority vote of less than a quorum may vote to adjourn;
2) Any of the following actions shall require a unanimous vote of the entire Board:
    a) Adoption, modification or alteration of the GSP or of the GSA boundaries;
    b) Adoption of assessments, charges or fees;
    c) Admission of additional Members to the BVBGSA;
    d) Setting the amounts of any contribution or fees to be made or paid to the BVBGSA by any Member; and
    e) Issuance of bonds or other indebtedness.

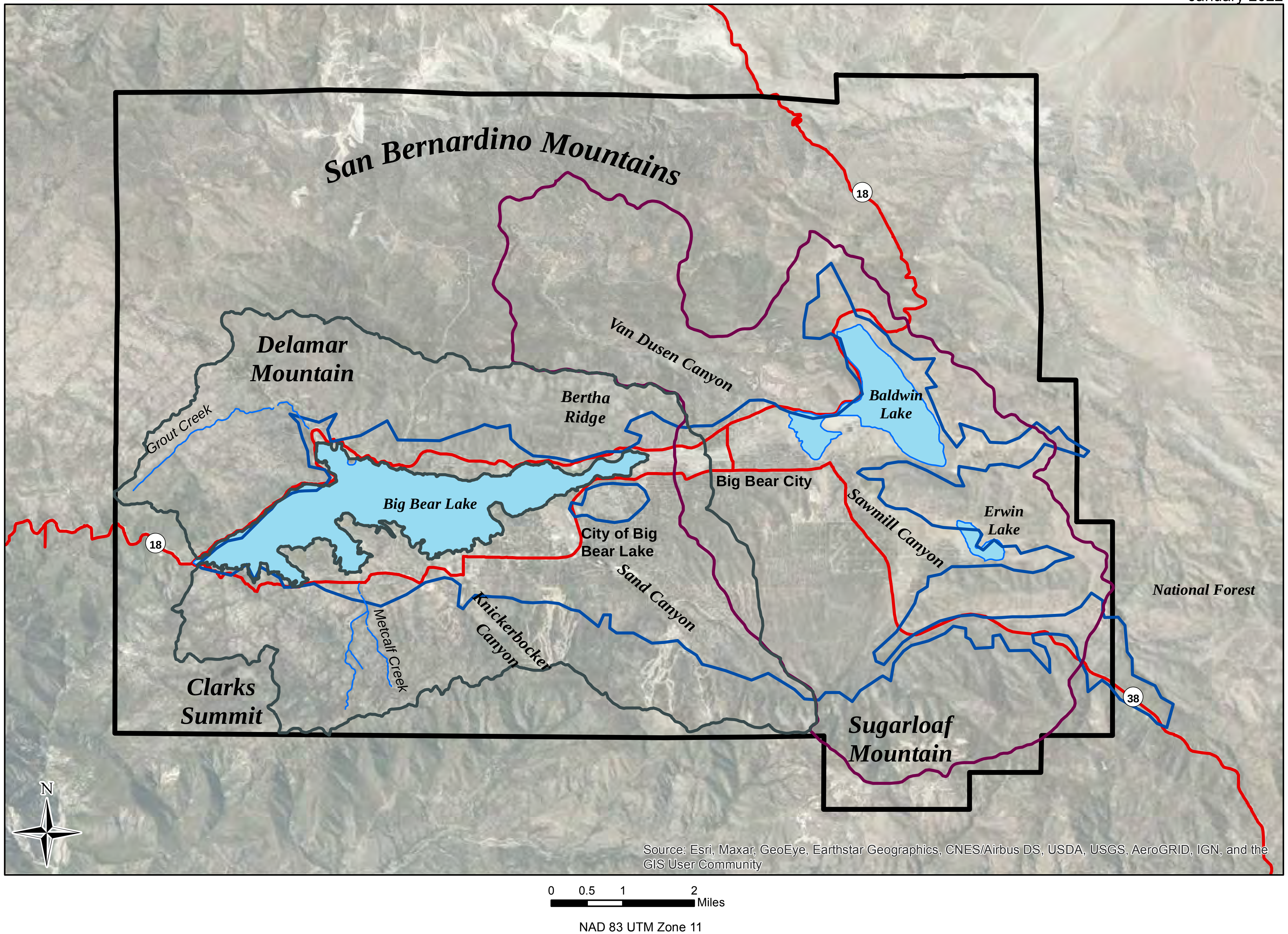
The officers of the BVBGSA includes a Chairperson, a Vice-Chairperson, a Treasurer and a Secretary. Names of the officers appointed to the Board of Directors are provided below:

Bob Ludecke, Chairman

Craig Hjorth, Treasurer

John Green, Vice Chairman

James Miller, Secretary



Regional Map

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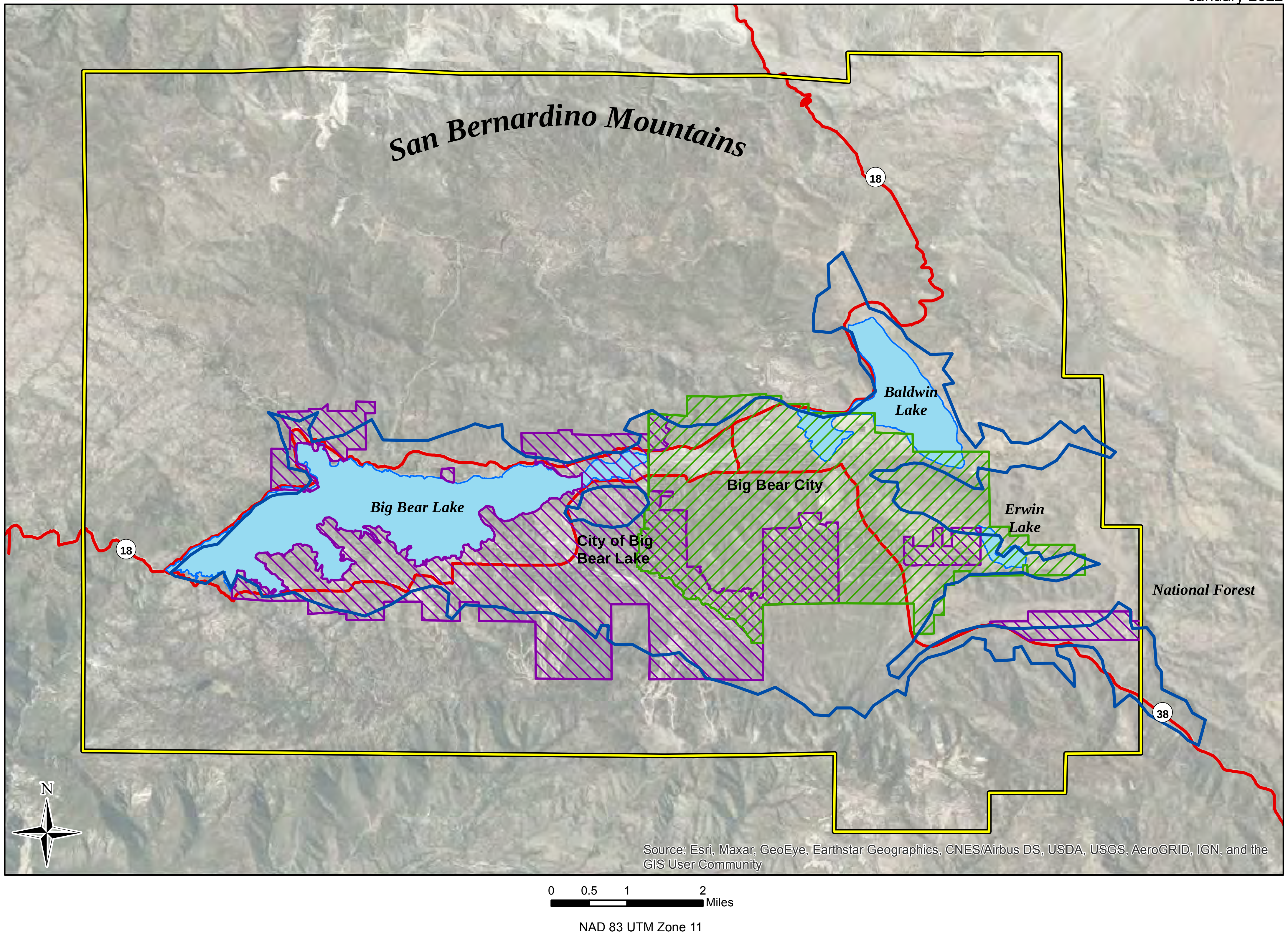
Bear Valley Basin

Figure 1-1

January 2022



Map Features

- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)
- Bear Valley Basin Groundwater Sustainability Agency Boundary
- Big Bear Municipal Water District
- Big Bear City Community Services District Service Area
- Big Bear Lake Department of Water and Power Service Area
- Highway

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Bear Valley Basin Jurisdictional Map

Figure 1-2

2. Bear Valley Basin Setting

The Bear Valley Groundwater Basin (No. 8-009) covers approximately 30 square miles within the San Bernardino Mountains in southern San Bernardino County, California (see Figure 2-1). Bear Valley extends from Big Bear Lake Dam on the west to the eastern portion of Baldwin Lake on the east. The basin is characterized by two major watersheds, each which encompasses the two primary surface water features in the area: Big Bear Lake and Baldwin Lake. The area of the Bear Valley Basin is defined by the latest version of California Department of Water Resources (CDWR) Bulletin 118 (CDWR, 2018) and is shown on Figure 2-1.

The Bear Valley Basin area includes the jurisdictional areas of multiple water districts and service entities, including Big Bear Lake Department of Water and Power (BBLDWP), Big Bear City Community Services District (BBCCSD), Big Bear Municipal Water District (BBMWD), and Big Bear Area Regional Wastewater Agency (BBARWA).

2.1 Hydrogeologic Conceptual Model

The hydrogeologic conceptual model is a description of the groundwater flow system of the Bear Valley Basin and how it interacts with surface water and land use of the area. The conceptual model includes a description of the geologic setting, geologic structure, and boundary conditions including the principal aquifers and aquitards. The hydrogeologic conceptual model of the Bear Valley Basin, as described herein, has been developed in accordance with the requirements of California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14) and in consideration of CDWR's Best Management Practices (BMP) for the preparation of hydrogeologic conceptual models.

2.1.1. Sources of Data

Compilation, review, and analysis of multiple types of data were necessary to develop the hydrogeologic conceptual model and water budget of the Bear Valley Basin. The various types of data included geology, soils/lithology, hydrogeology, surface water hydrology, climate, land use, topography, remote sensing, and groundwater recharge and recovery. Data were obtained from multiple sources:

Geological Data including geologic maps and cross sections were obtained from the United States Geological Survey (USGS) and the California Geological Survey (CGS). Geophysical logs were obtained from reports provided by the City of Big Bear Lake Department of Water and Power (BBLDWP) and Big Bear City Community Services District (BBCCSD).

Lithological Data were obtained from drillers' logs and reports from the CDWR and detailed lithological logs from boreholes and wells drilled in the basin, as provided by BBLDWP and BBCCSD.

Hydrogeological Data including groundwater levels and pumping tests were obtained from the BBLDWP, BBCCSD, and Big Bear Area Regional Wastewater Agency (BBARWA).

Groundwater Quality Data from the BBLDWP, BBCCSD, California State Water Resources Control Board Department of Drinking Water Database, Environmental Data Resources, Inc. EDR Radius Map, and contaminants identified in the California State Water Resources Control Board Geotracker website (Geotracker, 2019).

Well Information including water well construction and well locations were obtained from CDWR driller's logs (private wells) and BBLDWP and BBCCSD (municipal wells).

Groundwater Production Data was obtained from BBLDWP and BBCCSD.

Hydrological (i.e. Surface Water) Data including Big Bear Lake surface water levels, natural inflows, and releases from the dam were obtained from BBMWD. Spring flow data was obtained from BBLDWP and BBCCSD. Information on the Baldwin Lake water balance was obtained from the USGS.

Climate/Precipitation Data was acquired from BBMWD, BBCCSD, the County of San Bernardino, CDWR's California Irrigation Management Information System (CIMIS), and the Western Regional Climate Center website.

Land Use Data was obtained from the CDWR, and the USGS Earth Resources Observation and Science Center. Political boundaries were obtained from the BBLDWP, BBCCSD, and BBMWD.

In addition to the various types of data, numerous historical reports on the geology, hydrogeology and groundwater management of the Bear Valley Basin were reviewed and analyzed. These reports included USGS publications, CDWR reports and bulletins, consultant reports, and academic publications. Publications relied on for the hydrogeological conceptual model and water budget are summarized in the References Section (Section 2.5).

2.1.2. Geologic Setting

Bear Valley Basin is situated at an elevation of approximately 6,740 feet above mean sea level (amsl) in the San Bernardino Mountains in the Transverse Ranges province of Southern California (Figure 2-1). It is located at the west end of a continuous east-west valley-like feature that extends from the west end of Big Bear Lake to the east end of Baldwin Lake. The surrounding mountain

slopes are relatively steep (as much as 70 degrees) and rugged. Prominent mountain peaks and ridges surrounding Big Bear Lake include Delamar Mountain to the north (8,398 feet amsl), Bertha Ridge and Gold Mountain to the northeast (8,201 and 8,235 feet amsl, respectively), Moon Ridge to the southeast (7,583 to 7,866 feet amsl), Sugarloaf Mountain to the southeast (9,952 feet amsl), and Snow Summit and Clark's Summit to the south (8,182 and 7,816 feet amsl; see Plate 1). Big Bear Lake receives surface runoff from several small canyons and valleys, the most prominent of which are Grout Creek to the northwest, Van Dusen Canyon to the northeast, Sawmill Canyon to the southeast, Sand Canyon to the southeast, and Knickerbocker Canyon and Metcalf Creek to the south.

The San Bernardino Mountains formed because of uplift along a complex system of faults, including the San Andreas Fault System, which separates the San Bernardino Mountains from the neighboring San Gabriel Mountains to the west. Most of the tectonic activity that created the mountains occurred during Late Pliocene and Pleistocene times (2.6 million years ago to 12,000 years ago). However, uplift continues to occur at a rate of approximately 30 inches every 100 years. The June 28, 1992 Big Bear earthquake is evidence of the continued tectonic activity in the area.

In the Bear Valley Basin area, the San Bernardino Mountains consist primarily of Mesozoic granitic intrusive rocks, with lesser outcrops of Precambrian and Late Paleozoic metamorphic rock (see Figure 2-2). Geologic formations observed at the land surface and in the subsurface beneath the Bear Valley Basin can be grouped into three primary geologic formations, described below in order of increasing age:

Quaternary Alluvial Deposits – This unit consists of primarily Quaternary age (approximately 2.5 million years ago to present) clay and sandy clay with interbedded sand and gravel layers near Big Bear Lake and coarsens to predominately sand with some gravel and interbedded layers of silt and clay towards Baldwin Lake. Beneath Baldwin Lake, alluvial deposits consist of lacustrine (historical lake) deposits mostly consisting of clay, silt and interbedded sand. The coarse-grained layers make up the water-bearing aquifer in which wells pump from.

Recent alluvium is comprised of permeable sand and gravel with lesser interbedded layers of silt and clay. Most recent alluvium is located above the water table but where it is present, this permeable layer allows for infiltration of rainfall and runoff into the subsurface (Geoscience, 2004; Flint and Martin, 2012).

Tertiary Sedimentary Deposits – These sediments overlie the basement rocks throughout most of the Bear Valley Basin and are Tertiary age (approximately 65 million years ago to 2.6 million years ago). This unit consists primarily of consolidated to semi-consolidated

alluvial fan deposits of gravel, sand and clay. Some municipal wells have been constructed in these Tertiary deposits, but they are less permeable than overlying Quaternary sediments and do not yield significant water. Tertiary sedimentary deposits are exposed at the land surface southeast of Big Bear Lake in the Sugarloaf area, along the base of the hills on the north side of Big Bear Lake, and in the Lake Williams area. This unit is greater than 1,000 ft thick in the Sugarloaf area (Geoscience, 2005).

Pre-Tertiary Bedrock – Basement rocks underlying the Tertiary and Quaternary sediments consist of Cretaceous (65 to 145 million years ago) granitic rocks, Paleozoic (252 to 541 million years ago) sedimentary rocks consisting of limestone, and Proterozoic (older than 541 million years) metamorphosed sedimentary rocks consisting of quartzite and gneiss (Miller, 2004). The permeability of the geologic formations making up the basement rocks is generally very low and they are not considered major water-bearing units in the Bear Valley Basin. However, localized fractures in this bedrock allow for some groundwater production via springs and bedrock wells. The BBLDWP Cherokee Well in Fawnskin produces groundwater from fractures in the granitic rock in this area. BBLDWP's Lassen Well is constructed within fractures in the limestone south of Big Bear Lake.

The most significant fault near the Bear Valley Basin is the San Andreas Fault zone. The San Andreas Fault is a strike-slip fault that bounds the south side of the San Bernardino Mountains. A significant zone of frontal reverse faults exist on the north side of the mountains. These faults account for the uplift in the San Bernardino Mountains (Miller, 1987).

2.1.3. Lateral Basin Boundaries

The lateral boundaries of the Bear Valley Basin are defined by the surface contact between crystalline rocks of the San Bernardino Mountains and surficial alluvial sediments within the valley floors (see Figure 2-2). The westernmost extent of the basin is defined by the Big Bear Lake dam. The total area of the Bear Valley Basin is approximately 30 square miles (19,155 acres).

2.1.4. Bottom of Basin

The physical bottom of the Bear Valley Basin is defined by the interface between the Tertiary sedimentary deposits and the relatively impermeable crystalline basement complex underlying them. Variations in the thickness of alluvial sediments throughout the basin, based on both borehole intercepts and a gravity survey (Flint and Martin, 2012), is shown on Figure 2-3 and Plates 1 and 2). As shown, the alluvial/tertiary sedimentary thickness in some areas of the basin

exceeds 1,500 feet. However, the most permeable sediments, and the most productive aquifers for groundwater supply, are generally in the upper 500 feet of alluvial sediments.

2.1.5. Surface Water Features

The Bear Valley Basin is encompassed by two major watersheds: the Big Bear Lake Watershed at the west end of the basin and the Baldwin Lake Watershed at the east end of the basin.

The Big Bear Lake Watershed covers an area of approximately 38.5 square miles and delineates the area where surface water drains into Big Bear Lake (see Figure 2-4). The Big Bear Lake Watershed has been divided into seven hydrologic subareas: Gray's Landing, Grout Creek, North Shore, Division, Rathbone, Village, and Mill Creek (LeRoy Crandall & Associates, 1987a). The subareas are delineated based on surface water drainage divides.

The Baldwin Lake Watershed covers an area of approximately 34.3 square miles and delineates the area where surface water drains into Baldwin Lake. This watershed is divided into four hydrologic subareas: Erwin, West Baldwin, East Baldwin, and Van Dusen (LeRoy Crandall & Associates, 1987b).

2.1.5.1 Big Bear Lake

Big Bear Lake is a manmade reservoir that is fed by runoff from creeks that drain the mountains and valley floor within the Big Bear Lake watershed (see Figure 2-4). The maximum surface area of the lake is 2,971 acres and, when full, the lake storage capacity is approximately 73,320 acre-ft. At its deepest point at the dam, the lake is approximately 70 feet deep. Lake surface water elevations typically range from 6,743 feet above mean sea level (ft amsl) when full to 6,725 ft amsl during dry periods.

The dam that contains the lake was originally built in 1884 and then rebuilt in 1912 to create a reservoir to meet irrigation needs of downstream growers. The BBMWD manages lake levels in the context of water demands from downstream water rights holders and recreational uses for the local area. Downstream water demands are met through releases of lake water at the dam or from in-lieu water purchase agreements. Local recreational uses of the water include fishing and boating as well as water supply for snowmaking at the local ski resorts.

2.1.5.2 Baldwin Lake

Baldwin Lake is classified as a mountain playa. The lake is usually dry but periodically contains standing water during years of high rainfall. The surface area of this lake is approximately 1,500 acres (Johnson, 1994). During years of high rainfall, the surface water elevation of the lake can reach 6,707 feet (Johnson, 1994) with a corresponding lake depth of approximately 12 feet at

its deepest point. Surface water runoff into Baldwin Lake occurs via Van Dusen Canyon to the northwest and Shay Creek to the south (see Figure 2-4).

Surface water sources to Baldwin Lake are primarily in the form of ephemeral streams with relatively low flow volumes. The only stream where surface water flow has been periodically measured is Shay Creek at its outlet from Shay Pond (see Figure 2-4). During most years, surface water runoff does not reach Baldwin Lake but percolates into the groundwater system. However, during prolonged precipitation, surface water does collect in Baldwin Lake.

All surface water that enters Baldwin Lake is lost to evaporation. The high clay content of the playa sediments prevents vertical migration and the topographical configuration of the lake prevents surface runoff.

2.1.5.3 Lake Erwin

Lake Erwin is a small mountain playa located approximately one mile southeast of Baldwin Lake within the Erwin Hydrologic Subunit (see Figure 2-4). This lake contains water only during periods of high rainfall. The lake is fed from runoff in ephemeral streams that drain the hills to the north and south. The lake is also fed from the east via an unnamed stream that drains out of Gocke Valley to the south. There are no records available regarding surface water inflow to this lake.

2.1.5.4 Springs

Numerous springs feed ephemeral streams in the Big Bear Lake and Baldwin Lake watershed areas. Many of the springs have measurable flow at least part of the year and some are tapped by the BBLDWP and BBCCSD as sources of municipal water supply.

Big Bear Lake Watershed

Prominent springs utilized for water supply in the Big Bear Lake Watershed include Cedar Springs (Grout Creek subunit) and Dogwood Springs (Rathbone subunit) (see Figure 2-4). Water from these springs is captured by the BBLDWP for municipal water supply in the respective hydrologic subunits within which they are located. Annual production from the Cedar Springs (Cedar Dell Slant Wells) between 1990 and 2019 has been 32.5 acre-ft/yr. Annual production from the Dogwood Springs (Dogwood Slant Wells) between 1990 and 2019 has been 123 acre-ft/yr.

Baldwin Lake Watershed

Prominent springs utilized for water supply in the Baldwin Lake Watershed include the Greenspot and Fish Hatchery Springs (Erwin Subunit), and Van Dusen Slant Wells (Van Dusen Subunit).

Greenspot and Fish Hatchery Springs typically flow year-round and are used by BBCCSD for municipal water supply. The Van Dusen Slant Wells enhance a natural spring in Van Dusen Canyon for BBCCSD water supply. Water supply from the combined Green Spot Springs and Van Dusen Slant Wells averages approximately 190 acre-ft/yr.

Shay Pond is a natural surface water body at the southern base of an unnamed ridge that separates it from Baldwin Lake in the northern part of the Erwin Subunit. The nature of this pond is unknown, but it may be fed, in part, from spring flow, surface runoff, and periodically, groundwater intersecting the land surface. Although the pond may have historically been fed from surface water runoff in the ephemeral stream Shay Creek, urban development has altered the course of this stream and it no longer outlets into the pond. Surface water exits Shay Pond via Shay Creek, which flows northwards into Baldwin Lake.

2.2 Areas of Groundwater Recharge and Discharge

2.2.1 Recharge

Groundwater recharge in the Bear Valley Basin occurs from deep percolation of precipitation that falls on the younger alluvium and fractures in the bedrock and infiltration of surface runoff in ephemeral streams and soft bottom washes. The majority of natural recharge occurs in areas where Young Alluvial Fan Deposits are mapped at the land surface (see Figure 2-2).

Numerous studies have been conducted to identify areas favorable for artificial recharge of the aquifer system in the Bear Valley (Geoscience, 1990; Geoscience, 2004a; TH&Co, 2017). Areas that are most promising occur in or near ephemeral stream channels that are characterized geologically by recent alluvium or stream channel sediments (sand and gravel) and where the groundwater table is greater than 50 ft below ground surface (bgs). Areas of favorable recharge identified from previous studies are shown on Figure 2-5. These areas include the Sand Canyon area on the south side of Big Bear Lake in the Rathbone Subunit, the area north of Green Spot Spring in the Erwin Subunit south of Baldwin Lake, and Van Dusen Canyon north of Baldwin Lake. Favorability for recharge has been supported through analysis of both borehole testing and pilot-scale recharge tests (Geoscience, 2004a).

2.2.2 Discharge

The Bear Valley Basin is a closed basin with no natural outlets for groundwater outflow. Natural groundwater discharge within the basin occurs from numerous springs located throughout the basin (see Figure 2-4; Section 2.1.5.4). This spring flow is either captured by local agencies for municipal water supply or discharges into ephemeral washes and infiltrates into the subsurface.

During periods of prolonged above-normal precipitation, it is possible that some uncaptured spring flow from Green Spot Spring enters Baldwin Lake where it eventually evaporates.

Some discharge of groundwater occurs through evapotranspiration in areas where groundwater rises near the land surface during periods of high precipitation. These areas include the immediate Shay Pond area in the Erwin Subunit, parts of west Baldwin Lake, and the outlet of Rathbun Creek to Big Bear Lake.

The primary source of groundwater discharge within the Bear Valley Basin is groundwater pumping (see Section 2.3.2.2). Groundwater pumping is conducted from both municipal and private wells. There are 72 municipal groundwater production wells in the Bear Valley Basin (55 operated by BBLDWP and 15 operated by BBCCSD) (see Figure 2-6). There are numerous private wells located throughout the Bear Valley Basin, as many as 445 private wells have been documented from CDWR driller's logs as of 2019. Some of these wells have been verified in the field. However, the exact number of private wells is not known as many have been destroyed, others are inactive, and some may have been drilled but not properly recorded.

2.3 Principal Aquifer and Aquitards

2.3.1 Aquifer Formations

In general, groundwater is produced from three hydrogeological units in the subsurface beneath the Bear Valley Basin (see Plates 1 and 2):

1. Unconsolidated or semi-consolidated alluvial sediments
2. Fractures in Granitic Bedrock
3. Fractures and cavities in Carbonate Bedrock

Unconsolidated to Semi-Consolidated Alluvial Aquifer

Previous reports for the eastern portion of the Bear Valley Basin have described three individual aquifers within the unconsolidated to semi-consolidated alluvial sediments: an upper, middle, and lower aquifer (Geoscience, 1999). For this report, the prior designations have been extended to the remaining parts of the Bear Valley Basin, based on lithologic characteristics, permeability, and groundwater quality.

The upper aquifer consists of younger alluvium and is characterized by more permeable sand and gravel that occurs primarily within the major drainage channels (e.g. Shay Creek) and in the north central portion of the basin between Big Bear and Baldwin lakes. In general, the upper aquifer is

approximately 50 ft thick. This aquifer is the most permeable of the alluvial aquifer units but is locally unsaturated during dry climatic cycles. This aquifer is considered unconfined.

The middle aquifer consists of older alluvium and older fan deposits and is characterized by locally thick layers of silt and clay with relatively thin layers of sand and gravel. This aquifer extends throughout the basin and is approximately 150 feet thick to greater than 800 feet thick. Most of the municipal wells within the Bear Valley Basin are perforated within the middle aquifer because the sand and gravel layers within this unit are moderately permeable and yield economic quantities of water and the groundwater quality is very good. Groundwater production rates in wells perforated in this aquifer range from approximately 50 gpm to 1,000 gpm. This aquifer is confined.

The lower aquifer is characterized by gravel, coarse sand, pebbles and interbedded sandy clay in north central portion of the basin but is predominantly clay in the southern portion of the basin. While some municipal wells have been completed with perforations extending into the lower aquifer, it is characterized by relatively low permeability and high concentrations of naturally occurring fluoride and arsenic in groundwater at depth, which have prevented utilizing this aquifer for water supply.

Fractured Granitic Bedrock Aquifer

A small number of vertical wells have been constructed within the granitic bedrock on the north side of Bear Valley Basin. The BBLDWP Cherokee Well, in Fawnskin, produces groundwater from fractures in the granitic bedrock. This well is capable of producing discharge rates as high as approximately 60 gallons per minute (gpm), which is lower than most of the wells perforated in the alluvial aquifer system. Some private wells on the north side of Big Bear Lake are also known to be completed in the granitic bedrock. Individual well production rates from these wells are expected to be on the order of those observed in the Cherokee Well, or lower.

Fractured Carbonate Bedrock Aquifer

The BBLDWP operates one well that produces groundwater from the carbonate bedrock (Lassen Well No. 4). This well is located south of Big Bear Lake within the Rathbone Subunit.

2.3.2 Aquifer Physical Properties

The ability of aquifer sediments to transmit and store water is described in terms of the aquifer parameters transmissivity, hydraulic conductivity, and storativity. The most reliable estimates of these parameters are obtained from long-term (e.g. 24-hr or more constant rate) controlled pumping tests in wells. In the absence of this type of test, estimates can be obtained through short-term pumping tests and/or assignment of literature values based on the soil types observed in

driller's logs. Long-term pumping test data was obtained from BBLDWP and BBCCSD. Short-term pumping test data was obtained from driller's logs.

Transmissivity is a measure of the ability of groundwater to flow within an aquifer and is defined as the rate of groundwater flow through a unit width of aquifer under a unit hydraulic gradient (Fetter, 1994). Transmissivity was estimated from short-term pumping test data based on Theis et al., 1963 and the following relationship:

$$T = \frac{S_c \, x \, 2{,}000}{E}$$

Where:

T	=	Transmissivity (gpd/ft);
S_c	=	Specific Capacity (gpm/ft);
E	=	Well Efficiency (assumed to be 0.7)

Transmissivity values at individual wells were converted into hydraulic conductivity (i.e. aquifer permeability) by dividing by the aquifer thickness (in this case the perforation interval of the well). Horizontal hydraulic conductivity values for the alluvial aquifer are summarized in Table 2-1 and shown on Figure 2-7 and range from less than 1 ft/day to approximately 130 ft/day, the higher values indicating more permeable sediments.

Storage properties of the upper aquifer are expressed in terms of specific yield since most of this aquifer is conceptualized as unconfined. Specific yield is the ratio of the volume of water sediment will yield by gravity drainage to the volume of the sediment. The only specific yield value available for the upper aquifer is in the Erwin Subunit, where pumping tests and pilot recharge testing resulted in a value of 0.03 (see Figure 2-8).

The middle aquifer is confined and, as such, storage properties for this aquifer are expressed in terms of storativity. Storativity is a measure of the volume of water an aquifer can release from, or take into, storage per unit of aquifer surface area per unit change in hydraulic head. Storativity is derived from long-term pumping tests where pumping interference is measured in a monitoring well located a known distance from the pumping well. Values for storativity in the middle aquifer range from 0.00003 to 0.0006 (see Table 2-1; Figure 2-8). These values indicate confined aquifer conditions.

No storage property data are available for the lower aquifer or bedrock aquifers.

2.3.3 Geologic Structures that Affect Groundwater Flow

Numerous small unnamed faults have been mapped throughout the Bear Valley Basin (Sadler, 1982; Ron Barto & Associates, 1988). The only fault that has been observed to affect groundwater flow is an inferred fault that extends in a northeast/southwest trend at the west end of Lake Erwin (see Figure 2-2). The fault was inferred based on groundwater level differences on each side of the fault. The Bear Valley Basin is seismically active, as demonstrated from the 1992 Big Bear earthquake. Coincident with that earthquake, groundwater levels in some monitoring wells in the Erwin subunit changed significantly (Geoscience, 2001) and some wells along Baldwin Lake began flowing artesian (Heule, 1992). Thus, seismic activity in the area does impact groundwater flow although the correlation with specific faults is not known.

2.3.4 Aquifer Water Quality

Groundwater quality in the Bear Valley Basin varies across the basin and with depth in the aquifer system. Overall, the native groundwater quality of the upper and middle aquifers from which local agencies produce water is generally very good, with historical total dissolved solids (TDS) measurements generally in the range of 200 to 300 milligrams per liter (mg/L) with no detections above 500 mg/L (see Figure 2-9). Groundwater quality issues in the subbasin include both regional non-point groundwater quality issues and point-source contaminant issues.

Fluoride is a naturally occurring non-point constituent of concern in the Baldwin Lake and Lake William areas (see Figure 2-10). Concentrations of this constituent generally increase with increasing depth in the aquifer system where it is present. Depth-specific water quality sampling in wells near Baldwin Lake (e.g. BBCCSD's Wells 8, 9 and 10) have shown that fluoride concentrations below a depth of approximately 350 feet are generally higher than the maximum contaminant level (MCL) for this constituent of 2 mg/L (Geoscience 2003a, Geoscience, 2003b, and Geoscience, 2003c). This depth generally defines the boundary between the middle aquifer system and lower aquifer system in the Baldwin Lake area. Construction of most of the newer wells in this area is limited to the middle aquifer due to high fluoride in the deep aquifer. One exception is BBCCSD's Well 3B, located at the southwestern edge of Baldwin Lake. Depth-specific isolated aquifer zone testing showed that fluoride concentrations ranged from 6.3 mg/L at a depth of 300 to 320 ft bgs to 9.0 mg/L at a depth of 480 to 500 ft bgs (Geoscience, 2000).

Other naturally occurring groundwater quality constituents of concern have included arsenic, manganese, and uranium. Arsenic has been detected in samples from wells in the Grout Creek subunit (Cherokee Well), Rathbone Subunit (Owen Well) and Mill Creek Subunit (Canvasback test borehole) (see Figure 2-11). The arsenic concentration in the Canvasback test borehole was 88 µg/L and was detected in a depth-specific sample collected from 499 ft bgs (Geoscience,

2003d). Arsenic has not been detected in a shallower well completed near the test hole to a depth of 315 ft bgs, indicating the arsenic concentrations are unique to a deeper aquifer system at the site (Geoscience, 2004b). All other arsenic concentrations detected in the Big Bear Valley have been below the MCL. Uranium has been detected in the Canvasback Well at concentrations above the MCL. Manganese has been detected above its secondary MCL in wells in the Village Subunit and Division Subunit.

For point-source contaminants, there are nine active cleanup sites in the Bear Valley Basin identified on the California Geotracker website (see Figure 2-12; Table 2-2). Seven of the point source contamination sites are associated with leaking underground storage tanks (LUSTs) for which the primary contaminants are gasoline, methyl tert-butyl ether (MTBE), tertiary butyl alcohol (TBA) and/or other oxygenates. There is one Department of Toxic Substance Control (DTSC) site and one land disposal site listed within the basin (see Figure 2-12). Contaminants associated with these sites are not reported on the Geotracker website.

2.3.5 Aquifer Primary Uses

The predominant beneficial use of groundwater in the Bear Valley Basin is municipal water supply. The other beneficial use is private domestic water supply.

2.4 Uncertainty in the Hydrogeologic Conceptual Model

The primary sources of uncertainty in the hydrogeologic conceptual model include:

- Precipitation distribution across the Bear Valley Basin
- The surface water balance of Baldwin Lake
- Areal recharge from precipitation
- Tributary channel infiltration
- The nature of the aquifer system beneath Big Bear Lake.
- Aquifer characteristics of hydraulic conductivity, transmissivity and storativity.

2.5 Groundwater Conditions

2.5.1 Groundwater Occurrence and Flow

Most of the groundwater within the Bear Valley Basin occurs in the permeable sediments that make up the alluvium of the basin. Groundwater in the upper aquifer is unconfined. Groundwater in the older alluvial fan sediments of the middle and lower aquifers are confined. Groundwater also occurs in the secondary porosity features (i.e. fractures and cavities) within the granitic and limestone bedrock.

Groundwater in the Bear Valley Basin flows by gravity drainage from areas of recharge along the flanks of the surrounding mountains towards Big Bear Lake and Baldwin Lake (see Figures 2-13 through 2-16). In the western portion of the basin south of Big Bear Lake, groundwater flows to the northwest towards the lake and towards a groundwater pumping depression in the Village Subunit (see Figures 2-13 and 2-15). In the eastern portion of the Basin south of Baldwin Lake, groundwater flows to the north towards the center of the basin and Baldwin Lake. A slight groundwater pumping depression is present in the northwestern part of the Erwin Subunit (see Figures 2-14 and 2-16). There is also a groundwater flow divide in the north central part of the basin between Big Bear Lake and Baldwin Lake. The divide occurs in the vicinity of the outlet of Van Dusen Canyon where groundwater west of the canyon flows to the west and groundwater east of the canyon flows to the east.

Changes in groundwater levels over time vary from hydrologic subunit to hydrologic subunit as a function of the geology of the area, groundwater production, and precipitation patterns. Monitoring wells with historical groundwater level data are in the Grout Creek, North Shore, Mill Creek, Village, Rathbone, Division, West Baldwin and Erwin hydrologic subunits.

Grout Creek Subunit

Historical groundwater levels in the Grout Creek Subunit are documented for the Seminole Well with a period of record from 1996 to 2019 (see Figure 2-17). This well is relatively shallow (less than 100 feet deep) and perforated in alluvium that is known to be hydrologically connected with Big Bear Lake. Groundwater levels in this well have ranged from approximately 6,738 and 6,755 ft amsl (7 to 24 feet below land surface). Groundwater levels throughout the period of record have been relatively stable and, while dropping during dry climatic cycles, rise to historical high levels during wet precipitation cycles.

Groundwater levels in the bedrock aquifer, as indicated by measurements in the Cherokee Well, are at a similar elevation and range as the Seminole Well, ranging from approximately 6,739 to 6,758 ft amsl. The groundwater level trend has been relatively stable since the start of data collection in 2013.

North Shore Subunit

Groundwater level data are available for two wells that supply water for a recreational vehicle park on the north side of Big Bear Lake (RV Park Well Nos. 1 and 2) (see Figure 2-18). The period of record for these wells is from 1996 to 2019. Static groundwater levels in RV Park Well No. 1 have ranged from approximately 6,750 to 6,785 ft amsl. Since approximately 2011, groundwater levels in this well have shown a slight downward trend, dropping a total of approximately 20 feet.

Static groundwater levels in RV Park Well No. 2 have ranged from approximately 6,780 to 6,820 ft amsl. Groundwater levels in this well have remained relatively stable.

Groundwater levels in the Stanfield Monitoring Well, located on the east side of the North Shore Subunit, have ranged from approximately 6,740 ft amsl to 6,780 ft amsl (see Figure 2-18). Groundwater levels in this monitoring well track very closely with surface water levels in Big Bear Lake indicating that the shallow groundwater level at this location is likely in hydrologic communication with surface water in the lake.

Mill Creek Subunit

Historical groundwater levels are available for three monitoring wells in the Mill Creek Subunit: Metcalf, Canvasback Well and Mallard Well (Figure 2-19). The Canvasback and Mallard wells are nested, with isolated perforations in the Middle and Lower aquifers. Static groundwater levels in most of the wells are around 6,760 ft amsl. The groundwater level in the Lower Aquifer Canvasback well completion is 6,780 ft amsl, approximately 20 feet higher than the Middle Aquifer groundwater level and indicating confined aquifer conditions. Groundwater levels dropped approximately 100 feet at the Canvasback Middle Aquifer monitoring well in 2007 when BBLDWP began pumping the Canvasback production well, located approximately 50 feet from the monitoring well. Due to water quality issues, pumping from the Canvasback production well was discontinued shortly after and groundwater levels returned to their pre-pumping elevation. Groundwater levels in the Mill Creek Subunit are stable.

Village Subunit

The BBLDWP's Pennsylvania and Knickerbocker wells are used as monitoring wells in the Village Subunit (see Figure 2-20). Static groundwater levels in the Pennsylvania Well were as high as 6,730 ft amsl in 1996 before declining steadily to an elevation of approximately 6,690 ft amsl in 2004. After that time, BBLDWP reduced groundwater production in the Village Subunit to allow groundwater levels to recover. Since 2004, groundwater levels have been recovering or steady in both the Pennsylvania and Knickerbocker wells.

Rathbone Subunit

Three wells used for measuring groundwater levels in the Rathbone Subunit are the Sand Canyon Well (irrigation), Rathbone Fire Station Monitoring Well, and Elm Monitoring Well (see Figure 2-21). Groundwater levels in the Sand Canyon well have dropped over time from approximately 7,000 ft amsl in 1992 to approximately 6,920 ft amsl in 2004 and then again in 2019. During above-average precipitation years, the groundwater level rises as much as 60 feet but have not recovered to the historical high level observed in 1992. Groundwater levels in the Middle Aquifer

of the Rathbone Fire Station Well, located downgradient of the Sand Canyon Well, have shown a declining trend, dropping approximately 10 feet from 6,870 ft amsl in 2006 to 6,860 ft amsl in 2019. Groundwater levels measured in 2019 in the Elm Monitoring Well, downgradient from Rathbone Monitoring Well, are approximately five feet lower than groundwater levels measured at the historical high level in 1998.

Division Subunit

Monitoring wells used to measure groundwater levels in the Division Subunit are shown on Figure 2-22. These wells include the McAlister Nested Monitoring Well (Middle and Lower Aquifers), the Riffenburgh Monitoring Well, Division Well No. 4 (inactive production well used as a monitoring well), and Hillendale Monitoring Well. Except for the deep completion of the McAlister Nested Monitoring Well, all of these wells are perforated in the Middle Aquifer.

Groundwater levels in both McAlister Nested Monitoring Wells are similar when the McAlister production well (located approximately 100 feet away) is not pumping. The McAlister production well is perforated in the Middle Aquifer so when it is pumping, the interference in the shallow (Middle Aquifer) completed monitoring well is greater than the deep completion. Aside from an initial groundwater level decline when the McAlister production well was activated in 2006, groundwater levels in the monitoring wells are relatively stable.

The Riffenburgh Monitoring Well, Division Well No. 4 and Hillendale Monitoring Well are all located in the center of Big Bear Valley in the north-central part of the Bear Valley Basin. Prior to 2011, groundwater levels in these wells would periodically drop during dry climatic cycles but would rebound to historical high conditions during above average periods of precipitation. Between 2011 and 2019, a period characterized by historically dry climatic conditions, groundwater levels have remained approximately 20 to 40 feet below the previous historical high.

West Baldwin Subunit

Monitoring wells used to measure groundwater levels in the West Baldwin Subunit are shown on Figure 2-23. These wells include the Greenway, Maltby, and Van Dusen No. 1 monitoring wells. Greenway and Maltby monitoring wells are in the center of Big Bear Valley in the north-central part of the Bear Valley Basin. Van Dusen No. 1 monitoring well is in Van Dusen canyon. Groundwater levels in the Greenway and Maltby monitoring wells follow a similar pattern as the Division monitoring wells to the west, whereby they periodically drop during dry climatic cycles but rebound to historical high conditions during above average periods of precipitation. Since 2011, groundwater levels have remained approximately 20 to 40 feet below the previous historical high due to historically dry climatic conditions.

Erwin Subunit

Monitoring wells used to measure groundwater levels in the Erwin Subunit are shown on Figure 2-24. These wells include the Magnolia, Erwin, Vaqueros, and Monte Vista monitoring wells. Groundwater levels at the Erwin and Vaqueros monitoring wells are sensitive to precipitation events, showing short-duration peaks during these times. Aside from the groundwater level peaks, groundwater levels in Erwin Monitoring Well have returned to historical high conditions, except for the historically dry period from 2011 to 2019, during which they have been approximately 15 feet below historical high conditions. Groundwater levels in the Vaqueros Monitoring Well have been relatively stable. Groundwater levels in the Magnolia Monitoring Well were on a slight downward trend between 2006 and 2011 but began dropping at a faster rate when the Magnolia production well, located approximately 50 feet from the monitoring well, began pumping in 2012.

Groundwater levels in the Monte Vista Monitoring Well, located in the Lake Williams Tributary Subarea of the Erwin Subunit, are responsive to precipitation rates and local pumping. Groundwater levels rose approximately 30 feet in 2005 in response to a significant above-average precipitation year. From 2005 to 2015, groundwater levels declined but then stabilized after 2015 when groundwater production from the nearby Monte Vista production well was discontinued.

2.5.2 Groundwater Storage

Changes in groundwater storage within the Bear Valley Basin have been estimated through analysis of the water budget for the basin. Annual change in groundwater storage in the basin between 1990/91 and 2018/19 is shown in Table 2-4 and is graphically presented on Figure 2-25. Comparison of the groundwater inflow elements of the water budget with the outflow elements shows a cumulative change in groundwater storage over the 29-year period between 1990/91 and 2018/19 of approximately 60,100 acre-ft. The average annual change in storage resulting from the groundwater budget is approximately 2,100 acre-ft/yr over this time period. It is noted that the beginning of the period (1990/91) was the end of a dry climatic cycle and groundwater levels were relatively low. From 1990/91 through 1998/99 was relatively wet resulting in an increase in water in aquifer storage over the time period.

2.5.3 Seawater Intrusion

Seawater intrusion cannot occur in the Bear Valley Basin due to its location with respect to the Pacific Ocean. The Bear Valley Basin is an isolated mountain groundwater basin located approximately 70 miles inland of the Pacific Ocean (see Figure 2-1). This mountain aquifer system is separated hydraulically from the coastal aquifers that are susceptible to seawater intrusion.

2.5.4 Groundwater Quality Issues

The primary groundwater quality issues that could affect the beneficial uses of groundwater in the Bear Valley Basin are naturally occurring fluoride, arsenic, uranium as well as petroleum releases from leaking underground storage tank (LUST) sites. Fluoride has been detected at concentrations above the MCL in lower aquifer groundwater in the Baldwin Lake area, which limits the use of deeper groundwater for municipal supply. Arsenic and uranium detected in groundwater in the Mill Creek subunit prohibits groundwater production in this area for municipal supply without wellhead treatment. For point-source contaminants, there are nine active cleanup sites in the Bear Valley Basin identified on the California Geotracker website (see Figure 2-12; Table 2-2). Seven of the point source contamination sites are associated with LUSTs for which the primary contaminants are gasoline, MTBE, TBA and/or other oxygenates. There is one DTSC site and one land disposal site within the basin (see Figure 2-12). Contaminants associated with these sites are not available.

While manganese has been detected in groundwater in the Village and Division subunits, treatment systems have been implemented to remove the manganese. Fluoride concentrations in groundwater produced from the Baldwin Lake area are mitigated through blending with spring water sources and groundwater from wells with low fluoride concentrations.

2.5.5 Land Subsidence

Analyses of land subsidence in the Bear Valley Basin using satellite data shows very low amounts of land deformation. The USGS analyzed Interferometic Synthetic Aperture Radar (InSAR) data for the time periods 1995 to 1997 and 2004 to 2005. Land deformation was observed in the Village and Rathbone subunit areas, the Sugarloaf area of the Erwin Subunit, and in the area between Big Bear and Baldwin lakes (Flint and Martin, 2012). As much as 1.2 inches of land subsidence was observed in the area between Big Bear and Baldwin lakes between 1995 and 1997. In contrast, as much as 1.2 inches of uplift was observed in the same area between 2004 and 2005. As the time periods include extremes in groundwater level fluctuations in the basin, it is likely that the subsidence and later uplift is elastic and recoverable. Analysis of InSAR data for the period from 2015 through 2018, a period of declining groundwater levels in the Bear Valley Basin, did not result in land subsidence greater than 3 inches in any parts of the basin (the limit of resolution of the data).

2.5.6 Interconnected Surface Water Systems

Groundwater is periodically in hydrologic connection with surface water in Big Bear Lake in the northwest part of the basin (Fawnskin area) and in the eastern part of the lake in the vicinity of BBLDWP's Division wells. In the Fawnskin area, BBLDWP's Seminole Well is constructed with

shallow perforations and is within 500 feet of the high-water line of Big Bear Lake. This well is generally considered to be pumping groundwater that is in direct hydrologic connection with the lake. As such, groundwater produced from this well is treated prior to distribution for municipal supply. Certain older Division Wells, located on the east end of Big Bear Lake, have perforations that begin at 50 ft bgs. Groundwater level trends measured in these wells match surface water elevation changes in Big Bear Lake when groundwater levels are high. During low groundwater level conditions, the surface water elevation changes do not match groundwater level trends suggesting that the hydrologic connection only occurs during high groundwater conditions (TH&Co, 2020). Wells with deeper perforations do not show the connection.

The natural springs at the margins of the Bear Valley Basin appear to be fed from the bedrock aquifer system. All springs utilized for municipal supply by the BBLDWP and BBCCSD are located within areas of bedrock. Flow from the springs is associated with available precipitation and flow rates are highly sensitive to climatic cycles. There is no upgradient groundwater production that would artificially impact the flow of the springs.

Shay Pond is a natural surface water body in the northern part of the Erwin Subunit, as described in Section 3.1.5. Most of the time, the only natural source of water supporting the pond is surface water flow from Shay Creek and surrounding areas. During high groundwater conditions after prolonged periods of above average precipitation, the groundwater may rise above the land surface and provide a source of water to the pond (TH&Co, 2017a). The BBCCSD provides supplemental water to the pond via a well located near the pond.

2.5.7 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems require shallow groundwater or groundwater that discharges at the land surface. Groundwater levels in some areas of the Bear Valley Basin are periodically shallow enough to support groundwater dependent ecosystems. The areas most likely to support groundwater dependent vegetation are at the margins of Big Bear Lake in the Rathbone and Mill Creek Subunits, across much of the Baldwin Lake lakebed, and in the Shay Creek drainage downstream of Erwin Lake (see Figure 2-26).

2.6 Water Budget

2.6.1 Surface Water Budget

The surface water budget for the Bear Valley Basin was developed for the 30-year period from 1990/91 to 2018/19 (see Table 2-3). Inflow terms for the surface water budget include precipitation, natural lake inflows to Big Bear Lake and Baldwin Lake, discharge to the land surface from wells, and groundwater discharge to surface water (i.e. springs). Outflow terms

include areal recharge from precipitation, lake evaporation, tributary channel infiltration, return flow, municipal distribution pipeline losses, evapotranspiration (ET), Big Bear Lake withdrawals, measured releases at the Bear Valley Dam, and discharges to Lucerne Valley from BBARWA.

Ideally, the total surface water inflow to the basin would equal the total surface water outflow, indicating a complete accounting of water at the surface. In reality, there is uncertainty in many of the surface water budget terms for the Bear Valley Basin that does not allow for a perfect surface water accounting. These include estimates for precipitation recharge, tributary channel inflow, and return flow. For the Bear Valley Basin surface water budget, the percent difference between the average annual surface water inflow (89,660 acre-ft; Table 2-3) and average annual outflow (89,686 acre-ft) is less than 0.0001 percent. This represents a very good match between surface water inflows and outflows and indicates that the water budget is a good representation of actual conditions. As additional data become available, it is anticipated that the surface water budget will become more accurate with time.

It is noted that many of the surface water outflow terms are also groundwater inflow (i.e. groundwater recharge) terms.

Details of the individual surface water budget terms are provided in the following sections.

2.6.1.1 Surface Water Inflow

Precipitation

The annual volume of water entering the Bear Valley Basin as precipitation was estimated based on the long-term average annual isohyet map shown on Figure 2-27 and the annual precipitation data reported for the BBCCSD precipitation station and the Big Bear Lake Dam precipitation station (see Figures 2-28 and 2-29). The isohyet map was adapted from Flint and Martin, 2012 to include contoured bands of precipitation ranges. Precipitation volumes were estimated for each band by multiplying the long-term average for any given band by the area of the band. The average precipitation was then varied year by year based on the annual precipitation totals at the two precipitation stations. Annual precipitation variations in the Big Bear Lake watershed was based on precipitation data at the Big Bear Dam station. Annual precipitation variations in the Baldwin Lake watershed were based on precipitation data at the BBCCSD station. Total annual precipitation between 1990/91 and 2018/19 ranged from approximately 19,400 to 154,300 acre-ft/yr with an average of 68,400 acre-ft/yr (see Column A of Table 2-3a).

Natural Lake Inflow

Surface water inflow to the Bear Valley Basin occurs primarily as a combination of surface water runoff in tributary channels that eventually drain into Big Bear Lake and Baldwin Lake and precipitation falling on the lake surfaces (see Columns B and C of Table 2-3a). Inflow into Big Bear Lake is estimated and reported by BBMWD. For years 1990/91 to 2018/19, annual surface water inflow to Big Bear Lake ranged from 1,717 to 48,613 acre-ft/yr with an average of 14,385 acre-ft/yr. Values for the natural inflow to Baldwin Lake are based on the average inflow from a climate/surface water model published in Flint and Martin (2012). The average annual Baldwin Lake inflow was varied from year to year by the ratio between average annual Big Bear Lake inflow and average annual Baldwin Lake inflow.

Water Supply from Wells

Groundwater pumping for municipal supply is conducted by BBLDWP and BBCCSD for the local communities in the Bear Valley Basin. From years 1990/91 to 2018/19, average annual groundwater pumping by BBLDWP was 2,537 acre-ft/yr and average annual pumping by BBCCSD was 623 acre-ft/yr (see Columns D through F of Table 2-3a).

There are numerous private wells throughout the Bear Valley Basin. Assessing groundwater production from these wells is difficult since the Big Bear area is a weekend and vacation destination and many of the homes served by the private wells are not occupied full time. Nevertheless, for estimating purposes, it was assumed that each private well on record served a household and the water use in each household was 53 gallons per capita per day, based on the five year average per capita water use in the BBLDWP service area (BBLDWP, 2020). There are 583 private wells in the Bear Valley Basin documented from CDWR driller's logs. Assuming three persons per household, the average annual private well groundwater production was estimated to be 105 acre-ft/yr.

Spring Flow

A separate accounting of spring flow for the Green Spot Spring and Van Dusen Slant Wells is shown in Table 2-3, Column G, as provided by BBCCSD. Spring flow from these sources has historically ranged from 81 to 289 acre-ft/yr with an annual average of 190 acre-ft/yr. Spring flow is also captured by BBLDWP but is accounted for in the water supply from wells (Column E of Table 2-3a).

2.6.1.2 Surface Water Outflow

Areal Recharge from Precipitation

Areal recharge from precipitation falling on the valley floor was based on a surface water model of the Big Bear Lake and Baldwin Lake surface water drainage basins (Flint and Martin, 2012). The analysis estimated that approximately 7.5 percent of precipitation falling within the combined Big Bear Lake and Baldwin Lake watersheds becomes groundwater recharge (Table 13 of Flint and Martin, 2012). When applied to annual precipitation, the resulting annual groundwater recharge from areal precipitation for the period 1990/91 to 2018/19 ranged from approximately 1,500 acre-ft/yr to 11,600 acre-ft/yr with an average of approximately 5,100 acre-ft/yr (see Column H of Table 2-3b).

Lake Evaporation

Evaporation of surface water in Big Bear Lake is estimated and reported by BBMWD. For years 1990/91 to 2018/19, annual surface water evaporation in Big Bear Lake ranged from approximately 9,000 acre-ft/yr to 12,500 acre-ft/yr with an average of approximately 11,000 acre-ft/yr (see Column I of Table 2-3b). Values for evaporation of surface water in Baldwin Lake are based on the average evaporation used in the climate/surface water model published in Flint and Martin (2012), which was 3,342 acre-ft/yr (see Column J of Table 2-3b).

Tributary Channel Infiltration

During precipitation events, a portion of the runoff that collects in ephemeral soft bottomed streams on the perimeter and within the Bear Valley Basin infiltrates into the subsurface to become groundwater recharge. There are no data from which to make estimates of this recharge. As this is the least known element of the surface water budget, it was adjusted to balance the inflows and outflows. The resulting average annual tributary channel infiltration for the water budget period of record is approximately 730 acre-ft/yr (see Column K of Table 2-3b).

Return Flow

A portion of water applied to the land surface for landscape irrigation infiltrates past the roots zones of the plants and becomes groundwater recharge. Estimates of the volume of applied water that become groundwater recharge are a function of the volume of water used outdoors and an assumption regarding the percentage of applied water that becomes deep percolation. To estimate the percentage of water used outdoors, TH&Co compared estimates of water deliveries to customers in the BBLDWP and BBCCSD to influent measurements at the BBARWA treatment plant. The difference between the volume of water delivered to customers and the inflow to the plant was assumed to be water used outdoors. For BBLDWP, 35 percent of delivered water was

assumed to be used outdoors. For BBCCSD, 10 percent of delivered water was assumed to be used outdoors. Of the outdoor water use, 25 percent was assumed to become deep percolation and groundwater recharge. Average annual combined return flow from the two water purveyors in the Bear Valley Basin for the period from 1990/91 to 2018/19 was 218 acre-ft/yr (see Column L of Table 2-3b).

System Losses

A portion of the total groundwater pumped and delivered by BBLDWP and BBCCSD is lost in transit between the wells and the homes. BBLDWP has tracked pipeline losses over time, which have ranged from approximately 13 percent prior to 1997 to less than 10 percent after 2008. For BBCCSD, a loss rate of 10 percent was assumed. Based on these assumptions, the average annual system loss in the Bear Valley Basin for the 1990/91 to 2018/19 period was 327 acre-ft/yr (see Column M of Table 2-3b).

Evapotranspiration

Evapotranspiration (ET) is the loss of water to the atmosphere from free-water evaporation, soil-moisture evaporation, and transpiration by plants (Fetter, 1994). Evapotranspiration of precipitation is assumed to be the balance between total precipitation and areal recharge and is associated with native vegetation. From water years 1990/91 to 2018/19, evapotranspiration of precipitation was estimated to average approximately 63,000 acre-ft/yr (see Column N of Table 2-3b).

Big Bear Lake Withdrawals

Local ski resorts periodically withdraw water from Big Bear Lake for snow making. For years 1990/91 to 2018/19, annual withdrawals from Big Bear Lake, as provided by the BBMWD, ranged from approximately 200 acre-ft/yr to 750 acre-ft/yr with an average of approximately 440 acre-ft/yr (see Column O of Table 2-3b).

Releases at Bear Valley Dam

The BBMWD releases water from Big Bear Lake at the dam for downstream irrigation demands. For years 1990/91 to 2018/19, annual releases at the dam, as provided by the BBMWD, ranged from zero to approximately 17,500 acre-ft/yr with an average of approximately 2,400 acre-ft/yr (see Column P of Table 2-3b).

BBARWA Discharges to Lucerne Valley

Treated effluent from the BBARWA treatment plant is exported out of the Bear Valley Basin to a discharge site in Lucerne Valley, approximately 12 miles to the north. Based on data provided by BBARWA, annual discharges to Lucerne Valley during the 1990/91 to 2018/19 period have ranged from 1,892 acre-ft/yr to 4,008 acre-ft/yr with an average of 2,684 acre-ft/yr (see Column Q of Table 2-3b).

2.6.2 Groundwater Budget

The groundwater budget describes the sources and estimates the volumes of groundwater inflow and outflow within the Bear Valley Basin (see Table 2-4). A fundamental premise of the groundwater budget is the following relationship:

$$\text{Inflow} - \text{Outflow} = +/- \Delta S$$

Inflow terms include areal recharge from precipitation, recharge in tributary channels, return flow, and water distribution system losses. It is noted that many of the groundwater inflow terms are surface water outflow terms from Table 2-3. Outflow terms include groundwater pumping and evapotranspiration. The difference between the sum of inflow terms and the sum of outflow terms is the change in groundwater storage (ΔS) (see Table 2-4).

2.6.2.1 Sources of Groundwater Recharge

Areal Recharge

Areal recharge from precipitation falling on the valley floor is estimated to be approximately 7.5 percent of precipitation falling within the combined Big Bear Lake and Baldwin Lake watersheds as described in Section 2.3.1.2. Annual groundwater recharge from areal precipitation for the period 1990/91 to 2018/19 ranged from approximately 1,500 acre-ft/yr to 11,600 acre-ft/yr with an average of approximately 5,100 acre-ft/yr (see Column A of Table 2-4).

Tributary Channel Infiltration

During precipitation events, a portion of the runoff that collects in ephemeral soft bottomed streams on the perimeter and within the Bear Valley Basin infiltrates into the subsurface to become groundwater recharge, as described in Section 2.3.1.2. The average annual tributary channel infiltration for the water budget period of record is estimated to be approximately 730 acre-ft/yr (see Column B of Table 2-4).

Return Flow

A portion of water applied to the land surface for landscape irrigation infiltrates past the roots zones of the plants and becomes groundwater recharge, as described in Section 2.3.1.2. Average annual combined return flow from the two water purveyors in the Bear Valley Basin for the period from 1990/91 to 2018/19 was 218 acre-ft/yr (see Column C of Table 2-4).

System Losses

A portion of the total groundwater pumped and delivered by BBLDWP and BBCCSD is lost in transit between the wells and the homes, as described in Section 2.3.1.2. The average annual system loss in the Bear Valley Basin for the 1990/91 to 2018/19 period was 327 acre-ft/yr (see Column D of Table 2-4).

2.6.2.2 Sources of Groundwater Discharge

Municipal Groundwater Pumping

Groundwater pumping for municipal supply is conducted by BBLDWP and BBCCSD for the local communities in the Bear Valley Basin, as described in Section 2.3.1.1. From years 1990/91 to 2018/19, average annual groundwater pumping by BBLDWP was 2,537 acre-ft/yr and average annual pumping by BBCCSD was 623 acre-ft/yr (see Columns E and F of Table 2-4).

Private Groundwater Pumping

Groundwater production from private wells in the Bear Valley Basin was estimated to be approximately 105 acre-ft/yr, as described in Section 2.3.1.1 (see Column G of Table 2-4).

Evapotranspiration

Evapotranspiration directly from the groundwater occurs in areas where groundwater is shallow enough to support riparian vegetation. The areas identified as groundwater dependent ecosystems on Figure 2-26 were assumed to be areas of groundwater ET. The annual ET rate of 52.6 inches was obtained from the CIMIS station at the Big Bear Lake Golf Course in the Rathbone Subunit. Multiplying the ET rate by the area of riparian vegetation (approximately 247 acres) results in an average annual ET of 1,071 acre-ft/yr. The ET was varied by year in proportion to changes in areal recharge from precipitation. The changes in annual ET reflect the ratio between the long-term average annual recharge from precipitation (5,128 acre-ft/yr) and long-term average annual ET (1,071 acre-ft/yr) (see Column H of Table 2-4).

2.6.3 Changes in Groundwater Storage

Comparison of the groundwater inflow elements of the water budget with the outflow elements shows a cumulative change in groundwater storage over the period between 1990/91 to 2018/19 of approximately 60,000 acre-ft (see Table 2-4; Figure 2-25). The average annual change in storage resulting from the groundwater budget is approximately 2,100 acre-ft/yr.

2.6.4 Overdraft

The average annual change in groundwater storage over the period from 1990/91 to 2018/19, which approximates average hydrologic conditions within the Bear Valley Basin, was approximately 2,100 acre-ft/yr. As the average annual change in storage is positive, there is no overdraft of the groundwater basin. The findings from the groundwater budget are consistent with groundwater level trends in monitoring wells in the basin that show groundwater levels recovering to historical high conditions during periods of above normal precipitation (see Figures 2-17 through 2-24).

2.6.5 Water Year Type

All water budget elements and change in groundwater storage presented herein are based on a water year, which begins October 1 and ends September 30. Water year types with respect to hydrologic conditions (i.e. above average, average or below average precipitation conditions based on Figures 2-28 and 2-29) are shown in the historical water budget tables (Tables 2-3 and 2-4).

2.6.6 Sustainable Yield

Sustainable yield is defined in the Sustainable Groundwater Management Act (SGMA) Chapter 2, §10721 (v) as:

The maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

The Sustainable Yield of the Bear Valley Basin is a function of the overall water balance of the area. Changes in surface water/groundwater inflow to the basin and surface water/groundwater outflow from the basin impact the Sustainable Yield. A generalized expression of the water balance is as follows:

$$\text{Inflow} - \text{Outflow} = +/- \text{ Change in Storage} \qquad (1)$$

The water balance equation for pre-developed conditions (prior to human occupation) can be further expressed as:

$$(I_{pr} + I_{str} + I_{mb}) - O_{et} = \Delta S \qquad (2)$$

Where:

I_{pr} = Inflow from Areal Recharge of Precipitation

I_{str} = Inflow from Infiltration of Runoff in Stream Beds

I_{mb} = Inflow from Mountain-Block Recharge

O_{et} = Evapotranspiration

ΔS = Change in Groundwater Storage

It is noted that the Bear Valley Basin is assumed to be closed such that there is no subsurface inflow to the basin or subsurface outflow from the basin. Under pre-developed conditions, the groundwater basin would be in a state of equilibrium such that the inflow and outflow would balance and there would be no significant long-term change in storage assuming a static climatic condition. Under this condition, groundwater levels would be relatively stable.

Underdeveloped land use conditions, the water balance changes as groundwater is pumped from the basin for municipal supply. Some of the pumped groundwater used for irrigation infiltrates past the roots of the plants and returns to the groundwater as return flow. Water distribution system losses is another source of recharge to the groundwater underdeveloped land use conditions.

The water balance equation for developed land use conditions can be modified as follows:

$$(I_{pr} + I_{str} + \mathbf{I_{rfgw}} + \mathbf{I_{sl}} + I_{mb}) - (O_{et} + \mathbf{O_p}) = \Delta S \qquad (3)$$

Where:

I_{rfgw} = Inflow from Return Flow of Applied Water from Groundwater Pumping

I_{sl} = Inflow from Water Distribution System Losses

O_p = Outflow from Groundwater Pumping

If the inflow terms exceed the outflow terms, then the groundwater in storage increases (become positive) and groundwater levels rise. If the outflow terms exceed the inflow, then the groundwater in storage decreases (become negative) and groundwater levels drop. It is assumed that the

Sustainable Yield of the Bear Valley Basin is the long-term average groundwater pumping rate, under projected land use conditions, that results in no significant long-term net negative change in groundwater storage in the basin. Based on this premise, the water balance equation can be rearranged and simplified to estimate Sustainable Yield:

$$\text{Sustainable Yield} = \Delta S + O_p \qquad (4)$$

Thus, if the change in groundwater storage over the planning period is zero then the Sustainable Yield is equal to the pumping. This relationship is valid if the following conditions are met:

1. The Sustainable Yield incorporates a hydrology that is representative of a relatively long period of record that includes multiple wet and dry hydrologic cycles.
2. The land use conditions are representative of the time period.

The Sustainable Yield can also be expressed as all components of the water balance not explicitly expressed in Equation 4:

$$\text{Sustainable Yield} = I_{pr} + I_{str} + I_{rfgw} + I_{mb} \qquad (5)$$

Applying Equations 4 and 5 to the historical water budget of the Bear Valley Basin results in a Sustainable Yield of approximately 5,300 acre-ft/yr.

2.6.7 Current Water Budget

The surface water and groundwater budget for the Bear Valley Basin for the most recent water year with available data (2018/19) is shown in Tables 2-3 and 2-4. Total groundwater inflow to the basin for water year 2018/19 was approximately 9,400 acre-ft. Total groundwater outflow from the basin for the same water year was approximately 4,500 acre-ft. The net change in storage during the water year was approximately 4,900 acre-ft.

2.6.8 Historical Water Budget

The historical surface water and groundwater budgets for the Bear Valley Basin are shown in Tables 2-3 and 2-4 and described in Sections 2.3.1 and 2.3.2. Except for spring flow capture, there are no surface water supplies, imported or otherwise, available to the Bear Valley Basin. Water purveyors in the basin are reliant solely on groundwater. While groundwater production within the basin has never exceeded the long-term Sustainable Yield, the availability of groundwater supplies to meet local water demands is dependent on precipitation cycles. During an extended dry period between 1998 and 2004, groundwater levels dropped creating concern that, if allowed

to continue, would result in impacts to BBLDWP's and BBCCSD's infrastructure. As a result, both agencies implemented water conservation programs for their respective service areas that were successful at reducing water demand and associated groundwater pumping. Groundwater levels recovered in the 2004/05 water year because of significant above-average precipitation, but the agencies have continued with water conservation measures to ensure that groundwater levels would be sufficiently recovered before subsequent dry periods. The conservation and reduced groundwater production have been successful at maintaining acceptable operational groundwater levels, even during the historically dry period from 2011 to 2017.

2.6.9 Projected Water Budget

A projected water budget for the Bear Valley Basin has been developed to incorporate planned increases in groundwater production as well as projects and management actions for maintaining sustainability. The projection also incorporates adjustments to ET to account for potential climate change. The projected surface water and groundwater budgets are shown in Tables 2-5 and 2-6.

Climate adjustments were applied to the precipitation, ET, and lake inflows in the surface water budget based on output from the CDWR's CalSim-II model, which provided adjusted historical hydrology for major drainages and imported supplies based on scenarios recommended by the CDWR Climate Change Technical Advisory Group.[1] The historical proxy time periods selected for the Bear Valley Basin projected water budget were 1991 to 2010 for 2021 to 2040 and 1981 to 2010 for 2041 to 2070. Climate change benchmark factors were assigned at two times within the SGMA planning horizon:

1. A 2030 central tendency time period, which provides near-term projections of potential climate change impacts on hydrology, centered on the year 2030, and
2. A 2070 central tendency time period, which provides long-term projections of potential climate change impacts on hydrology, centered on the year 2070.

Adjustments to future precipitation and ET projections based on the 2030 central tendency time period were applied to the period 2021 through 2040. The central tendency precipitation change factor for this period is 0.971. Change factors for 2020 through 2029 and 2031 through 2040 were linearly decreased based on a linear regression from 1 (2020) and 0.971 (2030). The central tendency ET change factor is 1.04. The change factor for 2020 through 2029 and 2031 through 2040 were linearly decreased as described for precipitation.

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[1] DWR Climate Change Technical Advisory Group, 2015. Perspectives and Guidance for Climate Change Analysis. DWR Technical Information Record.

Adjustments to future precipitation and ET projections based on the 2070 central tendency time period were applied to years 2041 through 2070. The precipitation change factor for this time period is 0.939 and the ET change factor is 1.04. Change factors for 2041 through 2070 were based on a linear regression from the 2040 interpreted change factor and the 2070 central tendency value.

Application of the climate adjustments to the future water budgets results in a reduction of Sustainable Yield in the Bear Valley Basin over the 50-year SGMA planning horizon. In comparison to the historical Sustainable Yield of 5,300 acre-ft/yr, the forecasted Sustainable Yield for the 2020 to 2040 time period is estimated to reduce to 5,100 acre-ft/yr (see Figure 2-30). Further into the future, the Sustainabile Yield is forecast to reduce to 4,300 acre-ft/y during the 2040 to 2070 time period.

2.7 Management Areas

The water agencies within the Bear Valley Basin have historically managed their groundwater resources in the context of the eleven hydrologic subunits and one tributary subarea shown on Figures 2-4 and 2-30. Each of these hydrologic subunits and the Lake Williams Tributary Subarea will be considered management areas for the purpose of this GSP.

2.7.1 Criteria for Management Areas

The management areas in the Bear Valley Basin have been created to account for the varying geology, hydrogeology, and water resources across the basin. Although the hydrologic subunits on which the management areas are based were originally defined based on surface water drainage divides, each represents a unique set of geological and hydrogeological characteristics, which impact the availability of water resources within the areas. The management areas and their unique characteristics are described as follows:

Big Bear Lake Watershed

Grout Creek – Groundwater production from this management area serves the community of Fawnskin. While it is within the BBLDWP service area, the infrastructure is completely disconnected from the infrastructure in the main part of BBLDWP's service area south of Big Bear Lake. As such Fawnskin is self-sustained by local water supplies, which consist of a combination of captured spring flow (Cedar Springs), groundwater from the alluvial aquifer system (Seminole Well), and groundwater from the fractured bedrock aquifer (Cherokee Well). The sustainable yield of this management area has been previously estimated to be 280 acre-ft/yr (Geoscience, 2006).

North Shore – Groundwater production from wells in this management area serve a local mobile home park. Water supply to this small community is self-sustained by two wells within the park. The sustainable yield of this management area has been previously estimated to be 170 acre-ft/yr (TH&Co, 2010a).

Gray's Landing – The Gray's Landing management area is a 765-acre area on the west side of Big Bear Lake where granitic bedrock outcrops at the land surface throughout almost the entire area. There is a thin strip of alluvial sediments along the margin of Big Bear Lake where some private wells have been identified. However, no municipal groundwater production occurs from this management area.

Mill Creek – No municipal groundwater production currently occurs in the Mill Creek management area due to groundwater quality issues (uranium). Some private wells are known to be in this area. Future development of the groundwater resources of this area may occur in the future but will depend on wellhead treatment to address the water quality. The sustainable yield of this management area has been previously estimated to range from approximately 150 to 430 acre-ft/yr (Geoscience, 2006; Flint and Martin, 2012).

Village – The subsurface beneath this management area consists predominantly of clay and the thin aquifers from which groundwater is produced have limited natural recharge. This management area is separated hydrologically from the adjacent Mill Creek management area to the west by a granitic bedrock outcrop and the subsurface sediments were deposited in a different environment than the more channelized and permeable sediments of the Rathbone management area to the east. The sustainable yield of this management area has been previously estimated to be 250 acre-ft/yr (Geoscience, 2006).

Rathbone – The subsurface sediments in this management area are characterized by narrow sand channels of Rathbun Creek and Sand Canyon bounded by less permeable alluvium in the southern portion grading to increasing silt and clay deposits in the northern portion associated with low energy mountain meadow deposits. Water supply from this management area includes a combination of captured spring flow from the Dogwood Springs and groundwater production from eight active municipal wells and numerous private wells. The sustainable yield of this management area has been previously estimated to be 1,100 acre-ft/yr (Geoscience, 2006).

Division – Groundwater production in this management area occurs from both the upper and middle aquifer system. In the southern portion of the area, the BBLDWP's McAlister Well produces groundwater from the middle aquifer. In the northern part of the subunit, BBLDWP's Division well field produces groundwater primarily from the middle aquifer, but some wells produce groundwater periodically from the upper aquifer during periods of high groundwater levels. The sustainable yield of this management area has been previously estimated to be between 500 and 600 acre-ft/yr (TH&Co, 2010a).

Baldwin Lake Watershed

West Baldwin – This management area covers approximately 2,780 acres and includes Sawmill Canyon on the south and extends to the north to include a significant portion of the basin between Baldwin Lake and Big Bear Lake (see Figure 2-30). Most of BBCCSD's groundwater production for municipal supply occurs in this subunit. BBLDWP has one well in the Sawmill Canyon area, which is planned to be pumped in the future. Almost all groundwater production is from the middle aquifer although some wells are perforated into the lower aquifer. Groundwater quality in the lower aquifer is impacted by naturally occurring fluoride that exceeds the MCL. The sustainable yield of this management area has been previously estimated to be between 150 and 1,000 acre-ft/yr (Geoscience, 1999; Flint and Martin, 2012).

Erwin – The Erwin Management Area covers approximately 8,460 acres in the southeast portion of the Baldwin Lake watershed. Principal surface water features include Fish Hatchery Spring, Green Spot Spring, Shay Creek, Shay Pond, and Erwin Lake. Groundwater is produced primarily out of the middle aquifer and periodically out of the upper aquifer when groundwater levels are shallow. Spring flow from Green Spot Spring is captured for municipal supply. The sustainable yield of this management area has been previously estimated to be approximately 900 acre-ft/yr (Geoscience, 2006).

Lake Williams – The Lake Williams Tributary Subarea of the Erwin Hydrologic Subunit has been identified as a separate management area because it is, for the most part, hydrologically separated from the Erwin Management Area (see Figure 2-30). The Lake Williams Management Area covers approximately 1,226 acres in the southeast part of the Erwin Hydrologic Subunit. The BBLDWP serves the Lake William community, which is isolated from the infrastructure in the rest of BBLDWP's service area. As such, Lake William is self-sustained by local water

supplies, which consist solely of groundwater pumped from the alluvial aquifer system. The sustainable yield of this management area, which includes the Lake William Tributary Subarea and the Arrastre Creek Subarea, is estimated to be approximately 545 acre-ft/yr (Geoscience, 2004c; TH&Co, 2010b).

East Baldwin - The East Baldwin Management Area covers approximately 5,014 acres of the eastern portion of the Baldwin Lake watershed. This management area includes almost all of Baldwin Lake, which is the primary surface water feature. Most of the groundwater production in this management area is from private wells. The BBCCSD operates one well (Well 8) in the western part of the management area. The sustainable yield of this management area has been estimated to be approximately 170 acre-ft/yr (Flint and Martin, 2012).

Van Dusen – The Van Dusen management area covers approximately 4,345 acres of the northwestern part of the Baldwin Lake watershed. This management area is within the Bear Valley Basin GSA but outside of the Bear Valley Basin as defined by the CDWR. Aside from a relatively narrow band of alluvium along the Van Dusen Canyon drainage, the entire management area consists of bedrock. It is included as a management area because the BBCCSD captures water via a couple of slant wells in this area. The Van Dusen Canyon has also been investigated as a potential area for artificial recharge (Geoscience, 2004a). The sustainable yield of this management area has been estimated to be approximately 760 acre-ft/yr (Flint and Martin, 2012).

2.7.2 Monitoring Plan

A network of groundwater monitoring wells has been identified to enable the collection of groundwater levels and groundwater quality necessary to inform decisions with respect to the sustainability of the Bear Valley Basin (see Figure 2-31). Groundwater monitoring wells have been selected for each management area except Gray's Landing and Van Dusen, where no significant groundwater production is currently occurring. A detailed description of the monitoring network and monitoring plan, including data collection protocols and monitoring frequency, is provided in Section 3.5 of this GSP. The monitoring plan also includes an assessment of data gaps and a data management plan.

A subset of groundwater level monitoring features in the monitoring plan have been identified as representative monitoring sites to be relied on for the purpose of assessing progress with respect to groundwater level sustainability in the basin. The representative groundwater level monitoring sites are summarized in Table 2-7 and shown on Figure 2-31. At least one representative groundwater level monitoring site has been identified within the ten currently active management

areas. Where possible based on available wells, representative monitoring sites have been chosen with perforations exclusively in either the Middle or Lower Aquifer.

2.7.3 Coordination with Adjacent Areas

The Bear Valley Basin is an isolated, closed basin with no significant hydrologic interaction with other basins identified in CDWR Bulletin 118. The basin will be managed by one GSA, the BVBGSA. As such, coordination with adjacent basins will not be necessary.

Many of the management areas are relatively isolated hydrologically from one another and groundwater production from one has little impact on the other, despite being in relative proximity (e.g. Grout Creek, North Shore, Gray's Landing, Mill Creek, Village, Rathbone, Van Dusen, and Lake William). Minimum thresholds for the Management Areas that have the potential to be hydrologically connected to adjacent Management Areas have been selected such that, if exceeded, would not cause undesirable results in one or the other. These Management Areas include Division, West Baldwin, Erwin and East Baldwin.

Management of the Bear Valley Basin is adaptive. As management actions and projects are implemented throughout the basin and as additional data are collected through the Bear Valley Basin Monitoring Plan, minimum threshold values and measurable objectives may change. Changes to basin management to address undesirable results will be conducted through the BVBGSA.

Summary of Aquifer Properties

State Well Number	DWR Number or Well Name	Well Owner	Perforation Interval	Total Perforation Length (ft)	Year of Pumping Test	Pumping Test Type	Pumping Duration (hours)	Specific Capacity (gpm/ft)[1]	Transmissivity (gpd/ft)[2]	Hydraulic Conductivity (ft/day)[3]	Storativity
2N/01E-12	Well No. 3B	BBCCSD	130-250; 295-530; 630-790	515	2000	Constant Rate	24	35.70	24,100	6.3	0.00051
2N/02E-7	Well 8 Palomino Well	BBCCSD	90-175; 195-245; 260-360	235	2003	Constant Rate	24	23.00	35,900	20.4	N/A
2N/01E-14B	Well 9 (Greenway Park Site)	BBCCSD	200-362; 470-516	208	2003	Constant Rate	24	2.10	2,030	1.3	N/A
2N/01E-13	Well 10 (Booster Station Site)	BBCCSD	195-295; 545-620	175	2003	Constant Rate	24	4.00	4,680	3.6	N/A
N/A	Canvasback Well	BBLDWP	158-314	156	2005	Constant Rate	24	0.27	360	0.3	0.00060
N/A	Cherokee Borehole	BBLDWP	130-509	379	2005	Constant Rate	24	0.30	220	0.1	N/A
2N/01E-24J01	Maple Lane Well	BBLDWP	230-430; 440-750	510	1989	Constant Rate	24	4.65	9,700	2.5	N/A
N/A	McAlister Well	BBLDWP	130-460; 510-690	510	2004	Constant Rate	24	0.70	580	0.2	0.00003
N/A	Miralago No. 3	N/A	150-350	200	2004	Constant Rate	72	0.70	950	0.6	N/A
N/A	Moonridge Well	BBLDWP	585-910	325	2004	Constant Rate	24	0.20	110	0.05	N/A
N/A	MPA, LLC Well No.1	N/A	N/A	100	2004	Constant Rate	72	0.09	60	0.1	N/A
2N/01E-24N	Owen Well	BBLDWP	360-380; 424-534; 594-624; 760-800; 912-1,002	290	1990	Constant Rate	12	0.50	500	0.2	N/A
2N/01E-27A	Sheephorn	BBLDWP	141-291, 313-501	338	2001	Constant Rate	24	0.70	840	0.3	N/A
2N/01E-24E02	Sawmill	BBLDWP	240-530	290	2012	Constant Rate	24	2.60	5,360	2.5	N/A
N/A	Arrastre Creek Well	BBLDWP	180-265; 280-340	145	2014	Constant Rate	24	0.71	675	0.6	N/A
N/A	Seminole	BBLDWP	20-55	35	2011	Constant Rate	24	10.60	33,800	129.1	N/A

Summary of Aquifer Properties

State Well Number	DWR Number or Well Name	Well Owner	Perforation Interval	Total Perforation Length (ft)	Year of Pumping Test	Pumping Test Type	Pumping Duration (hours)	Specific Capacity (gpm/ft)[1]	Transmissivity (gpd/ft)[2]	Hydraulic Conductivity (ft/day)[3]	Storativity
N/A	Magnolia Production Well	BBLDWP	300-560; 570-650	340	2011	Constant Rate	24	3.30	7,500	2.9	0.016000
2N/01E-15C11	Division Well #2	BBLDWP	50-612	562	1977	Constant Rate	3.33	N/A	6,000	1.4	N/A
2N/01E-15C05	Division Well #5	BBLDWP	50-60; 125-152; 168-275; 307-314; 330-365; 420-430	196	1977	Constant Rate	6	1.50	5,000	3.4	N/A
2N/01E-15C10	Division Well #6	BBLDWP	50-400	350	1978	Constant Rate	4	2.06	3,200	1.2	N/A
2N/01E-21C14	Lakeplant Well #5	BBLDWP	0-50; 150-170; 190-210	90	1977	Constant Rate	240	N/A	5,210	7.7	N/A
N/A	FP-2	BBLDWP	60-120; 156-176; 216-278; 310-370	202	1987	Constant Rate	8	N/A	9,700	6.4	N/A
2N/01E-12N02	Well 1B	BBCCSD	100-312	212	1958	Constant Rate	18	7.19	20,543	13.0	N/A
2N/01E-12Q03	Well 3A	BBCCSD	91-129; 136-166	68	1987	Step-Drawdown	11.5	4.70	13,429	26.4	N/A
2N/02E-18L01	Well 2	BBCCSD	40-218	178	1957	Constant Rate	19.5	0.63	1,800	1.4	N/A
2N/01E-12M03	Well 4A	BBCCSD	42-80; 86-106	58	1987	Step-Drawdown	9	4.16	11,886	27.4	N/A
2N/02E-8Q3	8Q3	N/A	80-120	40	N/A	Constant Rate	N/A	N/A	50	0.2	0.000340
2N/02E-20	HR-2	N/A	20-110	90	1988	Constant Rate	24	0.30	400	0.6	0.000818
2N/02E-20M	20M	N/A	86-186	100	2005	Constant Rate	24	N/A	800	1.1	0.030000
2N/02E-08Q06	W-1	N/A	10-244	234	1992	Constant Rate	96	5.20	3,474	2.0	0.000135

Notes:

[1] gpm/ft = gallons per minute per foot of drawdown
[2] gpd/ft = gallons per day per foot
[3] ft/day = feet per day
[4] N/A = Not Available

Summary of Active Cleanup Sites Within the Bear Valley Basin

Geotracker Global ID	Site Type	Status	Constituent of Concern
80000973	DTSC Cleanup Site	Inactive - Needs Evaluation	NA
L10007155213	Land Disposal Site	Open - Closed/With Monitoring	None
T0607100630	LUST Cleanup Site	Open - Inactive	Gasoline, MTBE, TBA, other fuel oxygenates
T0607100283	LUST Cleanup Site	Open - Remediation	Gasoline, MTBE, TBA, other fuel oxygenates
T0607145144	LUST Cleanup Site	Open - Inactive	Gasoline, MTBE, TBA, other fuel oxygenates
T0607100237	LUST Cleanup Site	Open - Site Assessment	Gasoline
T0607124341	LUST Cleanup Site	Open - Site Assessment	Gasoline
T0607100236	LUST Cleanup Site	Open - Remediation	Gasoline
T0607100176	LUST Cleanup Site	Open - Eligible for Closure	Gasoline

Notes:

LUST = Leaking underground storage tank
DTSC = Department of Toxic Substances
MTBE = Methyl tert-butyl ether
TBA = Tertiary Butyl Alcohol
Source = https://geotracker.waterboards.ca.gov
NA = Not available

Bear Valley Basin Surface Water Budget Inflows

Date	Water Year Type	Inflows (acre-ft)							
		A	B	C	D	E	F	G	
		Precipitation on Land Surface[A]	Natural Lake Inflows		Water Supply from Wells			Spring Flow (Van Dusen and Greenspot)	Total
			Big Bear Lake[B]	Baldwin Lake	BBCCSD	BBLDWP	Private		
1990/91	Average	72,173	11,658	2,789	641	2,996	105	112	90,473
1991/92	Average	74,863	15,543	3,718	509	3,316	105	183	98,237
1992/93	Above Average	154,312	48,613	11,630	199	3,107	105	268	218,234
1993/94	Below Average	55,832	11,015	2,635	332	2,529	105	267	72,714
1994/95	Above Average	105,950	33,340	7,976	224	2,532	105	266	150,392
1995/96	Below Average	54,702	13,119	3,139	421	2,636	105	259	74,380
1996/97	Below Average	64,493	8,757	2,095	640	2,661	105	230	78,981
1997/98	Above Average	111,697	34,629	8,284	294	2,608	105	235	157,852
1998/99	Below Average	34,372	3,774	903	390	2,830	105	279	42,652
1999/00	Below Average	39,017	6,930	1,658	873	2,944	105	235	51,761
2000/01	Below Average	53,104	6,915	1,654	869	2,933	105	165	65,746
2001/02	Below Average	19,394	1,717	411	1,027	2,952	105	124	25,729
2002/03	Below Average	64,379	8,295	1,984	906	2,592	105	95	78,357
2003/04	Below Average	43,093	8,404	2,011	1,004	2,630	105	81	57,327
2004/05	Above Average	148,520	39,600	9,474	420	2,492	105	205	200,815
2005/06	Average	71,620	17,564	4,202	253	2,463	105	289	96,495
2006/07	Below Average	21,426	2,841	680	674	2,665	105	248	28,638
2007/08	Below Average	63,791	14,182	3,393	819	2,457	105	148	84,893
2008/09	Below Average	60,142	9,212	2,204	836	2,321	105	156	74,975
2009/10	Above Average	89,973	32,959	7,885	655	2,193	105	196	133,965
2010/11	Above Average	111,353	16,908	4,045	386	2,110	105	249	135,156
2011/12	Below Average	52,705	8,175	1,956	484	2,246	105	255	65,924
2012/13	Below Average	40,756	3,129	749	752	2,449	105	196	48,135
2013/14	Below Average	42,195	5,776	1,382	778	2,212	142	159	52,643
2014/15	Below Average	56,230	3,677	880	776	2,101	139	121	63,922
2015/16	Below Average	51,421	7,027	1,681	840	2,188	140	91	63,389
2016/17	Above Average	84,166	13,213	3,161	751	2,175	139	127	103,732
2017/18	Below Average	37,687	4,818	1,153	729	2,100	136	130	46,752
2018/19	Above Average	103,392	25,381	6,072	599	2,149	133	154	137,881
Average		68,371	14,385	3,441	623	2,537	112	190	89,660
Totals		1,982,755	417,171	99,802	18,078	73,584	3,237	5,520	2,600,148

Notes:

[A] Estimated based on annual precipitation rates from the Big Bear Lake Dam and Big Bear City Community Services District precipitation stations.

[B] From WSC Big Bear Lake Annual Watermaster Inflows and Outflows, 1977-2018.

[C] Losses reported by BBLDWP. Losses for BBCCSD assumed to be 10%.

Highlighted cells indicates average values.

Bear Valley Basin Surface Water Budget Outflows

Date	Water Year Type	Outflows (acre-ft)											Inflows - Outflows
		H	I	J	K	L	M	N	O	P	Q		
		Areal Recharge from Precipitation[A]	Lake Evaporation: Big Bear Lake[B]	Lake Evaporation: Baldwin Lake	Tributary Channel Infiltration	Return Flow	System Losses[C]	Evapo-transpiration	Big Bear Lake Withdrawals[B]	Releases at Bear Valley Dam[B]	BBARWA Discharges to Lucerne Valley	Total	
1990/91	Average	5,413	9,235	3,342	773	235	418	63,398	514	79	2,551	85,957	4,515
1991/92	Average	5,615	10,714	3,342	802	255	404	63,398	404	0	2,237	87,172	11,065
1992/93	Above Average	11,573	11,716	3,342	1,653	233	374	63,398	318	11,823	3,953	108,384	109,850
1993/94	Below Average	4,187	11,784	3,342	598	193	387	63,398	428	2,049	2,801	89,168	-16,454
1994/95	Above Average	7,946	11,861	3,342	1,135	191	376	63,398	211	17,116	3,760	109,336	41,056
1995/96	Below Average	4,103	12,262	3,342	586	203	396	63,398	452	315	2,660	87,716	-13,336
1996/97	Below Average	4,837	11,456	3,342	691	210	418	63,398	417	364	2,679	87,812	-8,831
1997/98	Above Average	8,377	11,464	3,342	1,197	198	365	63,398	318	11,625	2,698	102,982	54,870
1998/99	Below Average	2,578	12,473	3,342	368	215	383	63,398	547	271	2,643	86,218	-43,566
1999/00	Below Average	2,926	11,829	3,342	418	241	417	63,398	430	511	2,550	86,062	-34,302
2000/01	Below Average	3,983	11,299	3,342	569	243	438	63,398	411	562	2,298	86,543	-20,797
2001/02	Below Average	1,455	10,375	3,342	208	249	325	63,398	391	649	2,530	82,921	-57,192
2002/03	Below Average	4,828	9,382	3,342	690	223	289	63,398	472	601	2,373	85,598	-7,241
2003/04	Below Average	3,232	9,025	3,342	462	221	365	63,398	439	715	3,292	84,491	-27,164
2004/05	Above Average	11,139	11,525	3,342	1,591	199	250	63,398	305	420	4,008	96,178	104,637
2005/06	Average	5,372	12,421	3,342	767	192	300	63,398	460	901	2,848	90,001	6,494
2006/07	Below Average	1,607	11,921	3,342	230	217	359	63,398	557	888	2,399	84,917	-56,279
2007/08	Below Average	4,784	11,460	3,342	683	570	299	63,398	289	576	2,699	88,101	-3,208
2008/09	Below Average	4,511	11,233	3,342	644	224	312	63,398	414	740	2,247	87,065	-12,090
2009/10	Above Average	6,748	11,374	3,342	964	71	202	63,398	300	2,969	3,059	92,427	41,537
2010/11	Above Average	8,351	12,028	3,342	1,193	13	179	63,398	609	8,040	3,568	100,721	34,435
2011/12	Below Average	3,953	12,503	3,342	565	202	250	63,398	755	1,116	2,592	88,675	-22,751
2012/13	Below Average	3,057	11,645	3,342	437	283	278	63,398	542	1,626	1,966	86,574	-38,439
2013/14	Below Average	3,165	10,942	3,342	452	318	283	63,398	372	1,014	1,892	85,178	-32,535
2014/15	Below Average	4,217	9,709	3,342	602	320	285	63,398	561	721	1,973	85,128	-21,206
2015/16	Below Average	3,857	9,309	3,342	551	303	293	63,398	445	904	2,134	84,535	-21,147
2016/17	Above Average	6,312	9,777	3,342	902	0	286	63,398	413	664	2,711	87,806	15,926
2017/18	Below Average	2,827	9,391	3,342	404	345	286	63,398	491	900	2,000	83,382	-36,630
2018/19	Above Average	7,754	10,079	3,342	1,108	231	275	63,398	508	446	2,704	89,845	48,035
Average		5,128	11,041	3,342	733	227	327	63,398	440	2,366	2,684	89,686	-26
Totals		148,707	320,192	96,921	21,244	6,597	9,491	1,838,542	12,773	68,605	77,824	2,600,895	-747

Notes:

[A] Estimated based on annual precipitation rates from the Big Bear Lake Dam and Big Bear City Community Services District precipitation stations.

[B] From WSC Big Bear Lake Annual Watermaster Inflows and Outflows, 1977-2019.

[C] Losses reported by BBLDWP. Losses for BBCCSD assumed to be 10%.

Bear Valley Basin Groundwater Budget

Date	Water Year Type	Inflows (acre-ft)					Outflows (acre-ft)					Change in Storage
		A	B	C	D		E	F	G	H		
							Groundwater Pumping					
		Areal Recharge from Precipitation[A]	Tributary Channel Infiltration	Return Flow	System Losses[B]	Total	BBCCSD	BBLDWP	Other[C]	ET	Total	
1990/91	Average	5,413	773	235	418	6,838	641	2,996	105	1,130	4,871	1,967
1991/92	Average	5,615	802	255	404	7,076	509	3,316	105	1,172	5,101	1,975
1992/93	Above Average	11,573	1,653	233	374	13,833	199	3,107	105	2,416	5,827	8,006
1993/94	Below Average	4,187	598	193	387	5,366	332	2,529	105	874	3,839	1,526
1994/95	Above Average	7,946	1,135	191	376	9,648	224	2,532	105	1,659	4,519	5,129
1995/96	Below Average	4,103	586	203	396	5,288	421	2,636	105	857	4,017	1,270
1996/97	Below Average	4,837	691	210	418	6,156	640	2,661	105	1,010	4,415	1,741
1997/98	Above Average	8,377	1,197	198	365	10,137	294	2,608	105	1,749	4,756	5,381
1998/99	Below Average	2,578	368	215	383	3,544	390	2,830	105	538	3,863	-319
1999/00	Below Average	2,926	418	241	417	4,002	873	2,944	105	611	4,532	-530
2000/01	Below Average	3,983	569	243	438	5,233	869	2,933	105	831	4,739	494
2001/02	Below Average	1,455	208	249	325	2,236	1027	2,952	105	304	4,387	-2,151
2002/03	Below Average	4,828	690	223	289	6,030	906	2,592	105	1,008	4,611	1,419
2003/04	Below Average	3,232	462	221	365	4,279	1004	2,630	105	675	4,413	-134
2004/05	Above Average	11,139	1,591	199	250	13,180	420	2,492	105	2,325	5,342	7,838
2005/06	Average	5,372	767	192	300	6,631	253	2,463	105	1,121	3,941	2,690
2006/07	Below Average	1,607	230	217	359	2,413	674	2,665	105	335	3,779	-1,366
2007/08	Below Average	4,784	683	570	299	6,337	819	2,457	105	999	4,379	1,958
2008/09	Below Average	4,511	644	224	312	5,691	836	2,321	105	942	4,204	1,487
2009/10	Above Average	6,748	964	71	202	7,985	655	2,193	105	1,409	4,361	3,624
2010/11	Above Average	8,351	1,193	13	179	9,736	386	2,110	105	1,744	4,345	5,391
2011/12	Below Average	3,953	565	202	250	4,969	484	2,246	105	825	3,659	1,310
2012/13	Below Average	3,057	437	283	278	4,055	752	2,449	105	638	3,944	111
2013/14	Below Average	3,165	452	318	283	4,218	778	2,212	142	661	3,792	426
2014/15	Below Average	4,217	602	320	285	5,424	776	2,101	139	880	3,896	1,529
2015/16	Below Average	3,857	551	303	293	5,003	840	2,188	140	805	3,974	1,030
2016/17	Above Average	6,312	902	0	286	7,500	751	2,175	139	1,318	4,383	3,117
2017/18	Below Average	2,827	404	345	286	3,861	729	2,100	136	590	3,554	306
2018/19	Above Average	7,754	1,108	231	275	9,368	599	2,149	133	1,619	4,501	4,867
Average		5,128	733	227	327	6,415	623	2,537	112	1,071	4,343	2,072
Totals		148,707	21,244	6,597	9,491	186,038	18,078	73,584	3,237	31,045	125,945	

Cumulative Change in Storage: 60,093

Notes:

[A] Estimated based on annual precipitation rates from the Big Bear Lake Dam and Big Bear City Community Services District precipitation stations.

[B] Losses reported by BBLDWP. Losses for BBCCSD assumed to be 10%.

[C] Estimated based on per capita water use. Assumes three people per household.

Projected Future Bear Valley Basin Surface Water Budget

Date	Inflows (acre-ft)								Outflows (acre-ft)										
	A	B	C	D	E	F	G		H	I	J	K	L	M	N	O	P	Q	
	Precipitation on Land Surface[A]	Natural Lake Inflows		Water Supply from Wells			Spring Flow (Van Dusen and Greenspot)	Total	Areal Recharge from Precipitation[A]	Lake Evaporation		Tributary Channel Infiltration	Return Flow	System Losses[C]	Evapotranspiration	Big Bear Lake Withdrawals[B]	Releases at Bear Valley Dam[B]	BBARWA Discharges to Lucerne Valley	Total
		Big Bear Lake[B]	Baldwin Lake	BBCCSD	BBLDWP	Private				Big Bear Lake[B]	Baldwin Lake								
2019/20	72,173	14,000	3,300	1,035	2,150	112	190	92,960	5,052	11,100	3,300	1,108	230	330	63,400	440	2,400	2,700	90,060
2020/21	74,646	12,241	2,928	1,035	2,150	112	200	93,312	5,225	9,272	2,928	812	230	330	63,651	440	2,400	2,700	87,989
2021/22	153,417	15,388	3,681	1,035	2,150	112	188	175,971	10,739	10,799	3,681	794	230	330	63,903	440	2,400	2,700	96,016
2022/23	55,346	49,585	11,863	1,035	2,150	112	194	120,285	3,874	11,855	11,863	1,686	230	330	64,154	440	2,400	2,700	99,533
2023/24	104,721	10,905	2,609	1,035	2,150	112	188	121,720	7,330	11,971	2,609	592	230	330	64,406	440	2,400	2,700	93,008
2024/25	53,909	32,673	7,817	1,035	2,150	112	186	97,882	3,774	12,096	7,817	1,112	230	330	64,657	440	2,400	2,700	95,556
2025/26	63,371	13,381	3,201	1,086	2,258	112	194	83,604	4,436	12,554	3,201	598	230	330	64,908	440	2,400	2,859	91,956
2026/27	109,429	8,582	2,053	1,086	2,258	112	186	123,706	7,660	11,774	2,053	677	230	330	65,160	440	2,400	2,859	93,583
2027/28	33,574	33,590	8,036	1,086	2,258	112	184	78,840	2,350	11,828	8,036	1,161	230	330	65,411	440	2,400	2,859	95,045
2028/29	37,999	3,812	912	1,086	2,258	112	192	46,370	2,660	12,918	912	372	230	330	65,663	440	2,400	2,859	88,784
2029/30	51,564	7,277	1,741	1,086	2,258	112	200	64,236	3,609	12,298	1,741	439	230	330	65,914	440	2,400	2,859	90,260
2030/31	18,775	6,984	1,671	1,140	2,371	112	192	31,245	1,314	11,792	1,671	575	230	330	66,165	440	2,400	3,026	87,943
2031/32	62,139	1,700	407	1,140	2,371	112	188	68,056	4,350	10,869	407	206	230	330	66,417	440	2,400	3,026	88,674
2032/33	41,468	7,714	1,846	1,140	2,371	112	177	54,828	2,903	9,866	1,846	641	230	330	66,668	440	2,400	3,026	88,350
2033/34	142,490	8,824	2,111	1,140	2,371	112	200	157,248	9,974	9,526	2,111	485	230	330	66,920	440	2,400	3,026	95,442
2034/35	68,505	38,808	9,284	1,140	2,371	112	186	120,406	4,795	12,210	9,284	1,559	230	330	67,171	440	2,400	3,026	101,446
2035/36	20,432	17,037	4,076	1,196	2,490	112	184	45,527	1,430	13,209	4,076	744	230	330	67,422	440	2,400	3,201	93,483
2036/37	60,646	2,841	680	1,196	2,490	112	190	68,154	4,245	12,725	680	230	230	330	67,674	440	2,400	3,201	92,154
2037/38	57,002	14,891	3,562	1,196	2,490	112	200	79,453	3,990	12,278	3,562	718	230	330	67,925	440	2,400	3,201	95,074
2038/39	85,015	9,028	2,160	1,196	2,490	112	186	100,187	5,951	12,079	2,160	631	230	330	68,176	440	2,400	3,201	95,599
2039/40	104,894	33,948	8,121	1,196	2,490	112	196	150,957	7,343	12,276	8,121	993	230	330	68,428	440	2,400	3,201	103,762
2040/41	64,363	6,568	1,571	1,196	2,490	112	190	76,491	4,505	12,943	1,571	400	230	330	68,437	440	2,400	3,201	94,457
2041/42	105,575	25,470	6,093	1,196	2,490	112	192	141,129	7,390	12,011	6,093	909	230	330	68,446	440	2,400	3,201	101,451
2042/43	50,711	28,465	6,810	1,196	2,490	112	154	89,937	3,550	12,964	6,810	972	230	330	68,456	440	2,400	3,201	99,353
2043/44	49,552	8,666	2,073	1,196	2,490	112	152	64,240	3,469	12,645	2,073	472	230	330	68,465	440	2,400	3,201	93,725
2044/45	71,395	8,832	2,113	1,196	2,490	112	179	86,317	4,998	12,440	2,113	611	230	330	68,474	440	2,400	3,201	95,237
2045/46	37,923	13,536	3,238	1,196	2,490	112	186	58,682	2,655	12,438	3,238	657	230	330	68,483	440	2,400	3,201	94,072
2046/47	29,432	7,765	1,858	1,196	2,490	112	184	43,036	2,060	11,688	1,858	437	230	330	68,493	440	2,400	3,201	91,136
2047/48	31,693	3,459	827	1,196	2,490	112	144	39,922	2,219	12,059	827	304	230	330	68,502	440	2,400	3,201	90,512
2048/49	34,545	4,868	1,165	1,196	2,490	112	186	44,561	2,418	11,986	1,165	392	230	330	68,511	440	2,400	3,201	91,073
2049/50	67,915	5,001	1,196	1,196	2,490	112	196	78,106	4,754	10,313	1,196	412	230	330	68,520	440	2,400	3,201	91,796
2050/51	70,438	10,725	2,566	1,196	2,490	112	175	87,702	4,931	9,982	2,566	711	230	330	68,530	440	2,400	3,201	93,321
2051/52	145,177	16,786	4,016	1,196	2,490	112	205	169,983	10,162	11,582	4,016	866	230	330	68,539	440	2,400	3,201	101,767
2052/53	52,521	44,238	10,583	1,196	2,490	112	173	111,313	3,676	12,667	10,583	1,505	230	330	68,548	440	2,400	3,201	103,581
2053/54	99,657	10,134	2,424	1,196	2,490	112	175	116,188	6,976	12,743	2,424	550	230	330	68,557	440	2,400	3,201	97,852
2054/55	51,448	36,341	8,694	1,196	2,490	112	207	100,487	3,601	12,828	8,694	1,237	230	330	68,567	440	2,400	3,201	101,528
2055/56	60,649	12,594	3,013	1,196	2,490	112	182	80,237	4,245	13,263	3,013	563	230	330	68,576	440	2,400	3,201	96,261
2056/57	105,028	8,144	1,948	1,196	2,490	112	177	119,095	7,352	12,393	1,948	643	230	330	68,585	440	2,400	3,201	97,522
2057/58	32,316	32,205	7,705	1,196	2,490	112	177	76,200	2,262	12,403	7,705	1,113	230	330	68,594	440	2,400	3,201	98,678
2058/59	36,680	4,227	1,011	1,196	2,490	112	213	45,929	2,568	13,497	1,011	412	230	330	68,604	440	2,400	3,201	92,693
2059/60	49,917	6,445	1,542	1,196	2,490	112	177	61,879	3,494	12,802	1,542	389	230	330	68,613	440	2,400	3,201	93,440
2060/61	18,228	5,532	1,323	1,196	2,490	112	152	29,034	1,276	12,230	1,323	455	230	330	68,622	440	2,400	3,201	90,508
2061/62	18,228	1,305	312	1,196	2,490	112	144	23,788	1,276	11,231	312	158	230	330	68,632	440	2,400	3,201	88,210

Projected Future Bear Valley Basin Surface Water Budget

Date	Inflows (acre-ft)								Outflows (acre-ft)										
	A	B	C	D	E	F	G		H	I	J	K	L	M	N	O	P	Q	
		Natural Lake Inflows		Water Supply from Wells						Lake Evaporation									
Date	Precipitation on Land Surface[A]	Big Bear Lake[B]	Baldwin Lake	BBCCSD	BBLDWP	Private	Spring Flow (Van Dusen and Greenspot)	Total	Areal Recharge from Precipitation[A]	Big Bear Lake[B]	Baldwin Lake	Tributary Channel Infiltration	Return Flow	System Losses[C]	Evapotranspiration	Big Bear Lake Withdrawals[B]	Releases at Bear Valley Dam[B]	BBARWA Discharges to Lucerne Valley	Total
2062/63	60,504	7,963	1,905	1,196	2,490	112	182	74,352	4,235	10,158	1,905	662	230	330	68,641	440	2,400	3,201	92,202
2063/64	40,494	8,152	1,950	1,196	2,490	112	184	54,579	2,835	9,772	1,950	448	230	330	68,650	440	2,400	3,201	90,256
2064/65	139,549	39,996	9,568	1,196	2,490	112	192	193,104	9,768	12,481	9,568	1,607	230	330	68,659	440	2,400	3,201	108,685
2065/66	67,287	16,686	3,992	1,196	2,490	112	181	91,943	4,710	13,453	3,992	729	230	330	68,669	440	2,400	3,201	98,154
2066/67	20,127	3,324	795	1,196	2,490	112	222	28,267	1,409	12,913	795	269	230	330	68,678	440	2,400	3,201	90,665
2067/68	59,919	12,197	2,918	1,196	2,490	112	163	78,994	4,194	12,416	2,918	588	230	330	68,687	440	2,400	3,201	95,404
2068/69	56,485	9,028	2,160	1,196	2,490	112	186	71,657	3,954	12,171	2,160	631	230	330	68,696	440	2,400	3,201	94,214
2069/70	84,493	28,674	6,860	1,196	2,490	112	165	123,991	5,915	12,326	6,860	839	230	330	68,706	440	2,400	3,201	101,246
Average	64,388	15,108	3,614	1,161	2,416	112	184	86,982	4,507	11,963	3,614	707	230	330	67,477	440	2,400	3,091	94,759

Notes:

[A] Estimated based on annual precipitation rates from the Big Bear Lake Dam and Big Bear City Community Services District precipitation stations.

[B] From WSC Big Bear Lake Annual Watermaster Inflows and Outflows, 1977-2018.

[C] Losses reported by BBLDWP. Losses for BBCCSD assumed to be 10%.

Projected Future Bear Valley Basin Groundwater Budget

Date	Inflows (acre-ft)					Outflows (acre-ft)					Change in Storage
	A	B	C	D		E	F	G	H		
	Areal Recharge from Precipitation[A]	Tributary Channel Infiltration	Return Flow	System Losses[B]	Total	Groundwater Pumping			ET	Total	
						BBCCSD	BBLDWP	Other[C]			
2019/20	5,052	1,108	230	330	6,720	1,185	2,147	112	1,071	4,515	2,205
2020/21	5,225	812	230	330	6,597	1,185	2,147	112	1,075	4,519	2,078
2021/22	10,739	794	230	330	12,093	1,185	2,147	112	1,079	4,523	7,570
2022/23	3,874	1,686	230	330	6,121	1,185	2,147	112	1,084	4,528	1,593
2023/24	7,330	592	230	330	8,483	1,185	2,147	112	1,088	4,532	3,951
2024/25	3,774	1,112	230	330	5,446	1,185	2,147	112	1,092	4,536	910
2025/26	4,436	598	230	330	5,594	1,185	2,147	112	1,096	4,540	1,053
2026/27	7,660	677	230	330	8,897	1,185	2,147	112	1,101	4,545	4,352
2027/28	2,350	1,161	230	330	4,071	1,185	2,147	112	1,105	4,549	-478
2028/29	2,660	372	230	330	3,592	1,185	2,147	112	1,109	4,553	-961
2029/30	3,609	439	230	330	4,608	1,185	2,147	112	1,113	4,557	51
2030/31	1,314	575	230	330	2,449	1,206	2,164	112	1,118	4,600	-2,151
2031/32	4,350	206	230	330	5,115	1,206	2,164	112	1,122	4,604	511
2032/33	2,903	641	230	330	4,104	1,206	2,164	112	1,126	4,608	-504
2033/34	9,974	485	230	330	11,019	1,206	2,164	112	1,130	4,612	6,407
2034/35	4,795	1,559	230	330	6,915	1,206	2,164	112	1,135	4,617	2,298
2035/36	1,430	744	230	330	2,735	1,227	2,190	112	1,139	4,668	-1,933
2036/37	4,245	230	230	330	5,035	1,227	2,190	112	1,143	4,672	363
2037/38	3,990	718	230	330	5,268	1,227	2,190	112	1,147	4,676	591
2038/39	5,951	631	230	330	7,143	1,227	2,190	112	1,152	4,681	2,462
2039/40	7,343	993	230	330	8,896	1,227	2,190	112	1,156	4,685	4,211
2040/41	4,505	400	230	330	5,465	1,249	2,231	112	1,156	4,748	717
2041/42	7,390	909	230	330	8,859	1,249	2,231	112	1,156	4,748	4,111
2042/43	3,550	972	230	330	5,082	1,249	2,231	112	1,156	4,748	333
2043/44	3,469	472	230	330	4,501	1,249	2,231	112	1,157	4,749	-248
2044/45	4,998	611	230	330	6,169	1,249	2,231	112	1,157	4,749	1,420
2045/46	2,655	657	230	330	3,871	1,271	2,283	112	1,157	4,823	-952
2046/47	2,060	437	230	330	3,057	1,271	2,283	112	1,157	4,823	-1,766
2047/48	2,219	304	230	330	3,083	1,271	2,283	112	1,157	4,823	-1,741

Projected Future Bear Valley Basin Groundwater Budget

Date	Inflows (acre-ft)					Outflows (acre-ft)					Change in Storage
	A	B	C	D		E	F	G	H		
						Groundwater Pumping					
	Areal Recharge from Precipitation[A]	Tributary Channel Infiltration	Return Flow	System Losses[B]	Total	BBCCSD	BBLDWP	Other[C]	ET	Total	
2048/49	2,418	392	230	330	3,370	1,271	2,283	112	1,157	4,823	-1,453
2049/50	4,754	412	230	330	5,726	1,271	2,283	112	1,157	4,823	903
2050/51	4,931	711	230	330	6,202	1,271	2,283	112	1,158	4,824	1,378
2051/52	10,162	866	230	330	11,589	1,271	2,283	112	1,158	4,824	6,765
2052/53	3,676	1,505	230	330	5,741	1,271	2,283	112	1,158	4,824	917
2053/54	6,976	550	230	330	8,086	1,271	2,283	112	1,158	4,824	3,262
2054/55	3,601	1,237	230	330	5,399	1,271	2,283	112	1,158	4,824	574
2055/56	4,245	563	230	330	5,368	1,271	2,283	112	1,158	4,824	544
2056/57	7,352	643	230	330	8,555	1,271	2,283	112	1,159	4,825	3,730
2057/58	2,262	1,113	230	330	3,935	1,271	2,283	112	1,159	4,825	-890
2058/59	2,568	412	230	330	3,540	1,271	2,283	112	1,159	4,825	-1,285
2059/60	3,494	389	230	330	4,443	1,271	2,283	112	1,159	4,825	-382
2060/61	1,276	455	230	330	2,291	1,271	2,283	112	1,159	4,825	-2,534
2061/62	1,276	158	230	330	1,994	1,271	2,283	112	1,159	4,825	-2,831
2062/63	4,235	662	230	330	5,457	1,271	2,283	112	1,160	4,826	632
2063/64	2,835	448	230	330	3,842	1,271	2,283	112	1,160	4,826	-983
2064/65	9,768	1,607	230	330	11,936	1,271	2,283	112	1,160	4,826	7,110
2065/66	4,710	729	230	330	5,999	1,271	2,283	112	1,160	4,826	1,173
2066/67	1,409	269	230	330	2,238	1,271	2,283	112	1,160	4,826	-2,589
2067/68	4,194	588	230	330	5,342	1,271	2,283	112	1,160	4,826	516
2068/69	3,954	631	230	330	5,145	1,271	2,283	112	1,160	4,826	319
2069/70	5,915	839	230	330	7,313	1,271	2,283	112	1,161	4,827	2,487
Average	4,507	707	230	330	5,774	1,240	2,228	112	1,140	4,719	1,055
										Cumulative Change in Storage:	36,453

Notes:

[A] Estimated based on annual precipitation rates from the Big Bear Lake Dam and Big Bear City Community Services District precipitation stations.

[B] Losses reported by BBLDWP. Losses for BBCCSD assumed to be 10%.

[C] Estimated based on per capita water use. Assumes three people per household.

Summary of Representative Monitoring Sites (RMS)

Watershed	Management Area	Well Name	RMS Well	X Coordinate (UTM83)	Y Coordinate (UTM83)	Perforation Interval	Aquifer Monitored	Period of Historical Record
Big Bear Lake	Grout Creek	Cherokee Well	Yes	504836.77	3791997.54	130-590	Middle	2013 - 2019
Big Bear Lake	Grout Creek	Seminole	Yes	504963.02	3791800.43	20-55	Middle	1996 - 2019
Big Bear Lake	North Shore	FP-2	Yes	506126.45	3791375.63	60-120; 156-176; 216-278; 310-370	Middle	2014 - 2019
Big Bear Lake	North Shore	RV Park #1	Yes	508012.79	3791011.24	123-183	Middle	1996 - 2019
Big Bear Lake	North Shore	Stanfield Well	No	510627.54	3791036.03	40-150	Upper	1986 - 2019
Big Bear Lake	Division	Hillendale Monitoring Well	Yes	512681.78	3791295.26	65-114	Middle	1990 - 2019
Big Bear Lake	Division	Airport Well	No	513498.59	3791523.88	100-150	Upper	1987 - 2019
Big Bear Lake	Division	Division Well #4	Yes	512212.18	3791177.06	50-475	Middle	1993 - 2019
Big Bear Lake	Division	Riffenburgh Well	No	512057.68	3791015.29	96-466	Composite	2003 - 2019
Big Bear Lake	Division	McAlister Deep Monitoring Well	Yes	512305.87	3789711.98	490-690	Lower	2004 - 2019
Big Bear Lake	Division	McAlister Shallow Monitoring Well	Yes	512305.87	3789711.98	96-446	Middle	2004 - 2019
Big Bear Lake	Division	La Crescenta	No	513892.59	3788634.39	292-342; 366-386; 410-510; 532-552; 556-576	Lower	1993 - 2019
Baldwin Lake	West Baldwin	Van Dusen 1	No	513446.73	3792292.60	N/A	N/A	2006 - 2019
Baldwin Lake	West Baldwin	Greenway Monitoring Well	Yes	514206.20	3791472.21	0-109	Middle	1990 - 2019
Baldwin Lake	West Baldwin	Maltby Monitoring Well	Yes	515123.65	3791763.95	0-72	Middle	1990 - 2019
Baldwin Lake	West Baldwin	Sawmill Canyon	No	514831.83	3789079.54	240-530	Lower	1988 - 2015
Baldwin Lake	West Baldwin	Magnolia Monitoring Well	No	515636.97	3789195.60	300-700	Lower	2005 - 2019
Baldwin Lake	East Baldwin	CSD Well #8	Yes	516995.11	3791852.81	90-175; 195-245; 260-360	Composite	2003 - 2019
Baldwin Lake	Erwin	Vaqueros Monitoring Well	Yes	517535.45	3790086.24	N/A	Middle	1990 - 2019
Baldwin Lake	Erwin	Maple Well	Yes	516125.14	3788987.27	230-430; 440-750	Lower	1990 - 2019
Baldwin Lake	Erwin	Erwin Monitoring Well	No	517997.59	3788718.85	120-320	Composite	1987 - 2019
Baldwin Lake	Lake Williams	Monte Vista Monitoring Well	Yes	521094.65	3787921.43	65-105	Middle	2003 - 2019

Summary of Representative Monitoring Sites (RMS)

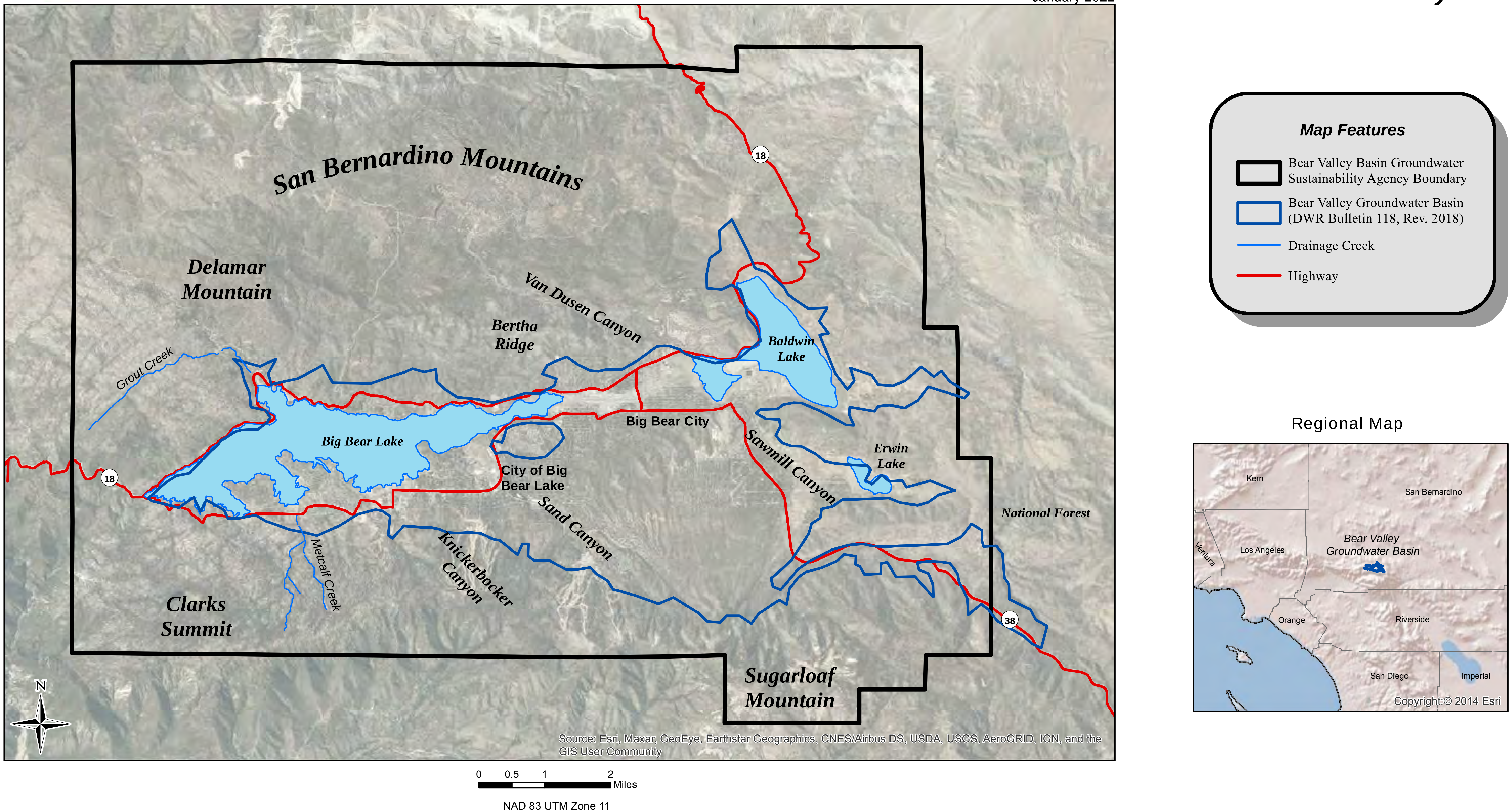
Watershed	Management Area	Well Name	RMS Well	X Coordinate (UTM83)	Y Coordinate (UTM83)	Perforation Interval	Aquifer Monitored	Period of Historical Record
Baldwin Lake	Lake Williams	Camp Oakes Monitoring Well	No	521462.96	3787961.08	80-205	Upper	2003 - 2019
Baldwin Lake	Arrastre	Arrastre Creek Well	No	522635.50	3787562.31	180-265; 280-340	Upper	N/A
Big Bear Lake	Rathbone	Treatment Plant Monitoring Well	No	509951.24	3790268.52	30-150	Upper	1986 - 2020
Big Bear Lake	Rathbone	Rathbun Well (DWP Yard)	Yes	510444.15	3789546.72	N/A	N/A	1986 - 2020
Big Bear Lake	Rathbone	Elm Monitoring Well	No	511499.27	3788957.90	50-123	Middle	1990 - 2019
Big Bear Lake	Rathbone	Moonridge Shallow Well	No	511706.26	3788875.84	80-160	Upper	2003 - 2019
Big Bear Lake	Rathbone	Moonridge Deep Well	No	511706.26	3788875.84	730-820	Lower	2003 - 2012
Big Bear Lake	Rathbone	Sand Canyon #1	Yes	512815.56	3787948.06	50-325	Composite	1993 - 2019
Big Bear Lake	Village	Knickerbocker Well	No	508234.51	3789193.42	220-775	Lower	1989 - 2019
Big Bear Lake	Village	Oak Well	Yes	509515.23	3788737.42	70-110; 144-154; 170-290; 312-352	N/A	1993 - 2019
Big Bear Lake	Mill Creek	Mallard Lane Deep Monitoring Well	Yes	506458.72	3789609.64	500-620	Lower	2003 - 2019
Big Bear Lake	Mill Creek	Mallard Lane Shallow Monitoring Well	Yes	506458.72	3789609.64	100-435	Middle	2003 - 2019
Big Bear Lake	Mill Creek	Canvasback Deep Monitoring Well	Yes	506132.96	3789435.20	415-485	Lower	2003 - 2019
Big Bear Lake	Mill Creek	Canvasback Shallow Monitoring Well	Yes	506132.96	3789435.20	160-315	Upper	2003 - 2019
Big Bear Lake	Mill Creek	Metcalf Monitoring Well	No	505864.26	3788646.59	45-185	Upper	1986 - 2019

Note:

N/A = Not available

Bear Valley Basin Groundwater Sustainability Plan

January 2022



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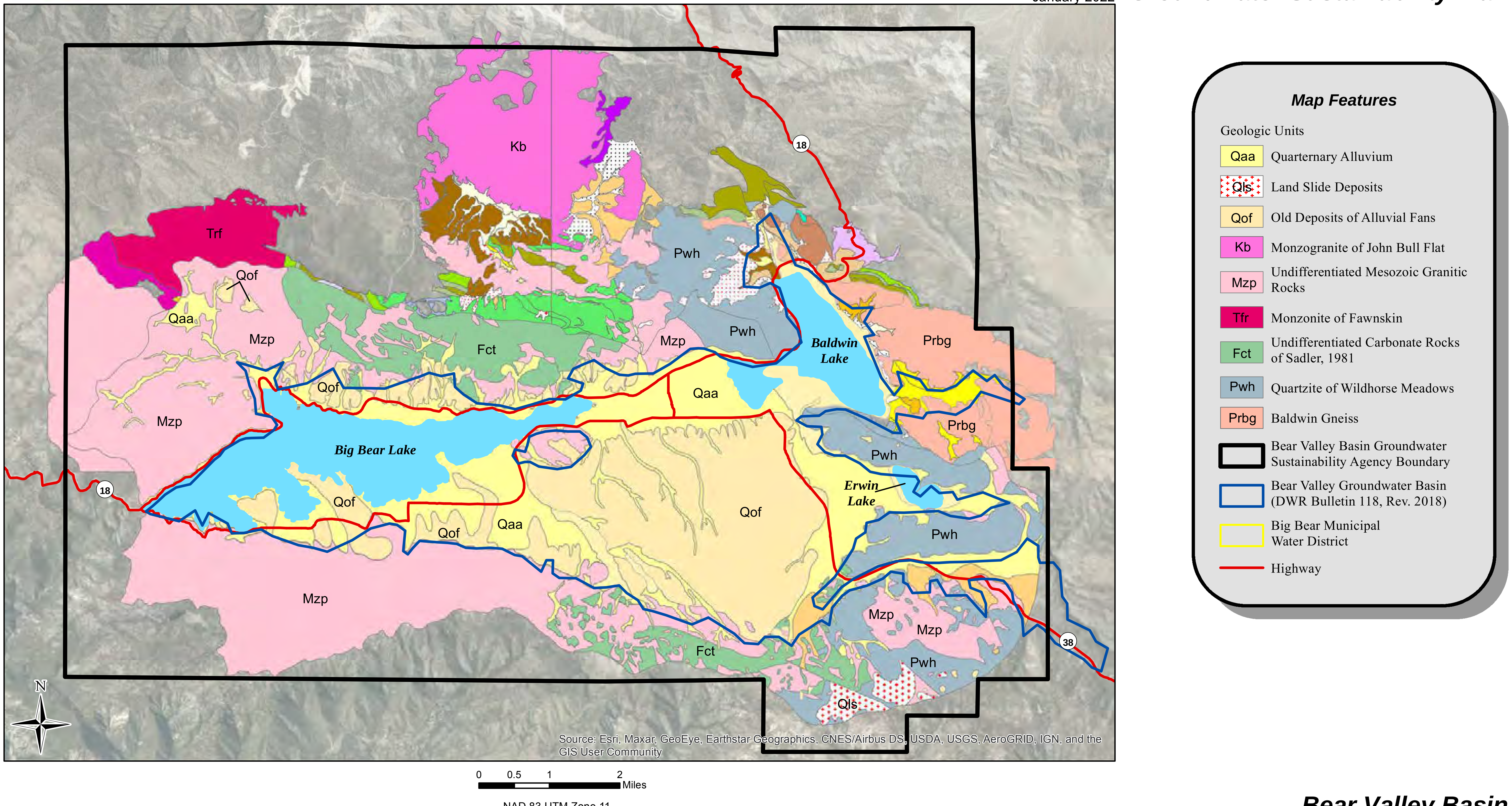
Bear Valley Basin

Figure 2-1

Bear Valley Basin Groundwater Sustainability Plan

January 2022



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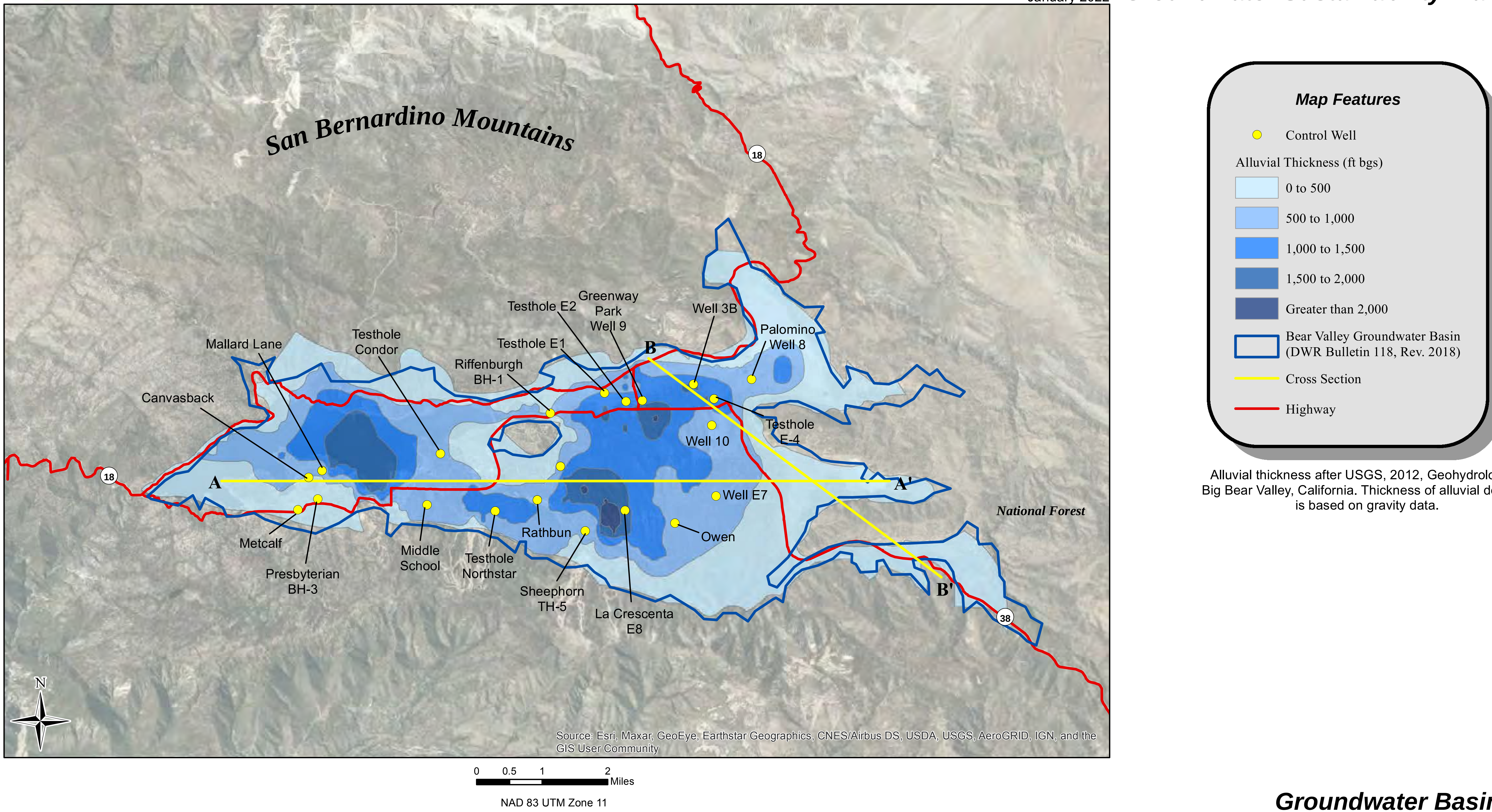
Bear Valley Basin Geology Map

Figure 2-2



Alluvial thickness after USGS, 2012, Geohydrology of Big Bear Valley, California. Thickness of alluvial deposits is based on gravity data.

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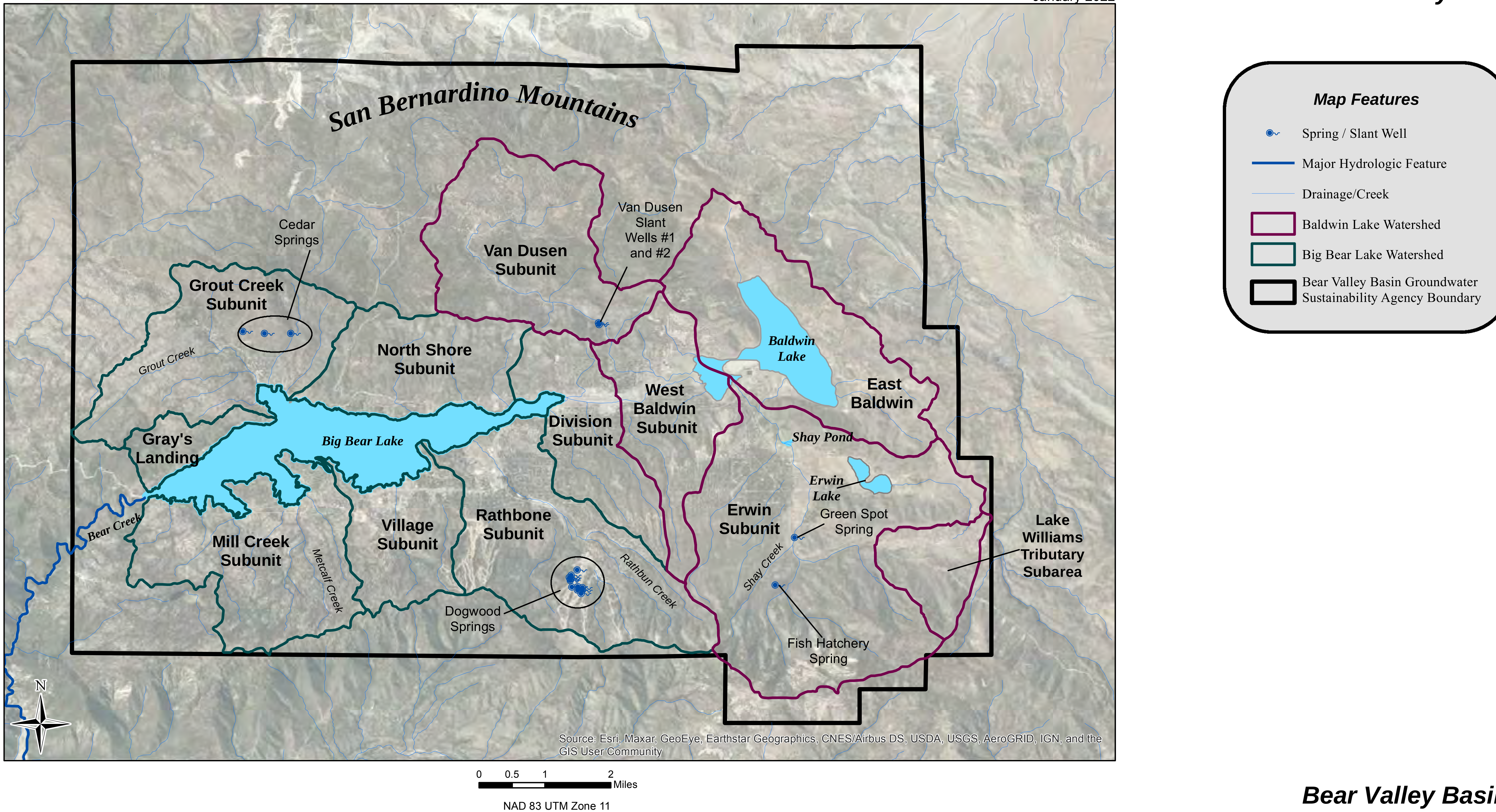
Groundwater Basin Alluvial Thickness

Figure 2-3

Bear Valley Basin Groundwater Sustainability Plan

January 2022



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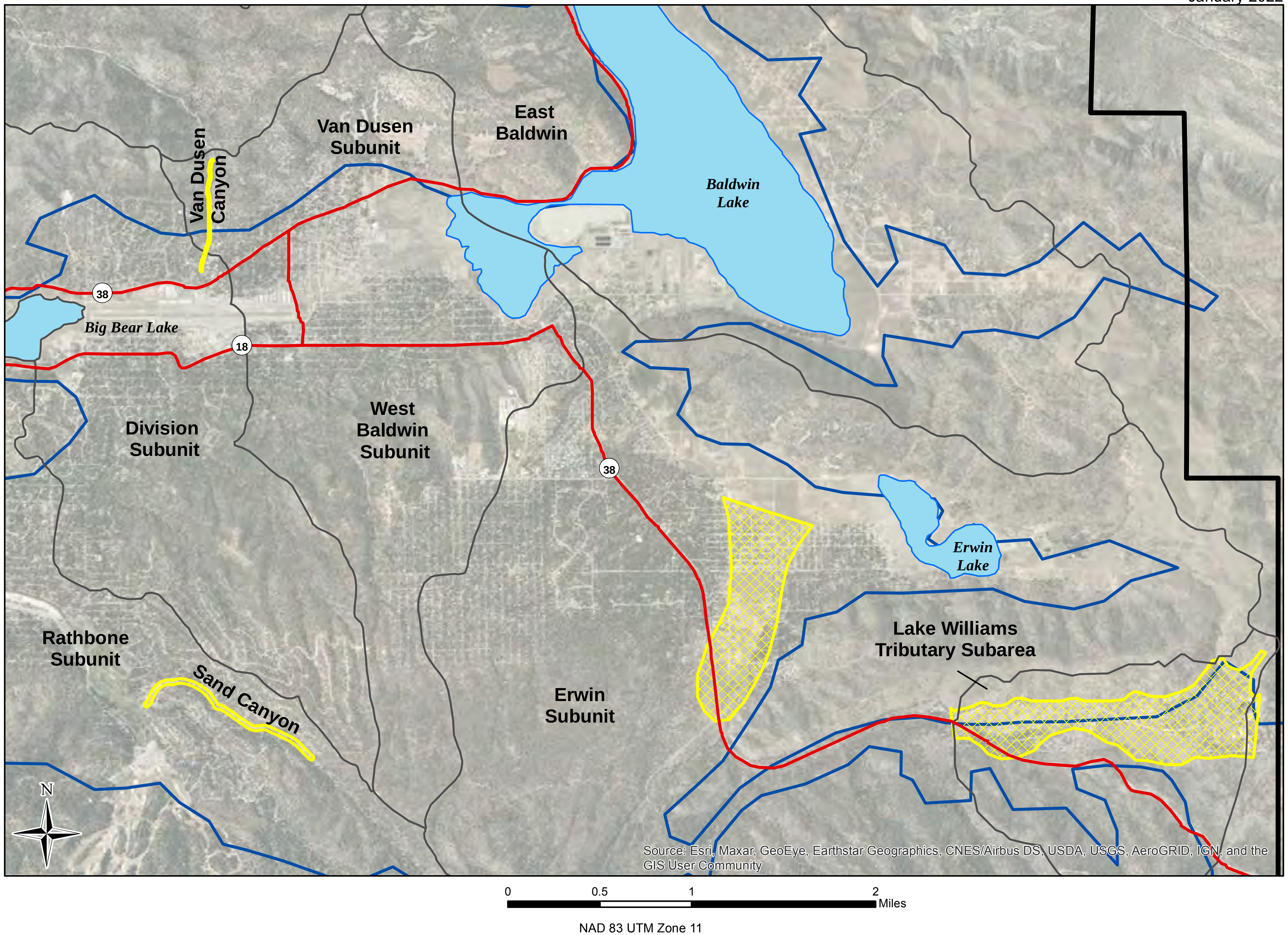
Bear Valley Basin Surface Water Features

Figure 2-4

January 2022

Bear Valley Basin
Groundwater Sustainability Plan



Map Features

- Area of Favorable Recharge
- Hydrologic Subunit
- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)
- Bear Valley Basin Groundwater Sustainability Agency Boundary
- Highway

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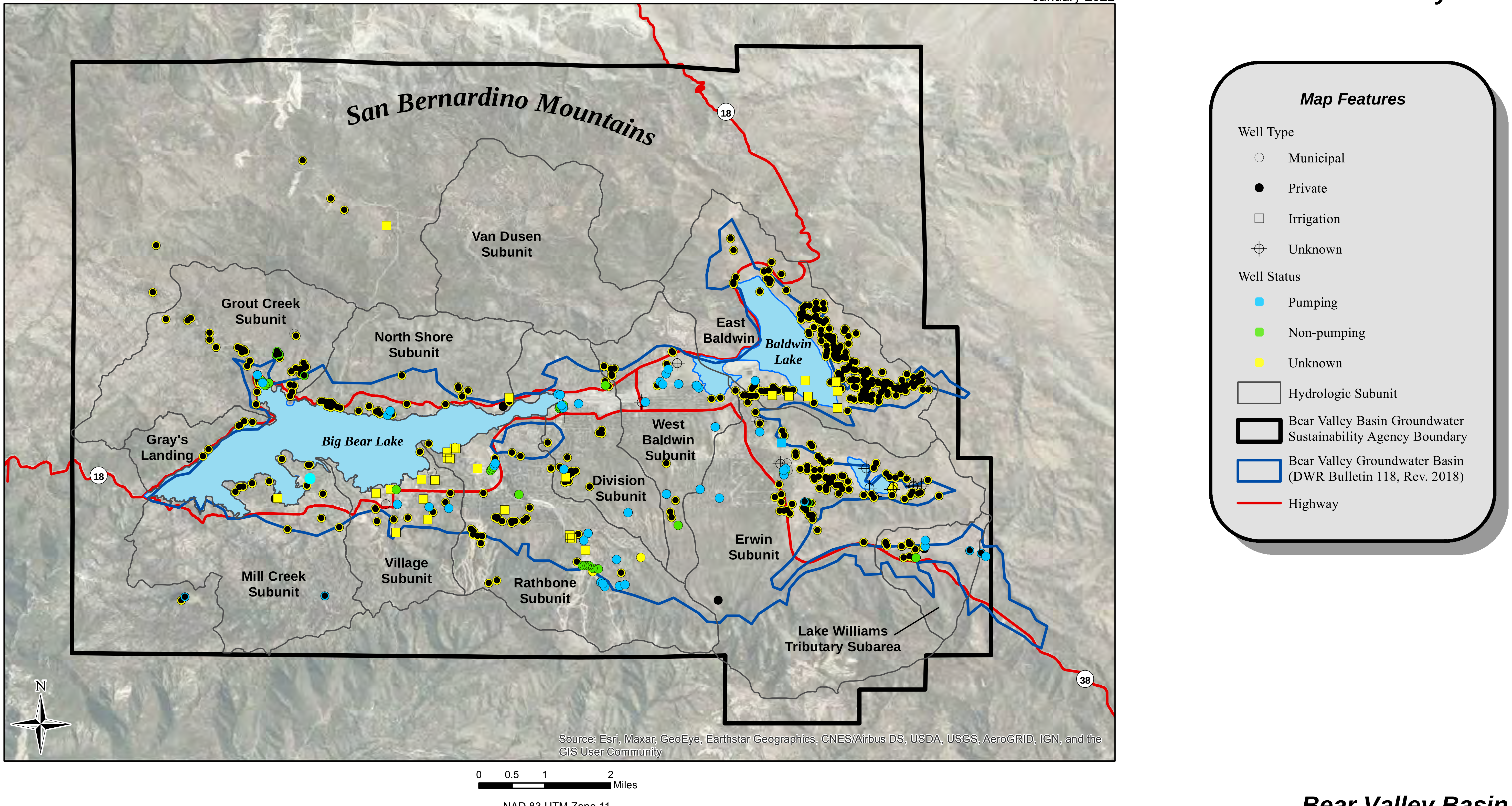
Bear Valley Basin
Areas of Favorable Recharge

Figure 2-5

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



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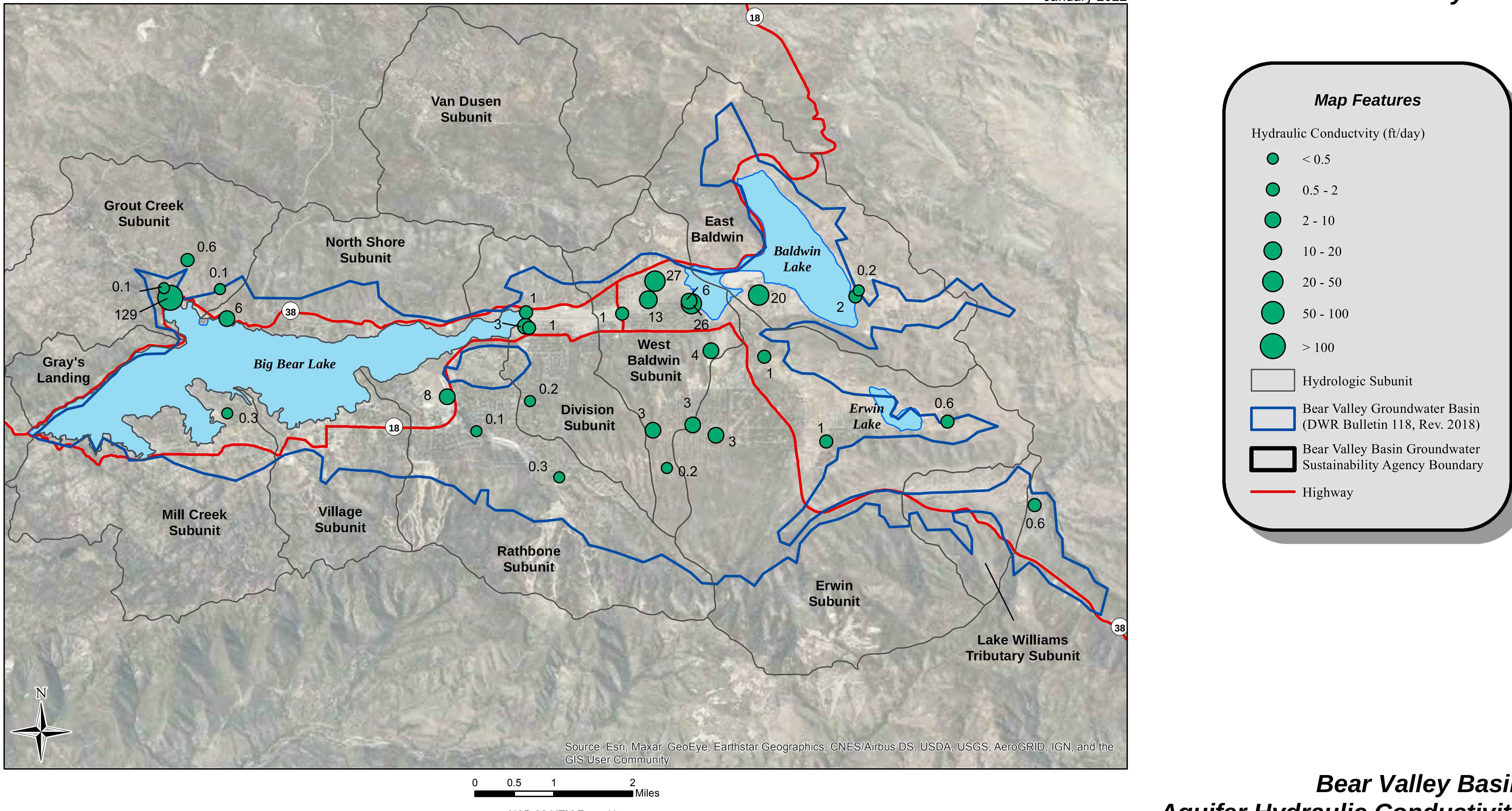
Bear Valley Basin
Well Location Map

Figure 2-6

January 2022

Bear Valley Basin
Groundwater Sustainability Plan



Bear Valley Basin
Aquifer Hydraulic Conductivity from Pumping Tests

Figure 2-7

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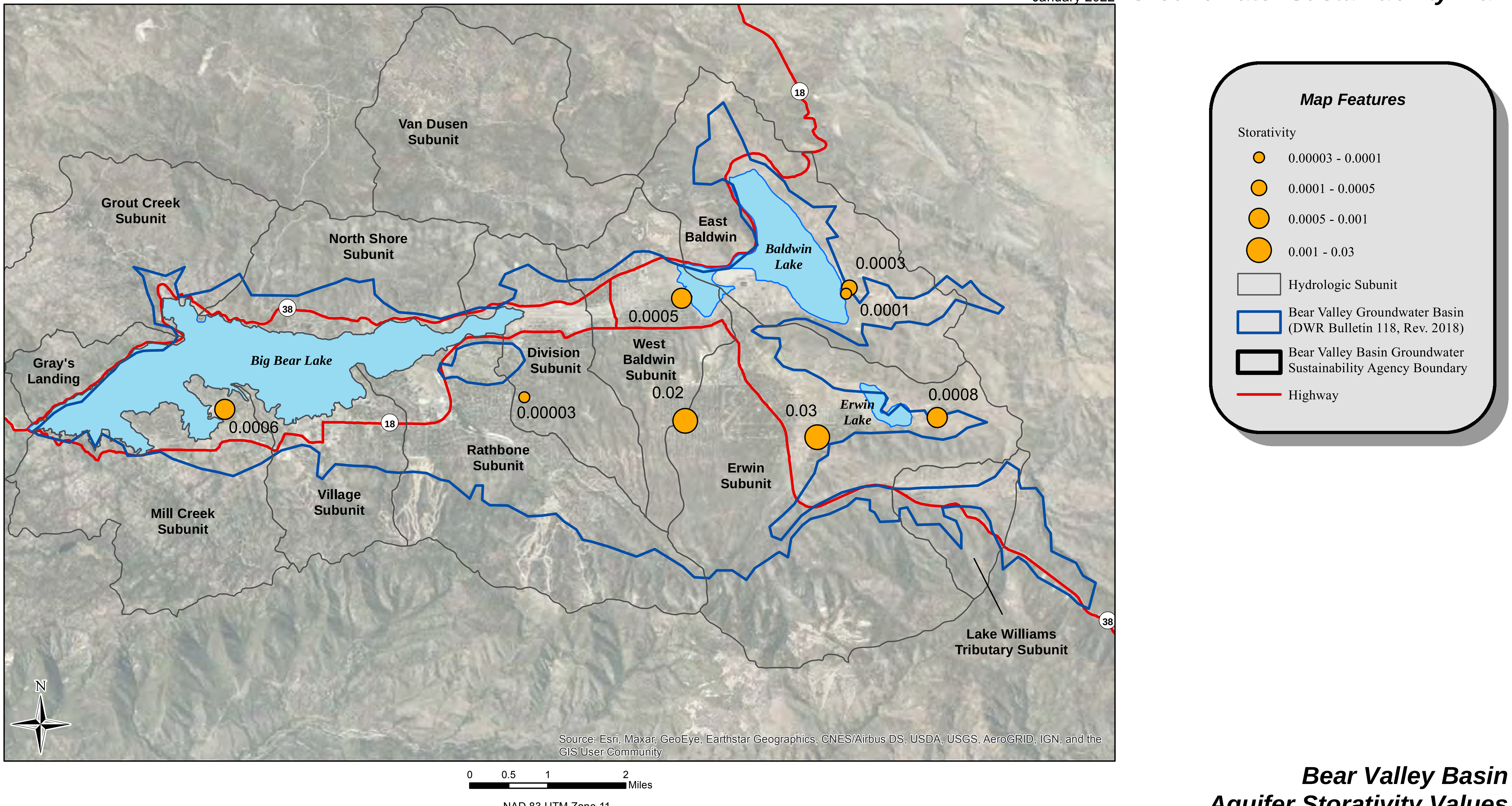

January 2022

Bear Valley Basin Groundwater Sustainability Plan

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Bear Valley Basin Aquifer Storativity Values from Pumping Tests

Figure 2-8

Bear Valley Basin Groundwater Sustainability Plan

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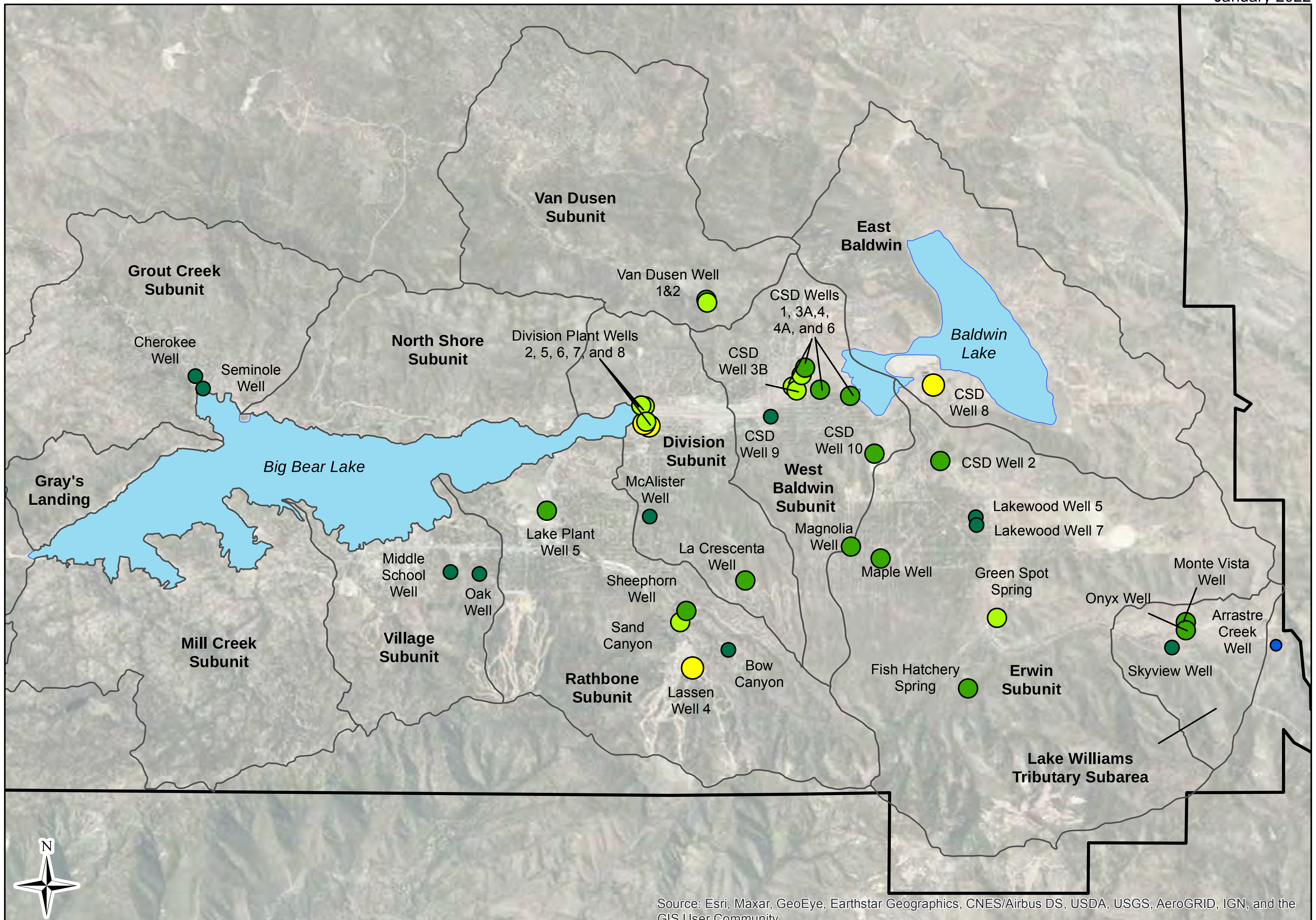

Map Features

Total Dissolved Solids (mg/L) - 2017

- < 100
- 100 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- Hydrologic Subunit
- Bear Valley Basin Groundwater Sustainability Agency

Note:

Total Dissolved Solids Secondary MCL = 500 mg/L

Source:
California Water Boards: State Water Resources Water Quality Analyses Data Library

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0 1 2 4 Miles

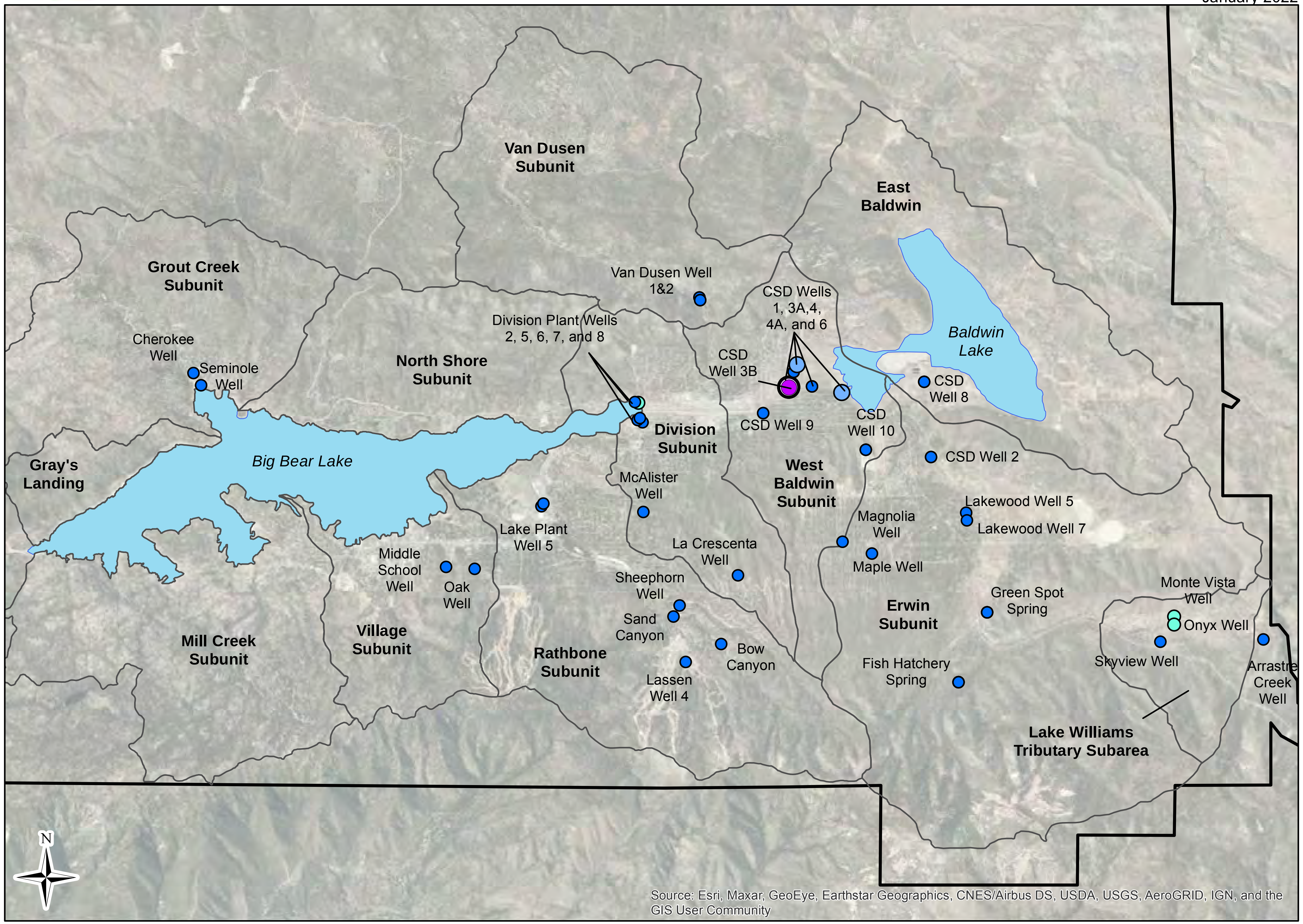
NAD 83 State Plane Zone 4

Groundwater Quality - Total Dissolved Solids

Figure 2-9

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



Map Features

Fluoride (mg/L) - 2017

- < 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- Hydrologic Subunit
- Bear Valley Basin Groundwater Sustainability Agency

Note:

Fluoride MCL = 2.0 mg/L

Source:
California Water Boards: State Water Resources Water Quality Analyses Data Library

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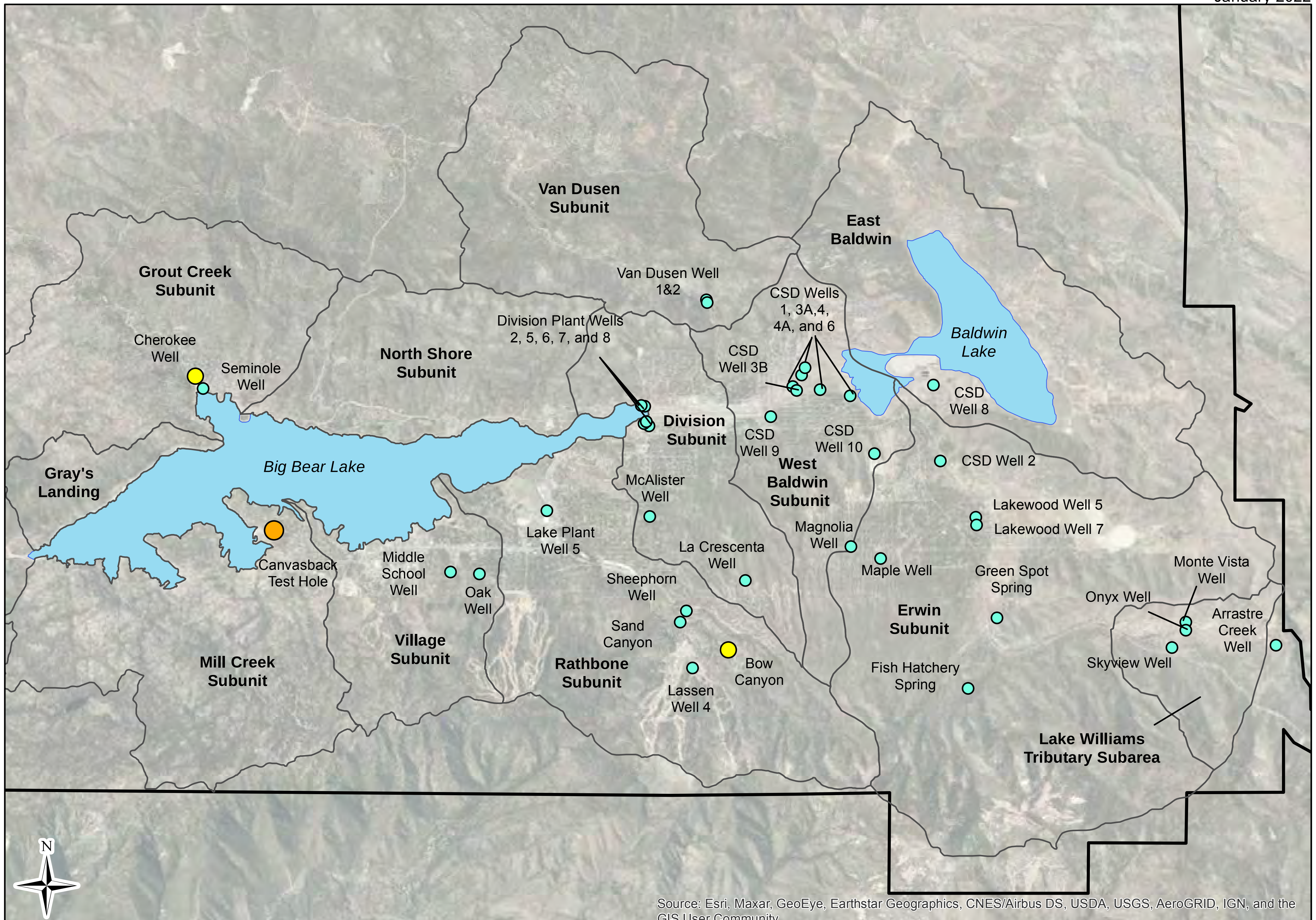
Groundwater Quality - Fluoride

Figure 2-10

Bear Valley Basin Groundwater Sustainability Agency

Bear Valley Basin Groundwater Sustainability Plan

January 2022



Map Features

Arsenic (µg/L) - 2017

- 0
- 7 - 8
- 88
- Hydrologic Subunit
- Bear Valley Basin Groundwater Sustainability Agency

Note:

Arsenic MCL = 10 µg/L

Source:
California Water Boards: State Water Resources Water Quality Analyses Data Library

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0 1 2 4 Miles

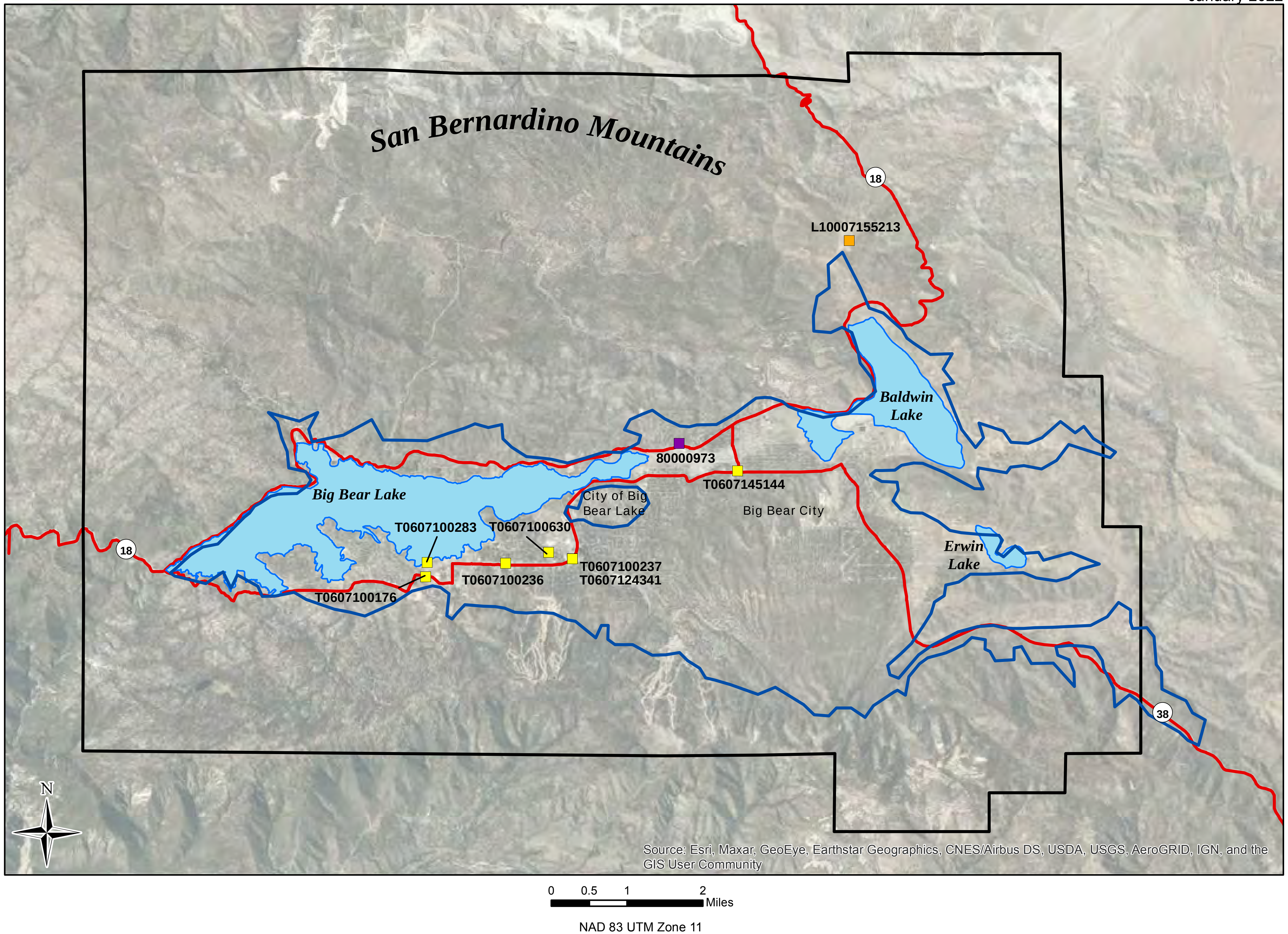
NAD 83 State Plane Zone 4

Groundwater Quality - Arsenic

Figure 2-11

January 2022

Bear Valley Basin
Groundwater Sustainability Plan



Map Features

Active Cleanup Site

- DTSC Cleanup Site
- Land Disposal Site
- LUST Cleanup Site
- Bear Valley Basin Groundwater Sustainability Agency Boundary
- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)
- Highway

Source: https://geotracker.waterboards.ca.gov

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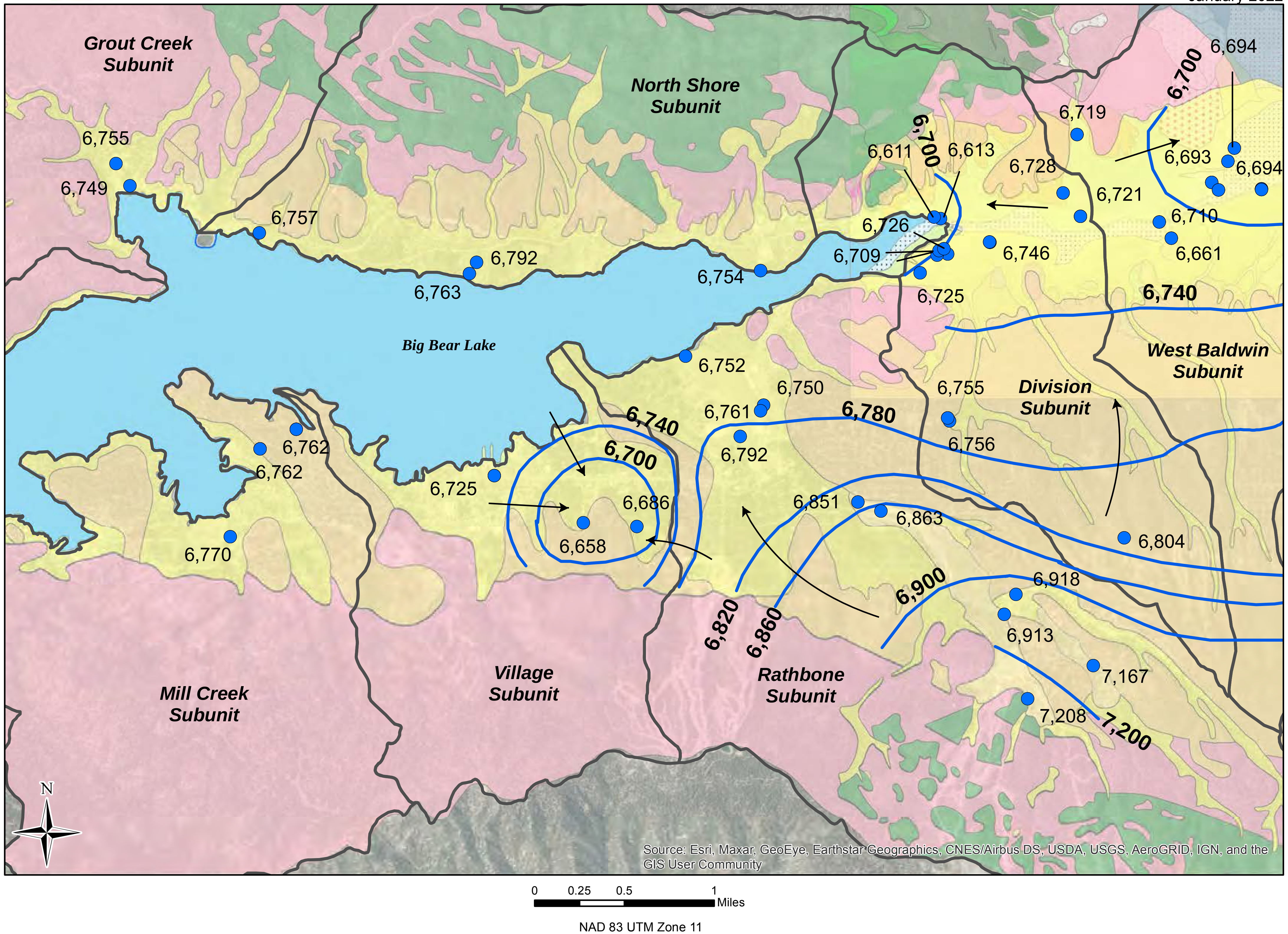
Active Clean Up Sites within the Bear Valley Basin
Figure 2-12

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



Map Features

- Well with Groundwater Elevation (ft amsl)
- 6,700 Groundwater Elevation Contour (ft amsl)
- Groundwater Flow Direction
- Hydrologic Subunit

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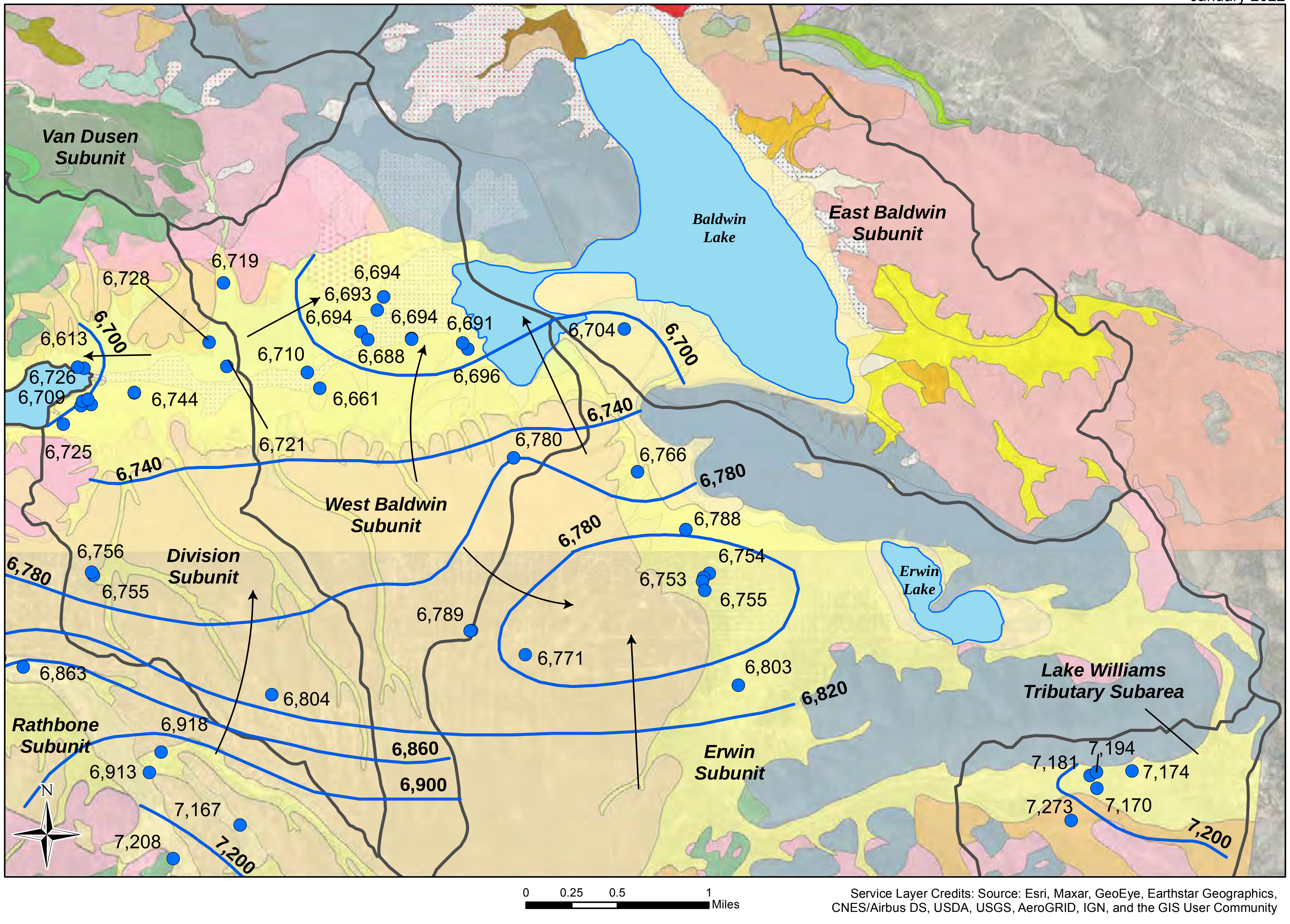
Bear Valley Basin West Spring 2019 Groundwater Elevation Contour Map

Figure 2-13



Map Features

- Well with Groundwater Elevation (ft amsl)
- 6,700 Groundwater Elevation Contour (ft amsl)
- Groundwater Flow Direction
- Hydrologic Subunit

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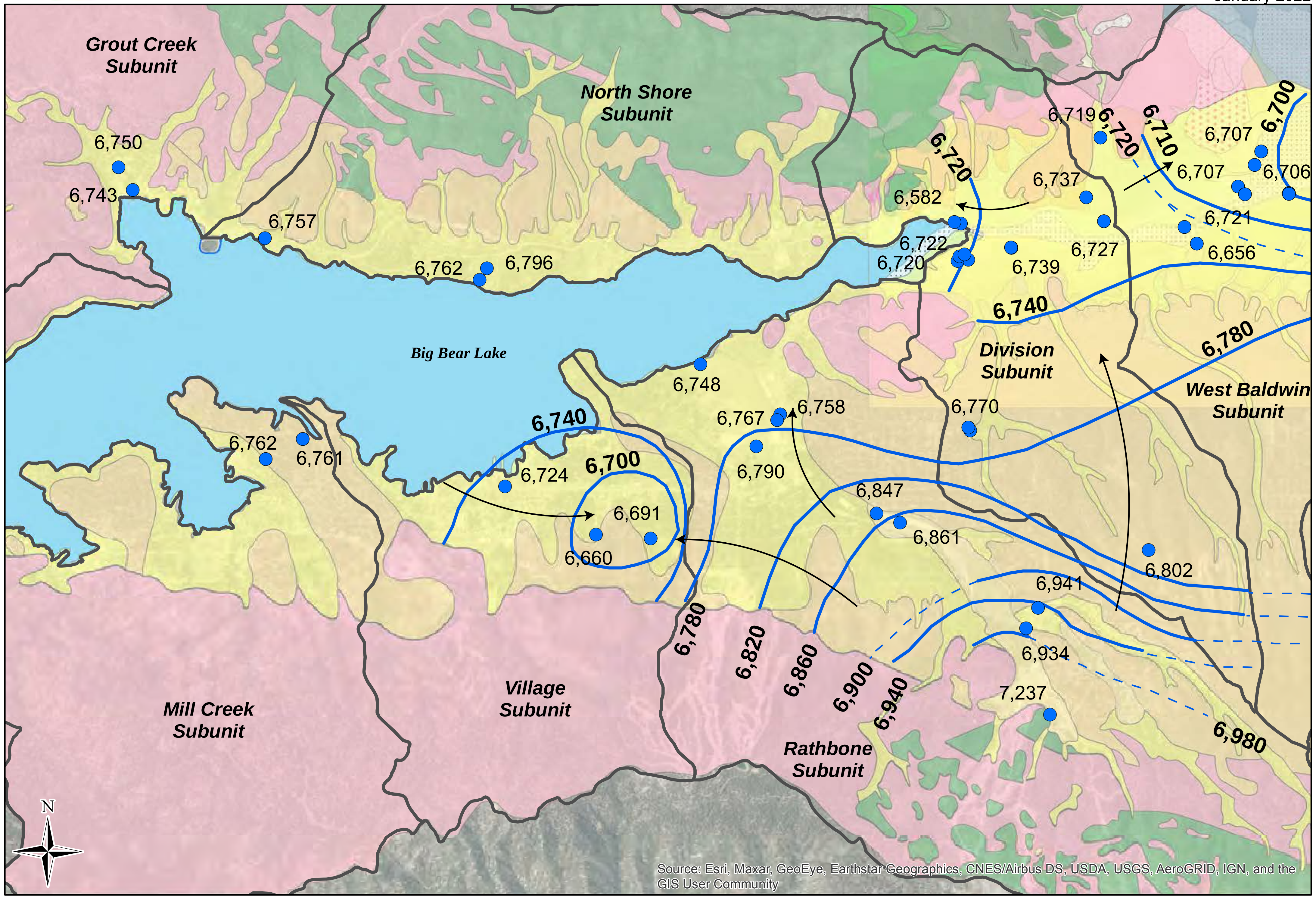
Bear Valley Basin East Spring 2019 Groundwater Elevation Contour Map

Figure 2-14

Bear Valley Basin Groundwater Sustainability Plan

January 2022



0 0.25 0.5 1 Miles

NAD 83 UTM Zone 11

Map Features

- Well with Groundwater Elevation (ft amsl)
- 6,700 Groundwater Elevation Contour (Dashed where approximate)
- Groundwater Flow Direction
- Hydrologic Subunit

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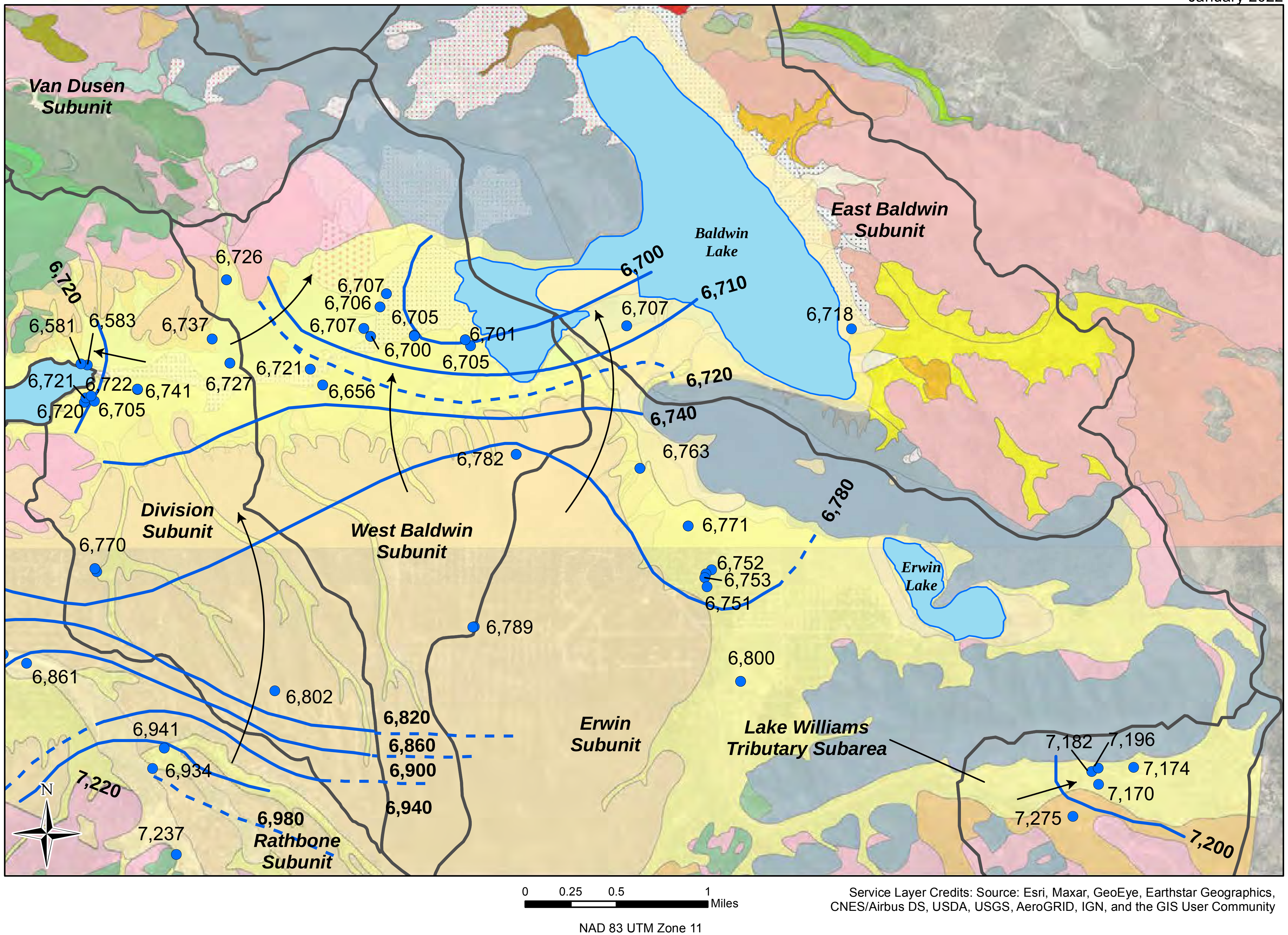
Bear Valley Basin West Fall 2019 Groundwater Elevation Contour Map

Figure 2-15

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map Features

- Well with Groundwater Elevation (ft amsl)
- 6,700 Groundwater Elevation Contour (Dashed where approximate)
- Groundwater Flow Direction
- Hydrologic Subunit

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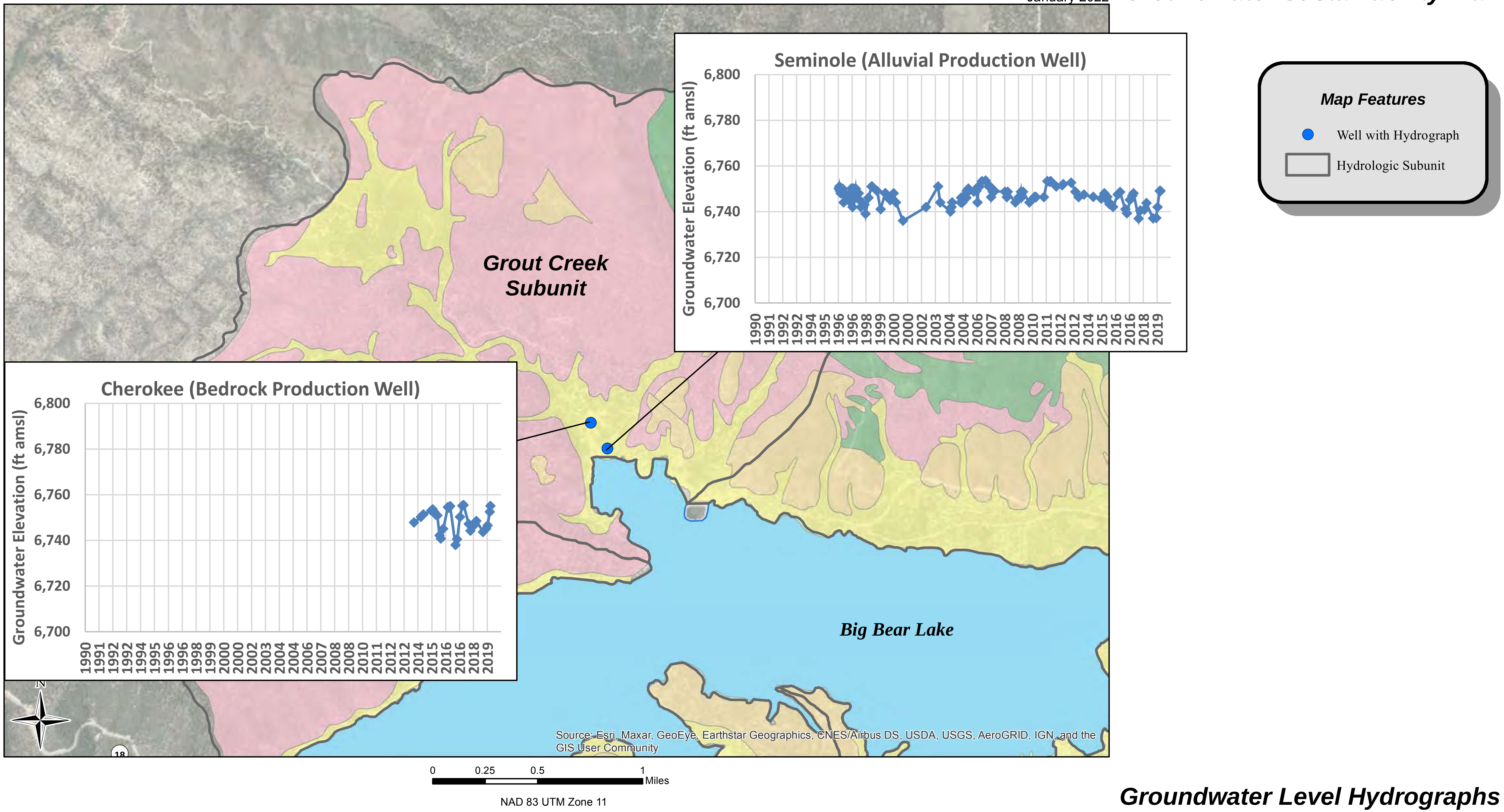
Bear Valley Basin East Fall 2019 Groundwater Elevation Contour Map

Figure 2-16



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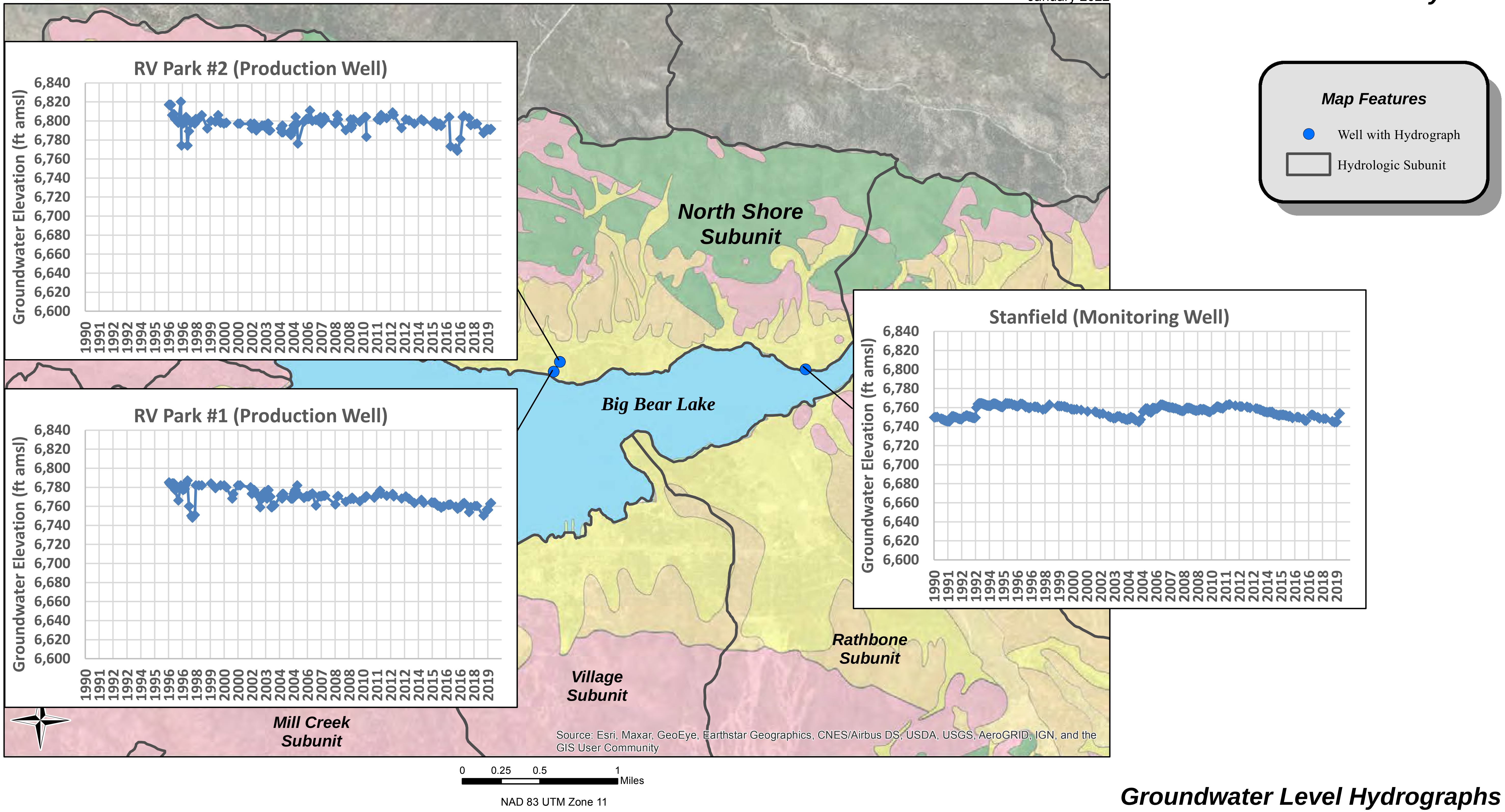
Groundwater Level Hydrographs
Grout Creek Subunit

Figure 2-17



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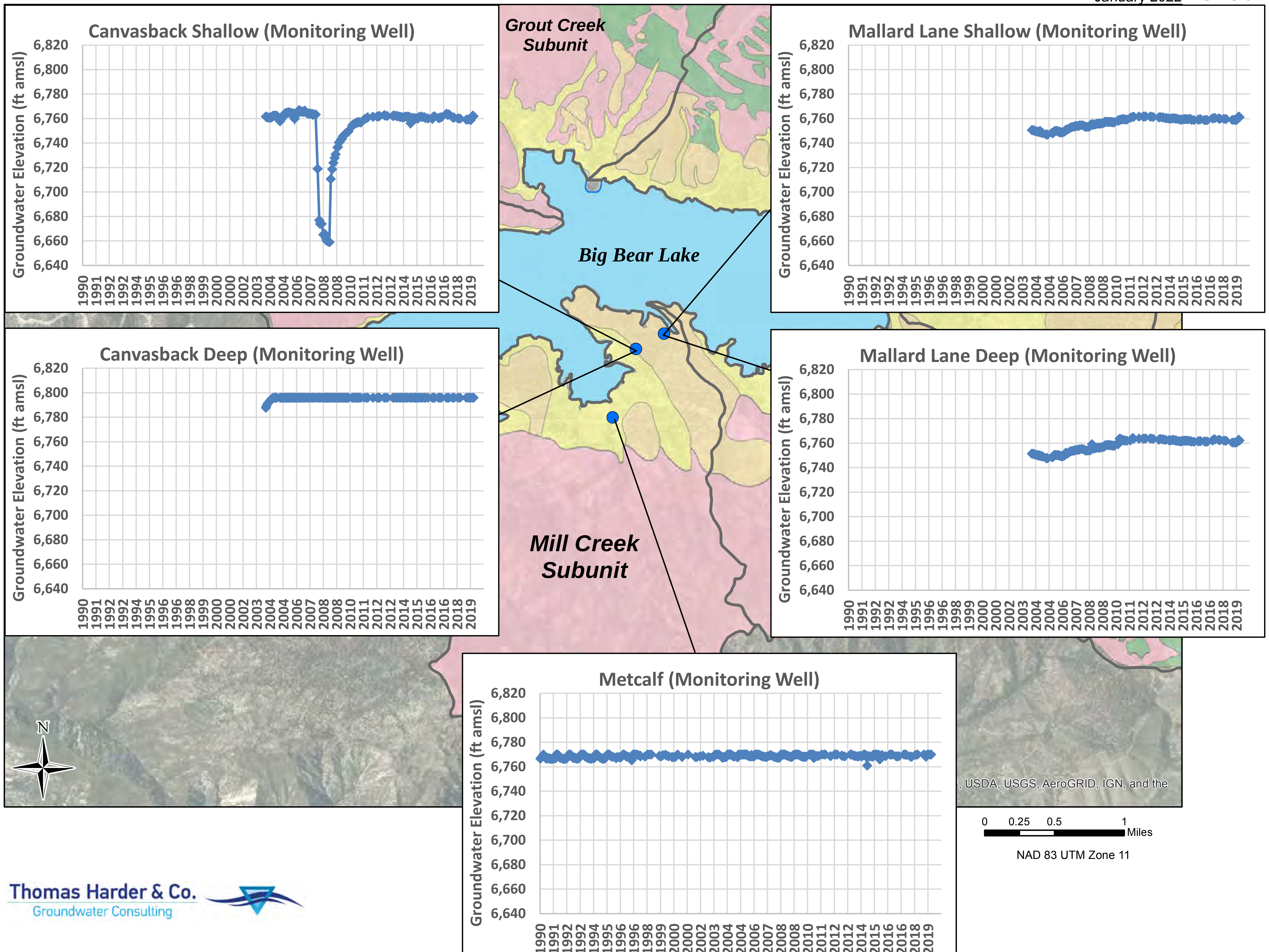
Groundwater Level Hydrographs
North Shore Subunit

Figure 2-18

Bear Valley Basin Groundwater Sustainability Plan

January 2022



Map Features

Well with Hydrograph

Hydrologic Subunit Boundary

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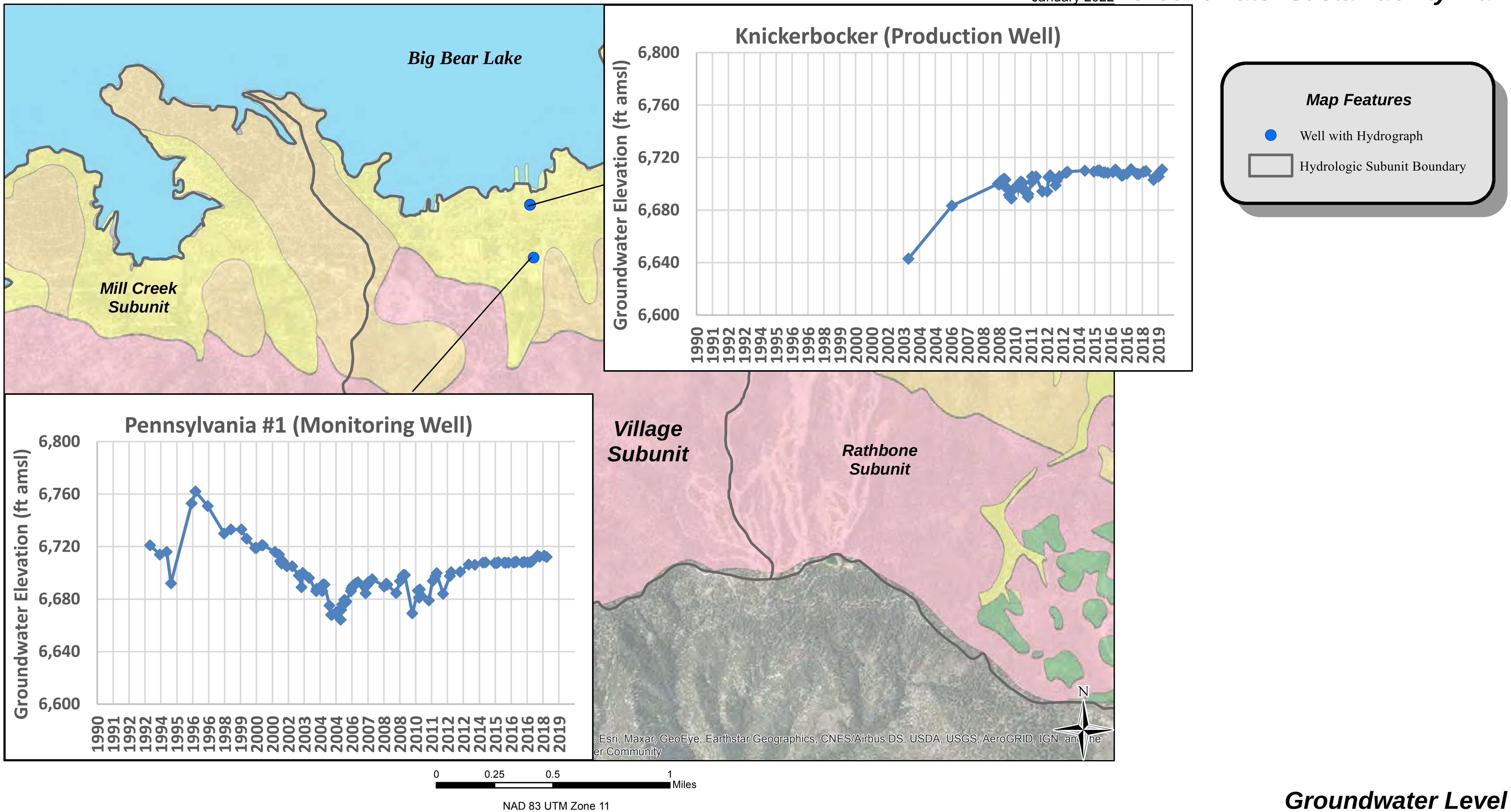
Groundwater Level Hydrographs Mill Creek Subunit

Figure 2-19



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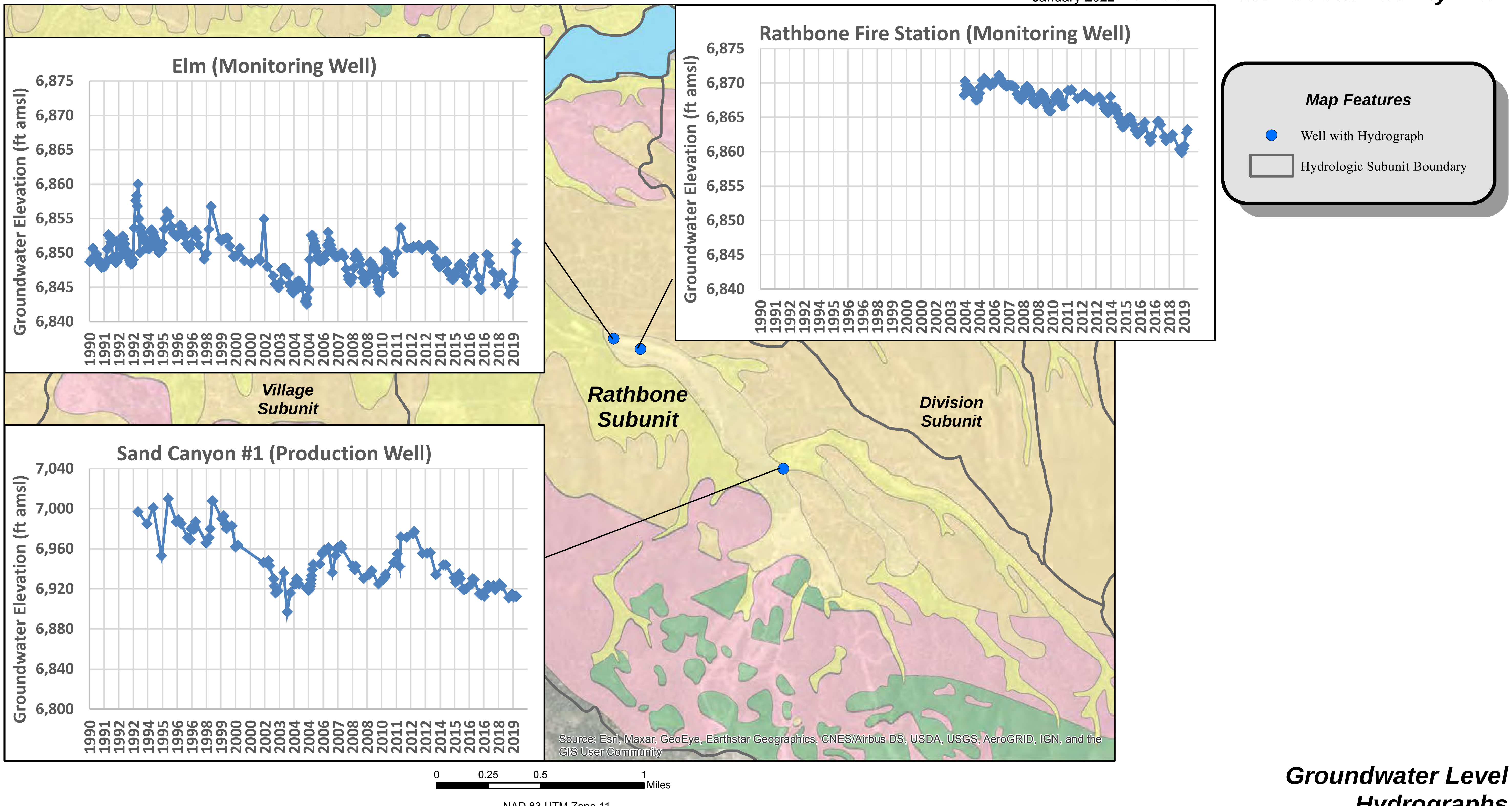
Groundwater Level Hydrographs - Village Subunit

Figure 2-20



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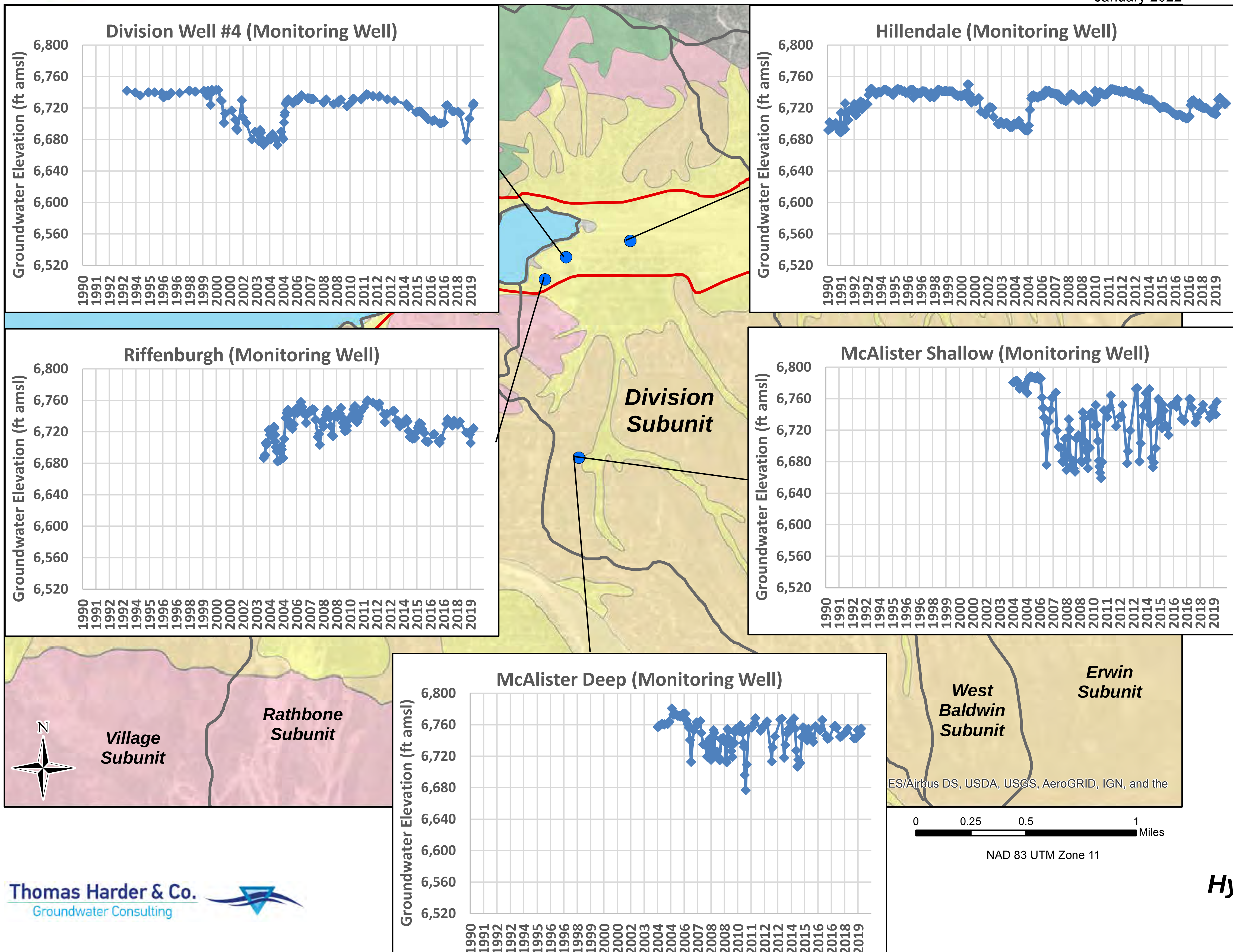
Groundwater Level Hydrographs Rathbone Subunit

Figure 2-21



Map Features

- Well with Hydrograph
- Hydrologic Subunit Boundary
- Highway

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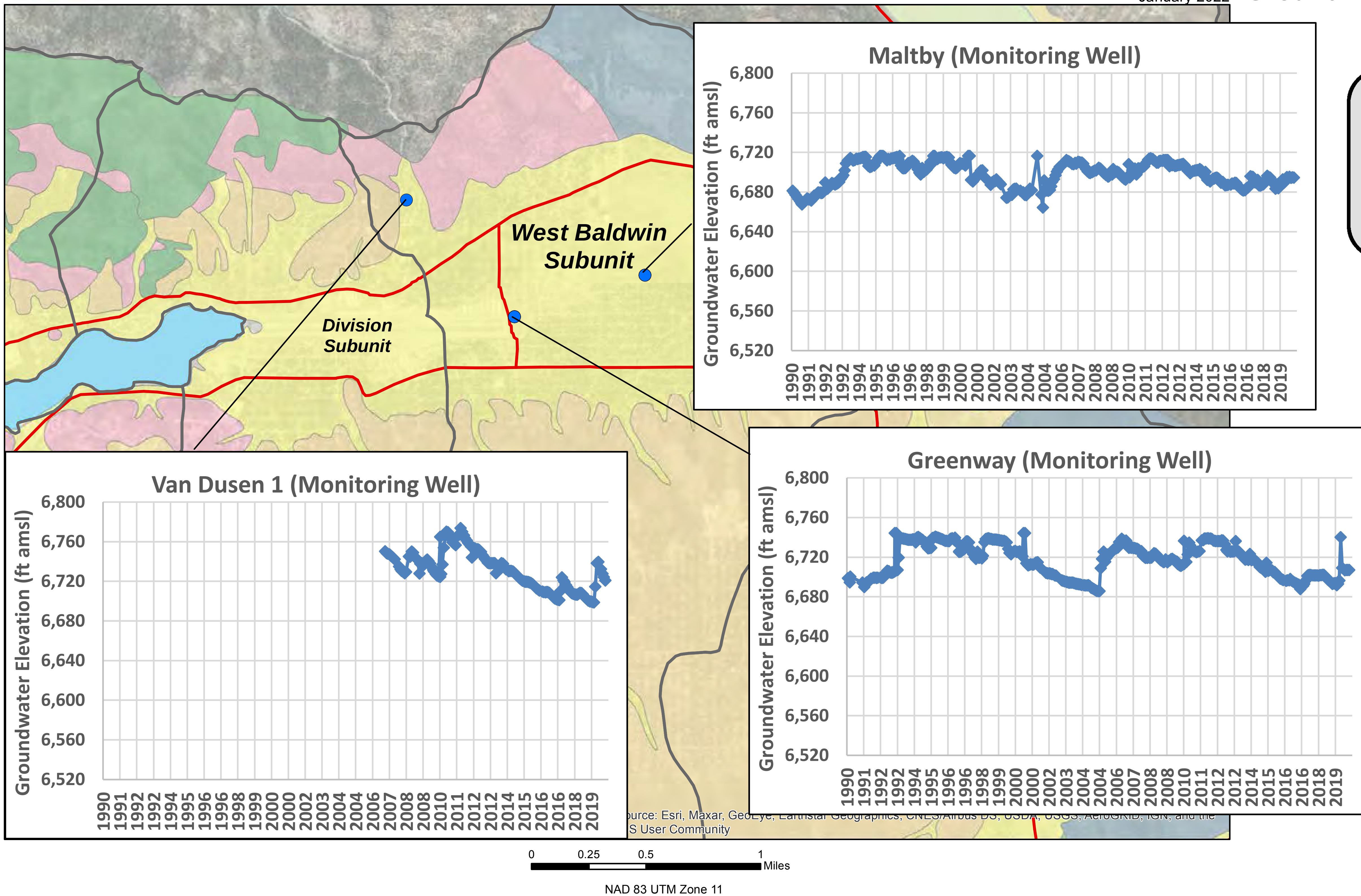
Groundwater Level Hydrographs - Division Subunit

Figure 2-22

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



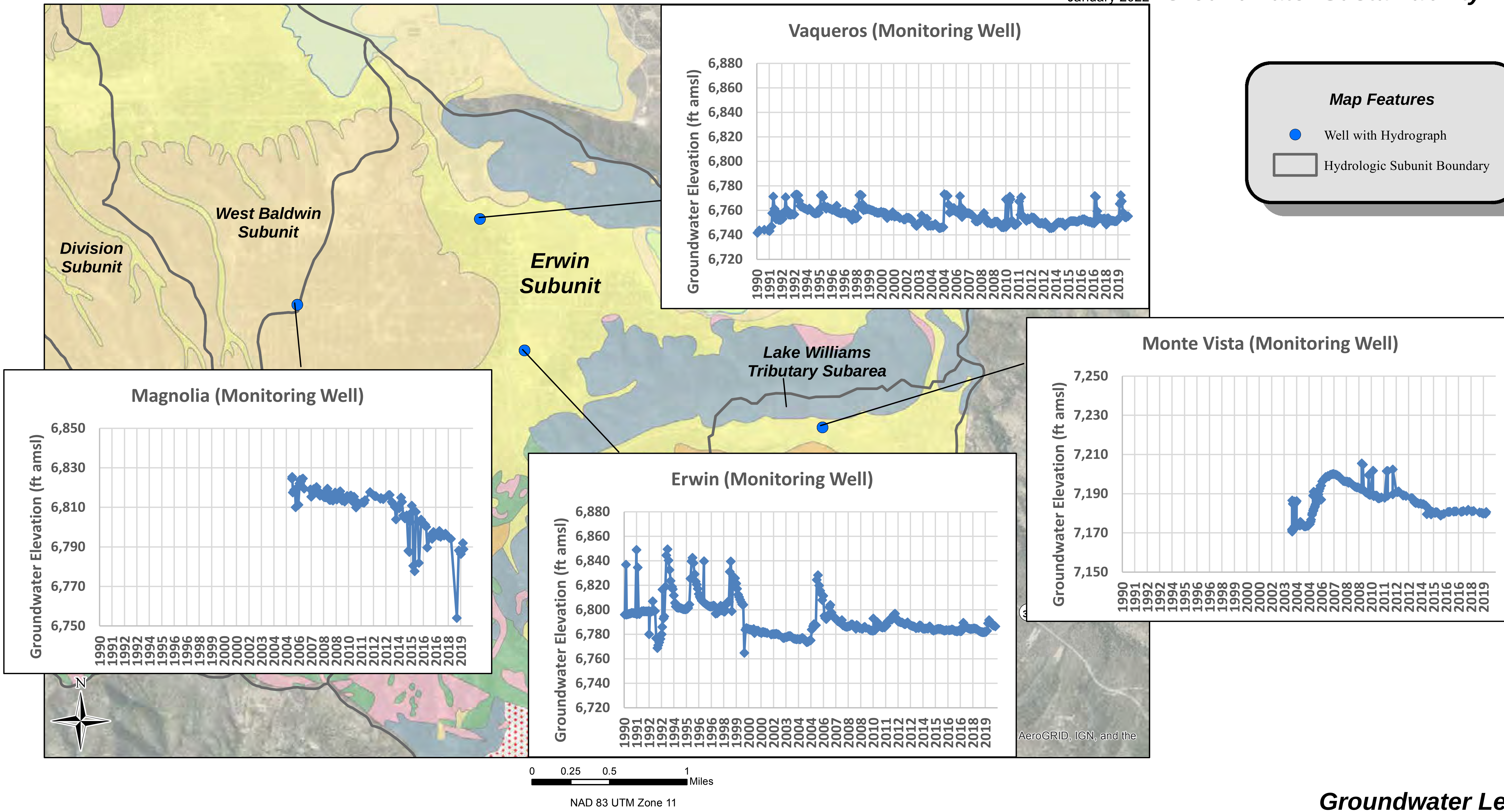
Map Features

- Well with Hydrograph
- Hydrologic Subunit Boundary
- Highway

Thomas Harder & Co.
Groundwater Consulting

Groundwater Level Hydrographs
West Baldwin Subunit

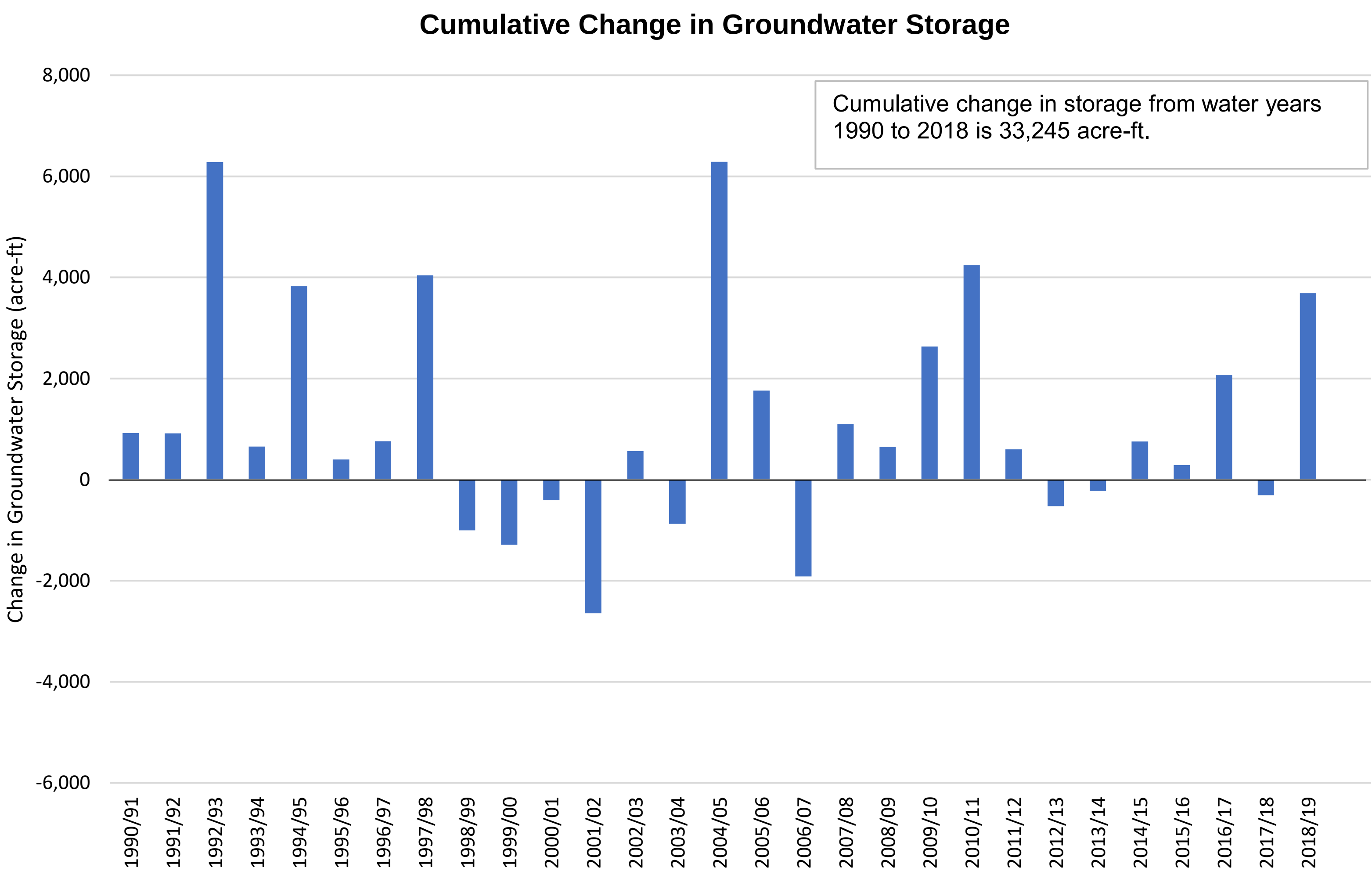
Figure 2-23



Thomas Harder & Co.
Groundwater Consulting

Groundwater Level
Hydrographs - Erwin Subunit
Figure 2-24

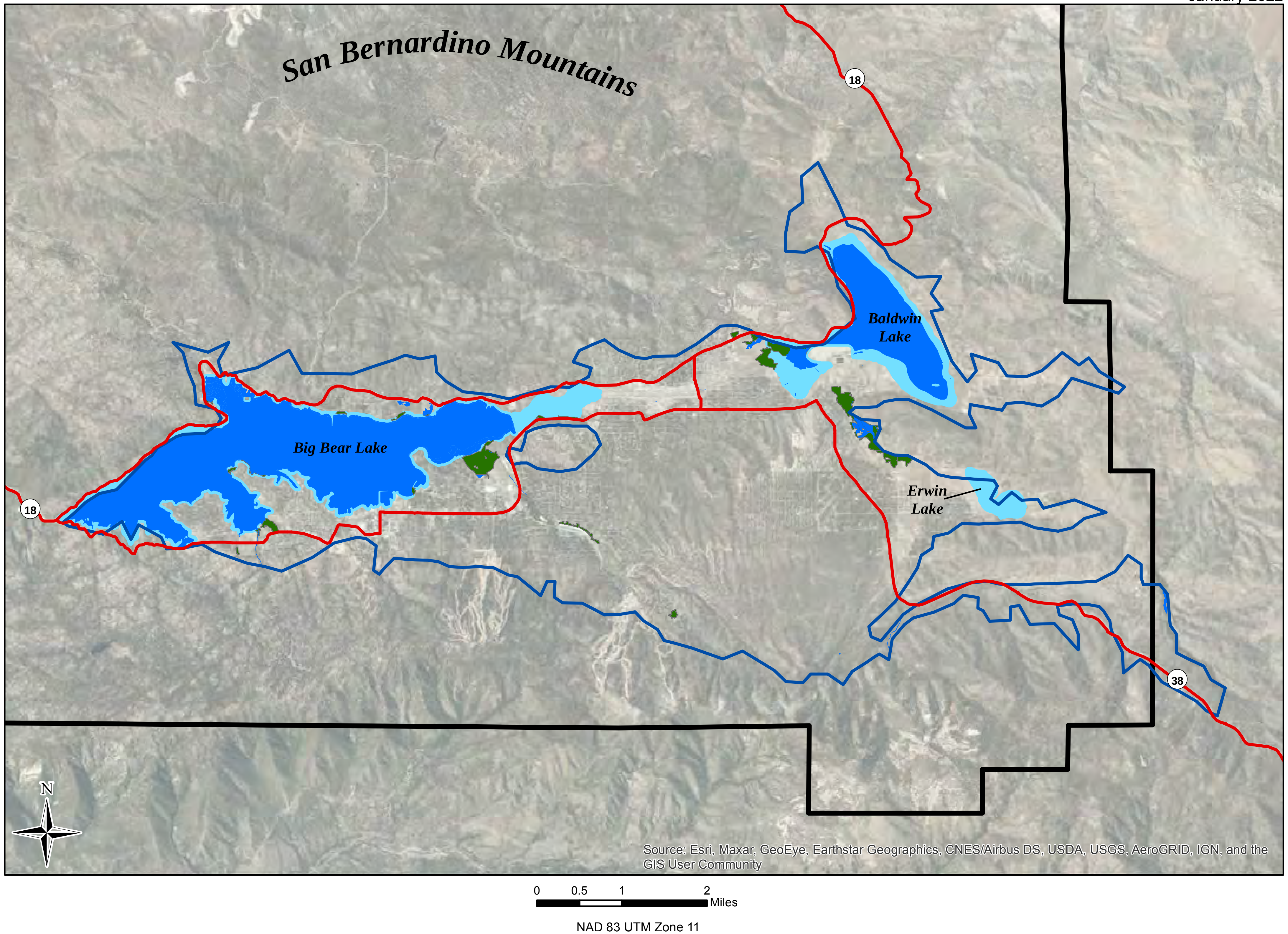
Figure 2-25



Note: Data in water years (October 1 to September 30).

Bear Valley Basin
Groundwater Sustainability Plan

January 2022



Map Features

- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)
- Bear Valley Basin Groundwater Sustainability Agency Boundary
- Groundwater Sourced Wetlands
- Groundwater Dependent Vegetation (Phreatophytes)
- Highway

Groundwater Dependent Ecosystem Data Source:

Natural Communities Commonly Associated with Groundwater Dataset - DWR

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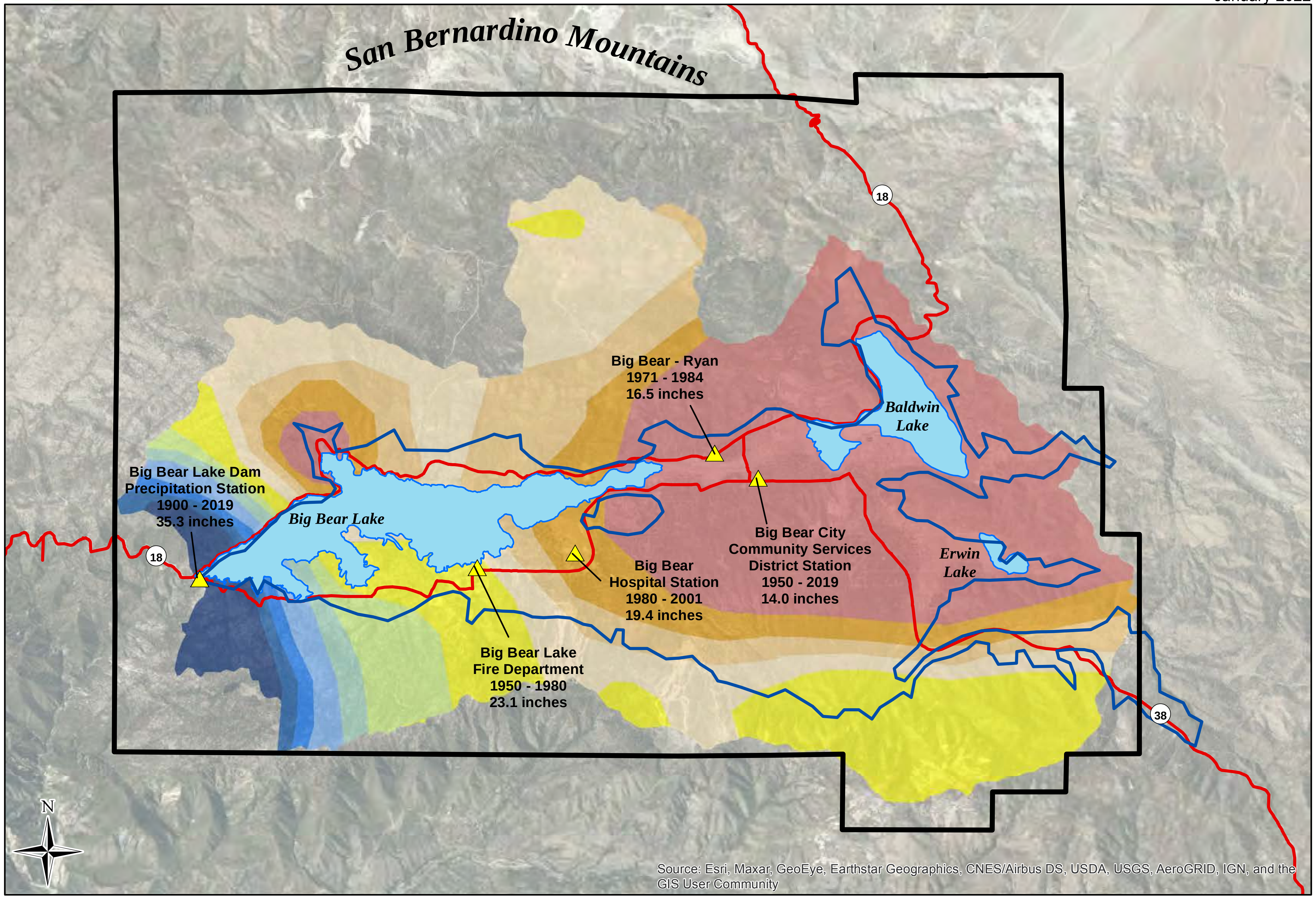
Bear Valley Basin Groundwater Dependent Ecosystems

Figure 2-26



0 0.5 1 2 Miles

NAD 83 UTM Zone 11

Map Features

Average Annual Precipitation (inches)

- 31 - 34
- 30 - 31
- 29 - 30
- 28 - 29
- 27 - 28
- 23 - 26
- 22 - 23
- 21 -2 2
- 20 - 21
- 19 - 20
- 10 - 19
- Precipitation Station, Period of Record, Average Annual Precipitation (Inches per Water Year)
- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)
- Bear Valley Basin Groundwater Sustainability Agency Boundary
- Highway

Notes: Precipitation station data from Big Bear Municipal Water District, San Bernardino County Department of Public Works - Flood Control District, and California Irrigation Management Information System.

Average Annual Precipitation Zones modified from the INFIL v3 model USGS 2012 Geohydrology of Big Bear Valley, California, Scientific Investigation Report 2012-5100.

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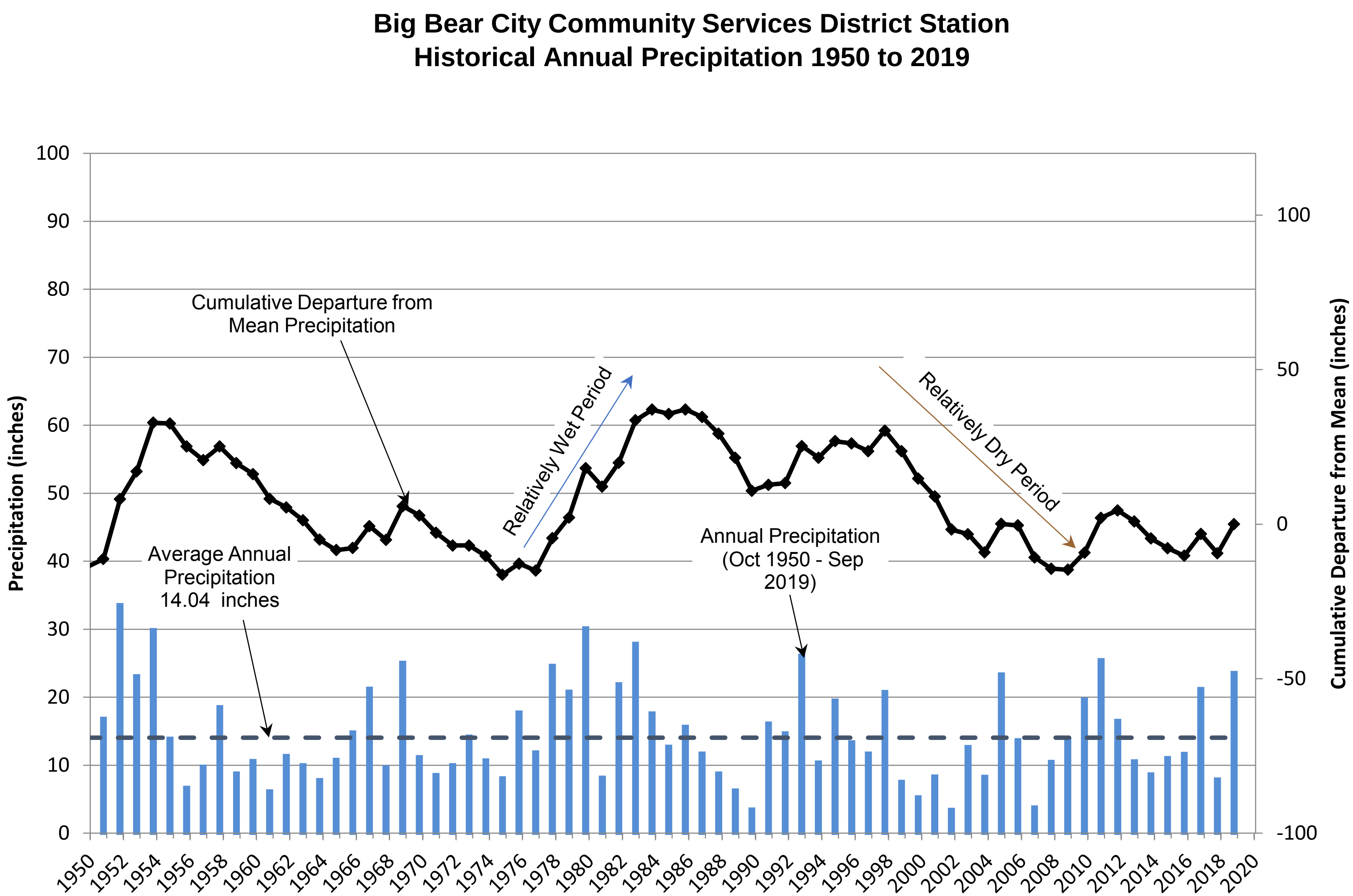
Isohyetal Map

Figure 2-27

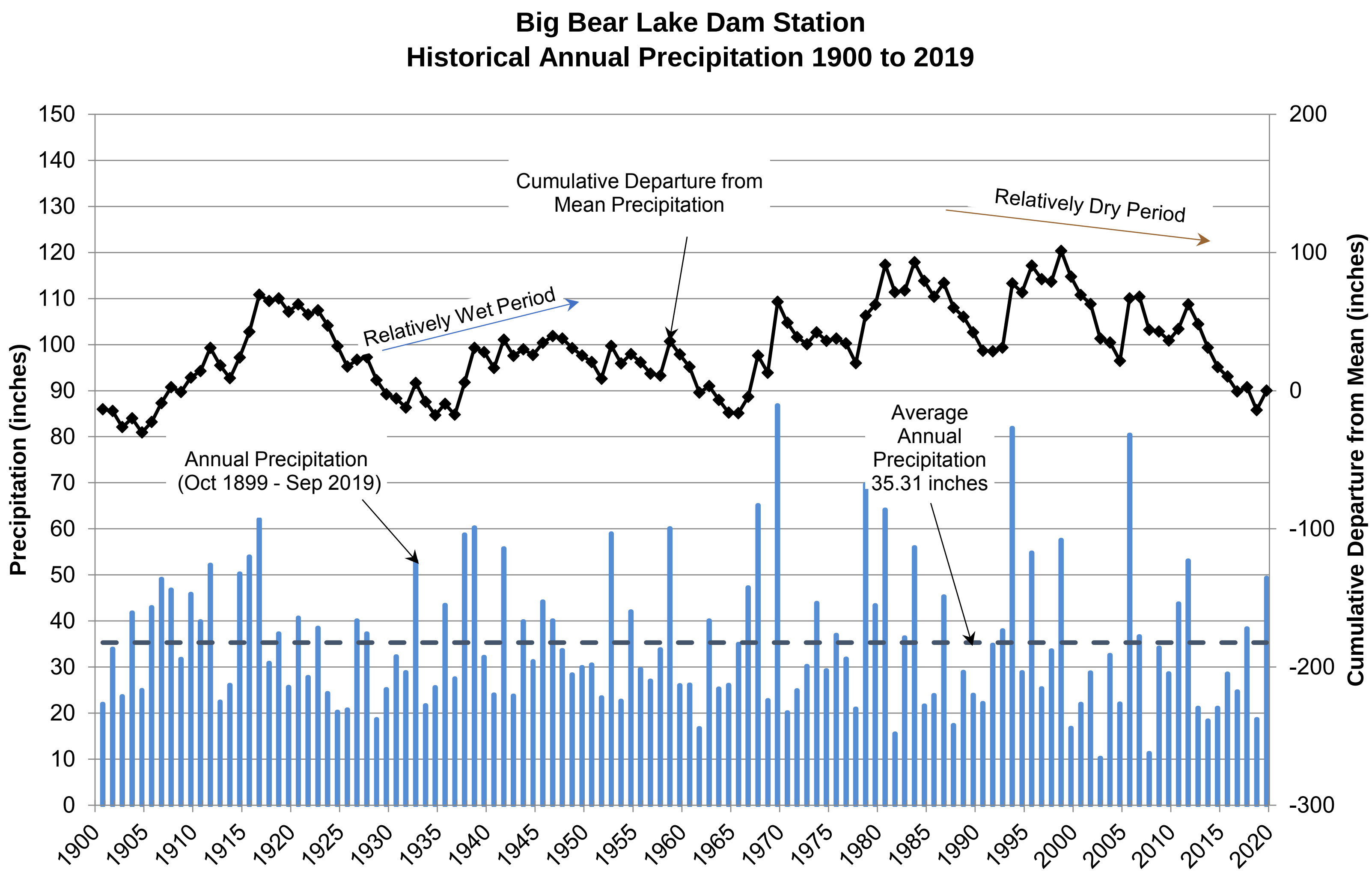
Figure 2-28



Data from San Bernardino County Department of Public Works.

* Data updated as of September 2019.

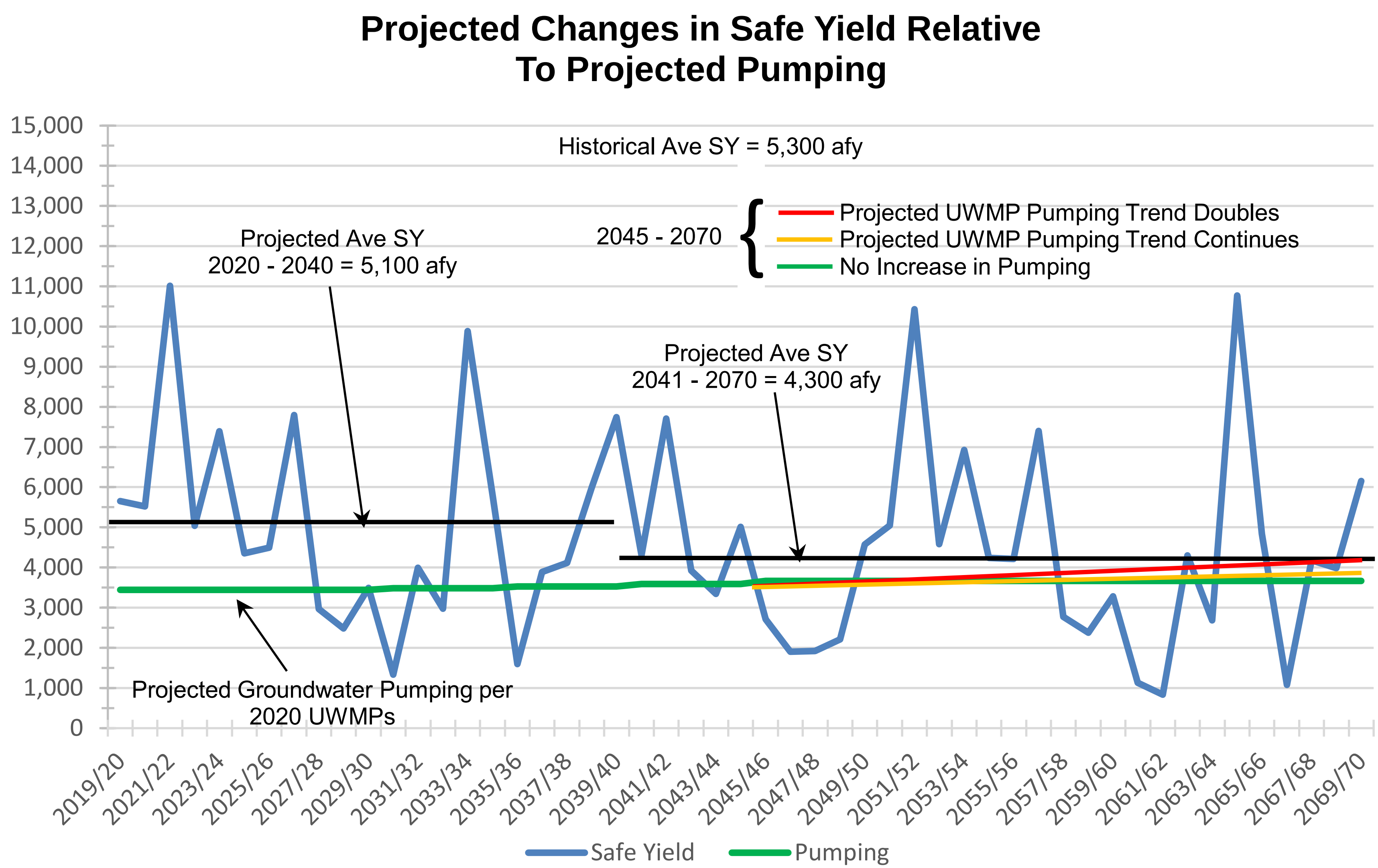
* Annual data for water years, October 1 through September 30.



Data from Big Bear Municipal Water District, Accessed May 2020. (https://www.bbmwd.com/historical-lake-levelprecip)

* Data updated as of September 2019.

* Annual data for water years, October 1 through September 30.


Projected Changes in Safe Yield Relative
To Projected Pumping
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Historical Ave SY = 5,300 afy
Projected Ave SY
2020 - 2040 = 5,100 afy
2045 - 2070
Projected UWMP Pumping Trend Doubles
Projected UWMP Pumping Trend Continues
No Increase in Pumping
Projected Ave SY
2041 - 2070 = 4,300 afy
Projected Groundwater Pumping per
2020 UWMPs
2019/20
2021/22
2023/24
2025/26
2027/28
2029/30
2031/32
2033/34
2035/36
2037/38
2039/40
2041/42
2043/44
2045/46
2047/48
2049/50
2051/52
2053/54
2055/56
2057/58
2059/60
2061/62
2063/64
2065/66
2067/68
2069/70
Safe Yield
Pumping

Map Features

Monitoring Well

- BBCCSD
- BBLDWP
- RMS Well
- Management Areas
- Bear Valley Groundwater Basin (DWR Bulletin 118, Rev. 2018)

0 0.5 1 2 Miles

NAD 83 UTM Zone 11

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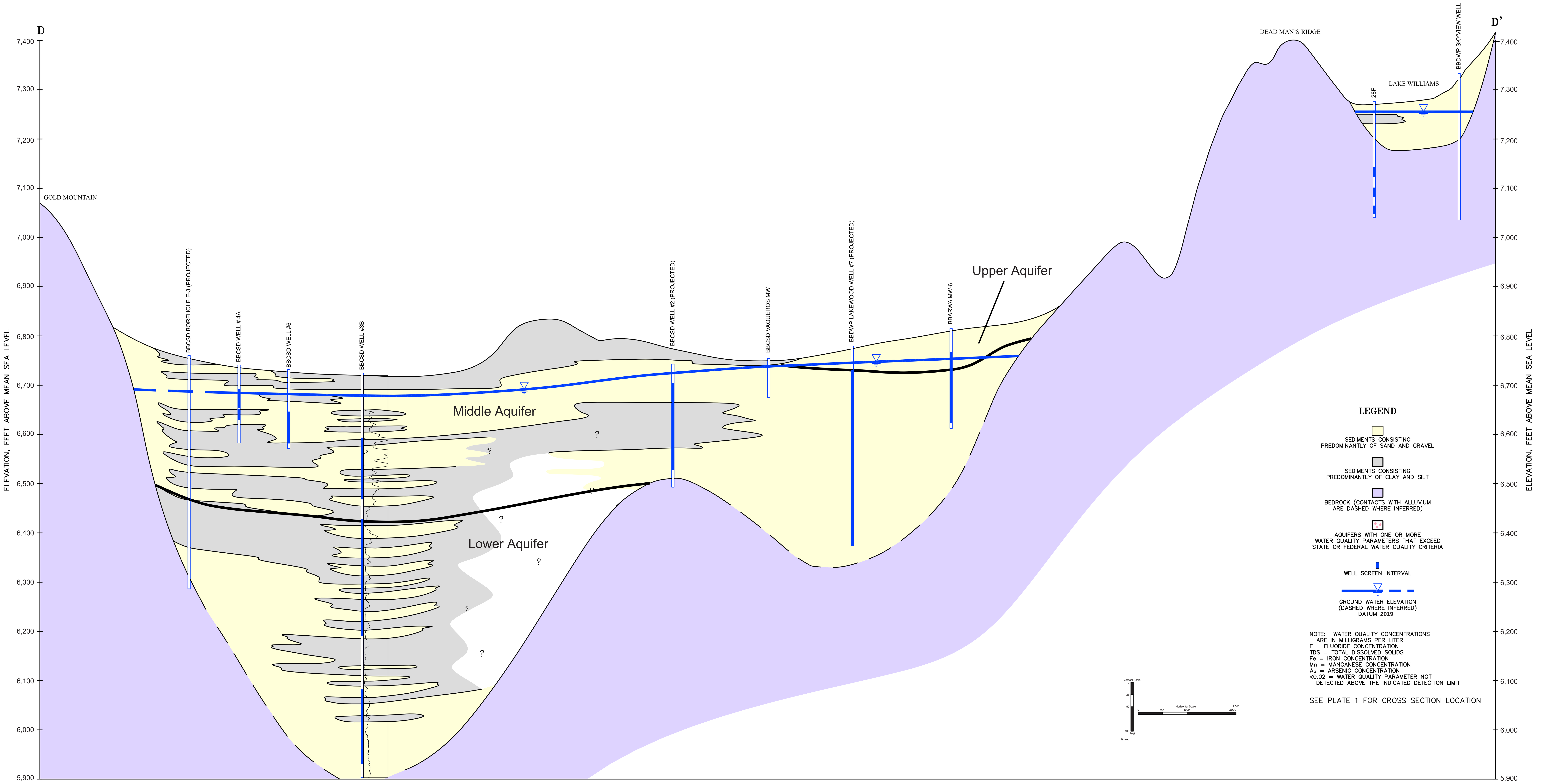
Groundwater Consulting

Bear Valley Basin
Monitoring Network
Figure 2-31

Bear Valley Basin
Basin Setting

Hydrogeologic Cross Section A-A'

Plate 1
January 2022



Hydrogeologic Cross Section B-B'

Plate 2

January 2022

3. Sustainable Management Criteria

3.1 Introduction

This section describes the conditions that constitute sustainable groundwater management for the Bear Valley Basin. Sustainable groundwater management will be evaluated in the context of the sustainability goal for the basin and the absence of undesirable results. Undesirable results are evaluated for each of the sustainability indicators specified in SGMA:[2]

- Chronic lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon;
- Reduction of groundwater storage;
- Seawater intrusion;
- Degraded water quality, including the migration of contaminant plumes that impair water supplies;
- Land subsidence that substantially interferes with surface land uses; and
- Depletions of interconnected surface water that have adverse impacts on beneficial uses.

When impacts associated with any one of the sustainability indicators become significant and unreasonable across the basin, it is considered an undesirable result.

It is noted that the Bear Valley Basin is isolated in the San Bernardino Mountains and not in hydrologic connection with any neighboring basins. As such, the sustainable management criteria identified herein will not result in groundwater impacts to other designated groundwater basins identified in CDWR Bulletin 118.

3.2 Sustainability Goal

The sustainability goal of the Bear Valley Basin (BVB) is the absence of undesirable results associated with groundwater pumping through a collaborative, basin-wide program of groundwater management. In adopting this GSP, it is the express goal of the BVBGSA to balance the needs of all groundwater users in the Bear Valley Basin within the sustainable limits of the basin's resources, while maintaining the unique cultural, community, and business aspects of the Bear Valley Basin.

3.3 Process for Establishing Sustainable Management Criteria

The Sustainable Management Criteria (SMC) discussed and established in this Section were developed in consultation with BVBGSA's member agencies, local stakeholders, technical leads,

[2] California Water Code, Division 6, Section 10721; Definitions x. Undesirable Result

and other interested parties. The general process leading up to the development and establishment of these SMC included:

- Reviewing existing hydrogeologic data assembled in the Bear Valley Basin Setting (Section 2).
- Corresponding with BVBGSA members and their staff to identify groundwater levels that would present undesirable results for the Bear Valley Basin and its individual management areas;
- Holding public workshops outlining the process for GSP development, discussing SMC, and providing data and context related to local groundwater-related issues; and
- Soliciting public feedback through public comment, stakeholder surveys, and written correspondence, to gather information on local values, locally relevant groundwater issues, and how local stakeholders might define groundwater conditions that they consider to be undesirable.

3.4 Sustainable Management Criteria

3.4.1 Chronic Lowering of Groundwater Levels

While groundwater levels in the Bear Valley Basin fluctuate seasonally and with prolonged wet and dry hydrologic periods, sustained lowering of groundwater levels below the minimum thresholds in any given management area is considered an undesirable result (see Section 3.4.1.5).

3.4.1.1 Information Used to Establish Measurable Objectives and Minimum Thresholds

Information and data used to establish measurable objectives and minimum thresholds related to groundwater levels included:

- Historical groundwater elevation data measured in wells monitored by BVBGSA managers.
- Information on the constructed depths and perforated intervals of production wells.
- Input from basin managers and stakeholders regarding preferred current and future operational groundwater elevations as well as groundwater levels that potentially could result in significant and unreasonable conditions.

3.4.1.2 Locally Defined Significant and Unreasonable Conditions

Significant and unreasonable groundwater levels in the Basin are those that:

- Reduce the pumping capacity of existing municipal wells to the point that they are no longer adequate to meet water demands.
- Cause significant financial burden to those who rely on the groundwater basin.
- Trigger other SGMA sustainability indicators (e.g. water quality, land subsidence, etc.).

3.4.1.3 Measurable Objectives

In the Bear Valley Basin, groundwater levels in most management areas are currently sustainable with conservation measures and support the water demands of both private and public stakeholders. As such, groundwater level Measurable Objectives have been selected at each Representative Monitoring Site (RMS) at the average 2019 groundwater level at that site. Representative Monitoring Sites are shown on Figure 2-31. Measurable Objectives for each RMS well are shown on Figures 3-1 through 3-10. Sustainable Management Criteria for each RMS well by management area are summarized in Table 3-1.

Groundwater pumping within the Basin, as a whole, has historically been within the Sustainable Yield resulting in relatively stable long-term groundwater levels. While there have periodically been localized groundwater level declines, pumping sustainability has been maintained through changes in pumping distribution between management areas and implementation of conservation measures. The BVBGSA plans to maintain pumping sustainability through continued managed pumping and conservation while allowing for strategic growth of the valley.

3.4.1.4 Interim Milestones

As the recent groundwater conditions are the same as the measurable objective, the interim milestones and measurable objectives are the same at most of the RMS wells (see Figures 3-1 through 3-10). At RMS wells in the Rathbone (Sand Canyon Well), Erwin (Maple Well), and North Shore (RV Park Well No.1), allowance is made for slightly lower interim milestones to allow for some fluctuation in groundwater levels during the sustainability transition period between 2022 and 2042.

3.4.1.5 Minimum Thresholds

As defined in Section §354.28(c)(1) of the SGMA regulations, "*The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.*" In general, the groundwater level minimum threshold was set, for any given RMS, at the depth/elevation at which it would become difficult for the local water supply municipality to produce groundwater in amounts historically necessary to meet municipal supplies. Minimum Thresholds for each RMS well are shown on Figures 3-1 through 3-10.

Minimum Thresholds are locally defined, in the sense that localized geological, hydrogeological, and hydrological conditions affected their selection. For example, in the Grout Creek Management Area, the Cherokee Well RMS is approximately 600 feet deep and perforated in granitic bedrock. The Seminole Well RMS, on the other hand, is only 65 feet deep and perforated in the alluvial aquifer. Even though these RMS wells are only 550 feet apart, their Minimum Threshold groundwater elevations are significantly different due to differences in well construction and source aquifers (it is noted that the Cherokee Well is the only RMS in the Bear Valley GSP that is constructed in bedrock).

Each management area is relatively distinct hydrologically and, in most cases, hydrogeologically. Accordingly, Minimum Threshold exceedances in one area are not anticipated to contribute to Minimum Threshold exceedances in neighboring management areas. In those cases where groundwater level impacts are determined to extend across multiple management areas, groundwater pumping distribution can be adjusted to mitigate the impacts.

3.4.1.6 Relationship of Groundwater Level Sustainable Management Criteria to Other Sustainability Indicators

Groundwater elevation SMC can influence the other sustainability indicators.

Change in groundwater storage. Changes in groundwater elevations result in changes in the amount of groundwater in storage. Pumping at or less than the Sustainable Yield will maintain average groundwater elevations in the basin. The goal of the BVBGSA is to maintain average groundwater elevations near the measurable objectives but above the minimum thresholds through the SGMA 50-year planning horizon, consistent with the practice of pumping at or less than the sustainable yield. As groundwater elevations provide an indication of groundwater in storage, maintenance of these levels will not result in a long term significant or unreasonable depletion of groundwater in storage.

Seawater intrusion. Given the Bear Valley Basin's isolated nature in the San Bernardino Mountains and its physical distance from the ocean, seawater intrusion cannot occur in this area. Accordingly, this sustainability indicator is not applicable to this basin.

Degraded water quality. Maintaining groundwater levels protects against degradation of water quality or exceeding regulatory limits for constituents of concern in supply wells. Fluoride concentrations in the discharge from some wells in the eastern portion of the Bear Valley Basin tend to increase when groundwater levels drop as the contribution of water to the wells comes increasingly from the deeper aquifers where the fluoride concentrations are higher. As such, the groundwater level minimum thresholds that have been selected

for wells in the Bear Valley Basin are protective of high fluoride concentrations in the produced groundwater.

Land Subsidence. A significant and unreasonable condition for subsidence is permanent pumping induced subsidence that substantially interferes with surface land use. Subsidence is caused by dewatering and compaction of clay-rich sediments in response to lowering groundwater levels. Very small amounts of recoverable land surface elevation fluctuations have been reported across the Bear Valley Basin. The groundwater elevation minimum thresholds are set below existing groundwater elevations, which are protective of nonrecoverable land subsidence. Should new subsidence be observed due to lower groundwater elevations, the groundwater elevation minimum thresholds will be raised to avoid this subsidence.

Depletion of interconnected surface water. While there is evidence for a connection between groundwater and some surface water bodies in the Bear Valley Basin under high groundwater conditions, the direct impact of low groundwater levels on the beneficial uses of each water body has not been established. In general, the measurable objectives developed for groundwater levels in the vicinity of surface water bodies in Bear Valley Basin have not resulted in significant and unreasonable conditions in the past. Accordingly, the groundwater level SMC used herein serve as a proxy for this sustainability indicator.

3.4.1.7 Undesirable Results

A lowering of groundwater levels below the Minimum Threshold in any one RMS well within any two management areas (not including the Lake Williams management area) for three consecutive months in any two consecutive years constitutes an undesirable result. Lowering of groundwater levels below the Minimum Threshold in the Lake Williams RMS well will require investigation and increased monitoring to determine the relative impact of the exceedance on the BBDWP's ability to meet municipal water supply demands.

3.4.2 Reductions of Groundwater in Storage

3.4.2.1 Information Used to Establish Measurable Objectives and Minimum Thresholds

Information and data used to establish measurable objectives and minimum thresholds related to groundwater storage included:

- Historical groundwater elevation data measured in wells monitored by BVBGSA managers.

- Information on the constructed depths and perforated intervals of production wells.
- Input from basin managers and stakeholders regarding preferred current and future operational groundwater elevations as well as groundwater levels that potentially could result in significant and unreasonable conditions.

3.4.2.2 Locally Defined Significant and Unreasonable Conditions

A significant and unreasonable reduction in groundwater storage in the basin occurs when:

- The pumping capacity of existing municipal wells is reduced to the point that they are no longer adequate to meet water demands.
- It causes significant financial burden to those who rely on the groundwater basin.
- It triggers other SGMA sustainability indicators (e.g. water quality, land subsidence, etc.).

3.4.2.3 Measurable Objectives

As the groundwater storage of the Basin is directly related to groundwater level conditions, the measurable objectives used for chronic lowering of groundwater levels (see Section 3.4.1.3 herein) are applicable to reduction in groundwater storage. The measurable objective, using the groundwater level proxy, is stable average groundwater levels at 2019 conditions.

3.4.2.4 Interim Milestones

As the groundwater storage of the Basin is directly related to groundwater level conditions, the interim milestones used for chronic lowering of groundwater levels (see Section 3.4.1.4 herein) are applicable to reduction in groundwater storage.

3.4.2.5 Minimum Thresholds

Section §354.28(c)(2) of the SGMA regulations states that "*The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.*"

It has been observed that groundwater levels decline in the Basin during dry years when natural recharge is limited and groundwater production exceeds recharge for that year (see Section 2.2.1 of this GSP). The Bear Valley Basin has successfully sustained groundwater production during many historical dry climatic cycles, each consisting of multiple below normal precipitation years. Although the groundwater storage capacity of the Bear Valley Basin is thought to be relatively small compared to other basins in southern California, as indicated by significant fluctuations in

groundwater levels during wet and dry periods, its exact storage capacity is unknown. A preliminary minimum threshold is established as a depletion of 9,000 acre-ft of groundwater in storage in any two-year period, which is a depletion of approximately the sustainable yield each year over two consecutive years. However, as more data are collected, this minimum threshold may be revised.

3.4.2.6 Undesirable Results

A depletion of storage by more than 9,000 acre-ft in any consecutive two-year period is anticipated to be an undesirable result, as groundwater levels would likely drop below the minimum thresholds in many RMS wells, potentially triggering the impacts described in Section 3.4.1.5, herein.

3.4.3 Seawater Intrusion

Seawater intrusion cannot occur in the Bear Valley Basin due to its location with respect to the Pacific Ocean. The Bear Valley Basin is an isolated mountain groundwater basin located approximately 70 miles inland of the Pacific Ocean (see Figure 2-1). This mountain aquifer system is separated hydraulically from the coastal aquifers that are susceptible to seawater intrusion. Thus, no sustainable management criteria need be established.

3.4.4 Degraded Groundwater Quality

3.4.4.1 Information Used to Establish Measurable Objectives and Minimum Thresholds

Information and data used to establish measurable objectives and minimum thresholds related to groundwater quality included:

- Historical groundwater quality data measured in wells monitored by BVBGSA managers.
- Input from basin managers and stakeholders regarding meeting future water quality standards and addressing portions of the groundwater basin that are currently unusable due to naturally occurring groundwater quality issues.

3.4.4.2 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were assessed based on federal and state mandated drinking water and groundwater quality regulations, public workshops, and discussions with BVBGSA managers. A significant and unreasonable groundwater quality condition occurs when the water produced from one or more municipal supply wells cannot be used for municipal supply because constituents of concern (COCs) exceed drinking water standards that cannot be mitigated through treatment or blending.

3.4.4.3 Measurable Objectives

The quality of the groundwater in Bear Valley Basin is excellent and, except for isolated areas with naturally occurring COCs, meets regulatory requirements for municipal supply. In those areas where naturally occurring COCs occur, local agencies have been able to beneficially use the water through treatment or blending. The measurable objective for groundwater quality in the Bear Valley Basin is to maintain the existing quality and address high concentrations of naturally occurring water COCs through treatment and/or blending.

3.4.4.4 Minimum Thresholds

Section §354.28(c)(2) of the SGMA regulations states that "*The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin*."

The primary beneficial use of the groundwater produced from the Bear Valley Basin is municipal supply. The inability to produce groundwater suitable for municipal supply due to groundwater quality is considered an undesirable result. In keeping with State of California and Federal drinking water regulations, the established maximum contaminant levels (MCLs) for the naturally occurring COCs found in the groundwater basin, as described in Section 2.2.4 of this GSP (i.e. fluoride, arsenic, uranium, and manganese) are also the minimum thresholds, given that the groundwater produced from wells cannot be used for municipal supply if any of COC concentrations exceed their respective MCLs.

Historically, the agencies within the Bear Valley Basin have been able to address COC concentrations by perforating new wells to avoid the constituents, treating the water through wellhead treatment, or blending. Fluoride concentrations in the discharge from some wells in the eastern portion of the Basin tend to go up when groundwater levels drop as the contribution of water to the wells comes increasingly from the deeper aquifers where the fluoride concentrations are higher. As such, the groundwater level minimum thresholds that have been selected for wells in the Basin are protective of high fluoride concentrations in the produced groundwater.

Movement of existing point source contaminant plumes resulting from groundwater production management is not anticipated to occur in the Bear Valley Basin. As groundwater levels are not predicted to change significantly into the future, neither are groundwater flow paths that might change the direction of contaminant plume migration.

3.4.4.5 Undesirable Results

Undesirable results for the water quality of the Bear Valley Basin include the following:

- Any reduction in the existing water quality of the Basin resulting from anthropogenic activity including projects and management actions associated with this GSP,
- An exceedance of the MCL for any COC in the discharge of one or more wells such that the groundwater from that well(s) cannot be treated or blended for municipal supply.

On average during any one year, no groundwater quality minimum threshold shall be exceeded as a direct result of projects or management actions taken as part of GSP implementation.

3.4.5 Land Subsidence

3.4.5.1 Information Used to Establish Measurable Objectives and Minimum Thresholds

Historical InSAR data has not detected permanent, non-recoverable land subsidence in the Bear Valley Basin (see Section 2.2.5 of this GSP). Land subsidence is a gradual settling of the land surface caused by compaction of fine-grained subsurface sediments in areas where the groundwater level has been lowered from groundwater pumping. If groundwater levels are kept low enough for a long enough period of time, the ensuing land subsidence can become permanent (i.e. non-recoverable). The primary sources of information to inform sustainable management criteria for land subsidence in the Bear Valley Basin are Flint and Martin (2012) and the California DWR online InSAR dataset.

3.4.5.2 Locally Defined Significant and Unreasonable Conditions

Land subsidence would become significant and unreasonable within the Bear Valley Basin if it was non-recoverable and caused damage to surface land uses such as roads, buildings or other infrastructure. The most vulnerable areas to future land subsidence are the area of the airport and the Big Bear Village, which are areas where there is thick layers of fine-grained clay sediments underground. However, non-recoverable land subsidence has not been observed in these areas and maintenance of groundwater levels above their respective minimum thresholds will be protective of land subsidence in the future.

3.4.5.3 Measurable Objective

Existing ground surface elevation data do not suggest the occurrence of permanent land subsidence in the Basin. Therefore, the measurable objective for subsidence is maintenance of current ground surface elevations.

3.4.5.4 Minimum Threshold

The minimum threshold for land subsidence in the Bear Valley Basin will be no more than 0.1 foot in any single year and a cumulative of 0.5 foot in any five-year period, as measured between June of one year and June of the subsequent year using InSAR.

3.4.5.5 Undesirable Results

Any pumping induced, non-recoverable land subsidence that causes damage to surface infrastructure or other surface land uses is considered an undesirable result.

3.4.6 Depletion of Interconnected Surface Water

3.4.6.1 Information Used to Establish Measurable Objectives and Minimum Thresholds

The potential for interconnection between surface water and groundwater in the Basin occurs in three different areas:

1. Beneath and at the margins of Big Bear Lake
2. Shay Pond in the Erwin Subunit
3. Natural springs fed by bedrock aquifers in the watershed surrounding the Basin

Studies of the relationship between surface water and groundwater at Big Bear Lake and Shay Pond have been conducted and described in Section 2.2.6 of this GSP. Detailed information regarding the historical flow rate of natural springs has been obtained from BBLDWP and BBCCSD. These data and studies were used to inform the sustainable management criteria for the depletion of interconnected surface water in the Basin.

3.4.6.2 Locally Defined Significant and Unreasonable Conditions

Regarding the connection between groundwater levels and surface water in Big Bear Lake and Shay Pond, while there is evidence for a connection between the two under high groundwater conditions, the direct impact of low groundwater levels on the beneficial uses of each water body has not been established. In general, the measurable objectives developed for groundwater levels in the vicinity of Big Bear Lake and Shay Pond have not resulted in significant and unreasonable conditions in the past. Groundwater and surface water monitoring will be required into the future to determine if groundwater levels approaching the minimum thresholds in these areas has an adverse impact on the surface water bodies.

As the spring flow fed by bedrock aquifers at the margins of the Basin is entirely dependent on precipitation, groundwater pumping does not have an impact on this surface water source.

3.4.6.3 Measurable Objectives

Measurable objectives applicable to depletion of interconnected surface water were not developed for the GSP. If in the future, data from the monitoring program allow for development of a relationship between lowered groundwater levels and their impact on surface water bodies, then measurable objectives specific to this sustainability indicator will be developed. In the meantime, groundwater level measurable objectives will serve as a proxy.

3.4.6.4 Minimum Thresholds

Minimum thresholds applicable to depletion of interconnected surface water were not developed for the GSP. If in the future, data from the monitoring program allow for development of a relationship between lowered groundwater levels and their impact on surface water bodies, then minimum thresholds specific to this sustainability indicator will be developed. In the meantime, groundwater level minimum thresholds will serve as a proxy.

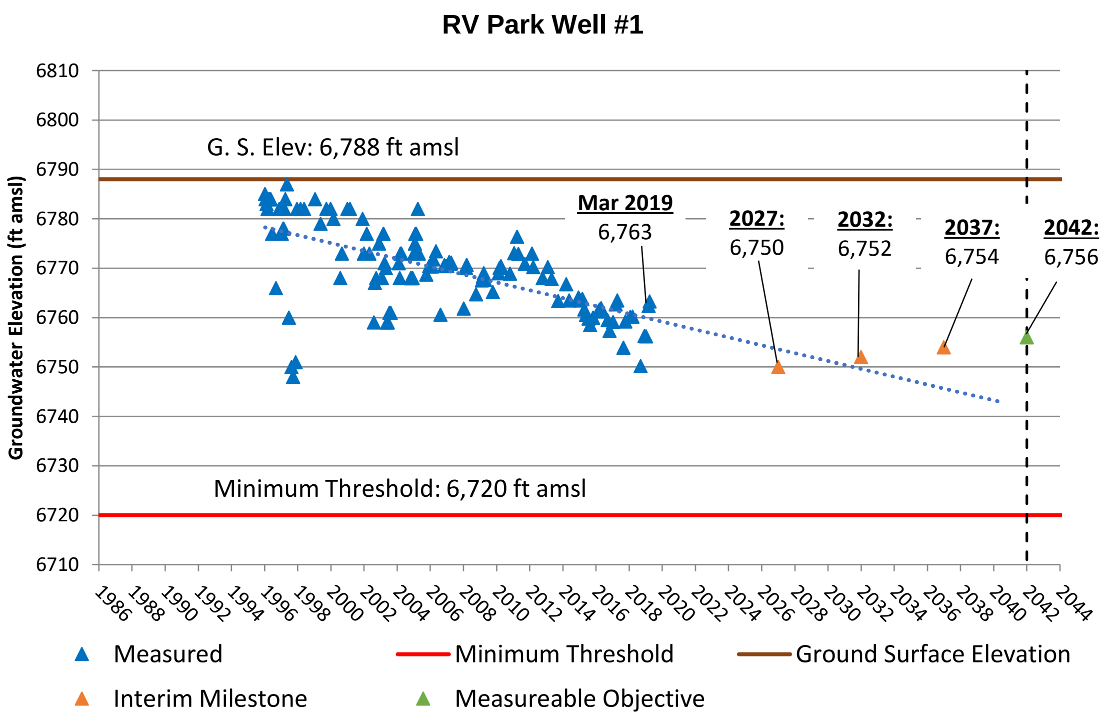
3.4.6.5 Undesirable Results

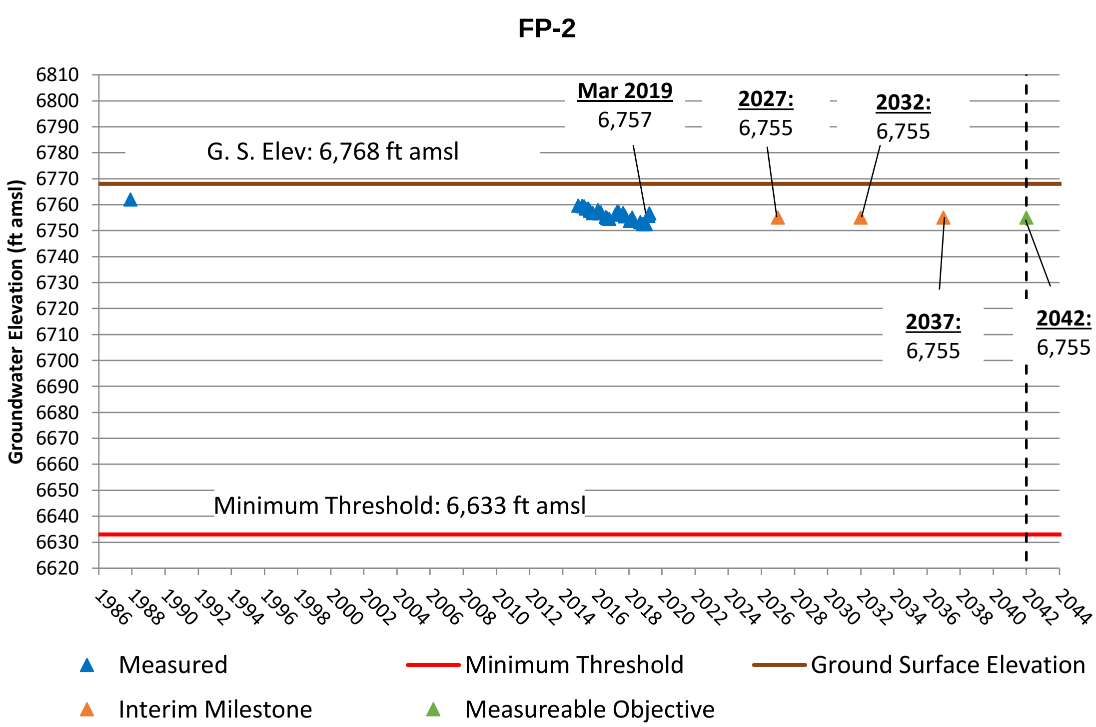
In general, if lowering of groundwater levels in the vicinity of Big Bear Lake and Shay Pond below their historical levels was shown to have a negative impact on the beneficial uses of these water bodies, then that would be considered an undesirable result. Future data collection and monitoring will help quantify the relationship between groundwater levels and surface water levels in these water bodies.

Sustainable Management Criteria at each RMS Well

Watershed	Management Area	RMS Well	Aquifer Monitored	Interim Milestone (GWE (ft amsl))			Measurable Objective (GWE (ft amsl))	Minimum Threshold
				2027	2032	2037	2042	
Big Bear Lake	North Shore	RV Park #1	Middle	6,750	6,752	6,754	6,756	6,756
Big Bear Lake	North Shore	FP-2	Middle	6,755	6,755	6,755	6,755	6,755
Big Bear Lake	Grout Creek	Cherokee Well	Middle	6,745	6,745	6,745	6,745	6,745
Big Bear Lake	Grout Creek	Seminole	Middle	6,745	6,745	6,745	6,745	6,745
Big Bear Lake	Mill Creek	Canvasback Shallow Monitoring Well	Middle	6,730	6,730	6,730	6,730	6,730
Big Bear Lake	Village	Oak Well	N/A	6,690	6,690	6,690	6,690	6,690
Big Bear Lake	Rathbone	Rathbun Well (DWP Yard)	N/A	6,780	6,780	6,780	6,780	6,780
Big Bear Lake	Rathbone	Sand Canyon #1	N/A	6,900	6,905	6,910	6,915	6,915
Big Bear Lake	Division	McAlister Shallow Monitoring Well	Middle	6,730	6,730	6,730	6,730	6,730
Big Bear Lake	Division	Division Well #4	Middle	6,700	6,700	6,700	6,700	6,700
Big Bear Lake	Division	Hillendale Monitoring Well	Middle	6,710	6,710	6,710	6,710	6,710
Baldwin Lake	West Baldwin	Maltby Monitoring Well	Middle	6,694	6,694	6,694	6,694	6,694
Baldwin Lake	West Baldwin	Greenway Monitoring Well	Middle	6,710	6,710	6,710	6,710	6,710
Baldwin Lake	East Baldwin	CSD Well #8	Middle	6,680	6,680	6,680	6,680	6,680
Baldwin Lake	Erwin	Vaqueros Monitoring Well	Middle	6,755	6,755	6,755	6,755	6,755
Baldwin Lake	Erwin	Maple Well	N/A	6,760	6,750	6,750	6,760	6,760
Baldwin Lake	Lake Williams	Monte Vista Monitoring Well	Middle	7,175	7,175	7,175	7,175	7,175

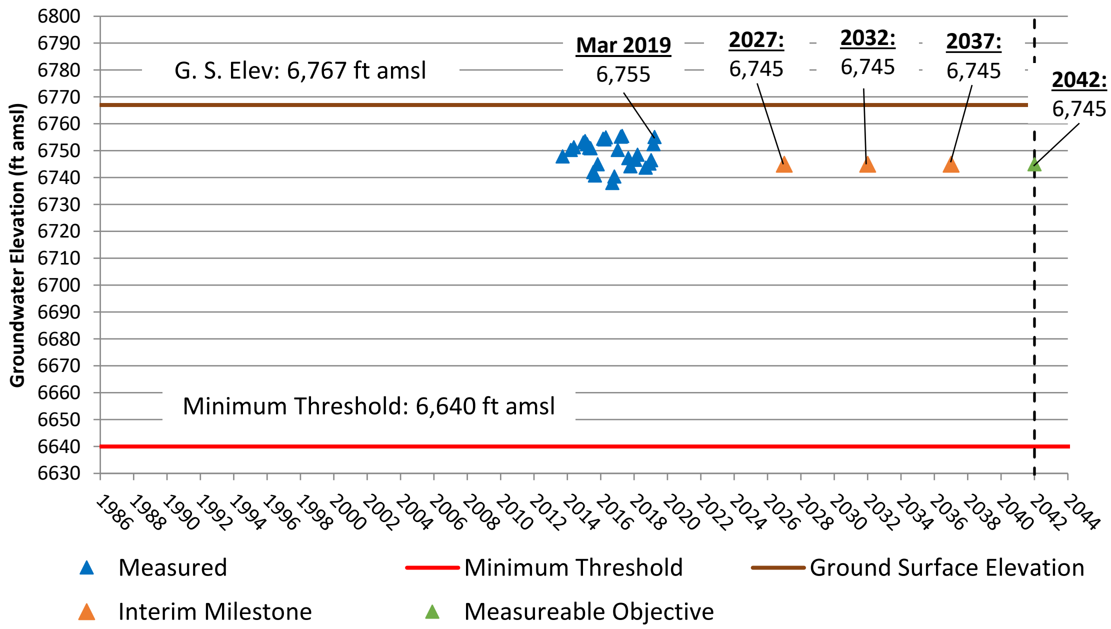
RMS Groundwater Elevation Hydrographs, North Shore



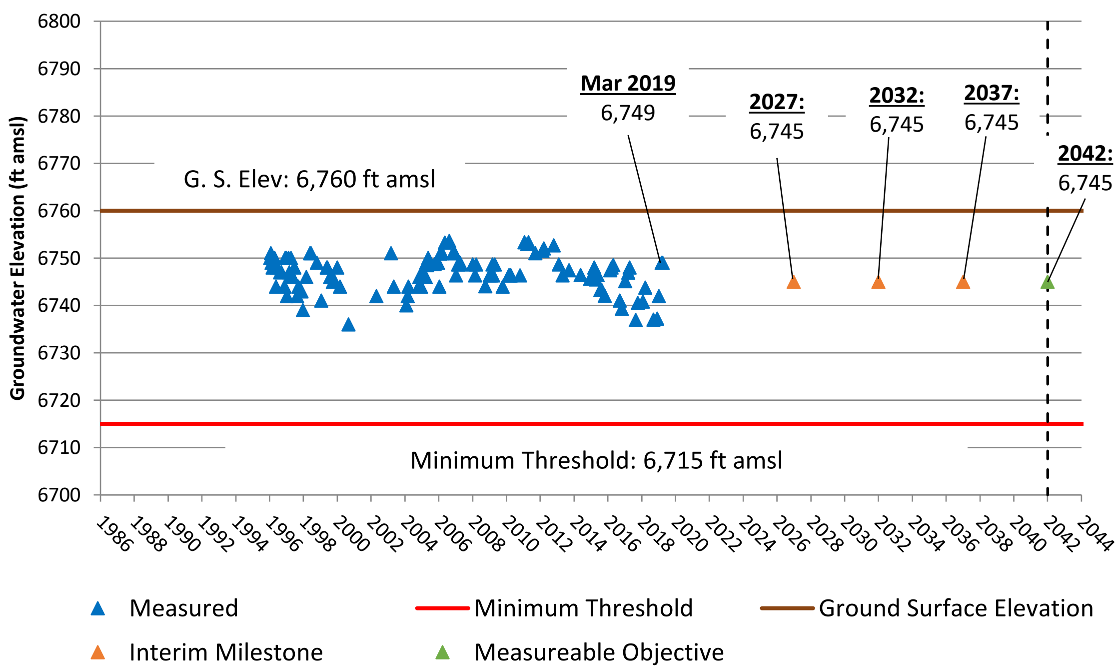


RMS Groundwater Elevation Hydrographs, Grout Creek

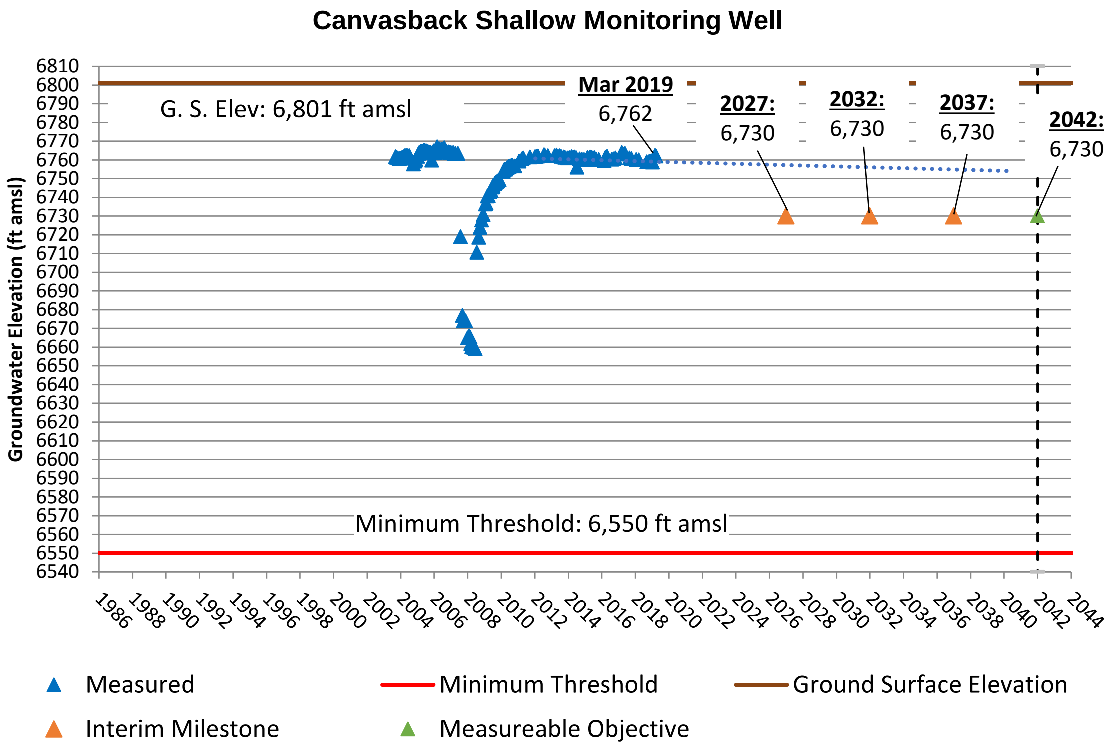
Cherokee Well



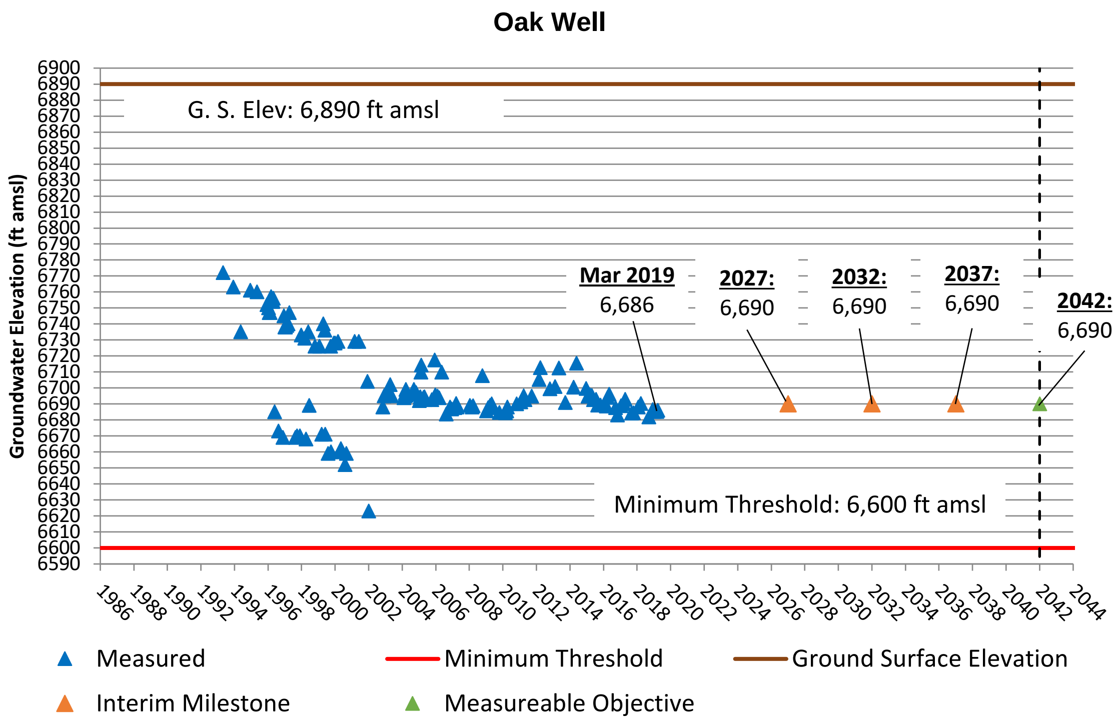
Seminole Well



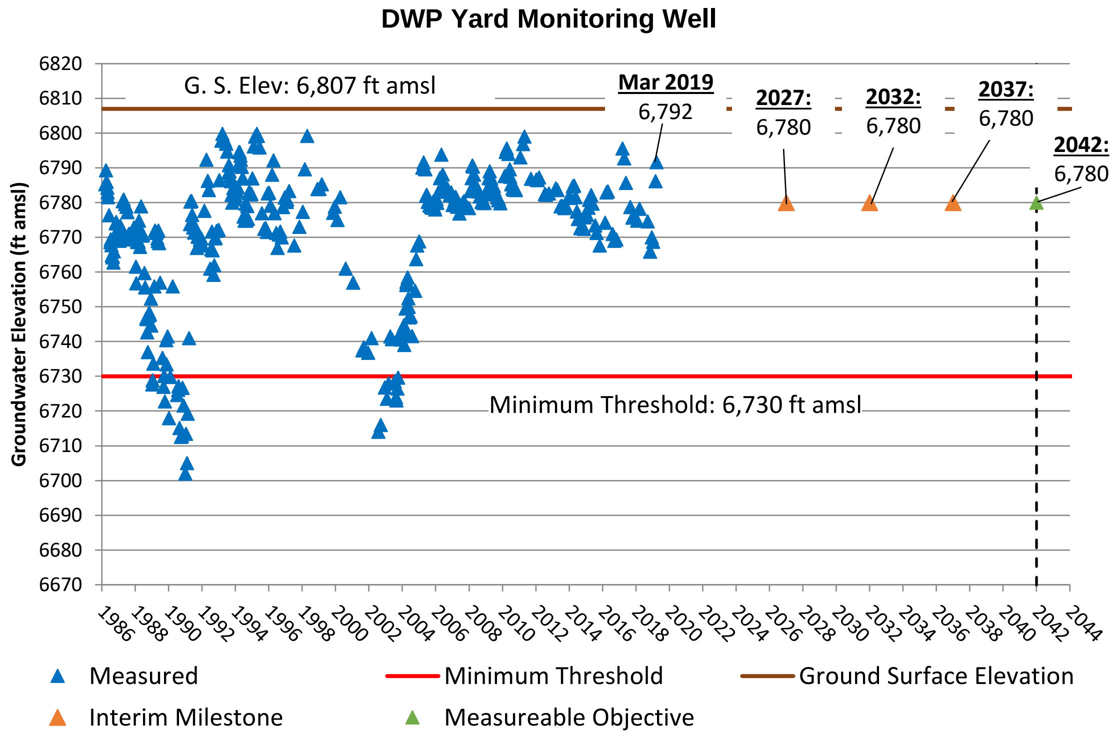
RMS Groundwater Elevation Hydrographs, Mill Creek



RMS Groundwater Elevation Hydrographs, Village



RMS Groundwater Elevation Hydrographs, Rathbone



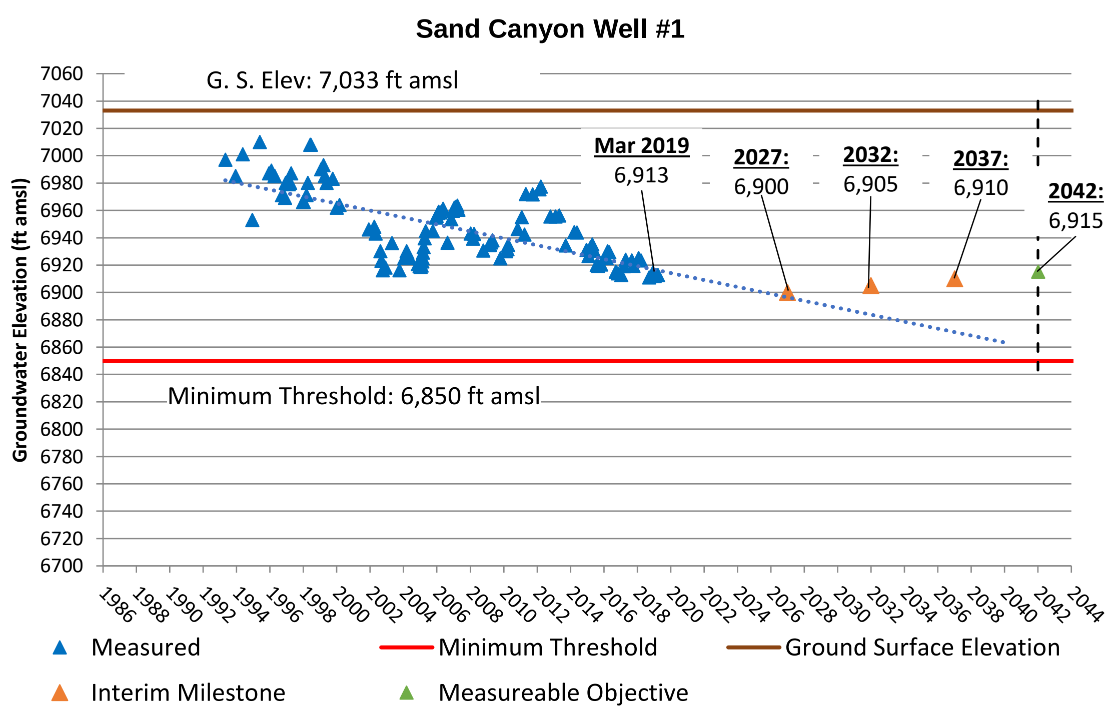
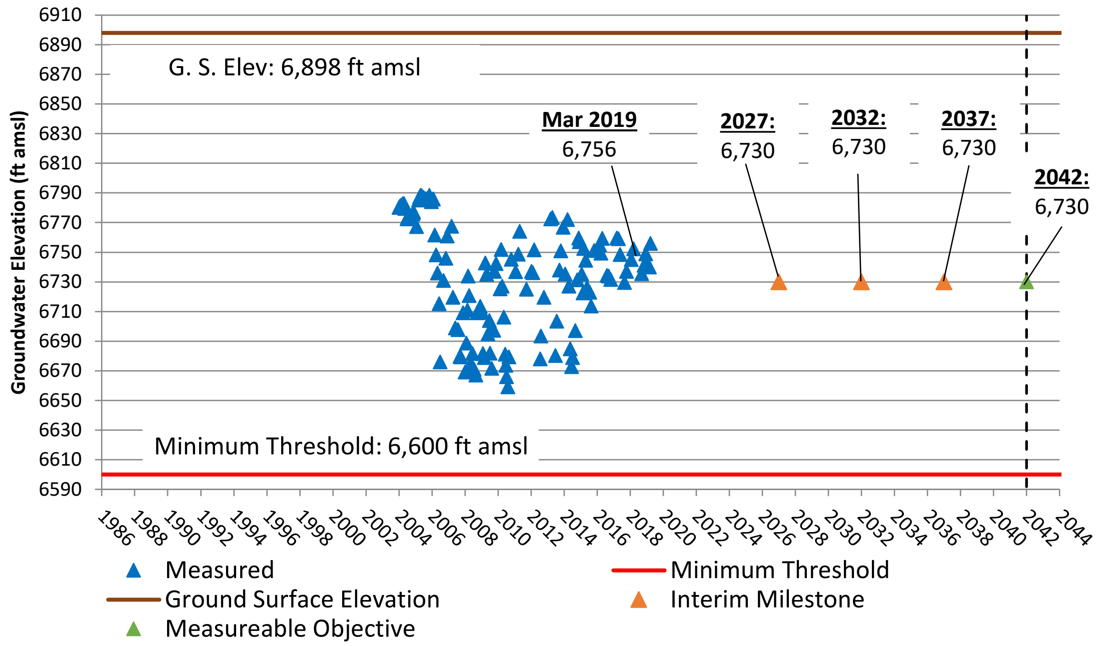


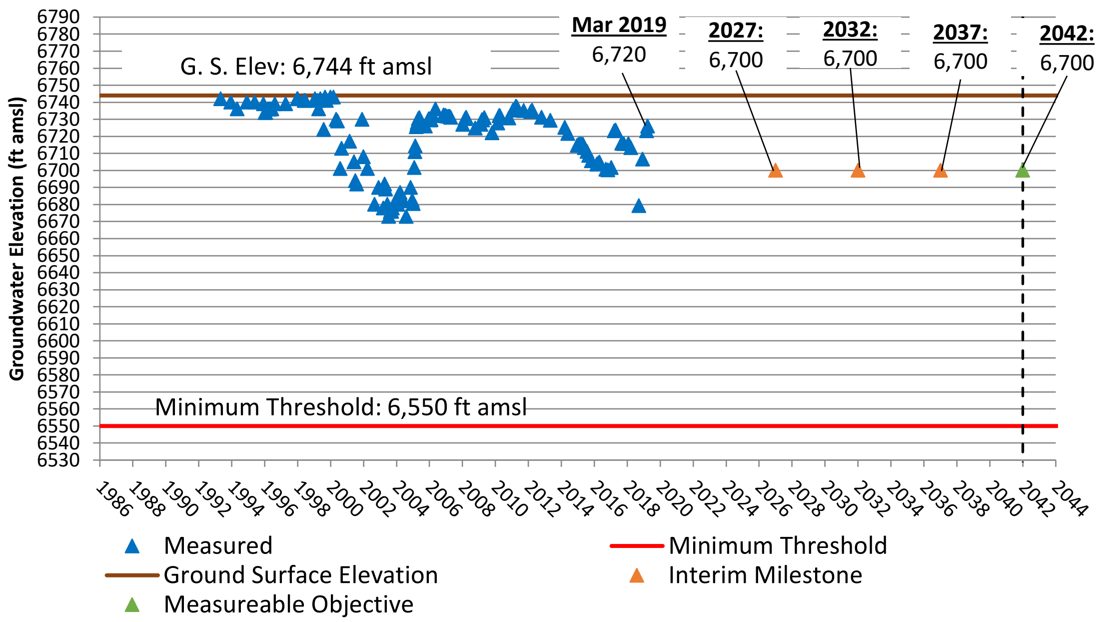
Figure 3-6

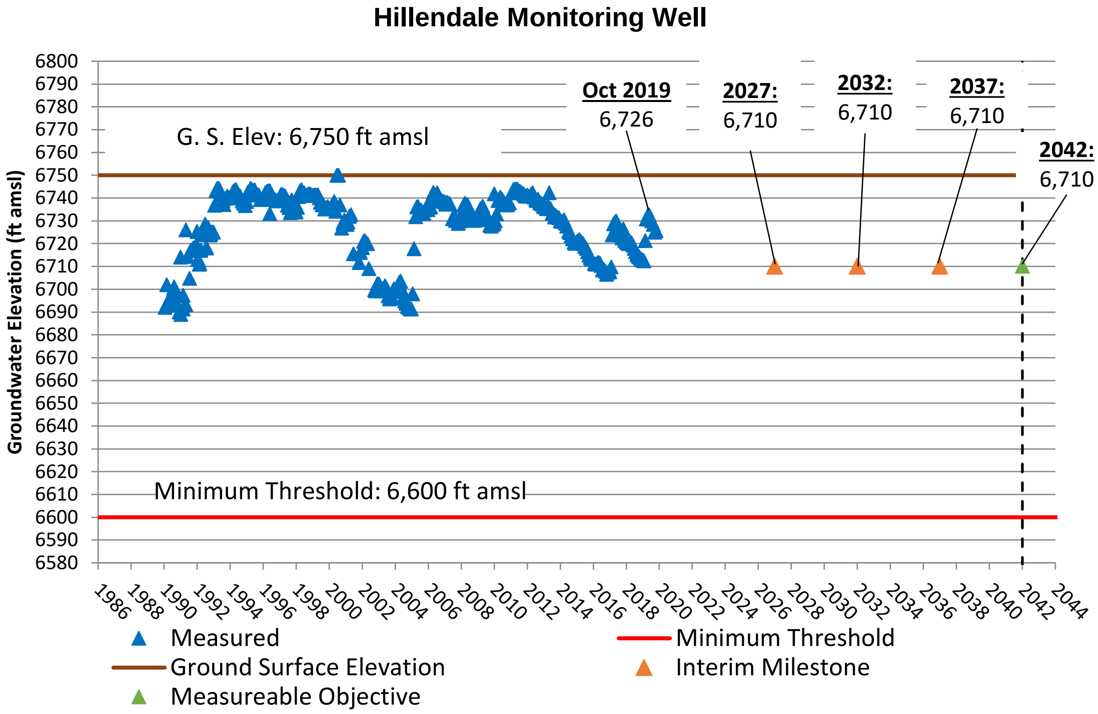
RMS Groundwater Elevation Hydrographs, Division

McAlister Shallow Monitoring Well



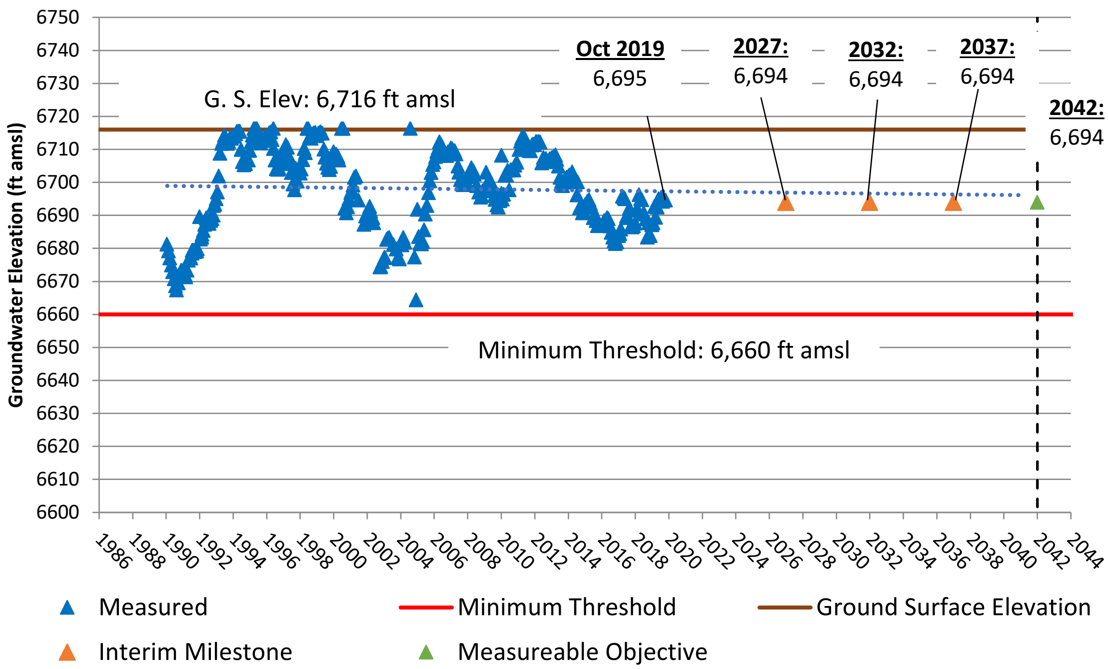
Division Well #4 (Monitoring Well)



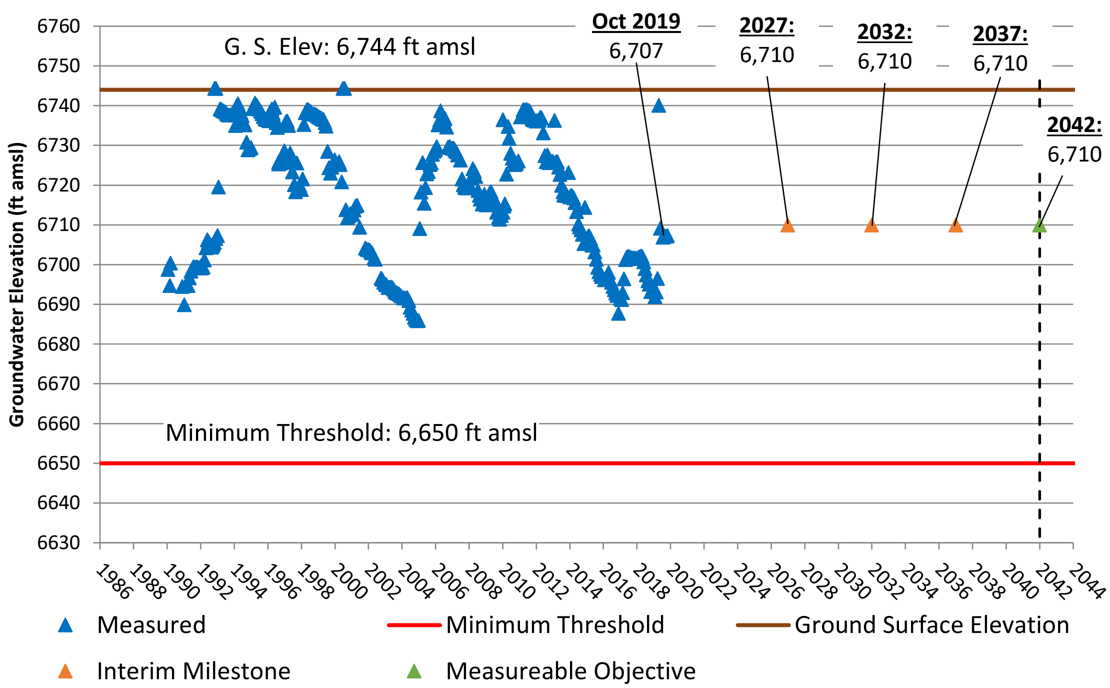

Hillendale Monitoring Well
Groundwater Elevation (ft amsl)
6800
6790
6780
6770
6760
6750
6740
6730
6720
6710
6700
6690
6680
6670
6660
6650
6640
6630
6620
6610
6600
6590
6580
G. S. Elev: 6,750 ft amsl
Minimum Threshold: 6,600 ft amsl
Oct 2019
6,726
2027:
6,710
2032:
6,710
2037:
6,710
2042:
6,710
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022 2024 2026 2028 2030 2032 2034 2036 2038 2040 2042 2044
Measured
Ground Surface Elevation
Measureable Objective
Minimum Threshold
Interim Milestone

RMS Groundwater Elevation Hydrographs, West Baldwin

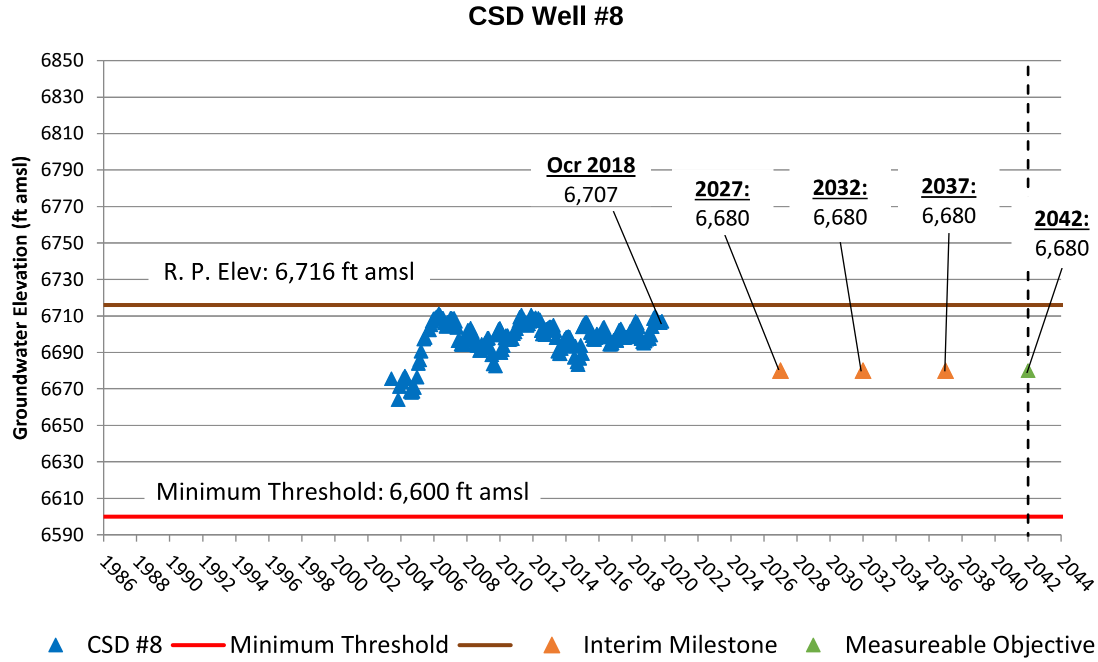
Maltby Well



Greenway Monitoring Well

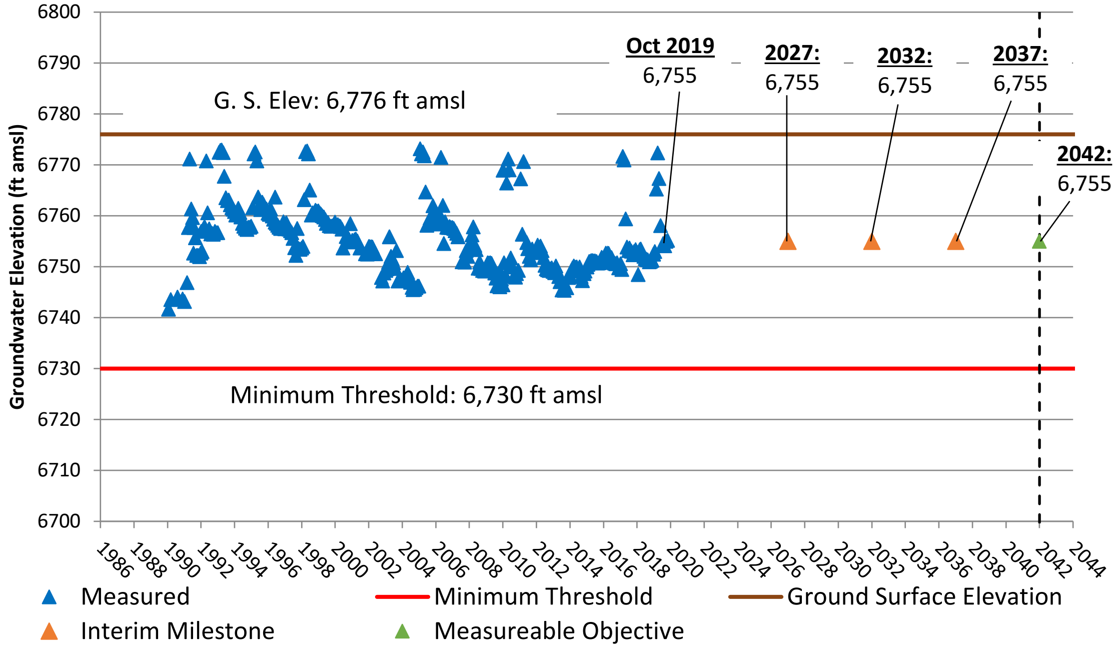


RMS Groundwater Elevation Hydrographs, East Baldwin

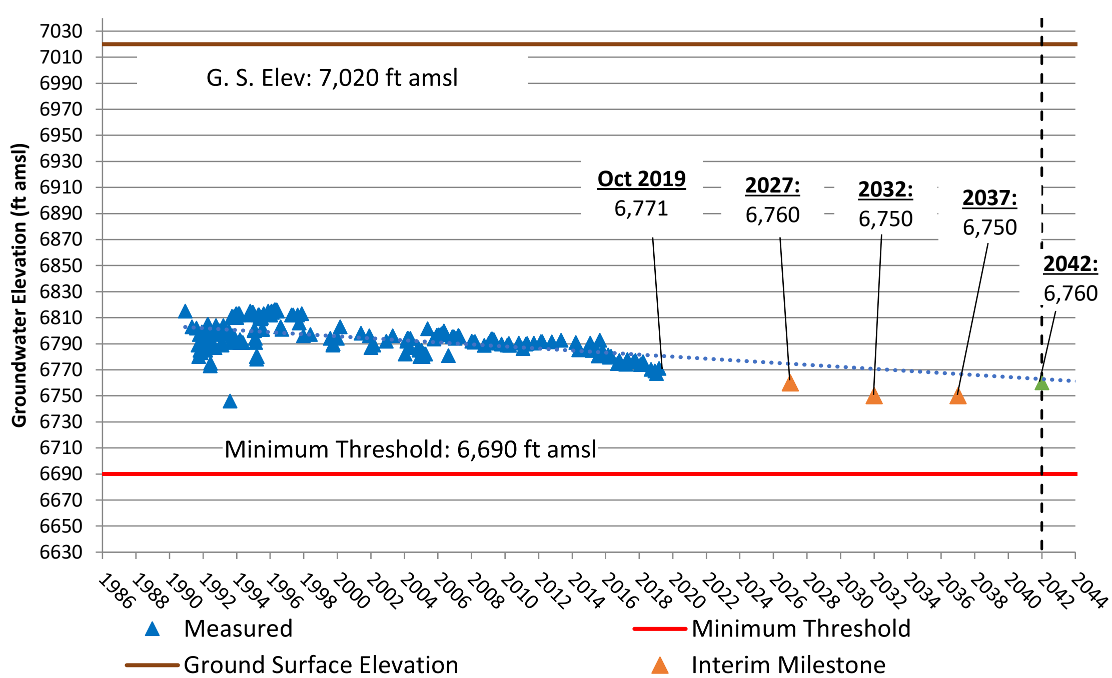


RMS Groundwater Elevation Hydrographs, Erwin

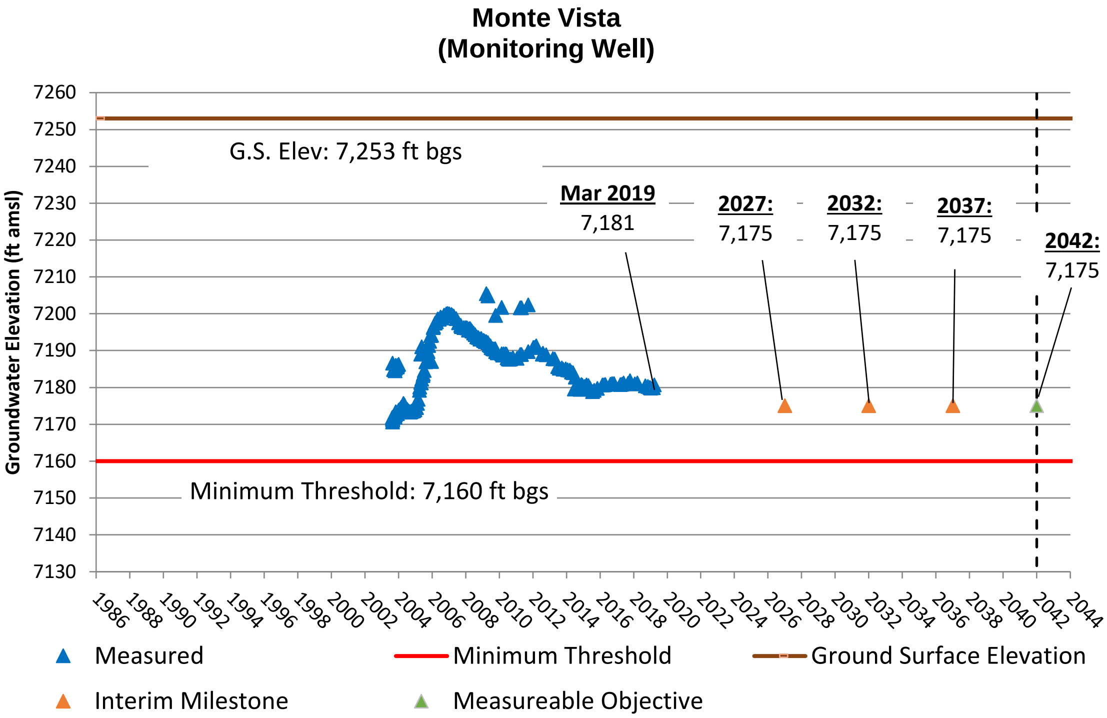
Vaqueros Monitoring Well



Maple Well



RMS Groundwater Elevation Hydrographs, Lake Willams



4. Monitoring Network

4.1 Introduction

The groundwater monitoring network presented herein is to be relied on by the BVBGSA to collect the data necessary to prepare its annual reports and assess progress with regard to achieving sustainability goals. Data to be collected from the monitoring network will include groundwater levels, groundwater quality and land elevation data. Groundwater levels and quality data will be collected from a network of monitoring wells spaced throughout the Bear Valley Basin. The monitoring well network includes existing monitoring wells and production wells. Changes in land elevation, in the form of InSAR satellite data, will be obtained from the CDWR website.

4.1.1 Monitoring Objectives

The monitoring network has been selected to meet the following Basin wide objectives:

- To ensure that the data collected within the basin are in sufficient quantities, areal distribution, frequency and accuracy to provide meaningful results for demonstrating progress toward achieving measurable objectives of each GSA and the sustainability goal of the subbasin as a whole.
- To monitor impacts to the beneficial uses and users of groundwater.
- To monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
- Enable the quantification of annual changes in water budget components.
- To identify data gaps and monitoring features to address the data gaps.
- To provide a standard methodology for the collection of groundwater and land surface subsidence data within the Basin.
- To provide for a central, secure monitoring database available to the BVBGSA for their use.

The monitoring network and associated monitoring plan is both flexible and iterative, allowing for the addition or subtraction of monitoring features, as necessary, and to accommodate changes in monitoring frequency and alternative methodologies, as appropriate.

4.1.2 Monitoring Plan Organization

The monitoring network enables the collection of the following types of data:

- Groundwater Level Data
- Groundwater Quality Data

- Land Subsidence Data

Each data type will be addressed in its own section that includes a description of the monitoring features for collecting data, the data collection protocols, and the monitoring frequency.

The final section of this section describes the data management system that includes a description of the database management platform, criteria for data QA/QC, file storage, security and access, and database maintenance.

4.2 Chronic Lowering of Groundwater Levels

Monitoring wells to be used to collect groundwater level data are shown on Figure 2-31. This groundwater level monitoring network consists of 37 existing wells located throughout the Basin. At least one monitoring well has been selected for each Management Area except Grays Landing. No groundwater production occurs in the Grays Landing Management Area and, as such, no groundwater level monitoring is conducted. A table of monitoring wells included in the Bear Valley Basin monitoring network is summarized in Table 2-7.

4.2.1 Monitoring Procedure

Groundwater level measurements shall be collected from each well using either a calibrated well sounder or a pressure transducer. Measurement devices will be calibrated to the nearest 0.01 ft. All equipment must be in good working condition. No damaged or refurbished electrical sounding tape shall be used.

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

4.2.1.1 Manual Groundwater Level Measurements

The following monitoring procedure shall be used to obtain manual groundwater level measurements in the field:

- Upon arrival at each site, the field technician shall note the well name, time of day, and date on the standard groundwater level data form (see Appendix A).
- All monitoring equipment shall be cleaned prior to lowering it into the well(s) using the following decontamination procedure:
  - Wash equipment with an Alconox solution which is followed by a deionized water rinse.

  - Triple rinse equipment with deionized water.
  - Place equipment on clean surface such as teflon or polyethylene sheet to air dry.
- To measure the depth to groundwater with an electrical sounder or meter, slowly lower the steel tape or water level electrical tape into the designated sounding port for production wells and into the main well for monitoring wells. Electrical tapes are lowered to the water surface, as determined by the audio signal, meter, or technician. Depths to groundwater are measured relative to the dedicated reference point at the top of the casing or sounding tube. Depth to groundwater shall be immediately recorded on the standard groundwater level data form (see Appendix A). Depths to groundwater shall be compared to previous measurements in the field and re-measured if significantly different.
- When finished sounding the groundwater level, all downhole equipment shall be removed, and where existing, the well cap shall be replaced, and the riser locked.
- Prior to leaving the monitoring well site, the field representative shall note any physical changes in the concrete well pad and riser pipe, such as erosion, cracks or damage. All changes shall be recorded on the standard field forms provided in Appendix A.

4.2.1.2 Automatic Groundwater Level Measurements Using Transducers

Transducers may be installed in monitoring wells identified as representative monitoring sites. Transducers shall be installed below the groundwater level with enough submergence to accommodate anticipated groundwater level fluctuations.

4.2.2 Frequency of Measurement

Groundwater level measurements from the monitoring wells shown on Figure 2-31 will be collected monthly. For those monitoring wells equipped with pressure transducers, the transducer will be programmed to record one groundwater level measurement per day. Pressure transducers will be downloaded on a semi-annual basis. During each download session, the field technician will also obtain a manual groundwater level measurement to verify transducer readings and ensure that the instruments are working properly.

4.3 Reduction in Groundwater Storage

Groundwater level data to be relied on for the change in groundwater storage estimates will be collected as described in Section 4.2 of this GSP. The change in groundwater storage will be estimated using the following equation:

$$V_w = S_y A \, \Delta h$$

Where:

V_w	=	the volume of groundwater storage change (acre-ft).
S_y	=	specific yield of aquifer sediments (unitless).
A	=	the surface area of the aquifer within the Tule Subbasin/GSA (acres).
Δh	=	the change in hydraulic head (i.e. groundwater level) (feet).

The change in storage estimate is specific to the shallow aquifer as the groundwater level in the deep aquifer will not likely drop below the top of the aquifer. The calculations will be made using a Geographic Information System (GIS) map of the Bear Valley Basin that will be discretized into 300-foot by 300-foot grids to allow for spatial representation of specific yield and groundwater level change.

The distribution of specific yield for the shallow aquifer will be based on values obtained from pumping tests conducted on wells in the basin.

For the areal distribution of change in hydraulic head within the Tule Subbasin/GSA, groundwater contours for the spring of the previous year will be digitized and overlain on the grid map of the Bear Valley Basin in GIS. Groundwater levels will then be assigned to each grid. A contour map with groundwater elevation contours from spring of the next year will also be digitized and overlain on the grid map. Change in hydraulic head (groundwater level) at each grid will be calculated as the difference in groundwater level between the two years.

The complete GIS files of specific yield and groundwater levels will be exported into a spreadsheet program for the final analysis of groundwater storage change. The change in groundwater storage will be calculated for each grid cell by multiplying the change in groundwater level by the specific yield and then by the area of the cell.

The data from the analysis can be used to develop change in storage maps for incorporation into the annual reports.

4.4 Seawater Intrusion

Seawater intrusion cannot occur in the Bear Valley Basin due to its location with respect to the Pacific Ocean. The Bear Valley Basin is an isolated mountain groundwater basin located approximately 70 miles inland of the Pacific Ocean (see Figure 2-1). This mountain aquifer system is separated hydraulically from the coastal aquifers that are susceptible to seawater intrusion. As such, monitoring for seawater intrusion is not necessary and is not included in this monitoring plan.

4.5 Degraded Water Quality

The groundwater quality monitoring plan specified in this section is designed to address the primary water quality undesirable result described in the Sustainable Management Criteria (Section 3 of this GSP), which is the inability to produce groundwater suitable for municipal supply. Accordingly, groundwater samples will be collected from agency production wells and analyzed in accordance with their required sampling and analysis schedule specified by the California Division of Drinking Water (DDW).

The groundwater sampling protocols described herein will ensure that:

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

4.5.1 Groundwater Quality Constituents to be Analyzed

Groundwater quality constituents to be analyzed as part of this GSP are the same as are currently being analyzed to comply with California DDW requirements for drinking water. A complete list of the constituents that are currently being analyzed and which are proposed to be analyzed into the future is summarized in Table 4-1. In general, these constituents include general mineral and physical properties (including nitrate), volatile organic compounds (VOCs), methyl tert butyl ether (MTBE), ethylene dibromide (EDB), dibromochloropropane (DBCP), and gross alpha.

4.5.2 Sample Collection Protocol

All samples shall be collected from the discharge point near the well head and placed in laboratory-prepared sample containers. Groundwater samples will be collected during normal operation of the well to ensure that the samples are reflective of groundwater quality and not stagnant water in the well. The technician collecting the sample shall wear new latex or neoprene gloves while collecting the sample. Sample containers shall be labeled before or immediately after sampling with self-adhesive tags having the following information written in waterproof ink:

- Well I.D.
- Sample I.D. number
- Date and time sample was collected
- Initials of sample collector

4.5.3 Handling, Storage and Transportation of Samples

Upon collection and labeling, all samples shall be placed immediately into a clean chest/cooler with ice to keep samples cool. Exposure to dust, direct sunlight, high temperature, adverse weather conditions, and possible contamination shall be avoided.

All samples will be transported to a State-certified analytical laboratory within 24 hours of collection. Samples shall be transported under chain-of-custody procedures, which document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis shall be recorded on a Chain-of-Custody Record, which includes instructions to the laboratory for analytical services.

Information contained on the triplicate Chain-of-Custody Record shall include:

- Well No.
- Signature of sampler(s)
- Date and time sampled
- Number of sample containers
- Sample matrix (water)
- Analyses required
- Remarks, including preservatives, special conditions, or specific quality control measures
- Turnaround time and person to receive laboratory report
- Method of shipment to the laboratory
- Release signature of sampler(s), and signatures of all people assuming custody
- Condition of samples when received by laboratory

Blank spaces on the Chain-of-Custody Record will be crossed out between the last sample listed and the signatures at the bottom of the sheet.

The field sampler shall sign the Chain-of-Custody Record and record the time and date at the time of transfer to the laboratory or to an intermediate person. A set of signatures is required for each relinquished/reserved transfer, including intermediate transfers. The original imprint of the Chain-of-Custody Record will accompany the sample containers. A duplicate copy shall be placed in the project file.

If the samples are to be shipped to the laboratory, the original Chain-of-Custody will be sealed inside a plastic bag within the ice chest, and the chest shall be sealed with custody tape which has been signed and dated by the last person listed on the Chain-of-Custody. U. S. Department of Transportation shipping requirements shall be followed and the sample shipping receipt retained in the project file as part of the permanent chain-of-custody document. The shipping company

(e.g. Federal Express, UPS, DHL) will not sign the chain-of-custody forms as a receiver, instead the laboratory shall sign as a receiver when the samples are received.

4.5.4 Quality Control Samples

Quality control samples shall consist of duplicates and blanks. At least one duplicate sample shall be collected during each day of sampling. The duplicate sample shall be collected from the same well as the original and immediately after the original sample. At least one blank sample shall be included with each batch of samples delivered to the laboratory. Blank samples shall consist of laboratory prepared deionized water that is containerized at the laboratory and delivered with the sample containers.

4.5.5 Frequency of Measurement

Groundwater quality samples will be collected from agency wells in the Bear Valley Basin and analyzed according to the schedule shown in Table 4-2. The analysis schedule is specified by the DDW.

4.6 Land Subsidence

Monitoring of changes in land surface elevation related to groundwater withdrawal will be conducted through evaluation of satellite data.

4.6.1 Monitoring Features

Changes in land surface elevation over time can be observed on a regional scale using satellite data. The data is generated using interferometric synthetic aperture radar (InSAR). Monthly InSAR datasets will be published on a quarterly basis by the DWR. Additional information on the DWR's InSAR subsidence data is available at https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence.

4.6.2 Monitoring Procedure

InSAR data will be downloaded from https://gis.water.ca.gov/arcgisimg/rest/services/SAR to develop maps showing regional land surface changes.

4.6.3 Frequency of Measurement

InSAR data will be downloaded from the DWR website and analyzed on an annual basis for evaluation and incorporation into the annual reports.

4.7 Depletions of Interconnected Surface Water

The measurable objectives developed for groundwater levels in the vicinity of Big Bear Lake and Shay Pond have not resulted in significant and unreasonable surface water conditions in the past. Although a lowering of groundwater levels to the minimum thresholds is not anticipated, ongoing monitoring of the impact of groundwater on surface water and vice versa will be conducted into the future to determine if groundwater levels approaching the minimum thresholds in these areas has an adverse impact on the beneficial uses of the surface water bodies.

4.7.1 Monitoring Features

Monitoring wells used to measure groundwater levels in areas where there is potential for direct groundwater and surface water interaction will be the primary monitoring features from which data is obtained to assess groundwater and surface water interaction. Surface water levels for Big Bear Lake will be obtained from the Big Bear Municipal Water District. Surface water level conditions in Shay Pond will be obtained from the BBCCSD.

4.7.2 Monitoring Procedure

Groundwater levels will be monitored using the procedures described in Section 4.2.1.

4.7.3 Frequency of Measurement

Groundwater level measurement frequency for depletions of interconnected surface water will be monthly, as described in Section 4.2.2.

Surface water stage level data will be compiled annually.

4.8 Representative Monitoring

4.8.1 Groundwater Levels

A subset of groundwater level monitoring features in the monitoring network have been identified as representative monitoring sites to be relied on for the purpose of assessing progress with respect to groundwater level sustainability in the Bear Valley Basin. The representative groundwater level monitoring sites are shown on Figure 2-31. At least one representative groundwater level monitoring site has been identified within each management area.

4.8.2 Reduction of Groundwater Storage

Changes in groundwater storage within the Bear Valley Basin will be estimated using the method described in Section 4.3 of this GSP. Groundwater level data to be relied on for the change in groundwater storage estimates will be collected as described in Section 4.2 of this GSP from the monitoring network shown on Figure 2-31 and summarized in Table 2-7. As such, there are no single representative monitoring sites for evaluating progress with respect to groundwater sustainability as it relates to changes in groundwater storage in the Bear Valley Basin.

4.8.3 Seawater Intrusion

Seawater intrusion cannot occur in the Bear Valley Basin due to its location with respect to the Pacific Ocean (see Section 3.4.3 herein). As such, representative monitoring sites for evaluating progress with respect to groundwater sustainability as it relates to seawater intrusion are not needed.

4.8.4 Degraded Groundwater Quality

Groundwater quality degradation in the Bear Valley Basin is being monitored and regulated in accordance with California DDW drinking water requirements. Groundwater produced from any municipal well in the basin that does not meet regulatory requirements for potable supply is considered an undesirable result. As such, all municipal production wells in the Bear Valley Basin serve as representative monitoring sites for groundwater quality.

4.8.5 Land Subsidence

Changes in land surface elevation across the Bear Valley Basin will be monitored using satellite data as described in Section 4.6 of this GSP. As such, there are no single representative monitoring sites for evaluating changes with respect to land subsidence in the Bear Valley Basin.

4.8.6 Interconnected Surface Water

The groundwater level data collected from the groundwater level monitoring network will serve as a proxy for monitoring changes with respect to interconnected surface water in the Bear Valley Basin. As such, the representative monitoring sites identified for evaluating groundwater sustainability as it relates to groundwater levels will also serve as the representative monitoring sites for evaluating interconnected surface water.

4.9 Data Management System

As per SGMA Regulations § 352.6, a data management system (DMS) has been developed for data filing, storage, and security during the implementation of the Bear Valley Basin GSP. Certain types of data necessary to implement the GSP and prepare annual reports will be stored in a relational computer database (Microsoft Access) that will enable the efficient communication and display of data, when needed. The general types of data to be stored in the database will include:

- Information on wells, including name, location, and construction
- Groundwater production
- Groundwater levels

Other types of data may be added to the database, as deemed necessary by the BVBGSA.

The database will be maintained by the BVBGSA or its technical representative. Data will be compiled and stored in the database, at a minimum, annually. The updated database will be made available to the BVBGSA managers and/or their technical representative(s) by December 1 of each year to provide the information necessary to prepare annual reports.

The BVBGSA and/or their technical representative will implement measures to prevent accidental loss of data and tampering with the database. All data entered in the database will be saved during each work session. The database will be backed up on a separate external drive or offsite (i.e. "cloud") server following each session. Access to the working database files will be limited to the BVBGSA managers, staff, and their assigned technical representatives.

For purposes of this plan, quality assurance (QA) is defined as the integrated program designed to assure reliability of monitoring and measurement data. Quality control (QC) is defined as the routine application of specified procedures to obtain prescribed standards of performance in the monitoring and measurement process (ASTM D-18). BBDWP and their assigned technical experts are responsible for assuring that the precision, accuracy, and completeness of data collected during as part of this GSP are known and documented. Accordingly, all field instruments will be operated in strict accordance with manufacturers specifications. All data and data collection procedures will be checked by a California Certified Hydrogeologist.

Laboratory Water Quality Suite

Constituent	Units	Detection Limit	Method
General Physical Properties			
Color	Color Unit	3.0	SM-2120B
Odor	Odor Unit	1.0	SM-2150B
Turbidity*	NTU	0.2	SM-2130B
General Minerals			
Ammonia as N	mg/L	0.1	EPA-350.1
Ortho Phosphate as P	mg/L	0.1	EPA-365.1
Total Phosphate	mg/L	0.2	EPA-365.4
Total Phosphorous as P	mg/L	0.1	EPA-365.4
Total Hardness	mg/L	3.1	SM 2340B/EPA
Calcium	mg/L	1.0	EPA-200.7
Magnesium	mg/L	1.0	EPA-200.7
Sodium	mg/L	1.0	EPA-200.7
Potassium	mg/L	1.0	EPA-200.7
Total Alkalinity, as $CaCO_3$	mg/L	3.0	SM 2320B
Hydroxide	mg/L	3.0	SM-2320B
Carbonate	mg/L	3.0	SM-2320B
Bicarbonate	mg/L	3.0	SM-2320B
Sulfate	mg/L	0.5	EPA-300.0
Chloride	mg/L	1.0	EPA-300.0
Nitrate, as N	mg/L	0.2	EPA-300.0
Fluoride	mg/L	0.1	EPA-300.0
pH*	pH unit	1.0	EPA-150.1
Temperature*	Degree C		
Electrical Conductance*	µmhos/cm	1.0	SM-2510B
Total Dissolved Solids (TDS)	mg/L	20.0	SM-2540C
Hydrogen Sulfide (H_2S)	µg/L	2.0	SM 4500 S2 H
Metals			
Arsenic	µg/L	2.0	EPA-200.8
Barium	µg/L	20.0	EPA-200.7
Cadmium	µg/L	1.0	EPA-200.8
Chromium	µg/L	1.0	EPA-200.8
Lead	µg/L	5.0	EPA-200.8
Mercury	µg/L	1.0	EPA-200.8
Selenium	µg/L	5.0	EPA-200.8
Aluminum	µg/L	50.0	EPA-200.7
Antimony	µg/L	6.0	EPA-200.8
Beryllium	µg/L	1.0	EPA-200.8
Nickel	µg/L	10.0	EPA-200.7
Thallium	µg/L	1.0	EPA-200.8
Manganese	µg/L	20.0	EPA-200.7
Iron	µg/L	100.0	EPA-200.7
Boron	µg/L	100.0	EPA-200.7

Laboratory Water Quality Suite

Constituent	Units	Detection Limit	Method
Copper	µg/L	50.0	EPA-200.7
Silver	µg/L	10.0	EPA-200.8
Hexavalent Chromium	µg/L	0.2	EPA-218.6
Vanadium	µg/L	2.0	EPA-200.8
Zinc	µg/L	50.0	EPA-200.7
Additional Analyses			
Perchlorate	µg/L	4.0	EPA-314.0
Gross Alpha	pCi/L	1.0	EPA-900.1
Gross Beta	pCi/L	1.0	EPA-900.1
Uranium	pCi/L	1.0	EPA-200.8
Cyanide	µg/L	100	SM 4500CN E
Volatile Organic Compounds (VOCs)			
1,1,1,2-Tetrachloroethane	µg/L	0.5	EPA-524.2
1,1,1-Trichloroethane	µg/L	0.5	EPA-524.2
1,1,2,2-Tetrachloroethane	µg/L	0.5	EPA-524.2
1,1,2-Trichloroethane	µg/L	0.5	EPA-524.2
1,1-Dichloroethane	µg/L	0.5	EPA-524.2
1,1-Dichloroethene	µg/L	0.5	EPA-524.2
1,1-Dichloropropene	µg/L	0.5	EPA-524.2
1,2,3-Trichlorobenzene	µg/L	0.5	EPA-524.2
1,2,4-Trichlorobenzene	µg/L	0.5	EPA-524.2
1,2,4-Trimethylbenzene	µg/L	0.5	EPA-524.2
1,2-Dichlorobenzene	µg/L	0.5	EPA-524.2
1,2-Dichloroethane	µg/L	0.5	EPA-524.2
1,2-Dichloropropane	µg/L	0.5	EPA-524.2
1,3-Dichlorobenzene	µg/L	0.5	EPA-524.2
1,3-Dichloropropane	µg/L	0.5	EPA-524.2
1,3-Dichloropropene	µg/L	0.5	EPA-524.2
1,3,5-Trimethylbenzene	µg/L	0.5	EPA-524.2
1,4-Dichlorobenzene	µg/L	0.5	EPA-524.2
2,2-Dichloropropane	µg/L	0.5	EPA-524.2
2-Butanone(MEK)	µg/L	5	EPA-524.2
2-Chlorotoluene	µg/L	0.5	EPA-524.2
4-Chlorotoluene	µg/L	0.5	EPA-524.2
4-Methyl-2-Pentanone(MIBK)	µg/L	5	EPA-524.2
Benzene	µg/L	0.5	EPA-524.2
Bis(2-chloroethyl)ether'"	µg/L	0.5	EPA-524.2
Bromobenzene	µg/L	0.5	EPA-524.2
Bromochloromethane	µg/L	0.5	EPA-524.2
Bromodichloromethane	µg/L	0.5	EPA-524.2

Laboratory Water Quality Suite

Constituent	Units	Detection Limit	Method
Bromoform	µg/L	0.5	EPA-524.2
Bromomethane	µg/L	0.5	EPA-524.2
Carbon Tetrachloride	µg/L	0.5	EPA-524.2
Chlorobenzene	µg/L	0.5	EPA-524.2
Chloroethane	µg/L	0.5	EPA-524.2
Chloroform	µg/L	0.5	EPA-524.2
Chloromethane	µg/L	0.5	EPA-524.2
cis-1,2-Dichloroethene	µg/L	0.5	EPA-524.2
cis-1,3-Dichloropropene	µg/L	0.5	EPA-524.2
Dibromochloromethane	µg/L	0.5	EPA-524.2
Dibromomethane	µg/L	0.5	EPA-524.2
Dichlorodifluoromethane	µg/L	0.5	EPA-524.2
Ethylbenzene	µg/L	0.5	EPA-524.2
Hexachlorobutadiene	µg/L	0.5	EPA-524.2
Isopropylbenzene	µg/L	0.5	EPA-524.2
Methyl tert butyl Ether (MTBE)	µg/L	0.5	EPA-524.2
Methylene Chloride	µg/L	0.5	EPA-524.2
n-Butylbenzene	µg/L	0.5	EPA-524.2
n-Propylbenzene	µg/L	0.5	EPA-524.2
Naphthalene	µg/L	0.5	EPA-524.2
p-Isopropyltoluene	µg/L	0.5	EPA-524.2
sec-Butylbenzene	µg/L	0.5	EPA-524.2
Styrene	µg/L	0.5	EPA-524.2
tert-Butylbenzene	µg/L	0.5	EPA-524.2
Tetrachloroethene (PCE)	µg/L	0.5	EPA-524.2
Toluene	µg/L	0.5	EPA-524.2
trans-1,2-Dichloroethene	µg/L	0.5	EPA-524.2
trans-1,3-Dichloropropene	µg/L	0.5	EPA-524.2
Trichloroethene (TCE)	µg/L	0.5	EPA-524.2
Trichlorofluoromethane	µg/L	0.5	EPA-524.2
Trichlorotrifluoroethane	µg/L	0.5	EPA-524.2
Vinyl Chloride	µg/L	0.3	EPA-524.2
Xylenes (m+p)	µg/L	0.5	EPA-524.2
Xylenes (ortho)	µg/L	0.5	EPA-524.2
Xylenes (Total)	µg/L	0.5	EPA-524.2

Laboratory Water Quality Suite

Constituent	Units	Detection Limit	Method
Per- and Polyfluoalkyl Substances (PFAS)			
Hexafluoropropylene oxide dimer acid	ng/L	0.2	EPA-537.1
N-ethyl perfluorooctanesulfonamidoacetic acid	ng/L	0.2	EPA-537.1
N-methyl perfluorooctanesulfonamidoacetic acid	ng/L	0.2	EPA-537.1
Perfluorobutanesulfonic acid	ng/L	0.2	EPA-537.1
Perfluorodecanoic acid	ng/L	0.2	EPA-537.1
Perfluorododecanoic acid	ng/L	0.2	EPA-537.1
Perfluoroheptanoic acid	ng/L	0.2	EPA-537.1
Perfluorohexanesulfonic acid	ng/L	0.2	EPA-537.1
Perfluorohexanoic acid	ng/L	0.2	EPA-537.1
Perfluorononanoic acid	ng/L	0.2	EPA-537.1
Perfluorooctanesulfonic acid (PFOS)	ng/L	0.2	EPA-537.1
Perfluorooctanoic acid (PFOA)	ng/L	0.2	EPA-537.1
Perfluorotetradecanoic acid	ng/L	0.2	EPA-537.1
Perfluorotridecanoic acid	ng/L	0.2	EPA-537.1
Perfluoroundecanoic acid	ng/L	0.2	EPA-537.1
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	ng/L	0.2	EPA-537.1
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	ng/L	0.2	EPA-537.1
4,8-dioxa-3H-perfluorononanoic acid	ng/L	0.2	EPA-537.1

<u>Explanation of Units</u>
NTU - nephelometric turbidity units
mg/L - milligrams per liter
µmhos/cm - micromhos per centimeter
µg/L - micrograms per liter
pCi/L - picocuries per liter
ng/L - nanograms per liter

*Temperature, pH, electrical conductivity and turbidity will also be measured in the field.

Groundwater Sampling Occurrence Recommendations

Management Area	Nitrate	General Mineral and Physical Inorganic[1]	MTBE[2]	EDB / DBCP[3]	Volatile Organic Compounds[1]	Gross Alpha Radiological
North Shore	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 3 Years
Grout Creek	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Gray's Landing	N/A	N/A	N/A	N/A	N/A	N/A
Mill Creek	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Village	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Rathbone	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Division	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Van Dusen	N/A	N/A	N/A	N/A	N/A	N/A
West Baldwin	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
East Baldwin	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Erwin	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 9 Years
Lake Williams	Annual	Every 3 Years	Every 3 Years	Every 3 Years	Every 6 Years	Every 3 Years

Note:

[1] See Table 4-1 for Constituent List and Analytical Methods

[2] MTBE: Methyl tert-Butyl Ether

[3] EDB: 1,2-Dibromomethane / DBCP: 1,2-Dibromo-3-Chloropropane

5. Project and Management Actions

This chapter describes the Projects, Management Actions, and Adaptive Management information that satisfies Sections 354.42 and 354.44 of the Sustainable Groundwater Management Act (SGMA) regulations. These projects, actions, and their benefits are intended to help achieve the sustainable management goals in the Basin.

Groundwater pumping within the Bear Valley Basin, as a whole, has historically been within the Sustainable Yield resulting in relatively stable long-term groundwater levels. While there have periodically been localized groundwater level declines, pumping sustainability has been maintained through adaptive management of pumping distribution between management areas and implementation of conservation measures. To maintain pumping sustainability into the future, the BVBGSA plans to continue these effective management actions on a routine basis and implement projects as needed that support sustainable management. These projects and management actions are described in detail in the following sections.

5.1 Introduction

Per Section 354.44 of the SGMA regulations, the GSP is to include the following:

- a) *Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.*
- b) *Each Plan shall include a description of the projects and management actions that include the following:*
    1. *A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:*
        - A. *A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.*
        - B. *The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions*

is being considered or has been implemented, including a description of the actions to be taken.

2. *If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.*
3. *A summary of the permitting and regulatory process required for each project and management action.*
4. *The status of each project and management action, including a timetable for expected initiation and completion, and the accrual of expected benefits.*
5. *An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.*
6. *An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.*
7. *A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.*
8. *A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.*
9. *A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.*

c) Projects and management actions shall be supported by best available information and best available science.

d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

5.2 Projects

Based on discussion with the BVBGSA stakeholders, two projects or types of projects have been identified for inclusion in the GSP because they support efforts to maintain long term groundwater sustainability:

- Replenish Big Bear
- Any projects that provide new or maintain existing groundwater pumping facilities

These projects are described in detail in the following sections.

5.2.1 Replenish Big Bear Project

Replenish Big Bear is a multi-benefit recycled water project that will utilize a water resource currently discharged outside of the Bear Valley Basin to secure a new drought proof local water supply that will support continued groundwater sustainability, among other benefits.

Replenish Big Bear includes permitting, design, and construction of treatment facility upgrades at the existing BBARWA Wastewater Treatment Plant (WWTP) to produce high quality recycled water, approximately 7 miles of pipeline for recycled water conveyance, three pump stations, a groundwater recharge facility, monitoring wells, and brine minimization and disposal facilities.

The project will produce approximately 1,950 acre-feet per year (AFY) of high-quality recycled water for various uses. Approximately 1,900 AFY will be discharged to Stanfield Marsh, which subsequently flows into Big Bear Lake (Lake). Pending confirmation of its suitability for use to sustain habitat for the endangered unarmored threespine stickleback fish, approximately 50 AFY of the treated water may be discharged on a continuous basis to Shay Pond in the Erwin Lake area, which is currently sustained with groundwater pumped from BBCCSD wells.

Of the water discharged to the Lake, some of it can be extracted and conveyed to Sand Canyon for groundwater recharge. The recharge potential at Sand Canyon is approximately 380 AF over a 6-month dry weather period (April – October) (TH&Co, 2017b). Groundwater recharge at Sand Canyon may require construction of monitoring wells to monitor water quality in the area, subject to regulatory permit conditions.

Water can also be extracted from the Lake to irrigate Bear Mountain Golf Course, which currently uses approximately 120 AFY from private groundwater wells for irrigation. The additional surface water available as a result of Replenish Big Bear would provide irrigation water in lieu of groundwater pumping, thus reducing the demand on the aquifer system in an area where groundwater levels have been declining.

While some of the 1,900 AFY of recycled water discharged to the Lake will later be extracted and used to supplement groundwater supplies, most of that water will remain in the Lake to help stabilize Lake levels and provide recreational and habitat benefits. As summarized in Table 5-1, up to 550 AFY of the water produced will benefit groundwater in the Bear Valley Basin.

An overview map of the project is shown on Figure 5-1.

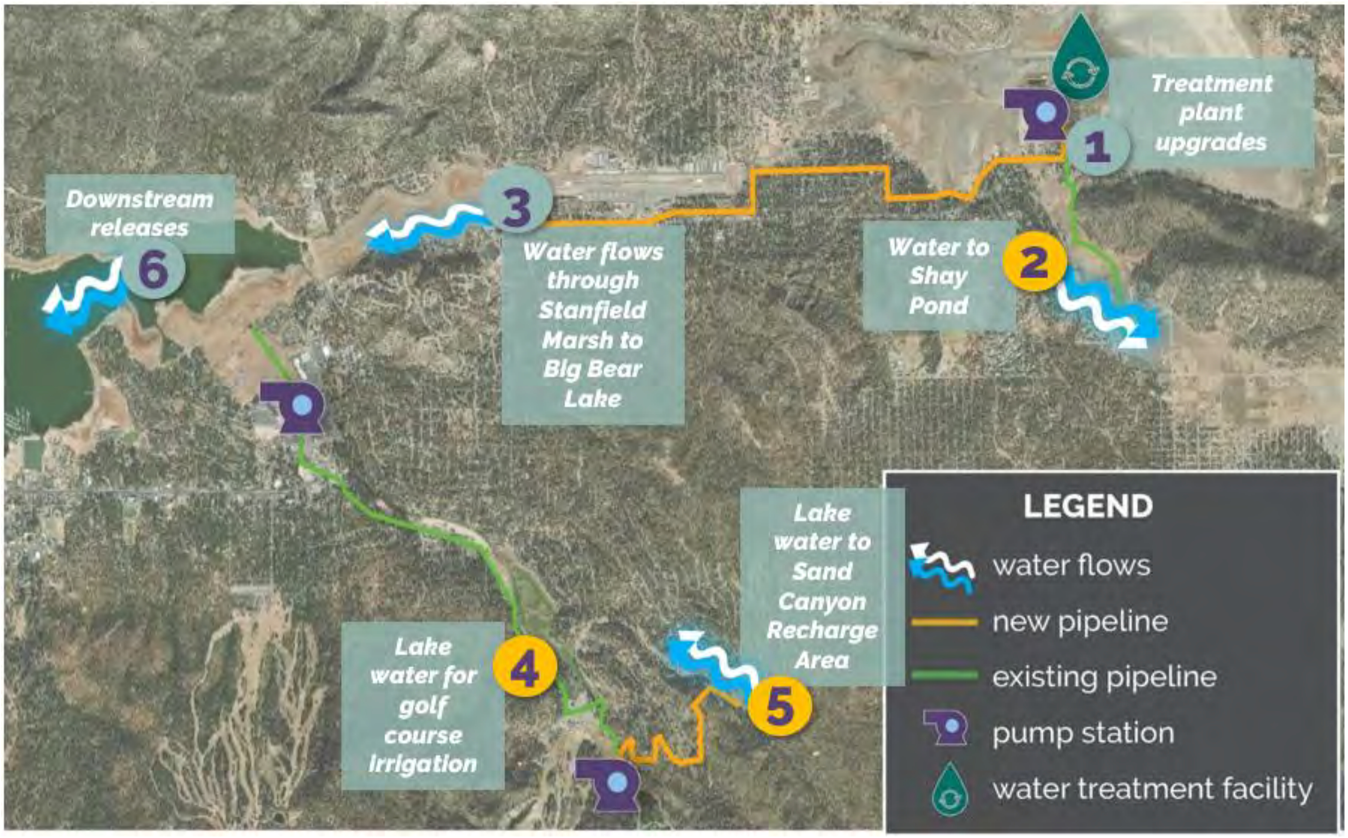


Figure 5-1. Replenish Big Bear Project Overview

5.2.1.1 Planned Treatment Plant Upgrades

Upgrades will be necessary to BBARWA's existing WWTP to meet the water quality objectives (WQOs) identified for the Lake in the Santa Ana Basin Plan (Basin Plan), the total phosphorus target identified in the Big Bear Lake Nutrient Total Maximum Daily Load for the Dry Hydrologic Conditions (TMDL) and regulatory requirements for groundwater recharge. To meet the WQOs and TMDL targets for the Lake, total dissolved solids (TDS), inorganic nitrogen and phosphorus concentrations must be reduced through multiple in-series treatment processes to meet the anticipated discharge limits – 175 mg/l, 0.15 mg/L and 0.035 mg/L, respectively. To achieve these expected strict effluent limits, BBARWA is planning to implement a series of advanced treatment upgrades to existing unit processes and integrate new unit processes, specifically:

- Upgrade the extended aeration process through retrofit of the existing oxidation ditches to optimize biological nitrification-denitrification (NDN).
- Nutrient-laden liquid sidestreams, which are produced during solids handling processes, may require treatment to mitigate reduced treatment capacity impacts from returning high nutrient loads to liquid stream processes.

- Addition of a denitrification filter to reduce nitrate-nitrogen concentrations and provide chemical phosphorus removal.
- Low-pressure filtration, such as ultrafiltration (UF), to reduce flocculated or colloidal solids upstream of the reverse osmosis (RO) process.
- RO to reduce TDS and nutrient concentrations.
- Pellet reactor brine minimization system to minimize brine stream from RO process.
- Addition of ultraviolet (UV) disinfection to deactivate any bacteria, viruses, and other microorganisms.

It is anticipated that 100% of the water discharged to the Lake and Shay Pond will be treated with RO and UV disinfection to meet the strict WQO. The permitting process with the Regional Water Quality Control Board (RWQCB) and DDW is ongoing, so the specifics of the treatment processes have yet to be finalized. Additional coordination with the California Department of Fish and Wildlife (CDFW) and United States Fish and Wildlife Serve (USFWS) is anticipated to occur once the Lake discharge requirements are better defined. However, the final treatment process intends to comply with all regulatory permitting requirements for discharge to the Lake and Shay Pond.

Incorporation of RO into the treatment process will require a brine management system. The preliminary RO brine management option for Replenish Big Bear is a brine minimization pellet reactor to minimize brine from the RO brine stream, followed by solar evaporation ponds located at a site near BBARWA. Using an RO recovery of 90% for the treated flow and RO influent of 2.2 million gallons per day (MGD) would result in 0.22 MGD of RO brine to be minimized through the pellet reactor, and approximately 0.022 MGD of brine to be conveyed to the evaporation pond. A total evaporation pond area of 23 acres is needed for the RO brine flows, which will be conveyed to evaporation ponds in Big Bear adjacent to the BBARWA WWTP. Alternative RO brine management strategies will be evaluated further as the Project enters the design phase.

5.2.1.2 Advanced Treated Water Quality

The water produced by the BBARWA WWTP, after the upgrades described in Section 5.2.1.1 are implemented, will be of high quality and is anticipated to satisfy WQOs and permitting requirements for discharge into the Lake and Shay Pond.

As part of the discharge permit for the project, it will be necessary to conduct a pilot test of the treatment process to demonstrate that the final treated water complies with regulatory requirements. As part of the project development process, a study of the treated product water will be conducted to confirm that the physical and chemical characteristics of the advanced treated product water are suitable for sustaining the unarmored threespine stickleback fish habitat in Shay Pond. Coordination with the CDFW and USFWS is anticipated to prepare the scope of work for

the fish survivability study and to interpret the results. The BBARWA will not discharge treated Project water to Shay Pond until it is determined that the quality of the water will not adversely impact the fish habitat.

5.2.1.3 Project Benefits

The various components of Replenish Big Bear provide multiple benefits to the Valley, including enhanced groundwater sustainability, increased Lake levels, and associated recreation, ecosystem and economic benefits. This section focuses on the groundwater benefits that support the sustainable management goals of the GSP. More information on the full components and benefits of Replenish Big Bear can be found on the project website at ReplenishBigBear.com.

The groundwater benefits associated with each project component and the Sustainable Management Criteria addressed are detailed in Table 5-1.

Table 5-1. Replenish Big Bear Groundwater Benefits

Component	Estimated Supply	Groundwater Benefit	Sustainable Management Criteria Addressed
WWTP Upgrades	Included below	Produces a new, high-quality drought proof source of supply that provides numerous benefits to the Valley, including supporting groundwater sustainability.	CHRONIC LOWERING OF GROUNDWATER LEVELS REDUCTION OF GROUNDWATER STORAGE
Shay Pond Discharge	50 AFY	Provides a new source of water for potential discharge to Shay Pond to sustain endangered species habitat. Groundwater from BBCCSD wells currently used for this purpose can be stored in the basin instead, helping to sustain groundwater levels and storage. Helps maintain the Measurable Objective of groundwater level for the Erwin Management Area.	
Sand Canyon Groundwater Recharge	380 AFY	Provides a new source of water to supplement natural recharge in Sand Canyon, which will increase groundwater levels and storage. Increases adaptive management opportunities by providing additional water that can be pumped out by BBLDWP and transferred to BBBCCSD using exisitng interconnections. Helps achieve the Measurable Objective of groundwater level for various Management Areas. Effectively increases Sustainable Yield by approximately 380 AFY.	
Bear Mountain Golf Resort Irrigation	120 AFY	Provides a new source of water for irrigation of the golf course. Groundwater from private wells currently used for this purpose can be stored in the basin instead, helping to sustain groundwater levels and storage. Helps achieve the Measurable Objective of groundwater level for various Management Areas.	

5.2.1.4 Supply Reliability

As previously mentioned, groundwater is the only potable water supply in the Bear Valley Basin. Efforts by the water agencies and community have been successful in reducing demand; and total potable consumption has been maintained below the Sustainable Yield of the groundwater basin. BBLDWP and BBCCSD have implemented a series of ongoing conservation, education and outreach programs to help reduce water usage in the service area. In the past decade, BBLDWP and BBCCSD have maintained a decreasing trend in per capita demands through conservation efforts. However, while past conservation efforts have been very effective, the agencies expect that additional demand reduction will become slower and more difficult or costly to achieve in the future. As more and more customers take advantage of water efficient fixture upgrades, low water use landscaping and adopt more efficient water use behaviors, additional opportunities for customers to further reduce water demand will become more limited.

In addition, climate change is anticipated to have an impact on the timing and intensity of precipitation, which will impact how much natural runoff can percolate into the groundwater basin. Climate change models indicate that these changes will result in a reduction of Sustainable Yield in the Bear Valley Basin over time, as discussed in Section 2.3.9 of this GSP.

If Sustainable Yield declines over time, growth in the Valley continues and water users have limited ability for further conservation, additional supply will likely be needed in the future to maintain supply reliability. The drought proof supply provided by Replenish Big Bear will become more critical to maintain water reliability in times of extended drought and provide insurance against climate change uncertainty.

5.2.1.4.1 Groundwater Depletion

The Project would provide substantial benefits to help mitigate localized imbalances in the Bear Valley Basin. While the Bear Valley Basin as a whole is sustainable, there are localized areas that show persistent groundwater level declines, which may exceed established sustainability criteria if allowed to continue. One such area is in the vicinity of the Sand Canyon Golf Course. The greens for the course are irrigated, in part, from private wells located on or near the property. As shown on Figure 5-1, groundwater levels in the monitoring well Sand Canyon No. 1, which were evaluated for the GSP, have shown an overall decline since 1992, despite periodic recovery during wet years. Without a change in groundwater management in the area, groundwater levels in this well could drop below the minimum threshold by 2042 (see Figure 5-1)

The Project will include the future option to pump 380 AF of blended recycled water and Lake water from the Lake to Sand Canyon, thus providing an alternative source of water for the Sand Canyon Golf Course. As the golf course is the primary groundwater pumper in the area, in-lieu

water supply from the Project is anticipated to have the beneficial effect of stabilizing groundwater levels and avoiding undesirable results.

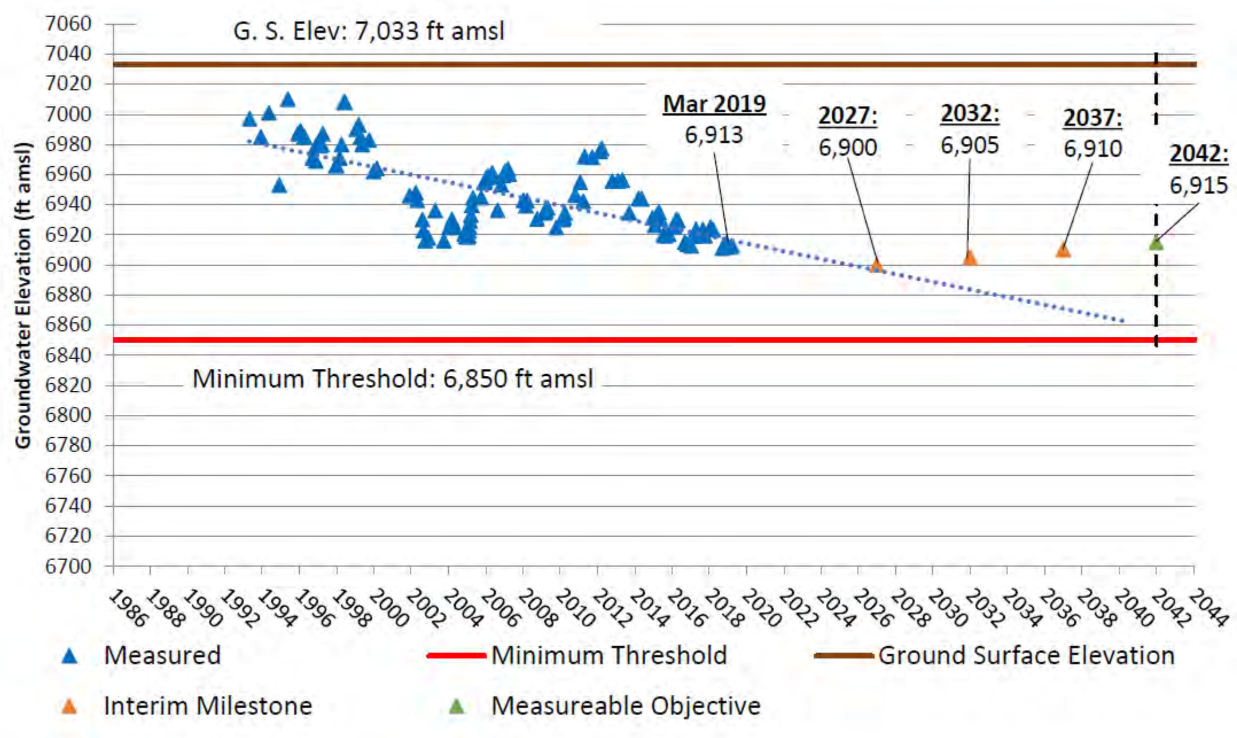


Figure 5-1. Groundwater Elevation Hydrograph, Sand Canyon Well #1

5.2.1.4.2 Availability of Alternative Supplies

The water agencies in the Bear Valley Basin rely solely on groundwater to supply municipal potable water demand. Absent Replenish Big Bear, surface water in Big Bear Lake is not available for municipal water supply in Big Bear as the lake is adjudicated and the natural inflows are reserved for other uses. Imported water, such as from the State Water Project (SWP), is not financially feasible due to the lack of infrastructure to the Valley's high elevation and isolated location. Also, there is a concern that the reliability of SWP imported supplies will continue to decrease due to multiple factors including increased demands for environmental uses and municipal demand increases with growing populations. Replenish Big Bear will provide a local, drought-resistant water supply with up to 550 AFY used to sustain groundwater levels and storage in the Basin.

5.2.1.5 Project Costs

The estimated Replenish Big Bear capital cost is approximately $55,717,000 with an annual O&M of $2,438,000. This includes the cost of the treatment upgrades at the BBARWA WWTP, as described in Section 5.2.1.1 herein, to produce the high-quality recycled water and the cost of pipelines and pump stations to convey the water to the various use locations.

To date, Replenish Big Bear has been awarded approximately $6.7 million in grant funding toward capital costs. The project team is continuously identifying and applying for new funding sources and anticipates receiving additional grant funding. Project costs not paid for by grant funding will likely be paid for through a combination of local funding sources and funding from project partners associated with the project benefits provided. The project team is currently in the process of identifying funding sources.

5.2.1.6 Project Implementation

The BVBGSA will continue to monitor projected Sustainable Yield and projected pumping to estimate when additional supply may be needed. However, due to the extended drought in recent years and the availability of grant funding to support drought resilience projects, the BVBGSA members are working to implement Replenish Big Bear in the near term to proactively address the threat of drought and begin accumulating local storage to reduce the impact of future droughts on groundwater sustainability.

The Replenish Big Bear Team, which consists of all of the member agencies of the BVBGSA, is working to obtain the necessary permitting to continue the project implementations. The current schedule anticipates completing the project by November 2025. However, the regulatory process is on the critical path and may cause the project schedule to be extended for reasons outside the agencies' control.

Once it is demonstrated that the treated Project water will be suitable for use in Shay Pond, the Replenish Big Bear Team will work with the CDFW and USFWS to develop a monitoring plan to monitor any adverse effects on the fish from changing the source of water to the pond. The existing well currently providing water to the pond will be kept on standby to provide a backup source of water should adverse impacts be observed.

5.2.1.7 Basin Uncertainty (§ 354.44.9d)

While Replenish Big Bear will help mitigate localized groundwater level and storage imbalances in the near-term, its greatest benefit will be providing insurance against uncertainty in future long-term climate change projections that affect groundwater supply in the Bear Valley Basin. Based on the current climate change projections provided by the CDWR, the average Sustainable Yield

of the basin is projected to decrease from approximately 5,300 acre-ft/yr in 2020 to approximately 4,300 acre-ft/yr by 2070 (see Figure 2-30). If current groundwater pumping projections are accurate, it is possible that pumping can be maintained below the climate-adjusted Sustainable Yield in the 50-year SGMA planning horizon. However, there is uncertainty in both the climate change projections and the pumping projections. If climate change has a bigger impact on water supply than projected, it is possible that pumping could exceed the long-term average Sustainable Yield within the 50-year SGMA planning horizon, which would result in long-term overdraft. Pumping demand in excess of that projected could also result in pumping exceeding Sustainable Yield. This uncertainty is directly addressed by the aspects of Replenish Big Bear that result in groundwater recharge and reduced groundwater pumping demand, both of which work to stabilize groundwater levels, increase groundwater in storage, and increase the Sustainable Yield of the Bear Valley Basin.

5.2.1.8 Legal Authority

California Water Code (CWC) §10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges. The BBARWA has the legal authority to sell the recycled water to BBCCSD and BBLDWP to recharge the Basin.

5.2.1.9 Permitting and Regulatory Processes

BBARWA will be responsible for acquiring permits needed for the discharge of recycled water to Shay Pond and Stanfield Marsh/Big Bear Lake. Permits for extraction of water from the Lake and discharge to the golf course and Sand Canyon are expected to be issued separately and may be issued to BBLDWP, BBCCSD and/or BBMWD.

Permits have not yet been acquired, but the Replenish Big Bear Team has initiated communications with the Regional Water Quality Control Board (RWQCB), United States Environmental Protection Agency (EPA), and the State Water Resources Control Board Division of Drinking Water (DDW) to discuss the permitting approach for the proposed discharge points. Permits will be pursued as early as possible during the design process. Coordination is underway with the permitting agencies to determine the Project's permitting strategy and the required technical studies. Anticipated new or modified permits/approvals include but are not limited to the following:

Federal Agencies:

- EPA – Total Maximum Daily Load (TMDL) compliance for discharge to Stanfield Marsh / Big Bear Lake

- USBR – National Environmental Policy Act (NEPA) lead agency which may require coordination with other federal agencies such as United States Fish and Wildlife Service, State Historic Preservation Office, Army Corps of Engineers, and National Marine Fisheries Service.

State Agencies:

- RWQCB – National Pollutant Discharge Elimination System (NPDES) for discharge to Stanfield Marsh / Big Bear Lake
- RWQCB – NPDES or Waste Discharge Requirement (WDR) for discharge to Shay Pond
- RWQCB – General Construction Permit
- RWQCB –WDR modification for changes in operation and the addition of RO brine evaporation in Big Bear.
- RWQCB – WDR for discharge to Sand Canyon
- SWRCB – Recycled Water Use Statewide General Permit
- DDW – Permitting requirements to be determined following ongoing coordination
- Caltrans – Encroachment permits for pipelines within the Caltrans Right-of-Way
- California Department of Fish and Wildlife – Approval for discharge to Shay Pond including a Lake and Streambed Alteration permit

Local Agencies:

- The City of Big Bear Lake and/or San Bernardino County – Encroachment permits for improvements within the respective Rights-of-Way
- The City of Big Bear Lake and/or San Bernardino County – Grading and building permits for treatment upgrades and the recharge basin
- South Coast Air Quality Management District – Authority to Construct and Permit to Operate the WWTP upgrades
- The Big Bear Watermaster

The Replenish Big Bear Team will work with the RWQCB, DDW, CDFW and USFWS to obtain the appropriate discharge permit(s) for Shay Pond and the Lake.

In accordance with CEQA, the Replenish Big Bear Team will prepare an Environmental Impact Report (EIR). Since federal funding is being pursued through Reclamation's Title XVI Program, an Environmental Impact Statement (EIS) or Environmental Assessment (EA) will also be prepared to comply with NEPA. All environmental documentation will require Replenish Big Bear to comply with endangered species laws, including the California Endangered Species Act and the Federal Endangered Species Act.

The Replenish Big Bear Team intends to proactively monitor and manage permitting needs and timelines to implement construction and operation of Replenish Big Bear in an efficient and timely manner.

5.2.1.10 Public Notice and Outreach

Information about Replenish Big Bear, project status updates and public meetings are shared with the public on the project website, ReplenishBigBear.com, as well as on social media, and in press releases and newspaper articles. In addition, members of the project team routinely present project updates at community meetings and public meetings, including BVBGSA meetings and the meetings of the BVBGSA members.

5.2.2 Groundwater Pumping Facilities

One of the primary strategies Bear Valley Basin agencies have used to maintain Basin-wide groundwater sustainability is adaptive management of groundwater pumping among the various Management Areas. This strategy works by shifting groundwater pumping from localized areas with declining groundwater levels to other areas with more stable groundwater levels. Basin groundwater levels and conditions change over time and may vary by Management Area so operational flexibility in the BBLDWP and BBCCSD water systems is necessary to support this adaptive management strategy. This flexibility is achieved by maintaining groundwater pumping facilities distributed throughout the Basin and by maintaining more pumping capacity than the minimum required to meet demands, particularly peak demands. This allows the agencies to turn off some wells for a period of time if groundwater levels indicate the need to reduce pumping, while still being able to provide reliable water service to the community.

There are a few Management Areas of the Bear Valley Basin that are underutilized with respect to groundwater resources. These include East Baldwin, Lake Williams, and Mill Creek. In East Baldwin, aside from private well pumping, there is no municipal pumping currently in the Management Area. The BBCCSD is currently drilling and constructing a new well in this Management Area to take advantage of the groundwater resources and increase operational flexibility. No new wells are currently planned for the Lake Williams and Mill Creek Management Areas. In Lake Williams, the existing wells are adequate to meet demand and in Mill Creek, naturally occurring groundwater quality issues (i.e. arsenic and uranium) prevent the groundwater in that area from being utilized for municipal supply. The groundwater resources in both of these Management Areas are underutilized. Future wells could be drilled in both Management Areas to provide additional operational flexibility for the agencies as well as address expected growth projections.

In addition to developing underutilized groundwater resources in the basin, maintenance of existing groundwater production facilities is essential to maintain operational flexibility to meet water demands. Currently, the BBLDWP and BBCCSD have more than 60 active wells in the Bear Valley Basin. Many of these wells and their associated pumping plants are nearing the end of their useful life of approximately 50 to 60 years and need to be repaired or replaced. In some cases, well replacement can be coordinated with the development of groundwater resources in underutilized Management Areas. Such projects are typically identified in an agency's Water Master Plan and consider expected growth projections.

In summary, there are numerous types of projects related to groundwater pumping facilities that may be needed to support the adaptive management strategy:

- Routine inspection and maintenance of wells
- Abandonment of wells that have reached the end of their life
- Drilling of new wells to replace abandoned wells
- Drilling of new wells to meet future growth
- Routine inspection, maintenance and replacement of well pumping equipment

These types of are projects routinely undertaken by BBLDWP and BBCCSD as part of their water system maintenance and will vary over time, so specific projects are not detailed in this GSP. Rather, the types of projects are described in this GSP to underscore the importance of these activities to maintaining long term Basin-wide groundwater sustainability.

The groundwater benefits associated with these projects and the Sustainable Management Criteria addressed are detailed in Table 5-1.

Table 5-2. Groundwater Pumping Facility Project Groundwater Benefits

Project	Groundwater Benefit	Sustainable Management Criteria Addressed
Well Maintenance and Replacement Pumping Equipment Maintenance and Replacement Drilling New Wells	Maintenance and expansion of groundwater pumping capacity in various locations throughout the Basin is critical to maintaining the operational flexibility needed to support adaptive management of groundwater pumping. Adaptive management may enable agencies to shift pumping away from localized areas of groundwater decline to limit decline to an acceptable level and recover through recharge.	CHRONIC LOWERING OF GROUNDWATER LEVELS REDUCTION OF GROUNDWATER STORAGE

5.2.2.1 Project Costs

The cost of groundwater pumping facility projects varies depending on the scope of necessary repairs or replacements. These costs are typically planned for in the annual operating and capital budgets adopted by BBLDWP and BBCCSD for their respective water systems and are funded by revenue from water sales, connection fees and grants, as appropriate.

5.2.2.2 Project Implementation

BBLDWP and BBCCSD will continue to be responsible for identifying and implementing projects as needed to maintain or expand their respective groundwater pumping facilities. Projects are typically identified and annual budgets and periodic Water Master Plan documents or other studies.

5.2.2.3 Basin Uncertainty

Maintaining operational flexibility will help the agencies respond to changes in actual Basin conditions based on routine monitoring, which mitigates uncertainty in the Basin setting information.

5.2.2.4 Legal Authority

BBLDWP and BBCCSD own their respective groundwater pumping facilities and have the legal authority to maintain or replace them as needed.

5.2.2.5 Permitting and Regulatory Processes

BBLDWP and BBCCSD will continue to be responsible for acquiring any permits needed for the drilling of new or replacement groundwater wells. Routine maintenance activities typically do not require permits. Discharges related to well maintenance are conducted under each agencies National Pollutant Discharge Elimination System (NPDES) permit.

Anticipated permits/approvals for new or replacement wells may include but are not limited to the following:

- San Bernardino County Department of Public Health Well Permit
- RWQCB –Construction Stormwater General Permit
- DDW – Modification of Drinking Water System Permit to include the new facility
- Caltrans – Encroachment permits for improvements or construction activities within the Caltrans Right-of-Way
- The City of Big Bear Lake and/or San Bernardino County – Encroachment permits for improvements within the respective Rights-of-Way
- South Coast Air Quality Management District – Authority to Construct and Permit to Operate a new well

In accordance with CEQA, the Replenish Big Bear Team will prepare an Environmental Impact Report (EIR). Since federal funding is being pursued through Reclamation's Title XVI Program, an Environmental Impact Statement (EIS) or Environmental Assessment (EA) will also be prepared to comply with NEPA.

The Replenish Big Bear Team intends to proactively monitor and manage permitting needs and timelines to implement construction and operation of Replenish Big Bear in an efficient and timely manner.

5.2.2.6 Public Notice and Outreach (§ 354.44B)

Information about planned groundwater pumping facility projects is presented at public meetings of the BBLDWP and BBCCSD Boards of Directors and is included in proposed and adopted annual budget materials and planning documents, which are public records available to the public.

5.3 Management Actions

The management actions in this Plan include continuing the existing adaptive management activities and water use efficiency measures the purveyors have implemented for many years.

5.3.1 Technical Review Team

A Technical Review Team (TRT) for the BBLDWP has been meeting routinely since 2004 to review Basin conditions and pumping in their service area and recommend actions needed to maintain Basin-wide sustainability. BBCCSD has historically provided their groundwater level data as input to the TRT process but has not been directly involved. The TRT will be expanded to include direct participation by the BBCCSD and will continue to meet routinely to evaluate data and make basin management decisions in the context of the Sustainable Management Criteria in this GSP. The TRT will meet a minimum of once per year but may increase the frequency to twice or more per year during drought conditions. The TRT will review the groundwater levels at each of the Representative Monitoring Stations and compare them with the Interim Milestones and Measurable Objectives established for each Management Area. The TRT will also review pumping data for the prior year for comparison with the estimated Sustainable Yield of the Basin.

The TRT may provide recommendations for adaptive basin management based on review of basin conditions and pumping. The TRT may recommend shifting pumping from a localized area with declining groundwater levels to areas with more stable groundwater levels. The General Manager of the respective agencies may then authorize a change to their respective operating strategy based on the recommendations of the TRT. The TRT may also recommend declaration of a water supply shortage stage in BBLDWP and BBCCSD's respective Water Shortage Contingency Plans, as discussed further in Section **Error! Reference source not found.**. Any such recommendation w ould be provided to the Board of Directors of the respective agencies for consideration; the TRT has no authority to declare a shortage.

5.3.2 Water Use Efficiency

BBLDWP and BBCCSD have implemented a variety of water use efficiency measures over the course of many years and have been successful in reducing demand; total potable consumption has been maintained below the Sustainable Yield of the groundwater basin. In the past decade, BBLDWP and BBCCSD have maintained a decreasing trend in per capita demands through conservation efforts.

BBLDWP and BBCCSD continue to implement a range of programs to help improve water use efficiency in the Valley. These programs, also known as Demand Management Measures, are summarized in Table 5-3 and described in detail in their respective 2020 Urban Water Management

Plans (UWMPs), which were adopted in June 2021 following a public comment period. These strategies are aimed to reduce water demands and comply with the state efficiency mandates.

Table 5-3. Demand Management Measures

MEASURE	DESCRIPTION
Water waste prevention ordinances	An ordinance that explicitly states the waste of water is to be prohibited. The ordinance may prohibit specific actions that waste water, such as excessive runoff from landscape irrigation, or use of a hose outdoors without a shut off nozzle.
Metering	Metering supply facilities and customer connections helps agencies and customers accurately account for water use and water loss and identify opportunities to improve water use efficiency. Advanced metering infrastructure (AMI) provides agencies and customers with access to more frequent and timely water use data that can be used to quickly identify leaks and evaluate use patterns that may lead to change in water use behaviors.
Conservation pricing	Tiered water rates where the cost per unit of water increases as the total volume of water used increase has been shown to encourage conservation.
Public education and outreach	Public awareness of the importance of water use efficiency and opportunities and incentives to reduce water use is critical to achieving demand reduction. Methods include bill inserts, media advertising, public signs, school programs for children, website and social media postings, community events and others.
Programs to assess and manage distribution system real loss	Water agencies conduct annual water loss audits to estimate the amount of water loss. Methods to reduce water loss include monitoring and fixing detected leaks, replacing old leaking water mains, and proactively detecting leaks using AMI meter data.
Water conservation program coordination and staffing	An established water conservation program and staff resources to support the program are critical for continued success.
Other demand management measures	Other measures include incentive and rebate programs for water-efficient items and indoor and outdoor conservation audits to help customers identify conservation opportunities.

5.3.3 Water Shortage Contingency Plan

The California Water Code requires urban water suppliers, including BBLDWP and BBCCSD, to have Water Shortage Contingency Plans (WSCPs), which are detailed plans for how each agency intends to predict and respond to foreseeable and unforeseeable water shortages. BBLDWP and BBCCSD most recently updated their WSCPs in June 2021 along with the 2020 UWMPs. Detailed information on the respective WSCPs can be found in the 2020 UWMPs, and a summary is provided here.

A water shortage occurs when the water supply is reduced to a level that cannot support typical demand at any given time. Water shortages can be triggered by a hydrologic limitation in supply (i.e., a prolonged period of below normal precipitation and runoff), limitations or failure of supply and treatment infrastructure, or a combination of conditions. Hydrologic or drought limitations tend to develop and abate more slowly, whereas infrastructure failure tends to happen quickly and

relatively unpredictably, such as during an earthquake. A WSCP is used to provide guidance to an agency's Board of Directors (Board), staff, and the public by identifying anticipated shortages and a range of potential response actions to allow for efficient management of any water shortage with predictability and accountability.

The current WSCPs include a new process to conduct an Annual Water Supply and Demand Assessment (AWSDA) each year, assuming that the following year will be dry, and submit the results to DWR beginning in July 2022. The groundwater level monitoring and pumping data evaluated by the TRT will also support each agency's determination of expected supplies and demands for the coming year. If the result of the TRT review and the AWSDA indicate that a water supply shortage is likely based on either on a shortage of supplies to meet demands or an unacceptable reduction in groundwater levels, the General Manager of the agency may recommend that the Board declare a water shortage at a level needed to address the supply shortage. BBLDWP's WSCP includes seven shortage levels and BBCCSD's includes six shortage levels, ranging from 0% water shortage to a greater than 50% water shortage. Each shortage level has a corresponding set of potential shortage actions that may be implemented as appropriate, with more severe actions corresponding to higher levels of water shortage. The specific shortage response actions vary by agency and can be found in the adopted BBLDWP and BBCCSD WSCPs. Examples of potential shortage response actions that may be implemented at various stages are:

- Limiting landscape irrigation to specific days and times
- Increased public outreach and education to increase awareness of current water supply conditions and the need to conserve water
- Using an intertie between BBLDWP and BBCCSD to transfer water supplies from one to another

The WSCPs are a tool that can be used in coordination with other projects and water management actions as part of GSP implementation to help prevent or address a supply shortage and promote long term groundwater sustainability.

6. Implementation Plan

This chapter is intended to serve as a conceptual roadmap for the BVBGSA to start implementing the GSP over the first five years and discusses implementation effects in accordance with the SGMA regulations sections 354.8(f)(2) and (3).

The implementation plan provided in this chapter is based on current understanding of Bear Valley Basin conditions and includes consideration of the projects and management actions included in Chapter 5, as well as other actions that are needed to successfully implement the GSP including the following:

- GSP implementation, administration, and management
- Funding
- Reporting, including annual reports and 5-year evaluations and updates

6.1 GSP Implementation, Administration, and Management

6.1.1 Administrative Approach/Governance Structure

The BVBGSA will continue to operate under the existing JPA that formed the GSA, unless and until actions are taken amending/revising the existing JPA.

6.1.2 Implementation Schedule

A general summary showing the major activities and estimated timeline for the GSP implementation is provided in Table 6-1. Additional details about the activities included in the schedule are provided in these activities' respective sections of this GSP.

6.1.3 Implementation Costs

Development of this GSP was funded through a Proposition 1 Sustainable Groundwater Planning Grant from DWR, along with in-kind contributions from the BVBGSA members.

The GSA may play a role in pursuing grants and low-interest financing to help pay for GSP implementation costs to the extent possible to offset costs for the GSA members. However, external funding/financing may only be eligible for projects and management action implementation and not ongoing GSP administrative expenses. Ongoing implementation of the GSP is expected to include contributions from the GSA member agencies, which are ultimately funded through customer fees or other public funds.

Costs related to the various activities anticipated for the first five years are shown in Table 6-1. The costs shown are limited to costs of support from consultants and do not include the costs of staff time contributed by BVBGSA member agencies.

Implementation of this GSP is estimated to cost an average of approximately $47,000 per year for the first five years of implementation, excluding the planning and development of the specific projects listed in Chapter 5, which are being implemented and funded separately. Estimates of future annual implementation costs (Years 6 through 20) will be developed during future updates of the GSP based on actual costs incurred in the first 5 years and expected changes for future implementation.

6.1.3.1 DWR Coordination for GSP Approval

After the adopted GSP is submitted to DWR, it will be posted to DWR's website for a public comment period of at least 60 days. DWR will also perform an evaluation of the GSP within two years of submittal and issue a written assessment indicating whether the GSP is approved or requires modifications prior to approval. Coordination with DWR may be needed to support the evaluation process and respond to any questions or comments from DWR. It is anticipated that DWR coordination will be conducted by staff of the of the BVBGSA member agencies with support from consultants as needed.

As shown in Table 6-1, the estimated cost of DWR Coordination for GSP Approval is estimated at approximately $5,000 , but actual costs will depend on the feedback received from DWR.

6.1.3.2 Monitoring Network Implementation

The Monitoring Network will consist of the existing monitoring network used by BBLDWP and BBCCSD to obtain groundwater level and quality data. BBLDWP and BBCCSD routinely collect groundwater level data as part of system operation and monitory water quality in accordance with the State Water Resources Control Board Division of Drinking Water requirements. No additional monitoring requirements are anticipated as part of the GSP. The cost of monitoring is already included in the BBLDWP and BBCCSD annual operating budgets, so no additional costs are included for GSP implementation, as shown in Table 6-1.

6.1.3.3 Technical Review Team

The TRT will meets a minimum of once per year but may increase the frequency to twice or more per year during drought conditions. The TRT will review the groundwater levels at each of the Representative Monitoring Stations and compare them with the Interim Milestones and Measurable Objectives established for each Management Area. The TRT will also review

pumping data for the prior year for comparison with the estimated safe Sustainable Yield of the Basin. Results and recommendations will be documented and included in the GSP Annual Report.

The TRT may provide recommendations for adaptive basin management based on review of basin conditions and pumping. The TRT may also recommend declaration of a water supply shortage stage in BBLDWP and BBCCSD's respective Water Shortage Contingency Plans, as discussed further in Section 5.3.3. The TRT will be led by staff from BBLDWP and BBCCSD with support from a hydrogeologist. In addition, support from a hydrogeologist may be needed between meetings. The annual cost for two (2) TRT meetings and as-needed support throughout a year is estimated to be approximately $9,400.

6.1.3.4 Project Implementation

The costs of specific projects and management actions will like vary year by year, based in part on needed adaptive management activities and the maintenance needs of groundwater pumping facilities.

Groundwater pumping facility maintenance and expansion will continue to be implemented as needed and funded by the owners of the respective facilities through a combination of rates, connection fees and grants.

The Replenish Big Bear project is a joint project with multiple benefits and beneficiaries and funding and financing discussions are underway and have not yet been finalized. The project has already been awarded approximately $6.7 million in grant funding and additional grants funding is being pursued. The GSA may play a role in pursuing additional grants and low-interest financing to help pay for a portion of Replenish Big Bear costs to the extent possible.

6.1.3.5 Reporting

SGMA regulations require the GSAs to submit annual reports to DWR on the status of GSP implementation. SGMA regulations require the GSAs to evaluate the GSP at least every 5 years and whenever the Plan is amended. The reporting requirements for the periodic evaluation are presented in Section 6.2.

It is anticipated that the BVBGSA will obtain the services of a hydrogeology consultant to lead preparation of the annual report, and BVBGSA member agency staff will support by preparing updated hydrographs and summarizing annual groundwater extractions. The estimated cost to prepare an annual report is $22,000/year.

The initial 5-year GSP evaluation is due for submission to DWR in 2027. It is anticipated that the GSA would obtain the services of a hydrogeology consultant to lead preparation of the initial 5-year update. The cost for the initial Five Year GSP update is estimated to be $75,000.

The total cost of reporting over the initial five years of the GSP implementation is estimated to be $185,000.

It is anticipated that the Reporting Costs will be paid for by the GSA member agencies.

6.1.4 Outreach and Communication

To meet the requirements of SGMA, implementation of the GSP will require additional communication and outreach efforts and coordination among the GSA Agencies. The GSA member agency staff will continue to post information and updates on the website and share information and updates at public meetings.

6.2 Reporting

As part of GSP implementation, SGMA Regulation §356.2 requires GSAs to develop annual reports and more detailed five-year evaluations, which could lead to updates of the GSP. The following sections describe the reporting requirements for both the annual reports and five-year evaluations.

6.2.1 Annual Reports

Annual reports will be developed to address current needs in the Basin and the legal requirements of SGMA. As defined by DWR, annual reports must be submitted for DWR review by April 1st of each year following the GSP adoption, except in years when five-year or periodic assessments are submitted. Annual reports are anticipated to include three key sections: General Information, Basin Conditions, and Implementation Progress. The GSA will compile information relevant to annual reports and coordinate collection of information and submit a single annual report for the Basin to DWR.

Development of an annual report will begin following the end of the water year, September 30, and will include an assessment of the previous water year. The annual report will be submitted to DWR before April 1st of the following year. The 2021 annual report covering water year 2021 will be submitted by the GSA by April 1, 2022. Five annual reports for the Basin will be submitted to DWR between 2022 and 2026, prior to the first five-year assessment of this GSP, which is to be submitted to DWR in January 2027.

6.2.1.1 General Information

The General Information section will include an executive summary that highlights the key content of the annual report. This section will include a map of the Basin, a description of the sustainability goals, a description of GSP projects and their progress, as well as an annual update to the GSP implementation schedule.

6.2.1.2 Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results in the Basin. This section will include an evaluation of how conditions have changed over the previous year and will compare groundwater data for the water year to historical groundwater data.

Pumping data, effects of project implementation (if applicable), total water use, and groundwater storage data will be included. Key required components include:

- Groundwater level data from the monitoring network, including contour maps of seasonal high and seasonal low water level maps
- Hydrographs of groundwater elevation data at RMS
- Groundwater extraction data by water use sector (including springs and slant wells)
- Groundwater Quality at RMS
- Total water use data
- Change in groundwater in storage
- Subsidence rates and associated survey data

6.2.1.3 Implementation Progress

Progress toward GSP implementation will be included in the annual report. This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key required components include:

- GSP implementation progress, including proposed changes to the GSP
- Progress toward achieving the Basin sustainability goals

6.2.2 Five-Year Evaluation Reports

As required by SGMA regulations, an evaluation of the GSP and the progress toward meeting the approved sustainable management criteria and the sustainability goal will occur at least every five years and with every amendment to the GSP. A written five-year evaluation report (or periodic evaluation report) will be prepared and submitted to DWR. The information to be included in the evaluation reports is provided in the sections below.

6.2.2.1 Sustainability Evaluation

A Sustainability Evaluation will contain a description of current groundwater conditions for each applicable sustainability indicator and will include a discussion of overall sustainability in the Basin. Progress toward achieving interim milestones and measurable objectives will be included, along with an evaluation of status relative to minimum thresholds.

6.2.2.2 Plan Implementation Progress

A Plan Implementation Progress section will describe the current status of project and management action implementation and whether any adaptive management actions have been implemented since the previous report. An updated project implementation schedule will be included, along with any new projects identified that support the sustainability goals of the GSP and a description of any projects that are no longer included in the GSP. The benefits of projects and management actions that have been implemented will be described and updates on projects and management actions that are underway at the time of the report will be documented.

6.2.2.3 Reconsideration of GSP Elements

As additional monitoring data are collected, land uses and community characteristics change, and GSP projects and management actions are implemented, it may become necessary to reconsider elements of this GSP and revise the GSP as appropriate. GSP elements to be reassessed may include basin setting, management areas, undesirable results, minimum thresholds, and measurable objectives. If appropriate, a revised GSP, completed at the end of the five-year assessment period, will include revisions informed by findings from the monitoring program and changes in the Basin, including changes to groundwater uses, demands, or supplies, and results of project and management action implementation.

6.2.2.4 Monitoring Network Description

A description of the monitoring network will be provided. An assessment of the monitoring network's function will be included, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a method for addressing these data gaps, along with an implementation schedule for addressing gaps and a description of how the GSA will incorporate updated data into the GSP.

6.2.2.5 New Information

New information available since the last five-year evaluation or GSP amendment will be described and evaluated. If the new information should warrant a change to the GSP, this will also be included, as described previously in Reconsideration of GSP Elements.

6.2.2.6 Regulations or Ordinances

A summary of the regulations or ordinances related to the GSP that have been implemented by DWR or others since the previous report will be provided. The report will include a discussion of any required updates to the GSP.

6.2.2.7 Legal or Enforcement Actions

Legal or enforcement actions taken by the GSA in relation to the GSP will be summarized, including an explanation of how such actions support sustainability in the Basin.

6.2.2.8 Plan Amendments

A description of amendments to the GSP will be provided in the five-year evaluation report, including adopted amendments, recommended amendments for future updates, and amendments that are underway.

6.2.2.9 Coordination

Ongoing coordination will be required among the GSA. The five-year evaluation report will describe coordination activities between these entities such as meetings, joint projects, data collection and sharing, and adaptive management efforts.

6.2.2.10 Reporting to Stakeholders and the Public

Outreach activities associated with the GSP implementation, assessment, and GSP updates will be documented in the five-year evaluation report.

GSP Implementation Activities and Costs (2022-2027)

GSP Implementation Activity	Description	Estimated Cost[2]	Unit	Anticipated Timeframe	Estimated Costs (2022 - 2027)
DWR Coordination for GSP Approval	Coordination with DWR during their evaluation process and response to any questions or comments from DWR	$5,000	Lump Sum	2022 - 2023	$5,000
Monitoring Network Implementation	Complete routine monitoring of groundwater levels and water quality	No additional cost			No additional cost
Technical Review Team	Conduct bi-annual reviews of basin conditions and document results	$9,400	Annual	2022 - 2026	$47,000
Project Implementation[3]	Implementation of Replenish Big Bear and Groundwater Pumping Facility projects	Varies			Budgeted separately
Annual Reports	Compile data and prepare GSP Annual Report	$22,000	Annual	2022 - 2026	$110,000
5-Yr GSP Updates	Compile data and prepare 5-yr GSP Updates,	$75,000	Lump Sum	Q2, 2026 - Q1, 2027	$75,000
				Total Estimated Costs (2022 - 2027)	$237,000
				Average Annual Estimated Cost (2022 - 2027)	$47,000

Notes:

[2]Consultant costs only, does not include staff time contributed by BVBGSA member agencies

[3]The cost for Replenish Big Bear and Groundwater Pumping Facility projects are not included in the Implementation cost estimate. Implementation and funding of these projects will be coordinated and budgeted separately.

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