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WATER YEARS 2016 – 2021
SIX YEAR REVIEW AND REPORT
OLYMPIC VALLEY, CALIFORNIA

Olympic Valley, Placer County California

Prepared for:

Olympic Valley Public Service District

January 2023

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SECTION 1: INTRODUCTION

This report is the third multi-year review and report prepared under the 2007 Olympic Valley Groundwater Management Plan (GMP). Previously, a Quinquennial Review and Report (QRR) was drafted in order to summarize the groundwater conditions and document the status of the groundwater management activities in the Olympic Valley Basin during the five-year period from the 2011 through the 2015 Water Years (October 1, 2010 through September 30, 2015) (HydroMetrics WRI, 2017). The QRR also recommended amendments to the original GMP following the review of the groundwater data. The purposes of the QRR included:

- Providing a succinct description of current groundwater conditions in Olympic Valley, and groundwater conditions in the previous five years;
- Providing all stakeholders data and analyses that can assist with groundwater management in Water Year 2016;
- Detailing recent basin management activities; and
- Recommending future groundwater management activities.

This report builds off of the previous QRR and summarizes the following six-year period from the 2016 through the 2021 Water Years (October 1, 2016 through September 30, 2021) and will be referred to as the Six Year Review and Report (SRR). The SRR is intended to inform groundwater users and stakeholders within the Olympic Valley Basin on activities that relate to water resources use and management, water resources data collected over the period, and the general status of water resources management in the basin. Informed and cooperative groundwater management is essential to effectively manage the groundwater resources in the Olympic Valley Basin.

1.1 OLYMPIC VALLEY GROUNDWATER MANAGEMENT PLAN

The California Groundwater Management Act (California Water Code §10753 *et seq.*), enacted as Assembly Bill (AB) 3030 in 1992, encouraged local public agencies to adopt formal plans to manage groundwater resources within their jurisdictions. In September 2002, Senate Bill (SB) 1938 was signed into law amending sections of the Water Code related to groundwater management. SB1938 set forth specific requirements for GMPs including establishing Basin Management Objectives (BMOs), preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management.

In accordance with AB3030 and SB1938, the Olympic Valley Public Service District (OVPSD) developed a GMP in 2007. This plan was developed in coordination with input from a stakeholders group that included representatives from other groundwater users, environmental advocates, regulatory agencies, and the general public. The OVPSD adopted the GMP on May 29, 2007. In accordance with the California Department of Water Resources (DWR) suggested components for a GMP (DWR, 2003) the Olympic Valley GMP included a requirement for regular reporting of groundwater activities and GMP implementation. This SRR is the vehicle for regular reporting on groundwater activities, and is an important component of the GMP implementation.

1.2 DESCRIPTION OF OLYMPIC VALLEY

1.2.1 BASIN BOUNDARIES AND GMP MANAGEMENT AREA

The GMP management area does not exactly coincide with the Olympic Valley Basin described in DWR Bulletin 118. The boundaries of the groundwater basin managed under the GMP are defined by geologic and hydrologic features that limit the movement of groundwater in the unconsolidated sediments filling Olympic Valley. These unconsolidated valley-fill sediments are bounded by low permeability granitic and volcanic rocks on the north, west, and south, and underlay the valley-fill sediments. The blue hydrogeologic boundary shown on Figure 1 outlines the extent of the hydrographic groundwater basin established in DWR Bulletin 118 (DWR 2003).

The GMP management area is a subarea of the unconsolidated sediments within the hydrogeologic boundary, and is shown with a green line in Figure 1. The eastern end of the GMP management area is delimited by low permeability glacial moraine deposits. These moraine deposits are considerably less permeable than sediments in other parts of Olympic Valley and are interpreted to constrain groundwater flow.

1.2.2 GEOLOGY OF GROUNDWATER BASIN SEDIMENTS

Groundwater extracted from Olympic Valley is derived primarily from unconsolidated sediments filling the valley. These unconsolidated valley-fill sediments are underlain by Cretaceous granitic rocks of the Sierra Nevada batholith and Pliocene volcanic rocks.

The unconsolidated sediments were deposited primarily by glacial, lacustrine, and fluvial processes. The most prominent glacial feature is the terminal moraine at the eastern end of the valley. This moraine formed a dam in the valley outlet during the Pleistocene. Various alluvial, glacial, and lacustrine sediments collected behind this dam, filling in the valley to its present elevation. This moraine currently serves as a "barrier" or constriction to groundwater flow, and forms the eastern boundary of the area managed under the GMP, as discussed in Section 1.2.1.

Geological interpretation of the valley-fill sediments is difficult because the alluvial and lacustrine deposits do not show clear lateral continuity between wells. However, the sediments filling the valley are generally coarser in the western part of the valley and become finer towards the northeastern part of the valley. This is consistent with the fact that Washeshu Creek flows from west to east through the valley. Coarser material is deposited by Washeshu Creek proximal to the mountain front; finer material is carried farther downstream and deposited in the eastern portion of the valley.

West Yost & Associates (2005) divided the basin sediments into three hydrostratigraphic units (HSU). HSU 1 is the shallowest unit. This unit consists of fine-grained glacial lake and modern stream deposits. The modern Washeshu Creek has cut channels in the lake deposits and deposited coarser grained stream sediments within the glacial sediments. HSU 2 underlies HSU 1 and consists of sands and gravels. West Yost & Associates (2005) interpreted these sediments as deposited by a stream between periods of glacial lake deposition. HSU 3, the deepest unit, consists primarily of fine-grained sediments (silts and clays) of low permeability which may represent glacial lake or glacial till deposits.

1.2.3 WATER SUPPLY

All domestic, municipal, and irrigation water in Olympic Valley is derived from local groundwater sources. Groundwater is primarily extracted from glacial deposits and river alluvium filling Olympic Valley; a lesser amount is extracted from fractured bedrock along the sides of the valley.

The bulk of the groundwater pumped from the Olympic Valley groundwater basin is pumped by four entities: OVPSD, Squaw Valley Mutual Water Company (SVMWC), the Resort at Squaw Creek (RSC), and Palisades Tahoe ski area. Table 1 lists the quantities pumped by these entities from wells over the past six water years (a water year is Oct 1 through Sept 30 of the calendar year).

Table 1: Major Pumping in Olympic Valley by Water Year

Entity	Water Year 2016		Water Year 2017		Water Year 2018		Water Year 2019		Water Year 2020		Water Year 2021	
	Million Gallons	Acre-feet	Million Gallons	Acre-feet	Million Gallons	Acre-feet	Million Gallons	Acre-feet	Million Gallons	Acre-feet	Million Gallons	Acre-feet
OVPSD	90	277	110	338	112	345	114	349	110	336	105	321
SVMWC	16	50	14	43	15	47	15	45	17	52	16	51
RSC	No Data	No Data	30 (incomplete data)	92	82	251	87	266	93	284	81	248
Palisades Tahoe	No Data	No Data	12	37	23	69	13	40	18	56	20	60

A relatively minor amount of groundwater was pumped from the basin by PlumpJack Inn. PlumpJack is a hotel that receives potable water from OVPSD, but a private well on the property is used only for limited landscape irrigation of an area of approximately 1.5 acres (Todd Groundwater et. al., 2015). Additional groundwater is supplied from outside the GMP management area from horizontal wells along the flanks of Olympic Valley. It should be noted that water produced from these horizontal wells is not included in the OVPSD and SVMWC total volumes shown in Table 1; horizontal well data are presented in Section 3.4. Groundwater is also pumped from private wells such as the Branaugh property well at the east end of the Valley, but no recorded information regarding volume or timing of this private water use are available. Because these wells lie outside the GMP management area, they are not discussed further in this report.

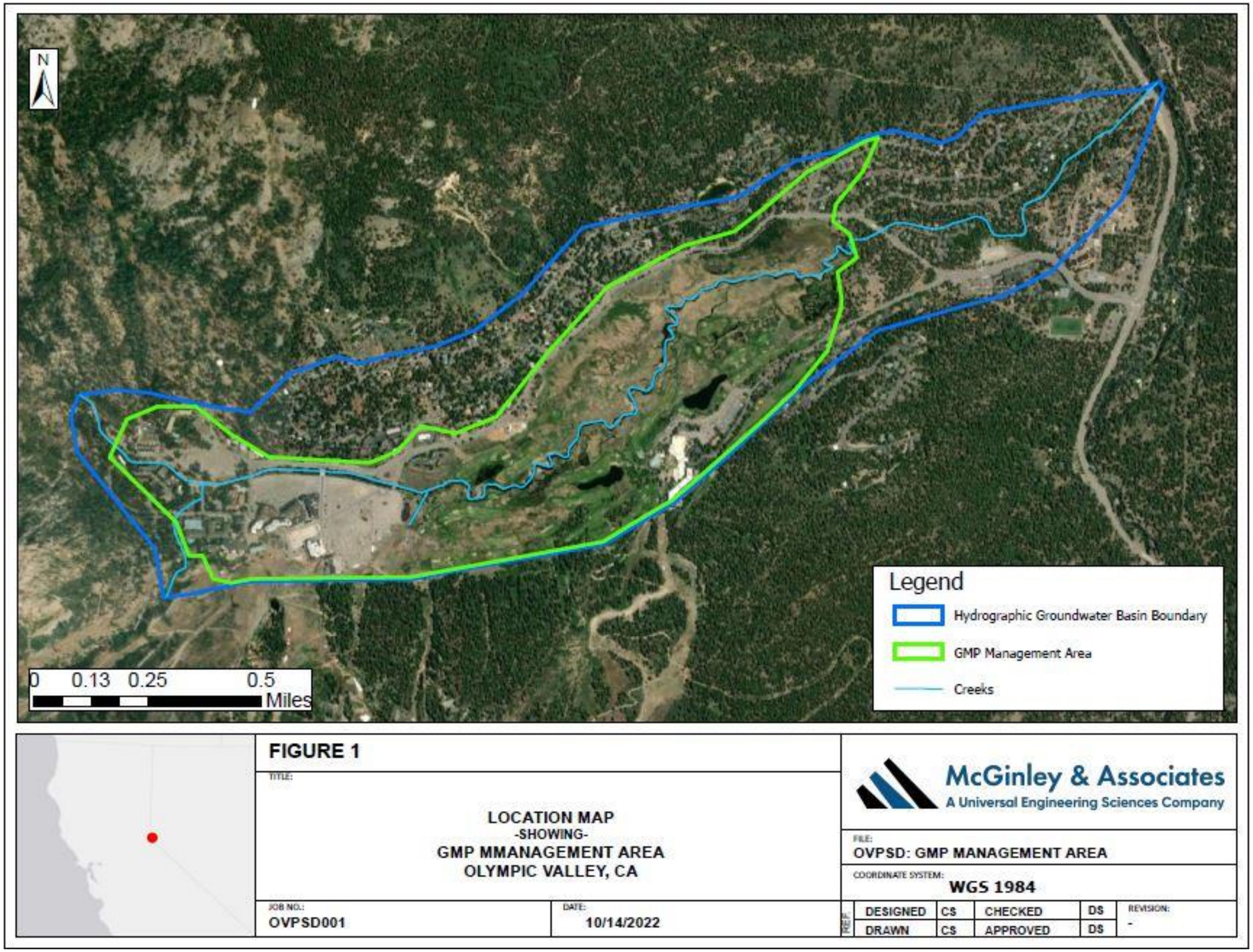


Figure 1: GMP Management Area Boundary

SECTION 2: DATA AVAILABILITY

This section reviews the availability of various data relevant to groundwater management in Olympic Valley. This review includes a summary of the data available for Water Years 2016 through 2021, the data source, frequency, and the period of record. The data are summarized in Section 3 of this report.

2.1 CLIMATE DATA

Climate data are available from two stations within the Olympic Valley: The Old Fire Station precipitation gauge and the Palisades Tahoe SNOTEL station.

2.1.1 OLD FIRE STATION

This station is operated by OVPSD and is located on the valley floor within the GMP management area. Daily precipitation data are largely complete at this station from Water Year 1965 through the present. Daily precipitation data at the Old Fire Station is complete for the entire Water Year 2016 through 2021 period.

A total of four gauges have operated at the Old Fire Station: data from a Davis gauge that began operation in 2002 was replaced with a newer NovaLynx gauge which has operated since January 2009. This gauge has been replaced with a new NovaLynx gauge in both 2015 and 2021. Prior to 2002, data were collected from the Old Fire Station by manual observations in a volumetric gauge.

2.1.2 SNOTEL PALISADES TAHOE

The SNOTEL station is operated by Palisades Tahoe and is located west of the GMP management area at an elevation of 8,029 feet. Data from the SNOTEL station is shared with the Natural Resources Conservation Service (NRCS). Data are available for this station since January 1981. Available data include snow depth, precipitation, and temperature. Historical daily and monthly data are available on the USDA NRCS website.

2.2 PUMPING DATA

Groundwater pumping data from within the GMP management area are available for OVPSD production wells, SVMWC production wells, irrigation and snowmaking from RSC wells, and for snowmaking from Palisades Tahoe wells within the valley.

2.2.1 OVPSD PUMPING

During Water Years 2016 through 2022, OVPSD pumped four wells within the GMP management area: wells OVPSD#1R, OVPSD#2R, OVPSD#3, and OVPSD#5R. Operation of well OVPSD#2 was stopped on May 24, 2011. This well was replaced by well OVPSD#2R, which started operation on October 26, 2011. OVPSD#1 was replaced by OVPSD#1R in June of 2005. Additionally, OVPSD produced groundwater from two horizontal wells outside the GMP management area. The data from these wells are complete for Water Years 2016 through 2022.

2.2.2 SVMWC PUMPING

During Water Years 2016 through 2022, SVMWC pumped two wells within the GMP management area: wells SVMWC#1 and SVMWC#2. In addition, SVMWC obtained water from their horizontal well which is outside of the GMP management area. The pumping data from the two vertical wells located in the GMP management area is complete for Water Years 2016 through 2022.

2.2.3 RSC PUMPING

During Water Years 2016 through 2021, RSC pumped from three wells within the GMP management area: wells 18-1, 18-2, and 18-3R. Water from these three wells is pumped into storage ponds, and used by RSC for irrigation or snowmaking. Water pumped from the storage ponds passes through a single flow meter. Monthly pumping data for this single flow meter was available for Water Years 2017 through 2021, as reported by RSC. The level of data QA/QC is not known.

2.2.4 PALISADES TAHOE PUMPING

Palisades Tahoe produces water for snowmaking during the winter months, and a much smaller amount of water for irrigation during the summer months, from four wells within the GMP management area: the Children's N, Children's S, Children's W, and Cushing wells (Figure 2). Data on pumped volume was provided by Palisades Tahoe and the level of data QA/QC is unknown. Data from Palisades Tahoe wells were not presented in previous annual GMP reports for water years before 2011.

2.3 HORIZONTAL WELL PUMPING DATA

At the request of the Basin Advisory Group, the group established by the GMP to advise groundwater management implementation done by OVPSD, production data from horizontal wells located along the edge of the valley are reported in this document in Section 3.4. OVPSD has two horizontal wells and SVMWC has one horizontal well. Each agency measures the monthly amount produced from their wells.

2.4 GROUNDWATER LEVEL DATA

During Water Years 2016 through 2021, groundwater level measurements were available from OVPSD, SVMWC, and RSC wells (Figure 2). Comprehensive aquifer monitoring was identified as a key element in implementing the GMP's stated goals, with the goal of populating the Olympic Valley GMP Database. Groundwater level data are compiled in the GMP database, which is maintained and regularly updated by OVPSD.

The aquifer monitoring program has increased the quality and availability of groundwater level data within the basin for Water Years 2016 through 2021. There is currently water level monitoring equipment installed in 14 wells. The monitoring program and database have provided valuable data and groundwater management information, and have supported numerous groundwater investigations since implementation.

Additional water level data were also collected from a group of RSC wells as part of RSC's Chemical Application Management Plan (CHAMP) monitoring program, and for shallow water table monitoring in Washeshu meadow. The sections below describe the groundwater data collected from OVPSD, SVMWC, and RSC.

2.4.1 OVPSD GROUNDWATER LEVEL DATA

Groundwater levels are currently collected by OVPSD using level data loggers for non-production wells, and water level transducers tied to a supervisory control and data acquisition (SCADA) software system at production wells OVPSD#1, OVPSD#2R, and OVPSD#5R. Groundwater level data from all of these wells are complete for Water Years 2016 through 2021. Well OVPSD#3 is not equipped with level transducer equipment and no water levels have been taken at this well. Additional groundwater level data are collected from OVPSD monitoring wells OVPSD#5S, OVPSD#5D, OVPSD#4R, Poulsen shallow, Poulsen deep, PlumpJack shallow, and PlumpJack deep using Diver transducers and data loggers that were installed in 2009 for the Creek/Aquifer Interaction Project (HydroMetrics WRI, 2010). Data are downloaded by OVPSD a minimum of twice a year per the Olympic Valley Monitoring Plan, and is reported to the California Statewide Groundwater Elevation Monitoring (CASGEM) Program.

2.4.2 SVMWC GROUNDWATER LEVEL DATA

Groundwater elevations have been measured in the SVMWC wells either by hand or using transducers for the entire period of Water Year 2016 through 2021. Monthly groundwater level measurements were collected by hand at wells SVMWC#1 and SVMWC#2/2R through 2014, after which water level transducers were installed and linked to a SCADA system. Updated SCADA data are available through Water Year 2021.

2.4.3 MEADOW AREA GROUNDWATER LEVEL DATA

Groundwater level data in the Washeshu meadow are collected under three programs: OVPSD's aquifer monitoring program, the RSC's Chemical Application Management Plan; and the RSC's meadow monitoring required as a condition of the Phase 2 EIR for resort expansion.

2.4.3.1 OVPSD MEADOW AREA GROUNDWATER LEVEL DATA

Since 2009, OVPSD has collected groundwater level data from seven monitoring wells in the Washeshu meadow:

- RSC-311,
- RSC-312,
- RSC-317,
- RSC-318,
- RSC-324,
- RSC-327,
- RSC-328.

Groundwater level data are collected from these seven wells using Diver transducers and data loggers. The groundwater level data for each of the seven wells contains numerous gaps during the period of time from Water Years 2016 through 2021 due to occasional equipment maintenance.

2.4.3.2 RSC MEADOW AREA GROUNDWATER LEVEL DATA

Groundwater levels are monitored by RSC at a number of wells in the Olympic Valley meadow. The monitoring is required by the California Regional Water Quality Control Board (CRWQCB) Order Number 6-93-26. This order incorporates provisions of RSC's CHAMP, including groundwater level monitoring.

Groundwater levels are measured during water quality sampling events specified in the revised Waste Discharge Requirements (WDR). The requirements were revised in May 2009, and state that all functioning meadow monitoring wells are to be monitored for static water level from May through October (CRWQCB, 2009). Previous to the 2009 WDR revision, shallow CHAMP wells were sampled every two years, and deep CHAMP wells were sampled every four years. The monitoring wells from which levels were collected included well numbers RSC-301 through RSC-312, and RSC-315 through RSC-332.

2.4.3.3 RSC Phase 2 EIR Meadow Monitoring

In the summer of 2017, five (5) shallow water table piezometers were installed in Washeshu Meadow to monitor shallow groundwater levels (Figure 2). The piezometers have been installed to comply with RSC Phase II SEIR mitigation measure 4.5.9c (PMC, 2008), whereby soil moisture is required to be monitored along vegetation transects, as initially surveyed for the SEIR Installation of the piezometers is documented by Interflow Hydrology (2017).

The PZ-1 to PZ-5 piezometers were constructed using drive points consisting of an integrated drive point and screen (Water Source USA, 36-inch length, 1-1/4-inch diameter, stainless steel drive point with 80 mesh screen), and 1-1/4-inch ID galvanized steel pipe risers. The drive point piezometers were installed on September 11 and 12, 2017, to depths of the 4.5 to 11 feet below land surface, depending on the depth to groundwater observed during installation. Water level recorders (Solinst Leveloggers) were installed on September 28, 2017 and programed to record water levels on an hourly frequency. Water level recording continued through November 2, 2017, after which transducers were removed for the winter, with anticipation of reinstallation in the spring of 2018 when snow-melt and ground conditions permit. Spring through fall water level recording has continued since 2017 installations, with the exception of a data gap in 2020 that was related to temporary cessation of RSC operations during COVID.

2.5 GROUNDWATER QUALITY

Three sources of groundwater quality data are available: municipal supply data available from Title 22 drinking water requirements, data from regulated environmental compliance sites, and groundwater quality monitoring data from the CHAMP program at the golf course.

2.5.1 Municipal Groundwater Quality

Groundwater quality data from OVPSD and SVMWC municipal production wells are collected as required under the California Code of Regulations (CCR) Title 22 requirements.

2.5.1.1 OVPSD

During Water Years 2016 through 2021, groundwater quality data were collected at wells OVPSD#1R, OVPSD#2/2R, OVPSD#3, and OVPSD#5R, as well as the OVPSD horizontal wells. These data are reviewed in Section 4.

2.5.1.2 SVMWC

During Water Years 2016 through 2021, groundwater quality data were collected by OVWMC at wells SVMWC#1 and SVMWC#2, as well as the SVMWC horizontal well. These data are reviewed in Section 4.

2.5.2 Environmental Compliance Sites

There are no active CRWQCB cleanup sites within the GMP management area at this time. The most recent active site was at a private residence, which was closed as of September 24, 2009, and included in previous reports (HydroMetrics WRI, 2011).

2.5.3 CHAMP Program

The CHAMP program samples groundwater quality at 32 shallow and deep monitoring wells in the meadow. Currently, as per the revised WDR for the Resort at Squaw Creek, five monitoring wells are sampled monthly from May through October. The wells included in the revised WDR are, from west to east: wells OVPSD#5S, RSC-305, RSC-306, RSC-322, and RSC-301. The constituents currently tested for include: dissolved nitrite as nitrogen, dissolved nitrate as nitrogen, dissolved kjeldahl nitrogen, dissolved total phosphorous, dissolved orthophosphate, pH, temperature, and specific conductivity. Dissolved constituents (filtered) instead of total constituents are now required by the California Division of Drinking Water (DDW). Filtering the water samples attempts to isolate organic forms of fertilizer now commonly used on golf courses.

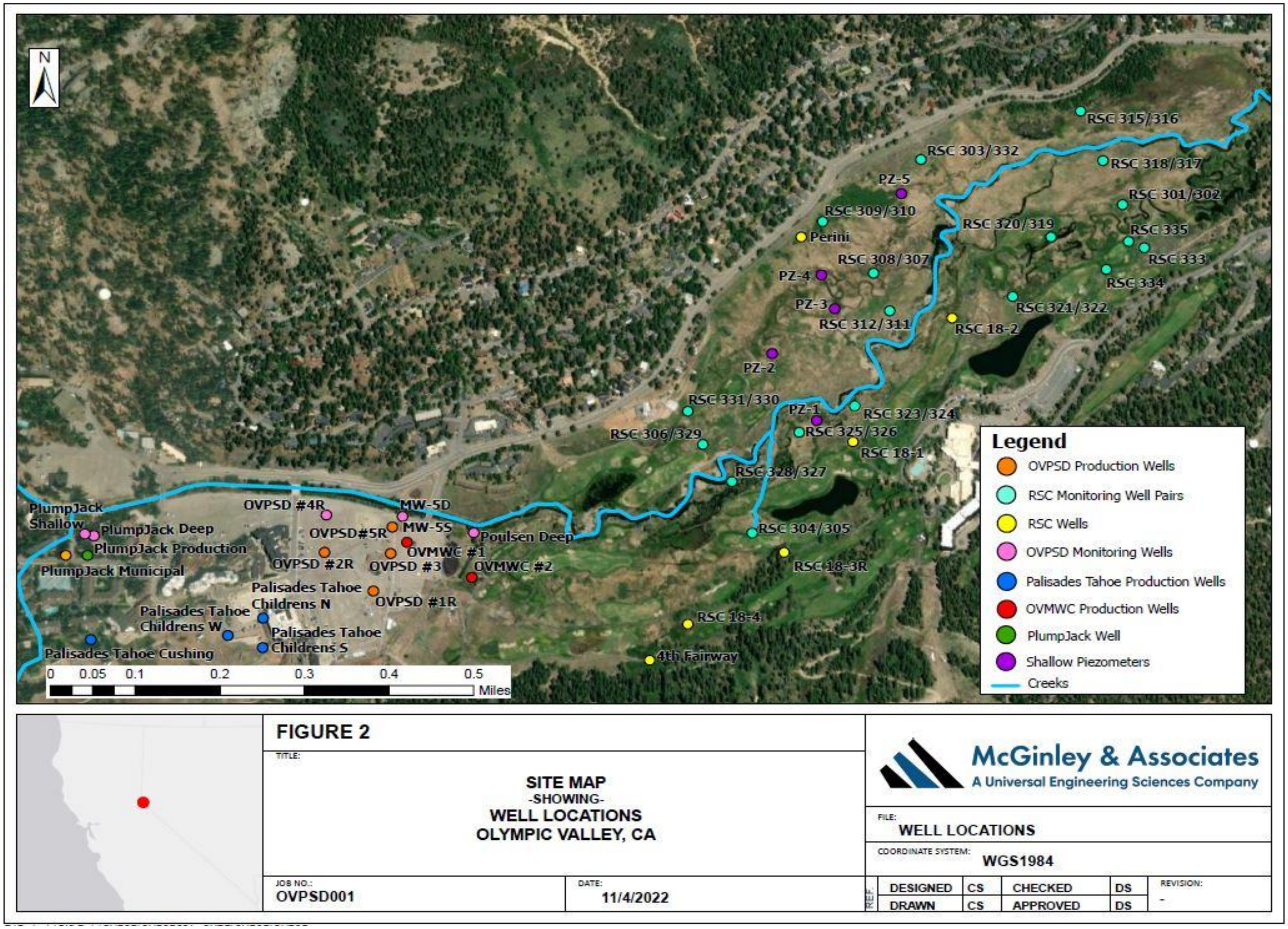


Figure 2: GMP Area Well Locations

SECTION 3: GROUNDWATER SUPPLY ASSESMENT

This section presents the status of the Olympic Valley Groundwater Basin during Water Years 2016 through 2021, including a review of stream flow, precipitation, pumping, and groundwater levels. The hydrology of Water Years 2016 through 2021 are also compared to conditions of past monitoring periods, as data are available.

3.1 PRECIPITATION

Snow-water equivalent precipitation measured at the Old Fire Station gauge for Water Years 2016 through 2021 are shown in Table 2. These average precipitation rates range from nearly two and half times the yearly seasonal average of 52.83 inches for all Water Years since 1965, to approximately half of the yearly seasonal average. The Old Fire Station precipitation data presented in this report were collected from a Davis gauge prior to 2009; since 2009 data reflect a newer NovaLynx gauge installed at this site.

Table 2: Old Fire Station Precipitation Data

Water Year	Snow-Water Equivalent Precipitation (inches)	Comparison to Yearly Seasonal Average
2016	64.09	121.00%
2017	129.26	244.04%
2018	53.07	100.19%
2019	71.18	134.38%
2020	31.18	58.87%
2021	30.49	57.56%

Snow precipitation increment measurement data at the Palisades Tahoe SNOTEL station for Water Years 2016 through 2021 are shown on Table 3. Precipitation data at the Palisades Tahoe SNOTEL station for the Water Years presented herein deviates slightly from the trend observed at the Old Fire Station gauge, but both gauges ultimately show 2017 and 2019 as the wettest years.

Table 3: SNOTEL Precipitation Data

Water Year	Snow-Water Equivalent Precipitation (inches)	Comparison to Yearly Seasonal Average
2016	148.1	70.13%
2017	342.6	162.24%
2018	115.2	54.55%
2019	261.3	123.41%
2020	96.7	46.12%
2021	85.3	40.39%

Total annual precipitation by Water Year for the gauges located at the Old Fire Station are presented in Figure 3. A horizontal line on Figure 3 shows the average precipitation for Water Year 1965 through Water Year 2021. Although Water Years 2020 and 2021 were relatively dry, Figure 3 shows that

Water Year 2001 remains the driest year as measured by precipitation on the floor of Olympic Valley.

Total annual precipitation increment data by Water Year for the Squaw Valley SNOTEL Station is presented in Figure 4. A horizontal line on Figure 4 shows the average SNOTEL precipitation for Water Year 1980 through Water Year 2021. Although Water Years 2020 and 2021 were relatively dry, Figure 4 shows that none of the six water years in the period of Waters Water 2016 to 2021 were drier than 1987, the driest year on record measured by precipitation at the SNOTEL station.

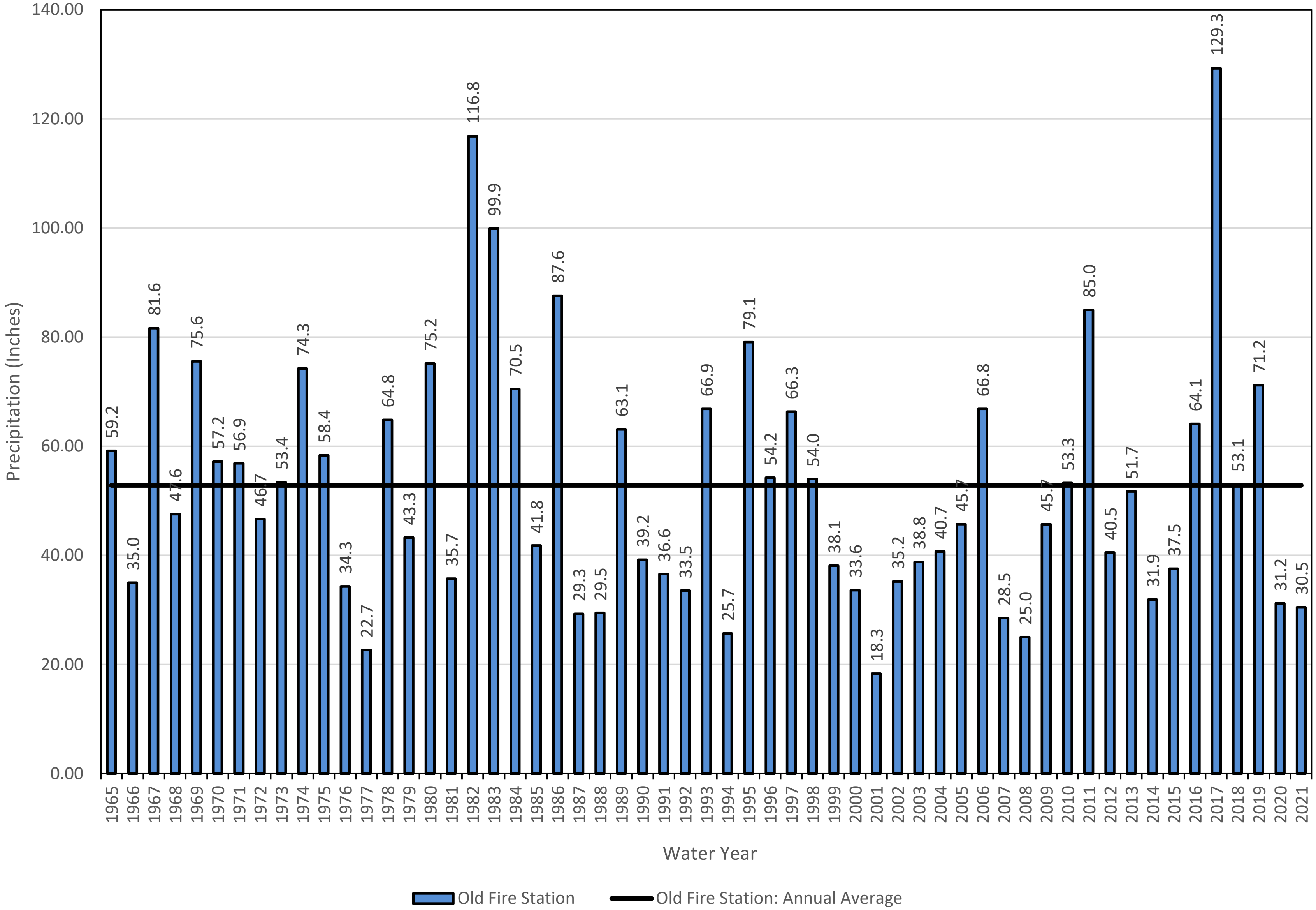


Figure 3: Olympic Valley Precipitation by Water Year: Old Fire Station

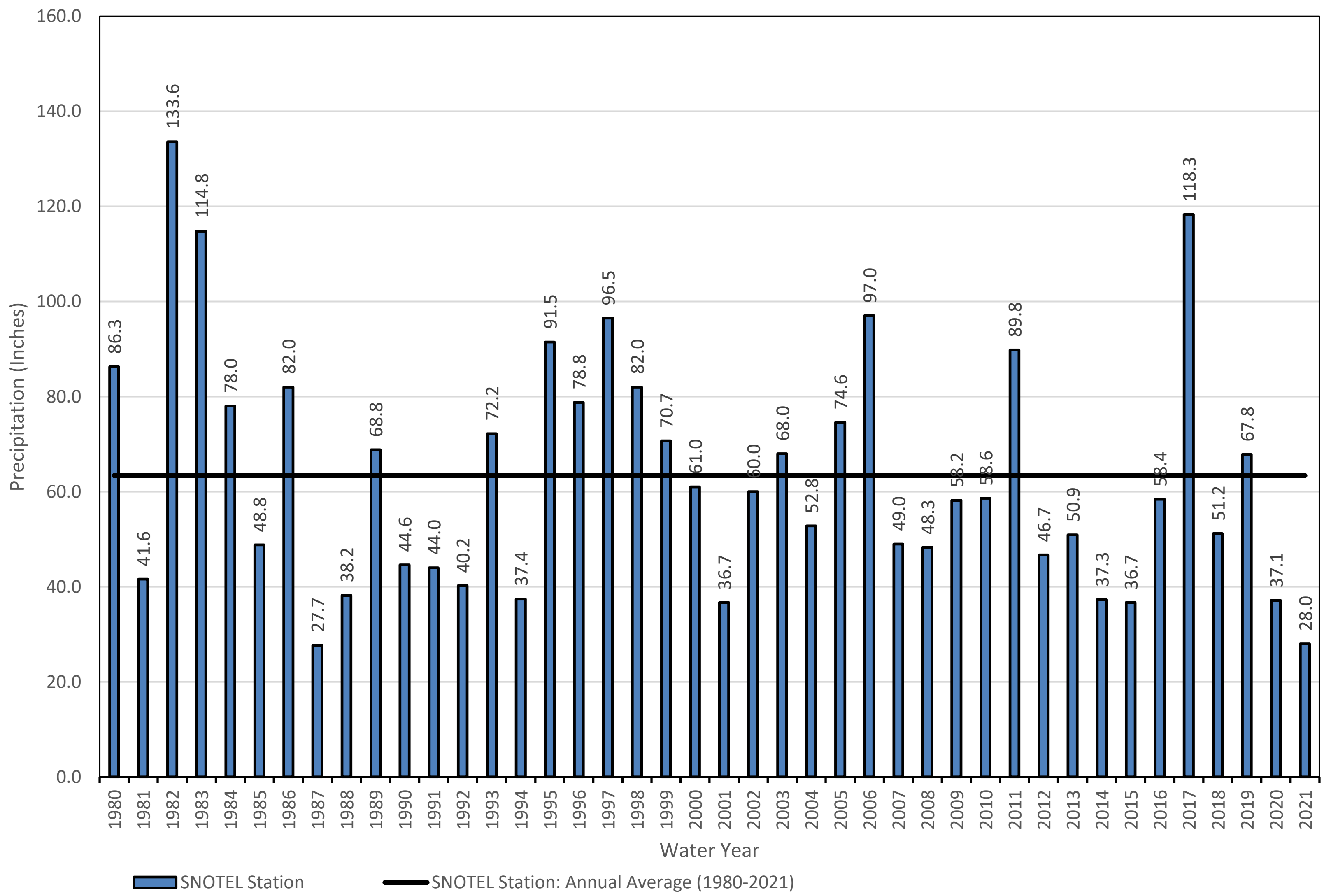


Figure 4: SNOTEL Snow Precipitation Data

3.2 STREAMFLOW

Over the five-year time period of Water Years 2016 through 2020, streamflow in Washeshu Creek was measured at five gauges, with locations shown in Figure 5. The gauges are located on the North Fork of Washeshu Creek (NFWC), Washeshu Creek at Far East Bridge (WCFB), Olympic Channel at Washeshu Creek (OCWC), Washeshu Creek at Golf Course Bridge (WCGC), and Washeshu Creek at County Bridge (WCCB). There are no streamflow data available for Water Year 2021, and there is no entity currently under contract to collect stream gage data. Data available for Water Year 2016 to 2020 were collected by Balance Hydrologics (2021). The streamflow monitoring effort is funded through a Wildlife Conservation Board grant to Trout Unlimited (Balance Hydrologics 2021).

The North Fork of Washeshu Creek (NFWC), previously referred to as QV1, is gauged at the western end of the Valley, just outside the GMP management area. This gauge measures flow in Shirley Canyon Creek. There previously was a gauge on the South Fork of Washeshu Creek, also just outside of the east side of the GMP management area, and previously measured the flow in the southern tributary of Washeshu Creek but was discontinued in 2013 due to steep and unstable bed conditions and the difficulty in accessing the channel during much of the year. In WY 2020, the gauge station at the Golf Course Bridge (WCGC) was affected by an active beaver dam immediately downstream of the station. The backup of flow caused the stage-to-discharge relationship to be unusable for calculations of streamflow and sediment transport (Balance Hydrologics, 2021). In November of 2019, Balance Hydrologics installed a new gauge station (WCFB) upstream of WCGC to develop an estimated record of streamflow and sediment transport at WCGC. The stream gauge at the Olympic Channel (OCWC) measures the flow of a small tributary that flows into Washeshu Creek a couple hundred feet downstream of WCFB. The sum of the flows through WCFB and OCWC were summed up to estimate streamflow at WCGC. The gauge on the county bridge, WCCB, measures flow downstream of the terminal moraine, east of the GMP management area boundary. Reports summarizing stream conditions for each Water Year are available from Balance Hydrologics (2021). Stream flow data are available and are generally complete for Water Years 2016 through 2020, with some intermittent data gaps that range from a couple hours to several months.

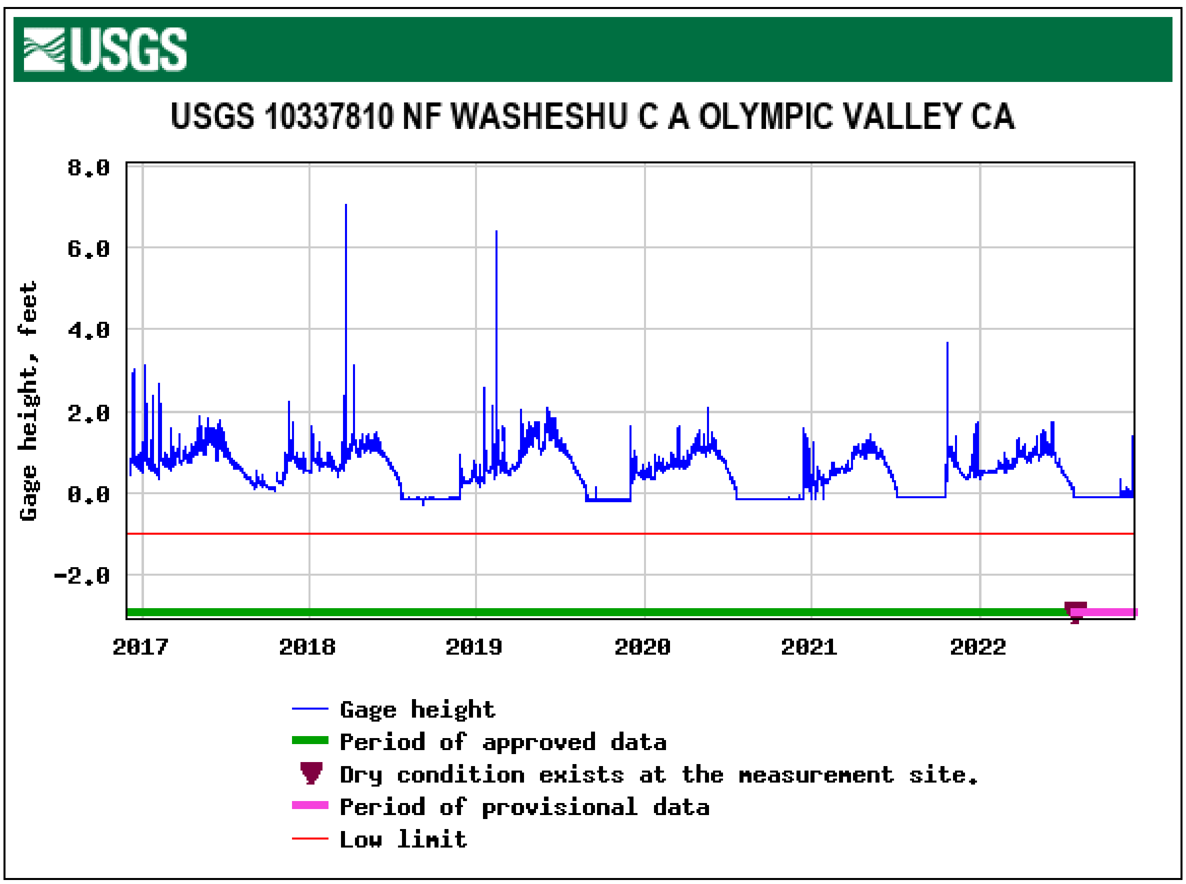
Table 4 shows that in prior water years, there is a net gain to Washeshu Creek within the GMP management area every year, indicating that more water flows out of the GMP management area through Washeshu Creek than flows into the area through the two main forks of Washeshu Creek. This is evident from the consistently larger yearly discharge measured at WCCB compared to the sum of NFWC and QV2 for previous water years where there are complete data. Sources of this additional outflow include smaller tributaries to Washeshu Creek such as the Olympic Channel, groundwater inflow to the creek including spring discharge, precipitation runoff, and runoff from golf course and other facility irrigation. In recent years, it has been difficult to confirm whether Washeshu Creek has continued to show a net gain through the extent of the GMP management area due to the fact that the South Fork of Washeshu Creek is no longer monitored. Without flow measurements of the South Fork, it is uncertain exactly how much flow is present in the western side of the GMP management area. With the added issue of the beaver damming downstream of WCGC, it is difficult to determine with absolute certainty if the trend of net gain has continued into the time period of Water Years 2016 – 2020.

Mean daily streamflow in Washeshu Creek at each of the five gauges during Water Years 2016 through 2020 are presented in Figure 6 through Figure 10. Intermittent flows in Washeshu Creek typically begin in October, with sharp spikes during storms and low flows in between storms. Beginning around

February or March, the hydrograph character changes at the five gauges; the daily discharge increases and is continuously higher. This more continuous flow starting in March is due to the contribution of snowmelt to streamflow.

Mean daily streamflow leaving Olympic Valley, measured at gauge WCCB for Water Years 2016, 2017, 2018, 2019, and 2020 are presented in Figure 11. The daily discharge in Washeshu Creek during Water Years 2012 through 2015 reflected the regional drought conditions relative to Water Year 2011 and previous reporting periods. During the most recent period of Water Years 2016 through 2021, excluding 2020 and 2021, Washeshu Creek at the County Bridge has showed a significant increase in daily discharge compared to Water Years 2012 through 2015. The most drastic increase in streamflow was in Water Year 2017 with total discharge being over triple the amounts in Water Years 2012 through 2015. The peak mean daily discharge at WCCB during Water Year 2017 was 1,229 cubic feet per second (cfs) compared to a peak mean daily discharge of near or below 200 cfs during Water Years 2014 and 2015.

Since December 5, 2016, the US Geological Survey has operated a stage recorder on Washeshu Creek near the NFWC location (USGS Gage 10337810 North Fork Washeshu Creek at Olympic Valley CA). The stage recorder measures the height of water in stream channel, but data are not being collected to convert stage to flow. The gage does however provide data on when flow is occurring in stream, and when the channel goes seasonally dry in the summer. Real-time stage data (provisional) may be viewed, and historical data plotted on the USGS website (see below).



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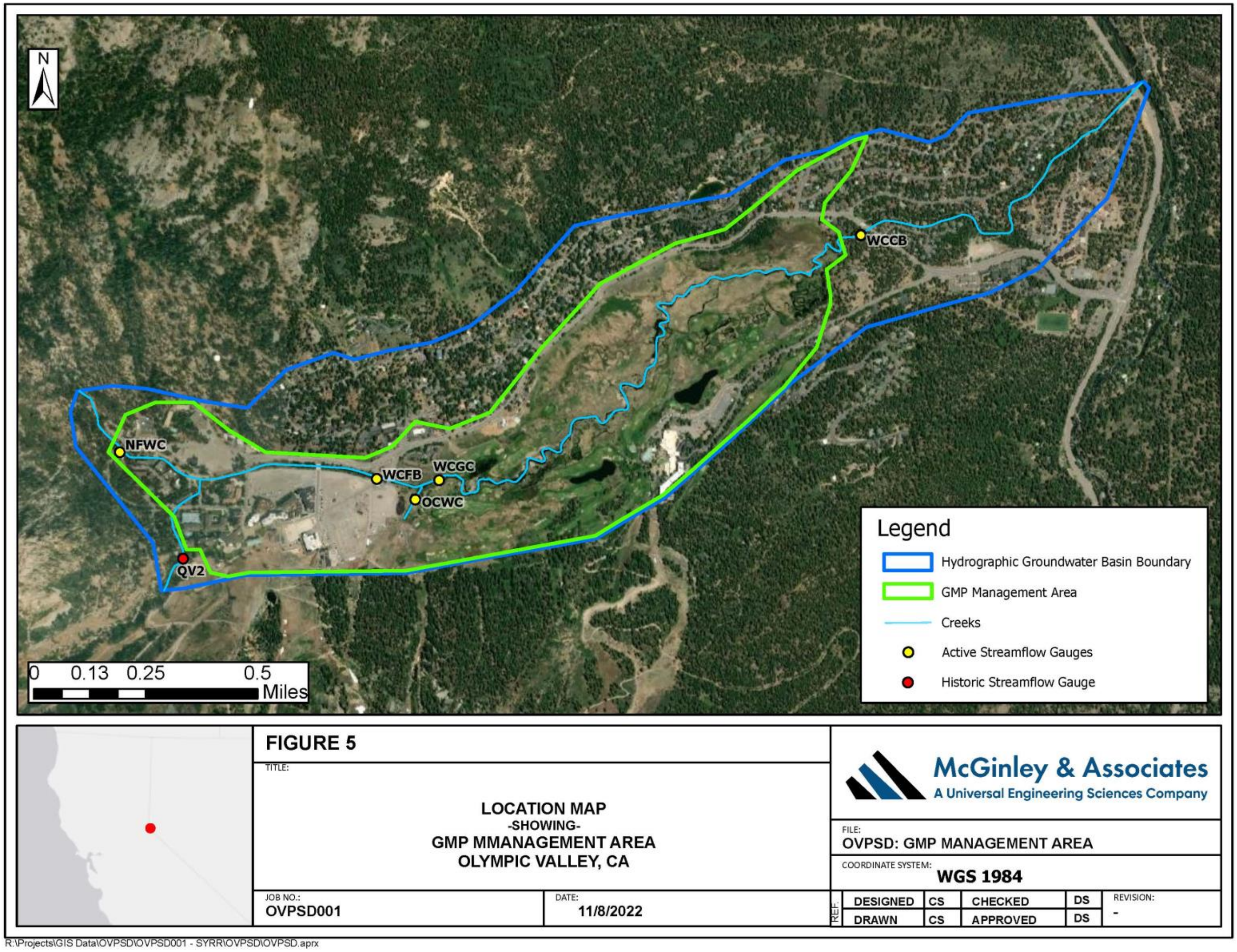

Figure 5: Stream Gauge Locations

Table 4: Total Water Year Discharge at Washeshu Creek Gauges

Water Year	NFWC Shirley Creek (acre-feet)	QV2 South Tributary (acre-feet)	Sum of NFWC + QV2 (acre-feet)	WCFB Far East Bridge (acre-feet)	OCWC Olympic Channel (acre-feet)	WCGC Golf Course (acre-feet)	WCCB Squaw Creek (acre-feet)
2003[1]	10,100	5,890	15,990	N/A	N/A	N/A	19,000
2004[1]	6,820	4,020	10,840	N/A	N/A	N/A	15,300
2005[2]	14,750	8,420	23,170	N/A	N/A	N/A	24,300
2006[2]	17,340	7,840	25,180	N/A	N/A	N/A	33,940
2007[2]	5, 750	4,380	10,130	N/A	N/A	N/A	11,380
2008[2]	5,443	3,587	9,030	N/A	N/A	N/A	12,540
2009[3]	8,527	5,640	14,167	N/A	N/A	N/A	18,239
2010[3]	No data available	No data available	No data available	N/A	N/A	N/A	18,169
2011[4]	19,566	No data available	No data available	N/A	N/A	N/A	24,816
2012[4]	5,405	4,533	9,938	N/A	N/A	N/A	13,830
2013[4]	6,991	4,608	11,598	N/A	N/A	N/A	16,527
2014[4]	4,612	3,229	7,841	N/A	N/A	N/A	10,186
2015[4]	4,185	3,419	7,604	N/A	**270**	N/A	8,917
2016	10,032	N/A	N/A	N/A	899	16,482 (incomplete data)	24,876
2017	15,988 (incomplete data)	N/A	N/A	N/A	2,128	41,330	42,374
2018	8,823 (incomplete data)	N/A	N/A	N/A	2,032	15,016 (incomplete data)	19,710
2019	14608 (incomplete data)	N/A	N/A	N/A	No data available	23,791 (incomplete data)	22,491
2020	5,572 (incomplete data)	N/A	N/A	8,509 (Incomplete data)	384	Inaccurate data due to beaver damming	10,113
2021	**No data available**	**N/A**	**N/A**	**No data available**	**No data available**	**No data available**	**No data available**

[1]Water Year 2003 and 2004 data from West Yost & Associates 2005
[2]Water Year 2005 through 2008 data provided by Watermark Engineering
[3]Water Year 2009 through 2010 data provided by Sound Watershed Consulting
[4]Water Year 2011 through 2015 data from Friends of Squaw Creek website
[5]Water Year 2016 through 2020 data from Balance Hydrologics (2021)

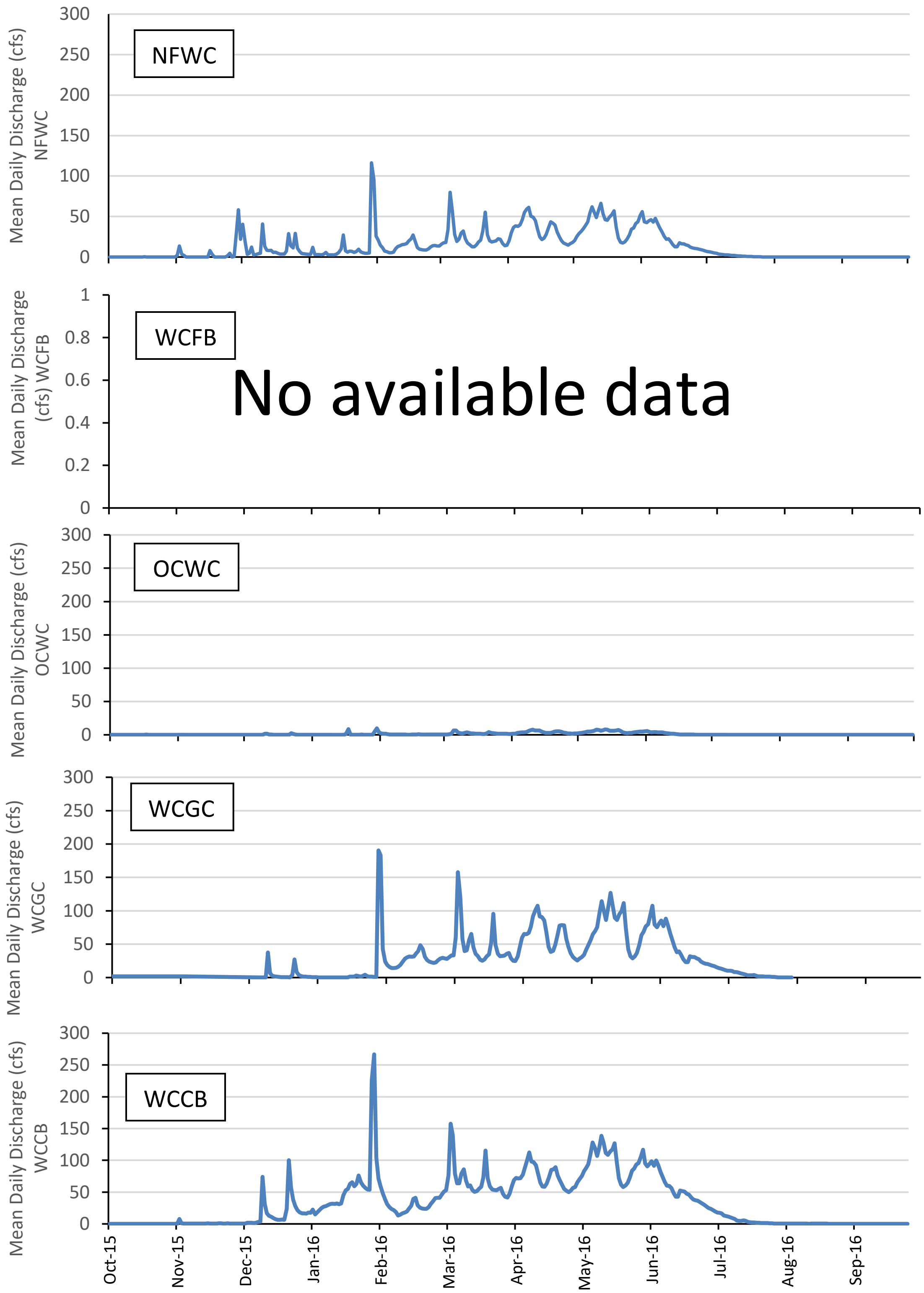

Figure 6: Water Year 2016 Mean Daily Streamflow

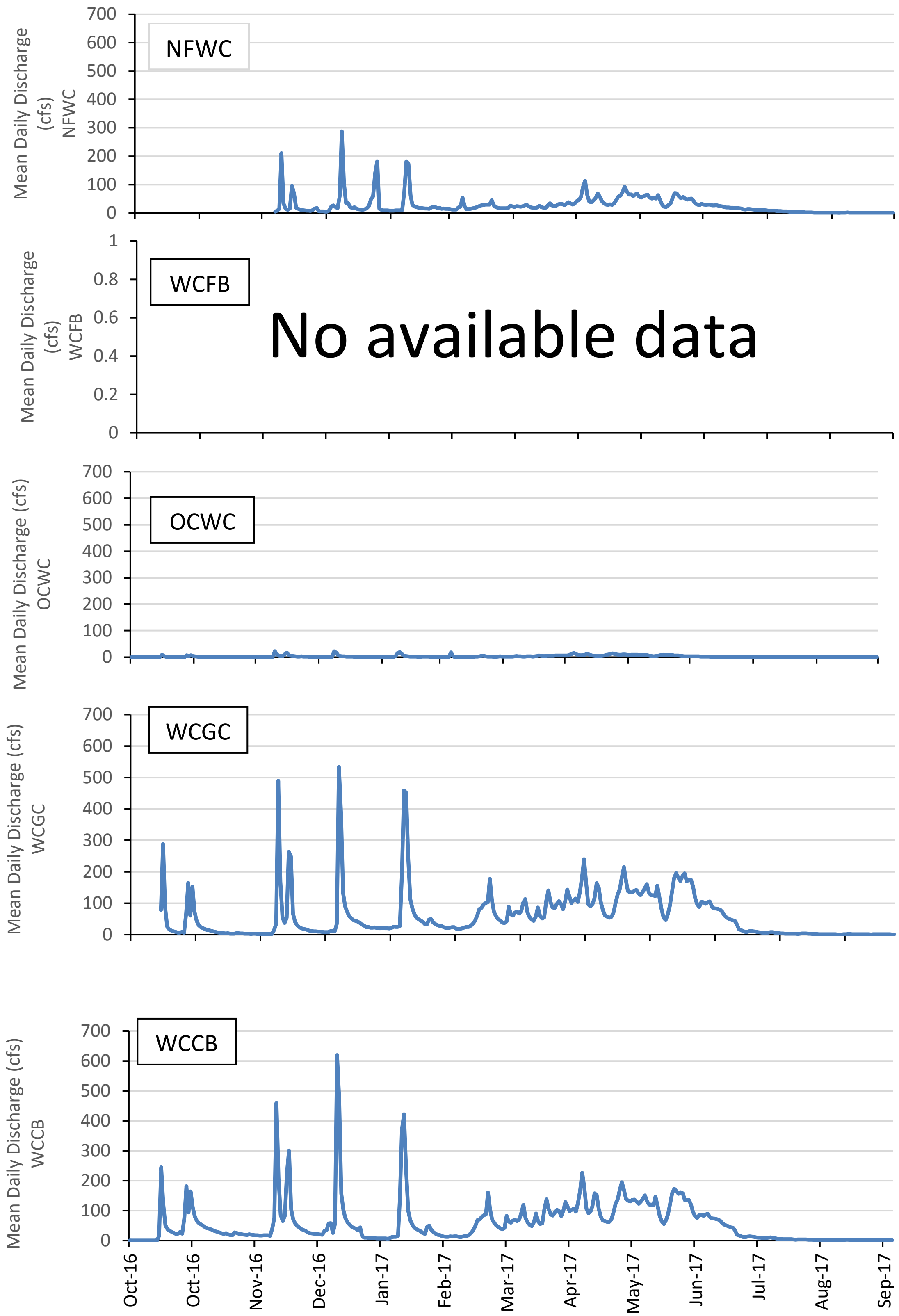

Figure 7: Water Year 2017 Mean Daily Streamflow

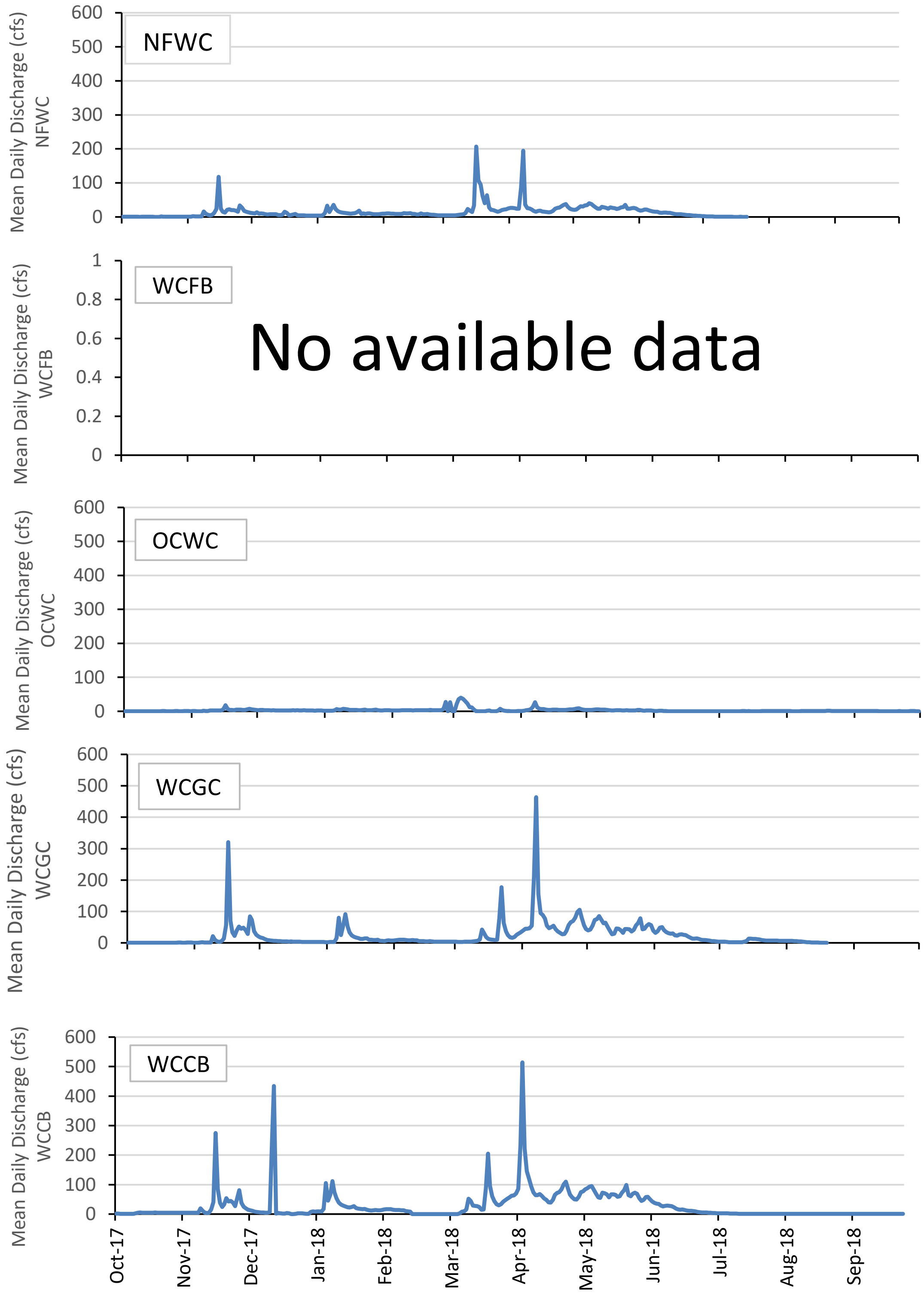

Figure 8: Water Year 2018 Mean Daily Streamflow

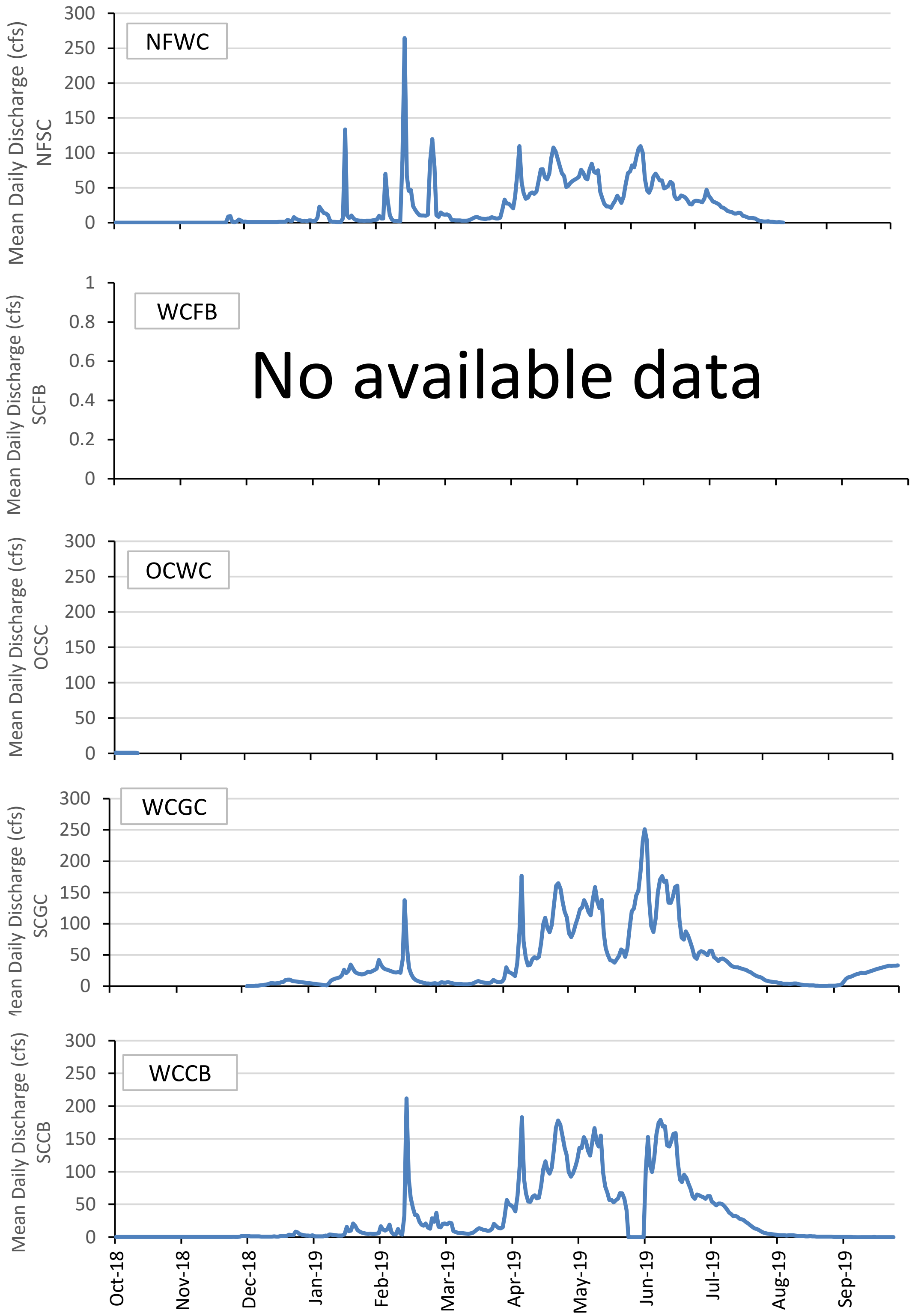

Figure 9: Water Year 2019 Mean Daily Streamflow

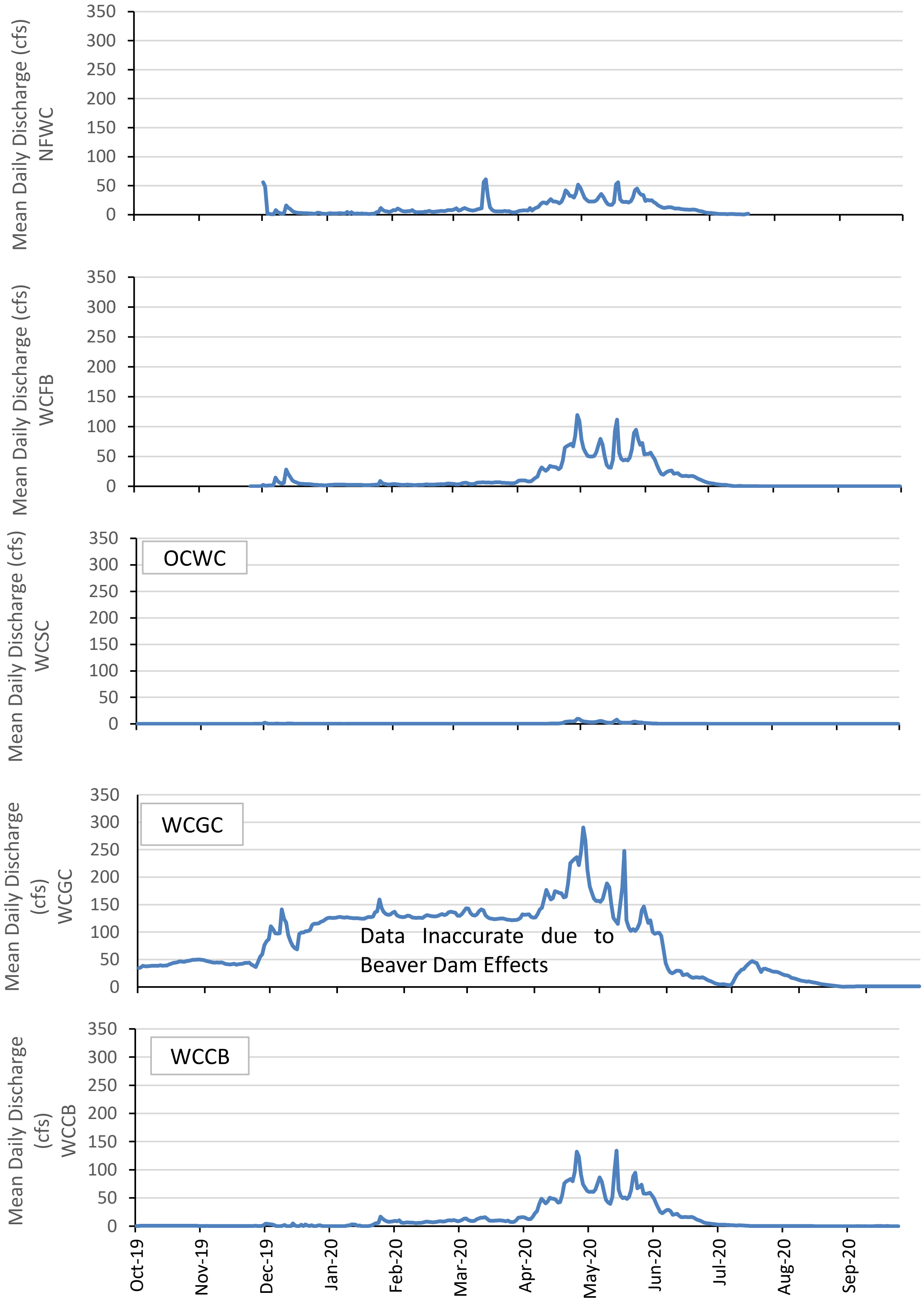

Figure 10: Water Year 2020 Mean Daily Streamflow

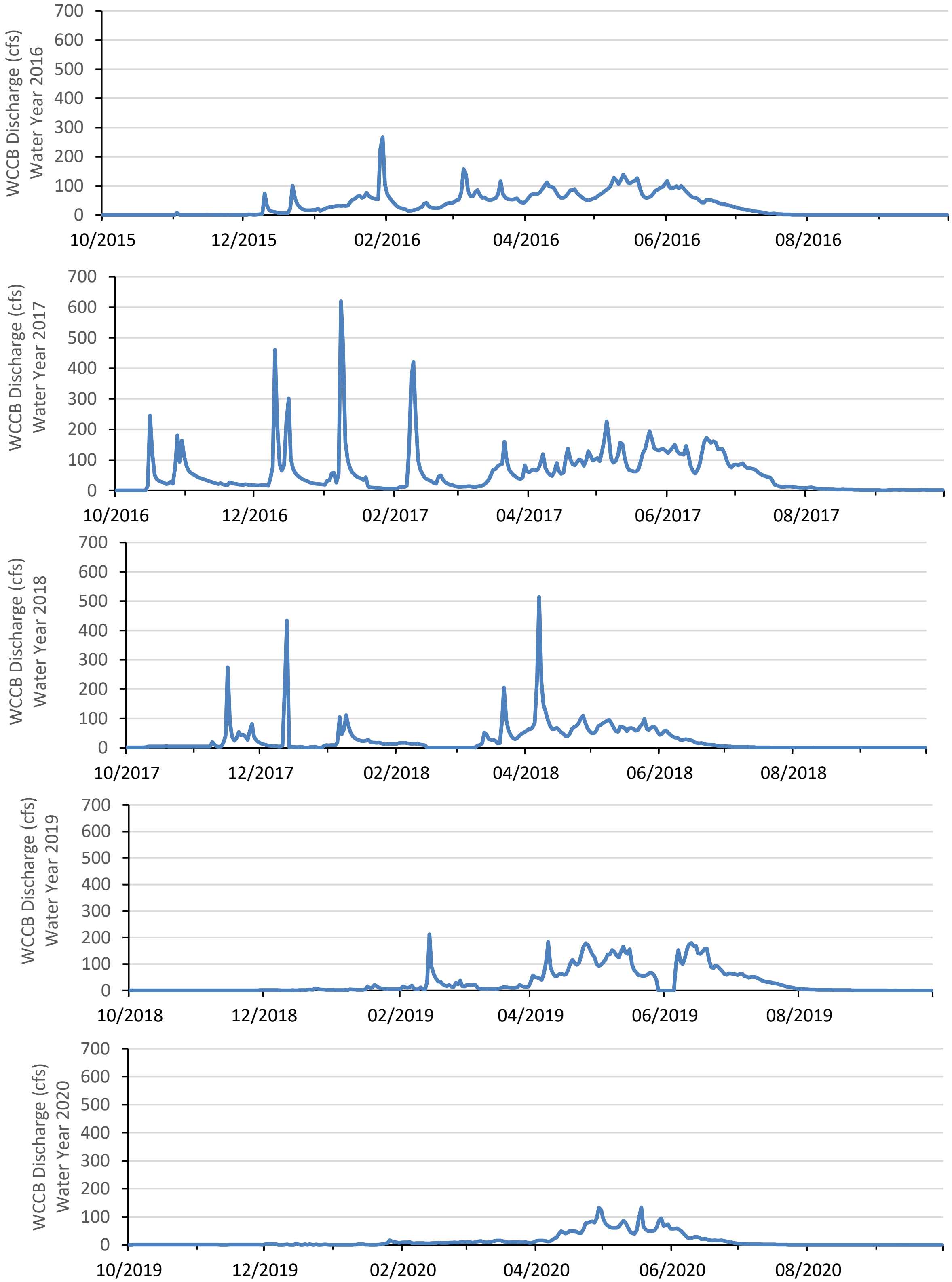

Figure 11: Mean Daily Streamflow at WCCB during Water Years 2016, 2017, 2018, 2019, 2020

3.3 GROUNDWATER PUMPING

Groundwater is extracted from the GMP management area by OVPSD, SVMWC, RSC, PlumpJack Inn, and Palisades Tahoe. These entities operate a total of fourteen wells. Four wells are currently pumped by OVPSD, two wells are pumped by SVMWC, three wells are pumped by the Resort at Squaw Creek, one well is pumped by PlumpJack Inn, and four wells are pumped by Palisades Tahoe. The quantities of groundwater pumped by the PlumpJack Inn is minor compared to the pumping by the other four entities. The well located on the PlumpJack property is used for irrigation only for a relatively small area. The PlumpJack hotel property receives potable water supply from OVPSD. There are no other known groundwater extractors in the GMP management area. Figure 2 shows the locations of the known active production wells in the GMP management area.

3.3.1 Pumping Trends

Historical pumping by Water Year is shown in Figure 12 for OVPSD, SVMWC, and RSC. The average pumping for each entity over Water Years 2016 through 2021 and the historical period is shown in Table 5.

Table 5: Average Annual Historical and Recent Pumping Rates

Entity	Average Pumping Water Year 2000-2010		Average Pumping Water Year 2011-2015		Average Pumping Water Year 2016-2021*	
	MG per year	Acre-feet per year	MG per year	Acre-feet per year	MG per year	Acre-feet per year
OVPSD	126	386	110	338	107	328
SVMWC	31	95	24	74	16	49
RSC	72	221	69	212	74	227
Palisades Tahoe	Not Reported	Not Reported	23	71	17	52
Totals	**229**	**702**	**226**	**693**	**214**	**656**

*Data for 2016 Water Year not available for RSC and Palisades Tahoe

Between Water Years 2016 and 2021, OVPSD, SVMWC, RSC, and Palisades Tahoe pumped a combined average of approximately 214 MG per year. This represents an overall slight decrease from the historical period of Water Year 2011 through 2015, when the combined average of these three entities was approximately 226 MG per year.

The wet 2017 resulted in notably less water use by the RSC for golf course irrigation in that year, affecting the 6-year total use average. Decreases in annual pumping over the past six years also reflect the successful system rehabilitation and conservation efforts undergone by OVPSD and SVMWC, including leak detection programs, pipeline replacement, and additional water meters which have contributed to decreases in annual water demand. The effects of these conservation efforts are further demonstrated in the overall downward trends demonstrated in the downward sloping logarithmic trend lines in Figure 13 and Figure 14, which show 15-year annual pumping trends for both OVPSD and SVMWC (excluding horizontal well production).

Historical monthly OVPSD pumping is presented in Figure 15. This plot shows a consistent seasonal pattern, with monthly pumping peaks occurring in the summer due to increased irrigation demand, with smaller seasonal peaks during the winter months related to visitation and occupancy during the ski season. This seasonal cycle in monthly pumping persisted for Water Years 2016 through 2021, and Figure 15 shows an overall decline in peak summer pumping over the past 15 years, which is again reflective of conservation efforts and reductions in irrigation demand. This monthly seasonal cycle and overall decline in peak summer pumping is also evident in the monthly SVMWC pumping data shown on Figure 16.

Figure 17 presents a plot of total precipitation as measured by the gauges at the Old Fire Station and total combined pumping by water year for OVPSD, SVMWC, and RSC pumping wells. Over the period shown, this plot does not indicate a strong correlation between total annual pumping and precipitation, which further demonstrates that recent decreases in total combined annual pumping for these entities is driven by conservation efforts and reduction in demand.

3.3.2 Monthly Pumping Distributions by Water Year

Monthly pumping volumes for Water Year 2016 through 2021 are presented in Figure 18 through Figure 23, respectively. The monthly total pumping volumes typically have two peak periods during each water year: a smaller December/January peak primarily due to pumping by RSC for snowmaking, and a second larger peak in July in response to increased irrigation demand by OVPSD and SVMWC customers, as well as peak golf course irrigation pumping by RSC. The exception to this pattern was in Water Year 2021, where October of 2020 had a slightly higher pumping total than December or January. OVPSD and SVMWC pumping production per well over the period from Water Year 2016 to Water Year 2021 is included in Figures 25 and 26. RSC and Palisades Tahoe total pumping over the period from Water Year 2016 to Water Year 2021 is included as Figures 27 and 28.

3.4 Horizontal Well Production

Annual horizontal well production for OVPSD ranged from zero to 7.44 MG (0 to 22.8 acre-feet) from the two horizontal wells between Water Year 2016 and 2021. OVPSD ceased use the horizontal well in 2018 and is working to reestablish them in the coming years. Annual horizontal well production for SVMWC ranged between 12.2 MG and 13.7 MG (37.3 to 42.1 acre-feet) between Water Years 2016 and 2021. SVMWC's horizontal well production generally declined year-to-year over that time period. Annual horizontal well production for each agency, and the total horizontal well production, is shown on Figure 24.

3.5 Groundwater Levels

Hydrographs presented in this report are grouped by location. Most groundwater pumping is concentrated in the west end of the basin. Consequently, groundwater levels are more strongly influenced by pumping in this area. In the meadow area, groundwater elevations are measured at wells more distant from active pumping centers, and do not exhibit strong short-term responses to pumping.

3.5.1 West End of Groundwater Basin

Hydrographs from ten wells in the western portion of the groundwater basin are shown on Figure 29 through Figure 35. In 2009, these wells were equipped with groundwater level transducers as part of the Creek/Aquifer interaction study. Older water level data may reflect hand-measured readings and although it is intermittent, it still is useful in demonstrating long-term groundwater elevation trends at each well. The most recent data (Water Years 2011 through 2021) shows either daily records reflecting the maximum daily water level, or monthly records reflected by the maximum recorded water level on the first day of each month. Although the monthly data may not reflect the maximum or minimum water levels observed at each month this presentation of the data is considered sufficient for the goals of this report, which is to assess seasonal, annual, and long-term groundwater elevation trends within the basin.

Hydrographs for wells OVPSD#1R, OVPSD#2R, and OVPSD#5R during the period of time from Water Year 2016 to 2021 show that the lowest annual groundwater levels, measured during late summer and early autumn, were generally similar to historical conditions, as were seasonal high water levels. No long-term deviations from trends observed for wet and dry year water level responses are observed.

Hydrographs for paired deep and shallow wells are shown on Figure 33 through Figure 35. Historically, data at these well pairs have demonstrated upward vertical groundwater gradients. The Poulsen deep water levels exhibit a declining trend, with shallow water levels being stable and rising up to near the deep monitoring well levels. It is possible that Washeshu Creek restoration is producing higher shallow groundwater levels observed in the hydrograph (Figure 34). Similarly, the shallow water levels observed in the PlumpJack monitoring well have resulted in a reversed gradient, where the deep monitoring well levels have remained at stable levels, but the shallow levels have risen, resulting in a downward gradient, rather than mild upward gradient (Figure 35). OVSPD#5 shallow and deep water levels appear stable, without a notable rise or decline. Washeshu Creek stream restoration efforts may be affecting shallow water table levels, and pumping or climate (2020 and 2021 dry years) may be affecting deep water levels.

Figure 36 to 38 compare daily maximum static water levels in OVPSD Wells #1R, #2R and #5R, for calendar years 2015 to 2021. Notable in these plots is the pronounced lower water levels in the summer of 2021 as a result of early cessation of Washeshu Creek flows, the primary source of aquifer recharge. Fortunately, early season precipitation and runoff occurred in October, replenishing the aquifer and producing notably earlier seasonal recovery in groundwater levels in fall, as contrasted with “normal” recharge occurrence.

Figures 39 and 40 show the historic groundwater elevations of wells SVMWC #1 and #2 dating back to the 1990s. The hydrograph of well SVMWC#1 shows a slight downward trend between Water Year 2016 and Water Year 2021 with numerous mid-summer to early autumn lows dropping below the normal elevation range of approximately the last 20 years. Groundwater elevations in well SVMWC#2 were relatively stable through the period, consistent with prior seasonal trends. The downward spike in the summer of 2021 was a historical low.. Figure 39 shows relatively high measured groundwater elevations in early 1995. This graph is an accurate depiction of the groundwater elevation data supplied by SVMWC. It is suspected that the early 1995 groundwater elevation data reported from well SVMWC#1 are approximately 3.25 feet above the actual level. However, there are no records to verify this potential groundwater elevation correction.

Figures 41 through Figure 45 compare groundwater levels in well OVPSD#2/2R, streamflow at 2 different gauge stations in Washeshu Creek, and OVPSD total pumping for Water Years 2016 through 2021. A figure comparing these same statistics for Water Year 2021 was excluded because there was no streamflow data available after the conclusion of Water Year 2020. The well OVPSD#2/2R hydrograph data in these plots typically show that the aquifer in this portion of the basin fills up rapidly in response to streamflow and rainfall recharge. During the first period of high flow in Washeshu Creek, groundwater levels in well OVPSD#2/2R typically reach a maximum or full level. Groundwater elevations also appeared to remain relatively high in winter of 2018, despite relatively low stream flows. This may be the results of relatively low OVPSD pumping during these months.

The general pattern for the water year between April and June is that slightly higher groundwater levels occur as snowmelt creates more sustained flows in the creek. Following this later peak in groundwater elevations, levels first begin to slowly decline due to three potential mechanisms:

1. Groundwater levels drop in response to reduced recharge from snowmelt, which also causes reduction in Washeshu Creek streamflow;
2. Groundwater levels drop in response to increased pumping that occurs during this period; and
3. Groundwater drains into the channel as streamflow and water levels drop in the creek.

The initial groundwater level decline likely does not represent a regional lowering of the aquifer; rather it represents a localized deepening of the cone of depression around well OVPSD#2R. During this period there is limited recharge from precipitation or snowmelt available to the aquifer.

This decline continues as flows in Washeshu Creek cease, and snowmelt no longer recharges the aquifer. Without a source of recharge, groundwater levels continue dropping as higher pumping demands persist through the summer and early autumn. This section of the hydrograph represents a regional lowering of groundwater levels in the western portion of the basin.

Figure 55 compares hydrographs for wells SVMWC#1 and OVPSD#2/2R with Water Year precipitation measured at the gauges at the Old Fire Station. Historically, the lowest annual groundwater levels, measured in the fall, appear to correlate with years with low annual precipitation. The relatively low precipitation in Water Years 2020 through 2021, however, appears to have resulted in lower maximum annual water level elevations at OVPSD#2/2R measured in spring, but not lower annual minimum values measured in the fall. The relatively high fall groundwater levels in Water Years 2020 through 2021 may be due to OVPSD and SVMWC leak detection and conservation measures, more accurate groundwater elevation monitoring since 2009, and overall reductions in water demand.

The likely relation between precipitation and annual low groundwater levels is as follows:

1. The groundwater basin fills up with the first significant precipitation and snowmelt events, which also result in flow in Washeshu Creek, and stays relatively full until snowmelt and streamflow ceases. The basin generally comes close to filling up every year, even in low precipitation years.
2. Groundwater levels decline regionally only after snowmelt and thus streamflow in Washeshu Creek ceases.
3. The date at which streamflow ceases is related to the amount of snow pack in the previous winter. The lowest precipitation years have a small snow pack which finishes melting earlier, causing streamflow to cease earlier in those years.

4. The volume of groundwater pumped after snowmelt and thus streamflow ceases and before the first significant flows in the fall or winter, determines how far groundwater levels will decline in the basin.

3.5.1 Meadow Area RSC CHAMP Water Levels

Groundwater level data from the meadow were collected by RSC as part of the CHAMP program monitoring, and by OVPSD as part of its aquifer monitoring program. The CHAMP program measures groundwater levels in 32 monitoring wells, shown on Figure 2. Hydrographs from representative wells were selected based on location and completeness of data. Data is displayed at daily average ground water elevation above mean seal level. Additionally, hydrographs for monitoring wells that have pressure transducers and are part of OVPSD's aquifer monitoring program are also included. The hydrographs are shown in Figure 46 through Figure 52, and are ordered from west to east. Well pairs are included on the same plot. Under the original CHAMP monitoring schedule, data were not collected frequently enough to see complete seasonal groundwater level fluctuations in the meadow wells. In 2009, the groundwater level monitoring schedule was changed to require monthly groundwater level measurements from May through October. Since this more frequent sampling schedule took effect, simultaneous measurement at shallow and deep groundwater levels are available for certain well pairs.

The hydrographs presented in these figures show no apparent long term groundwater level trends in any of the selected meadow wells. These wells generally exhibit seasonal water level fluctuations of between three and six feet. The exception is well RSC-324, located 250 feet away from the RSC's irrigation well 18-1, which has seasonal fluctuations of up to 17 feet (Figure 48). Vertical gradients for the meadow wells have been calculated and summarized in Table 6.

Well pair 311/312 is located toward the center of the basin and generally exhibited a downward vertical gradient for the time period of Water Years 2011 through 2015, with some intermittent gradient reversals through the historical monitoring period. In the time period of Water Year 2016 through 2021, the well pair 311/312 continued to exhibit a downward vertical gradient. The vertical gradient of well pair 328/327 reversed intermittently throughout the most recent six-year time period but generally exhibited a downward gradient more frequently than upward. The 318/317 well pair maintained its upward vertical gradient that was present during the period of time from Water Year 2011 through 2015.

Table 6: Vertical Hydraulic Gradients in Meadow Wells

RSC Well Pair	Vertical Hydraulic Gradient
311/312	Downward
328/327	Downward
318/317	Upward

3.5.2 Meadow Area RSC Shallow Piezometers

In addition to the wells in the meadow, there are also five shallow drive point piezometers installed in the summer of 2017 by RSC for meadow water table monitoring. The locations of these piezometers are shown in Figure 53. A hydrograph which plots the groundwater level data of each piezometer for 2017 through 2021 are included in Figures 54. Groundwater levels reflect seasonal fluctuations of declining levels through the summer season, recovering in the fall or early winter with the occurrence of precipitation and stream flow.

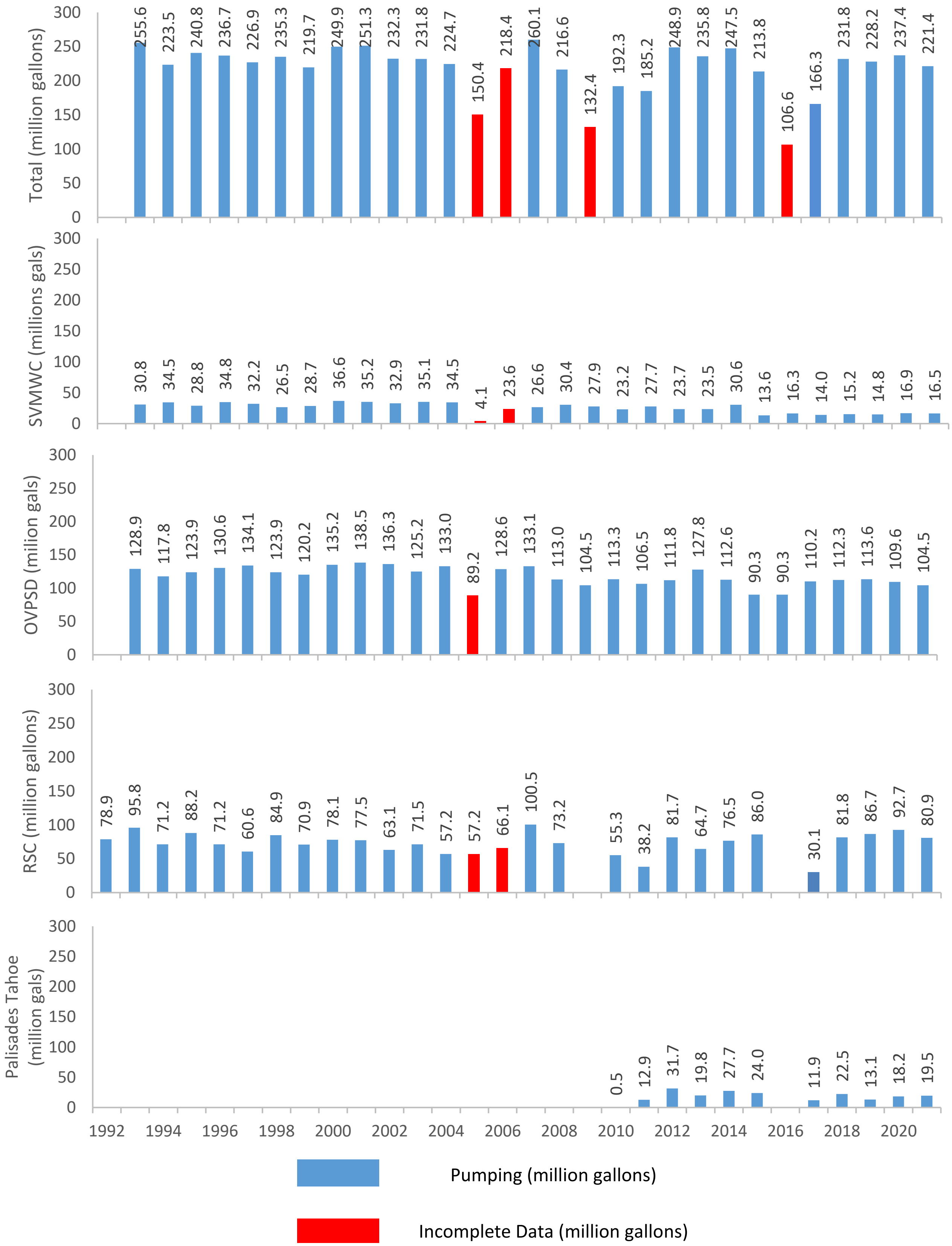

Figure 12: Annual Pumping by Water Year

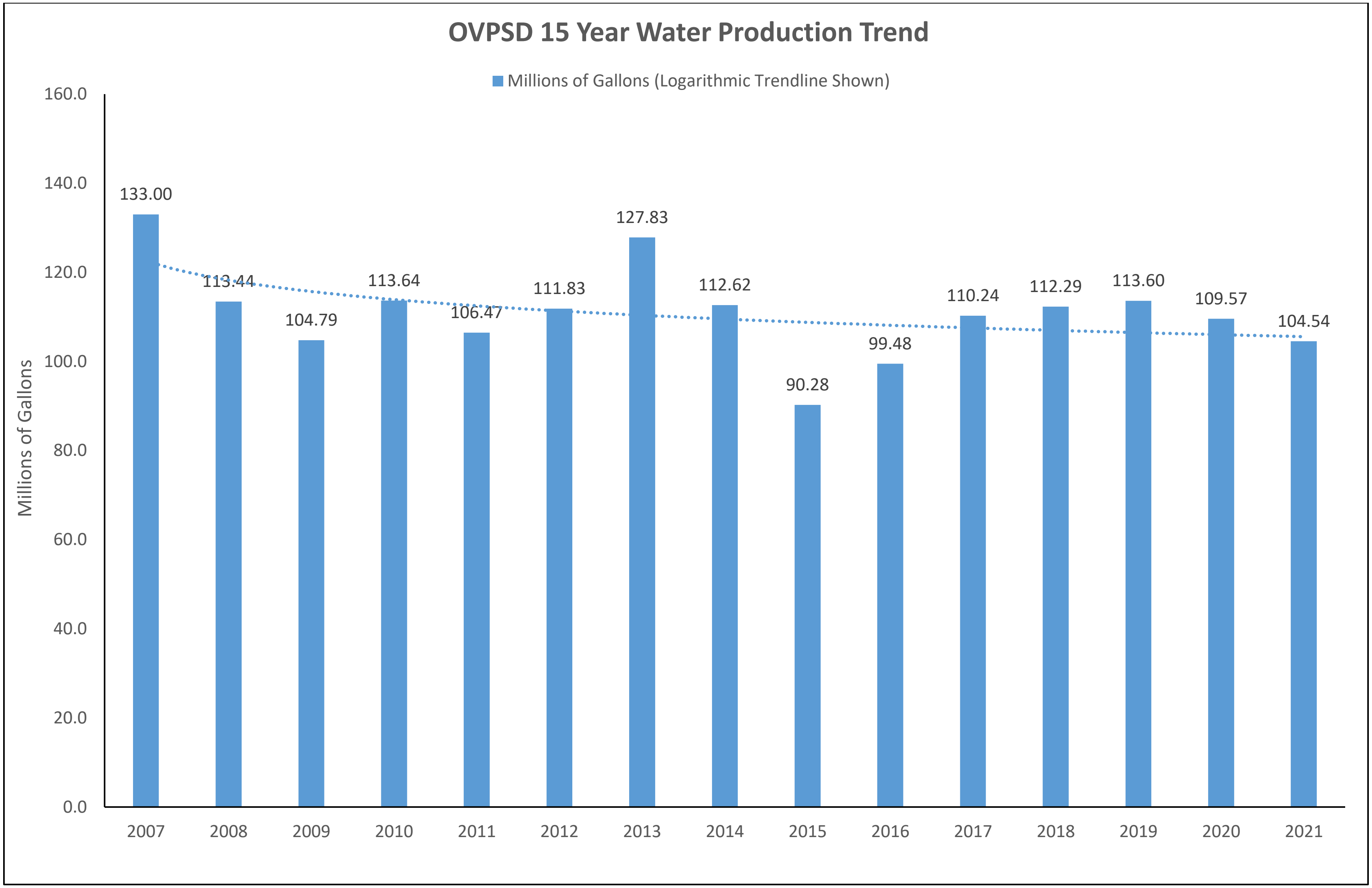

Figure 13: OVPSD 15-Year Water Production Record

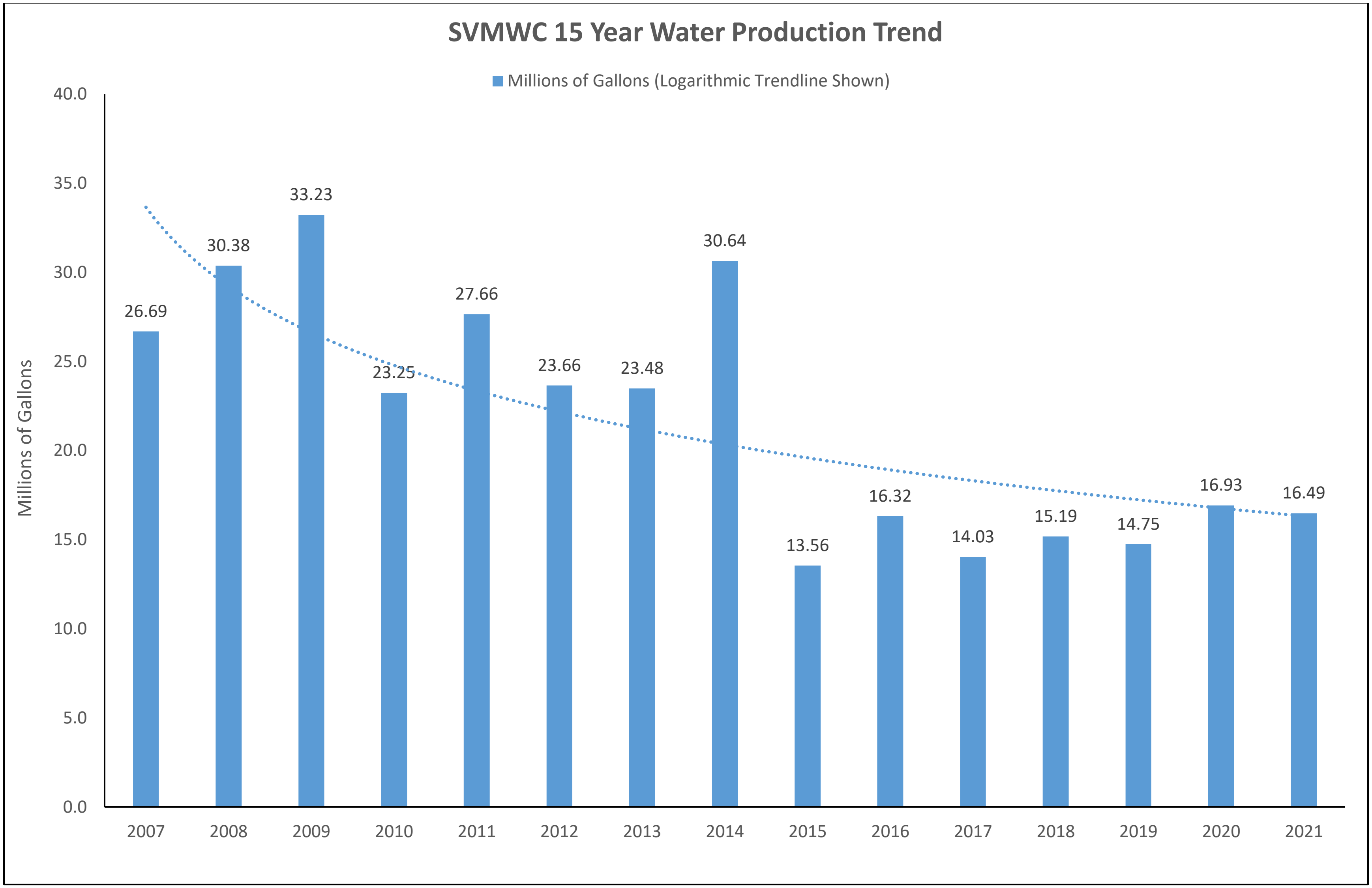

Figure 14: SVMWC 15-Year Water Production Trend

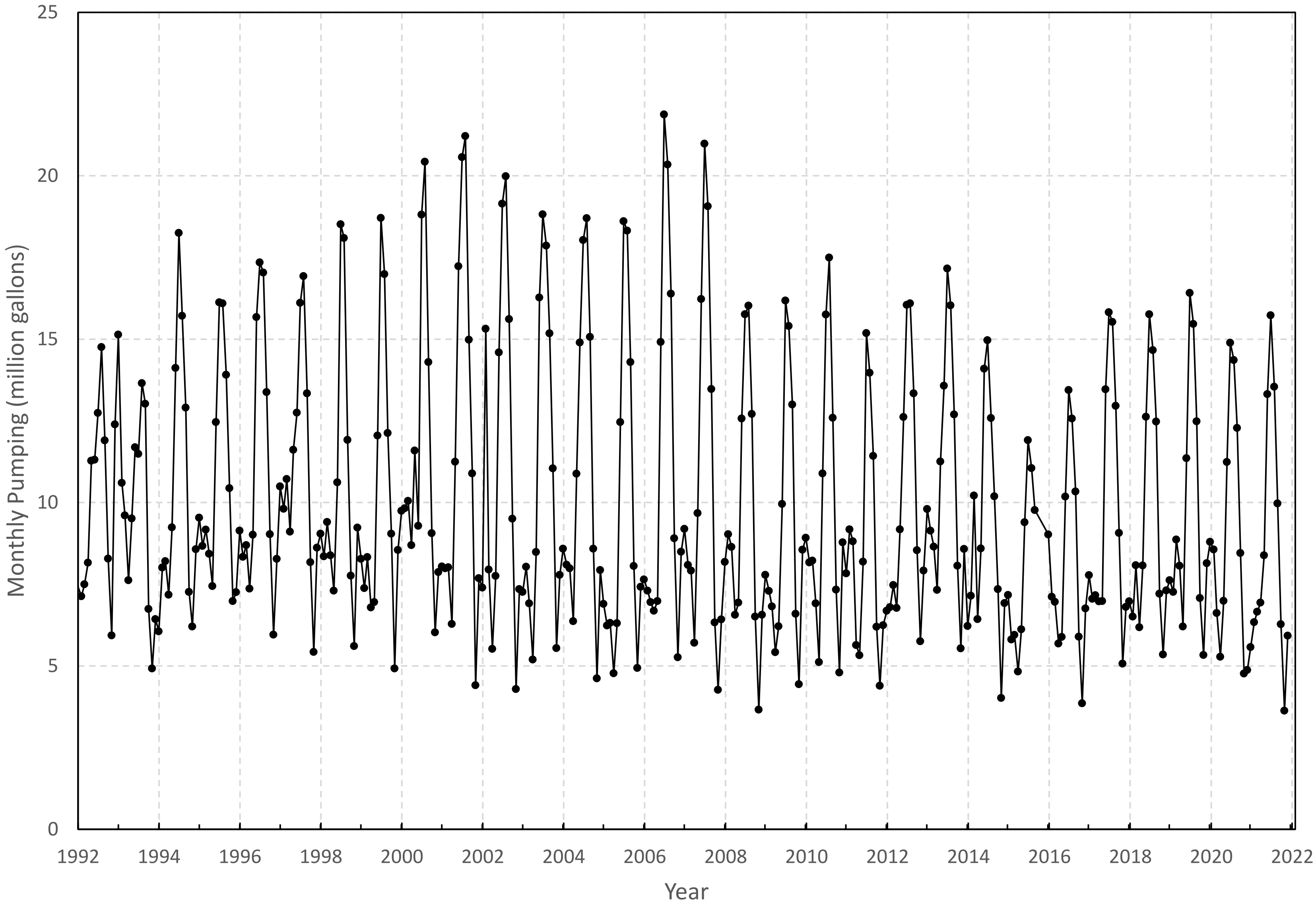

Figure 15: Historical Monthly OVPSD Pumping

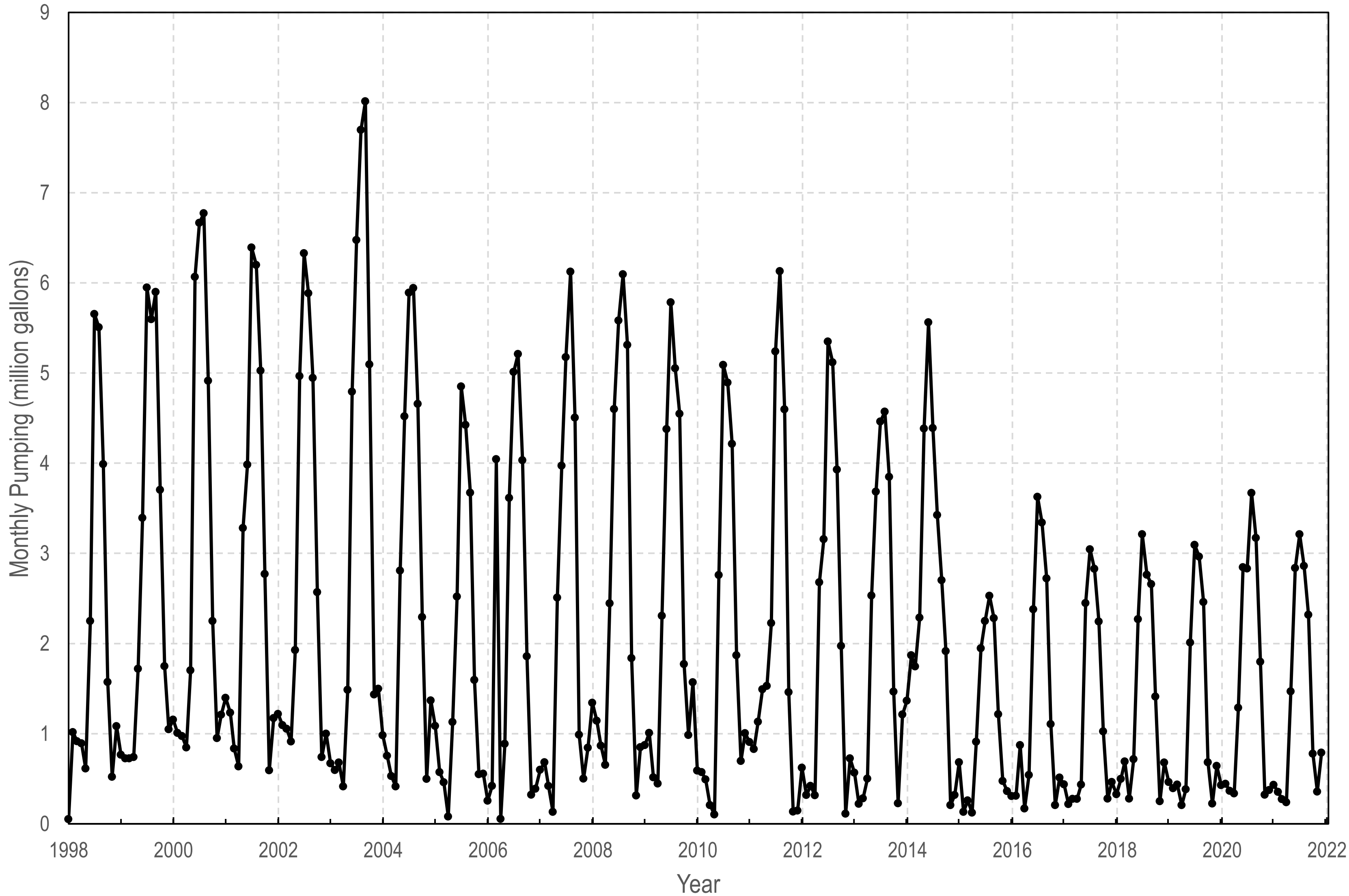

Figure 16: Historical Monthly SVMWC Pumping

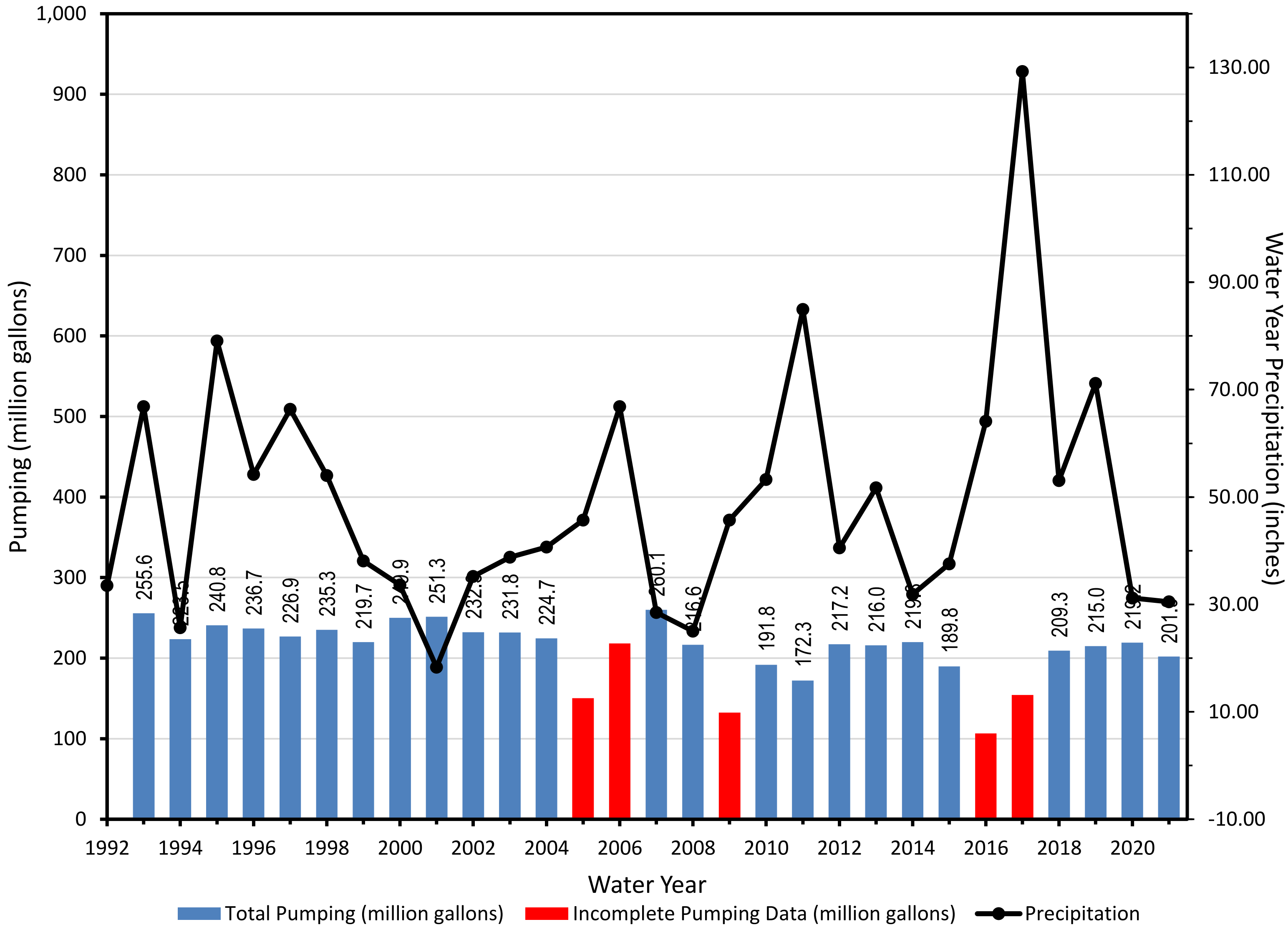

Figure 17: Historical Water Year Precipitation and Water Year Pumping

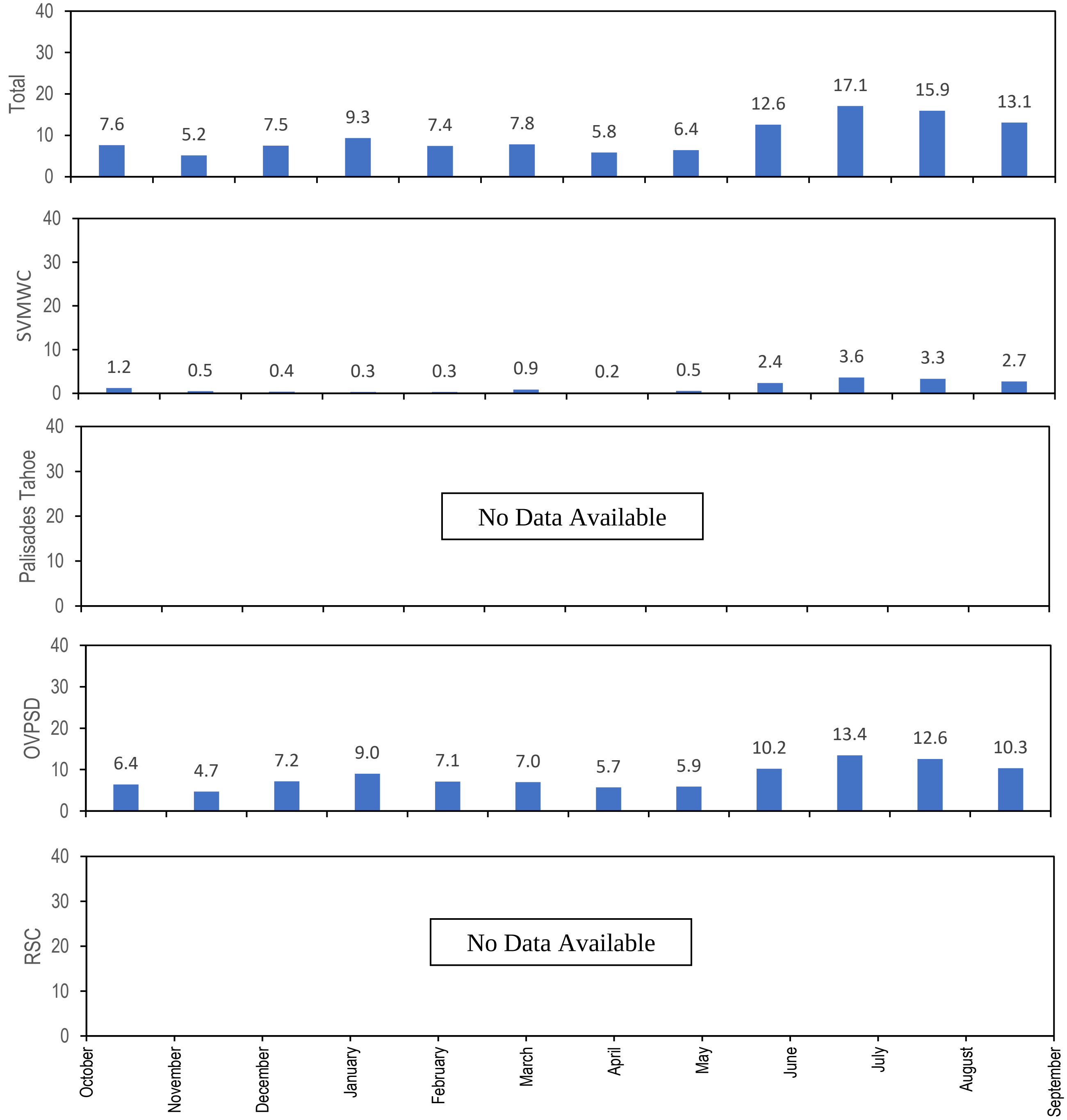

Figure 18: 2016 Water Year Monthly Pumping Distribution (million gallons)

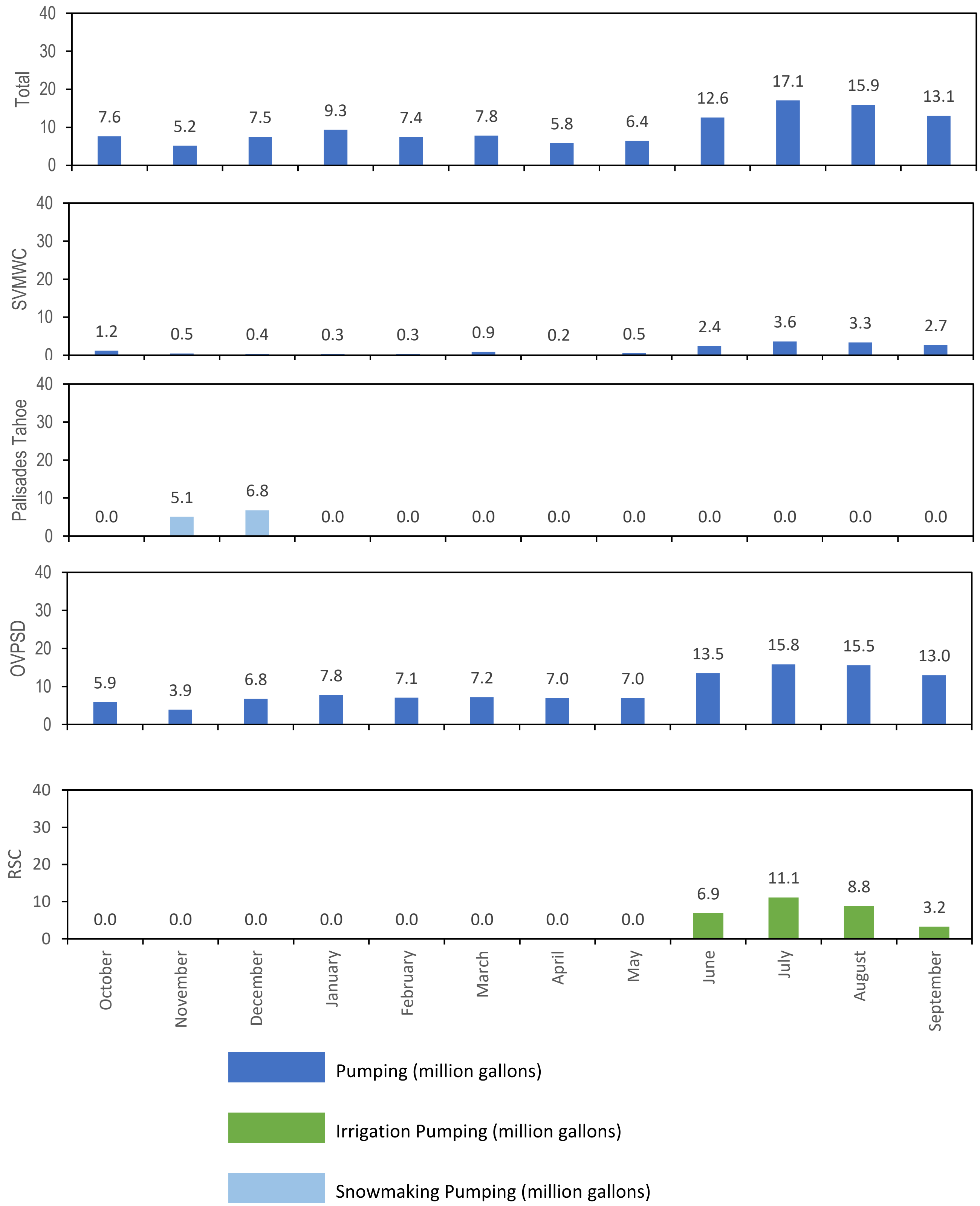

Figure 19: 2017 Water Year Monthly Pumping Distribution (million gallons)

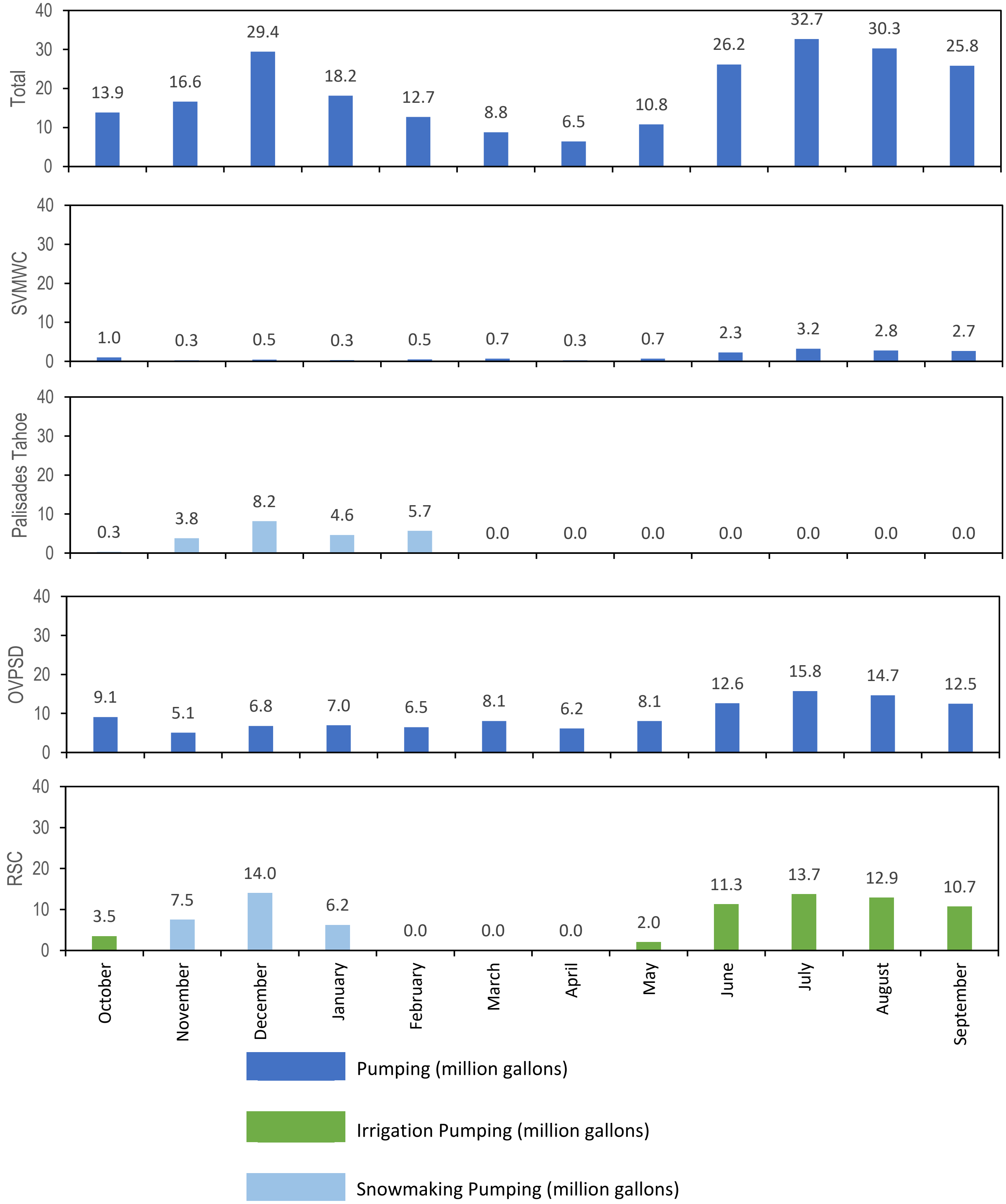

Figure 20: 2018 Water Year Monthly Pumping Distribution (million gallons)

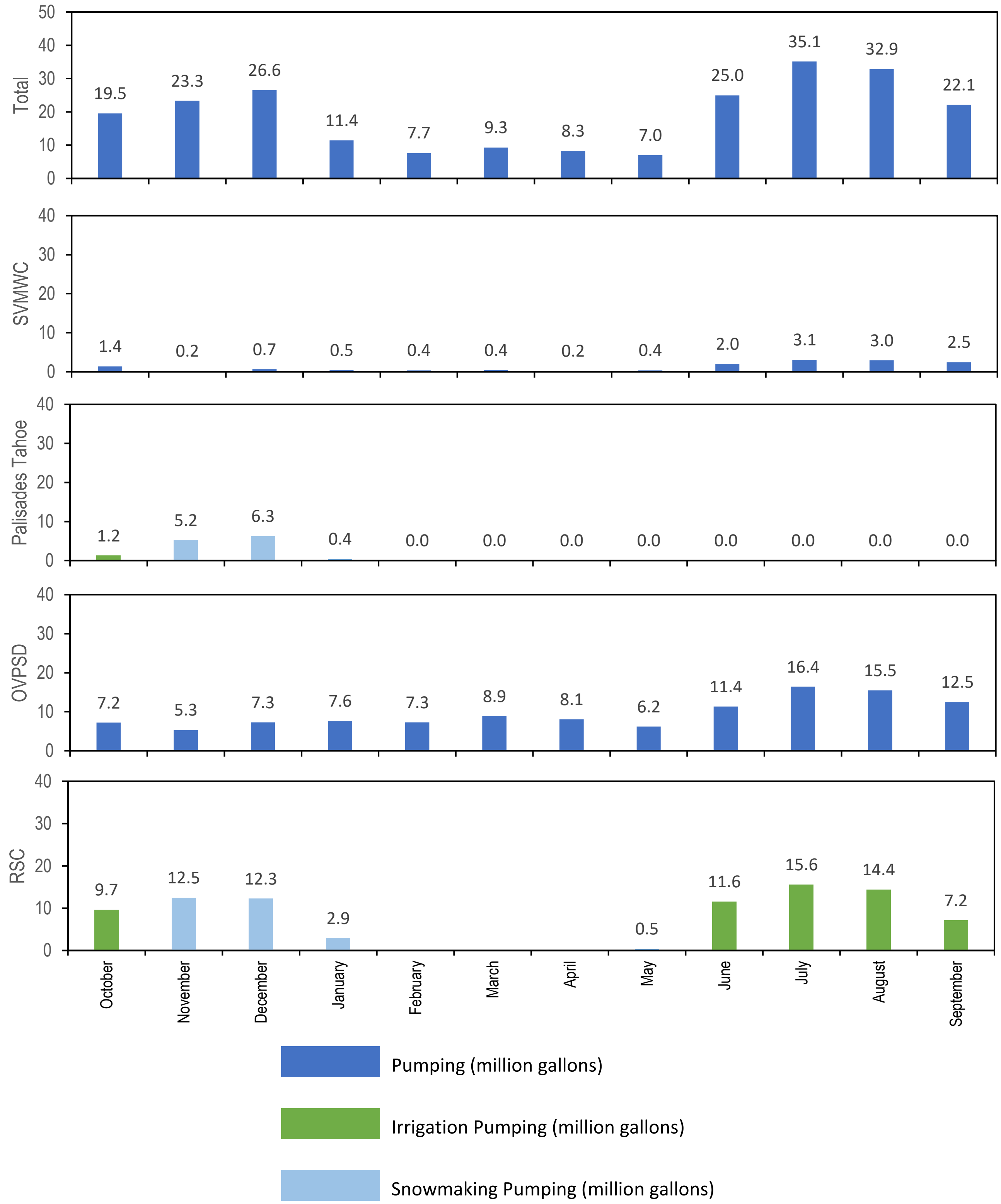

Figure 21: 2019 Water Year Monthly Pumping Distribution (million gallons)

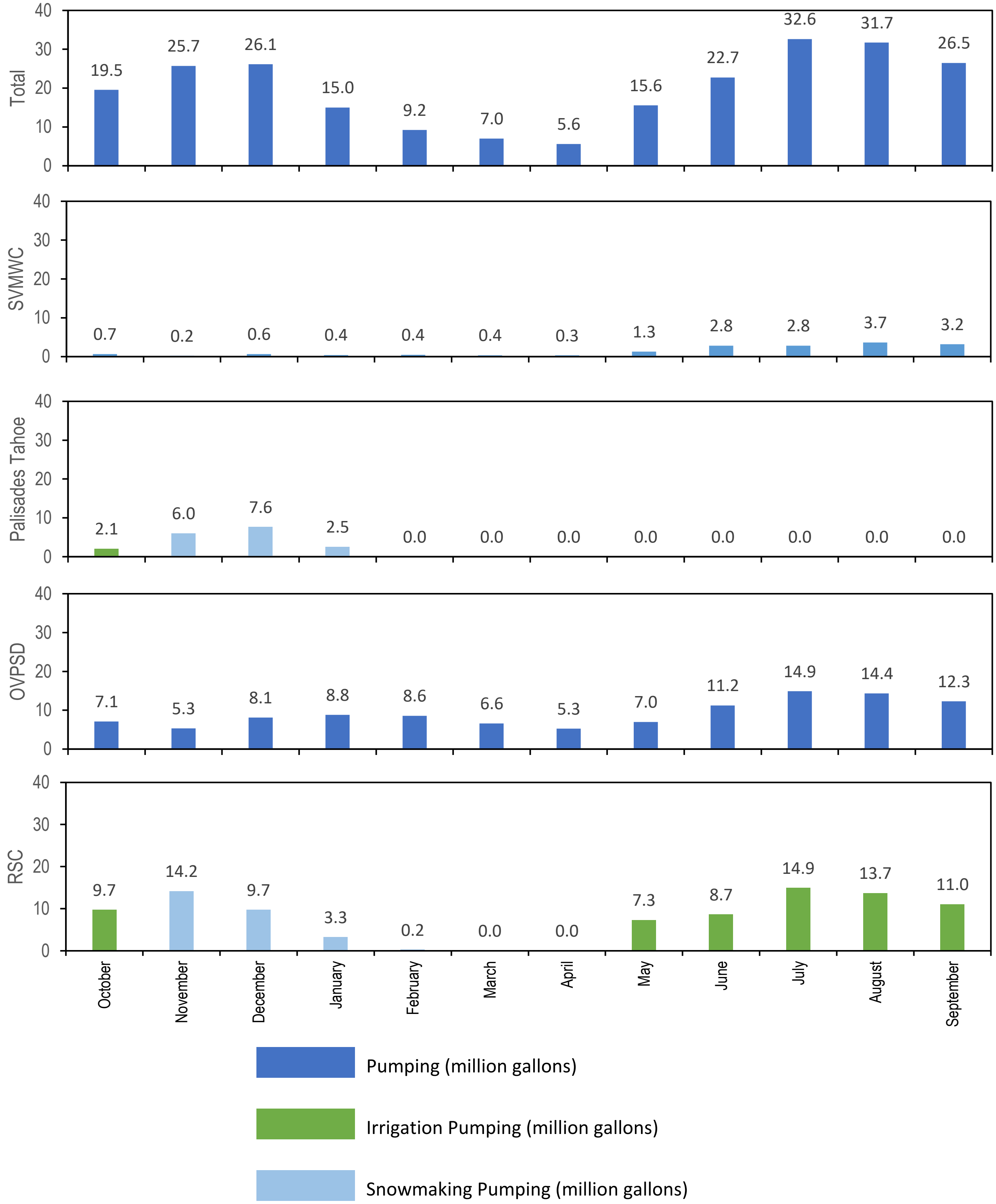

Figure 22: 2020 Water Year Monthly Pumping Distribution (million gallons)

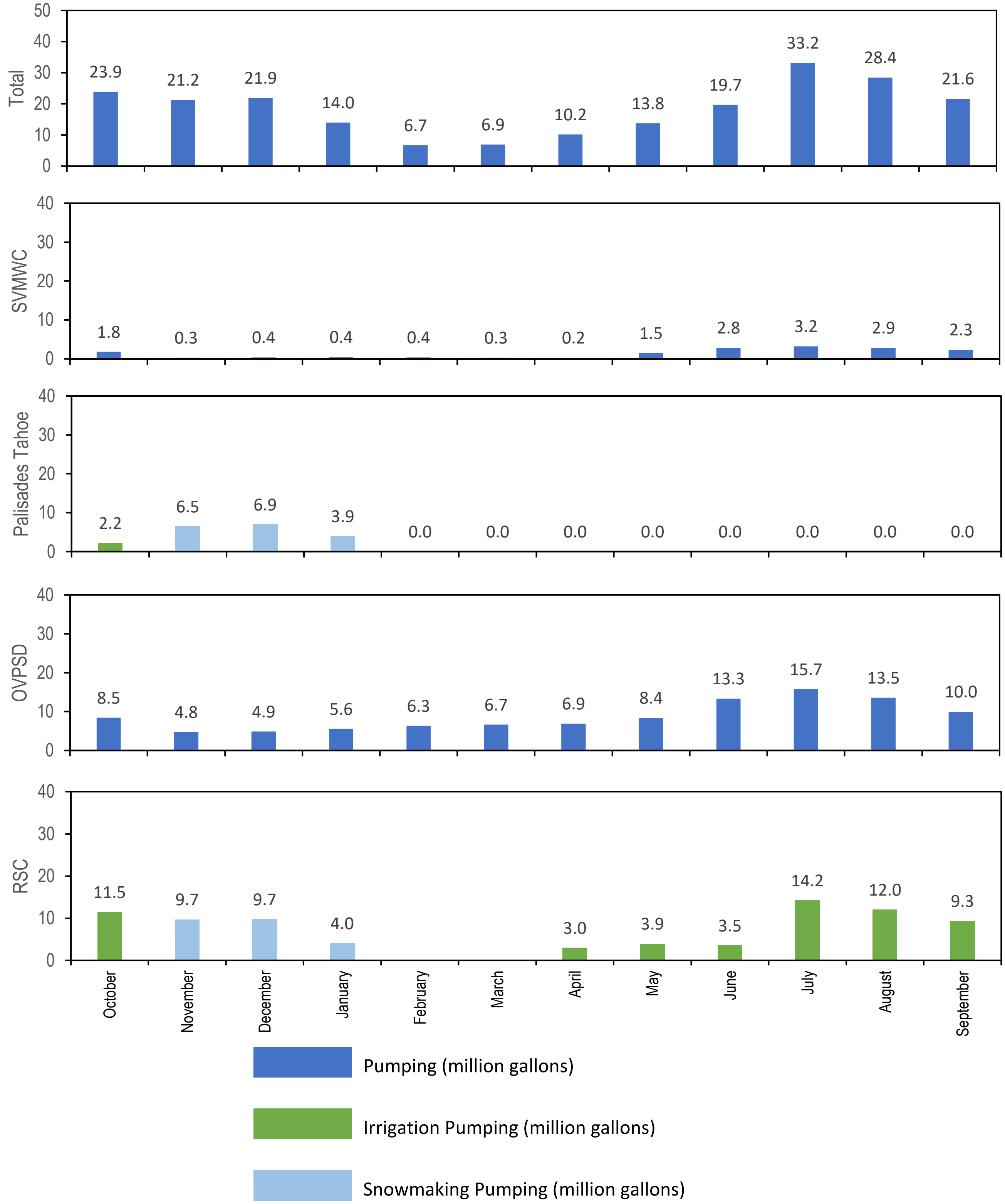

Figure 23: 2021 Water Year Monthly Pumping Distribution (million gallons)

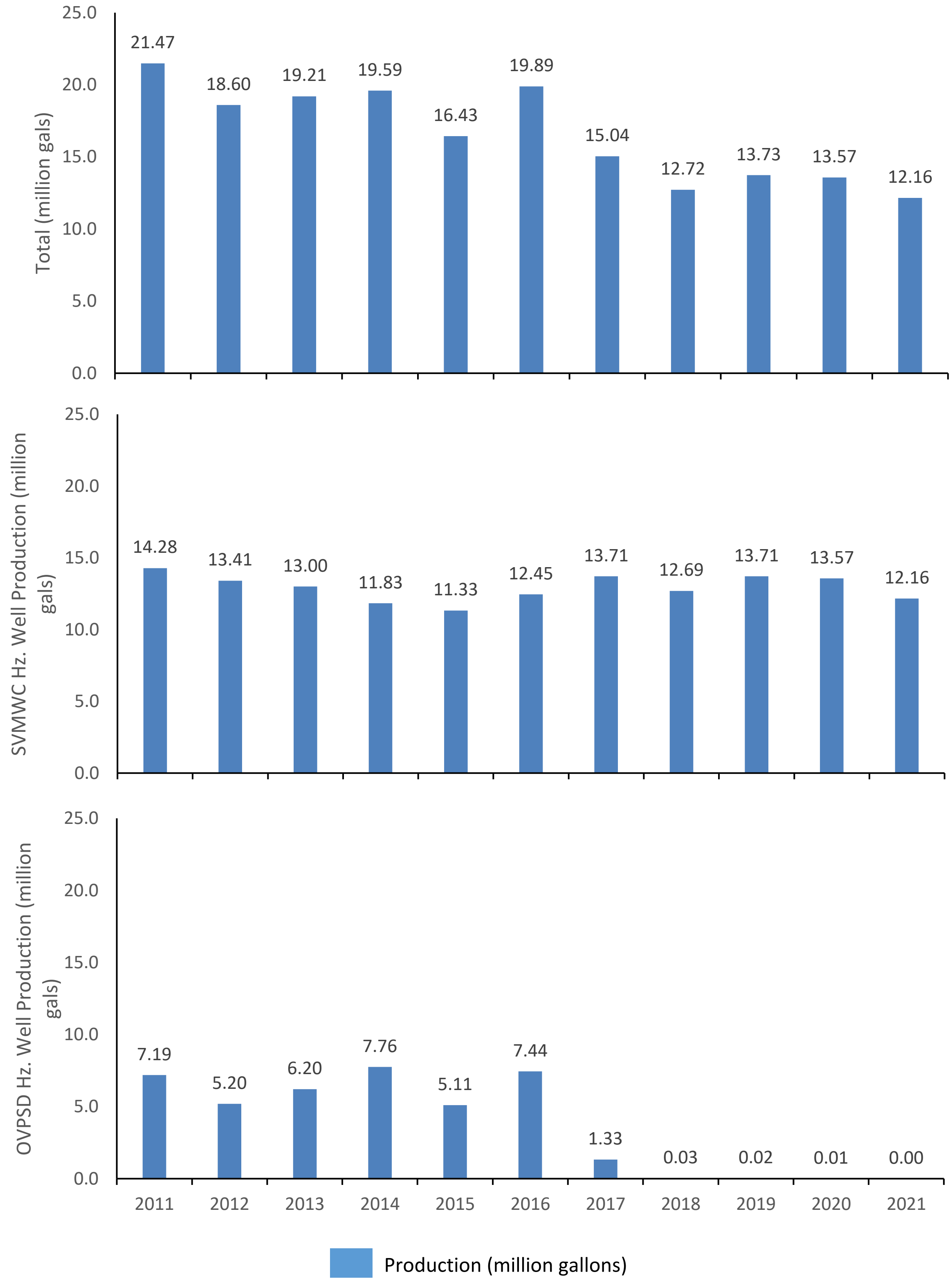

Figure 24: Annual Horizontal Well Production by Water Year

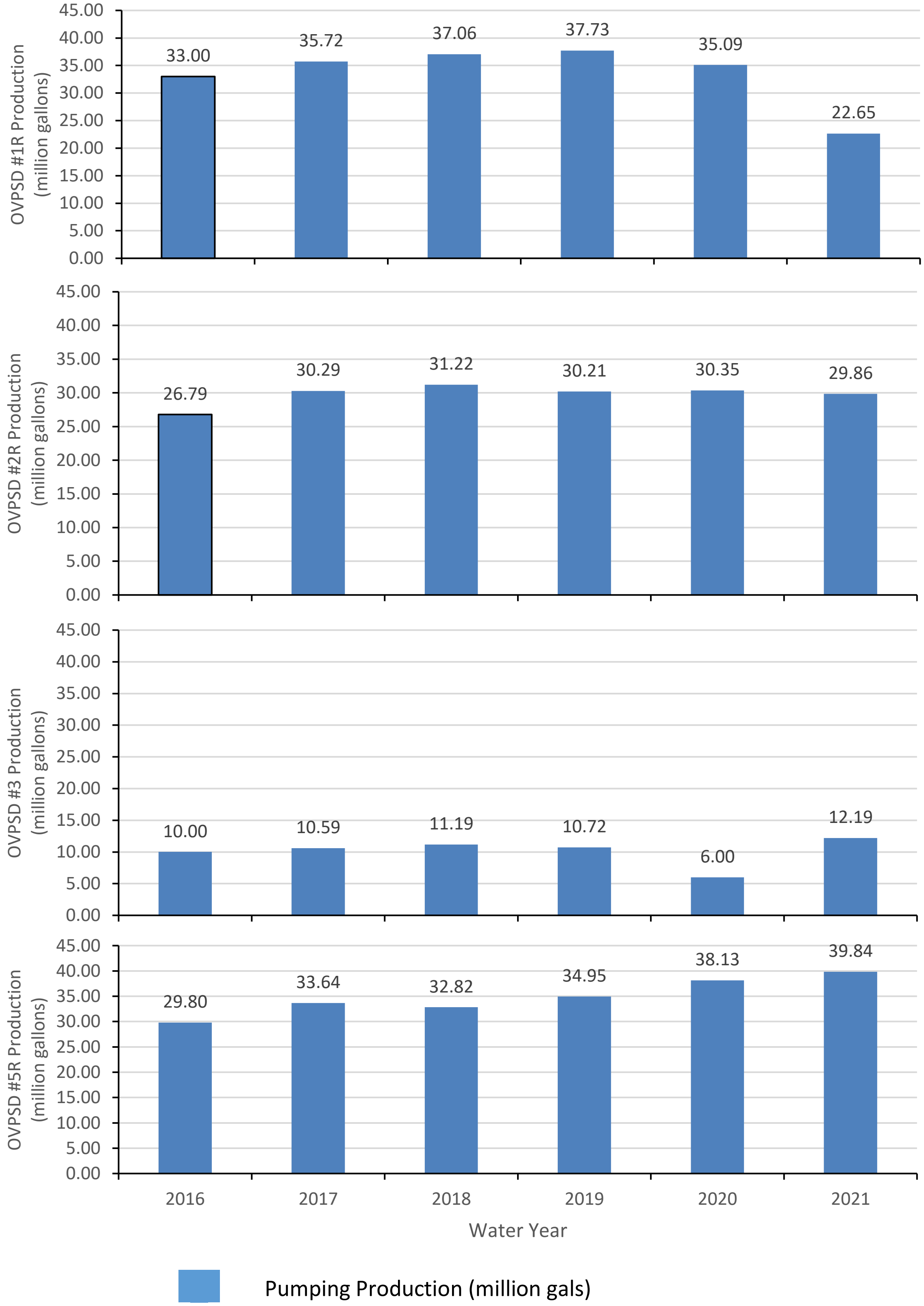

Figure 25: OVPSD Pumping per Well for Water Year 2016 - 2021

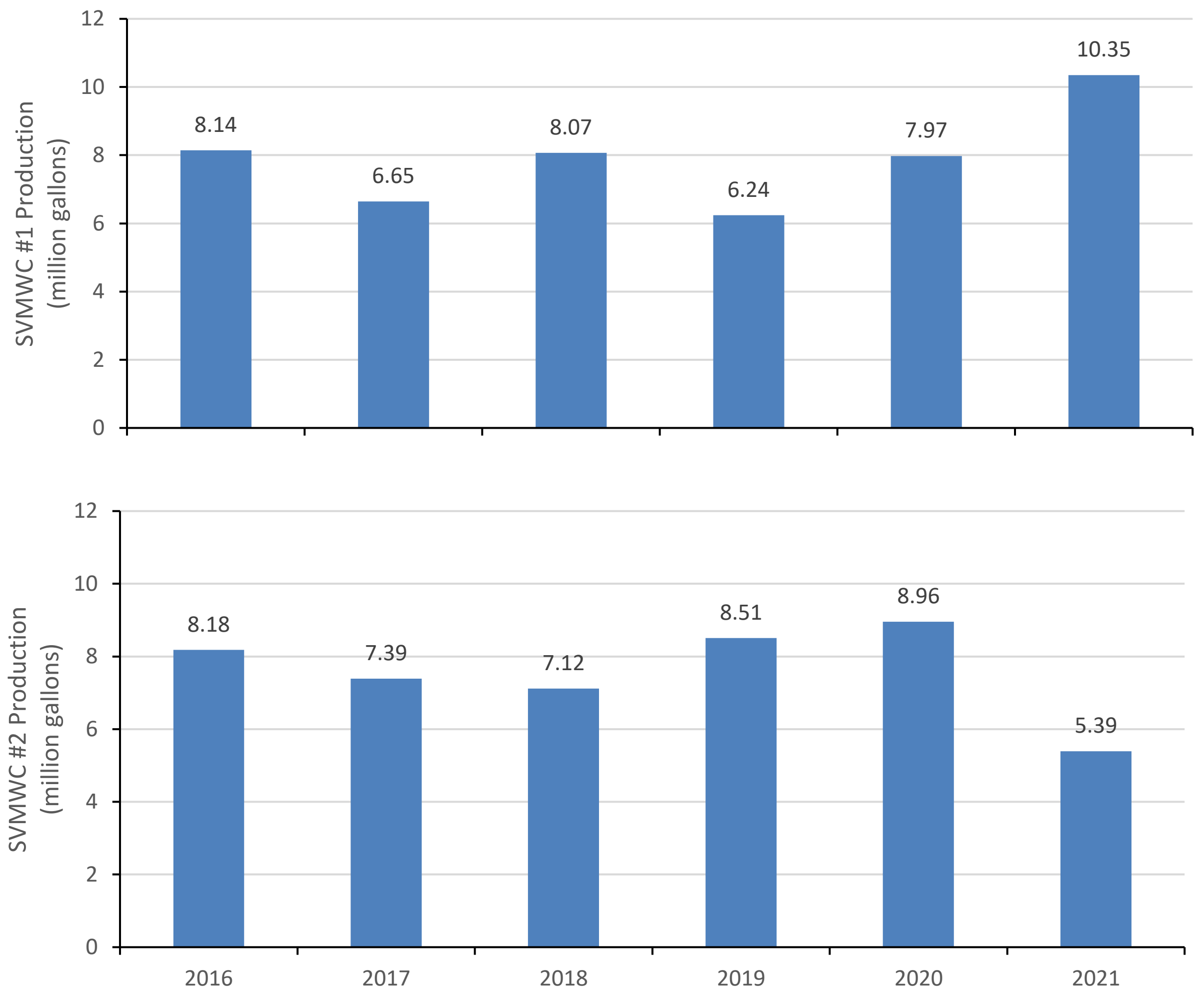

Figure 26: SVMWC Pumping per Well for Water Years 2016 – 2021

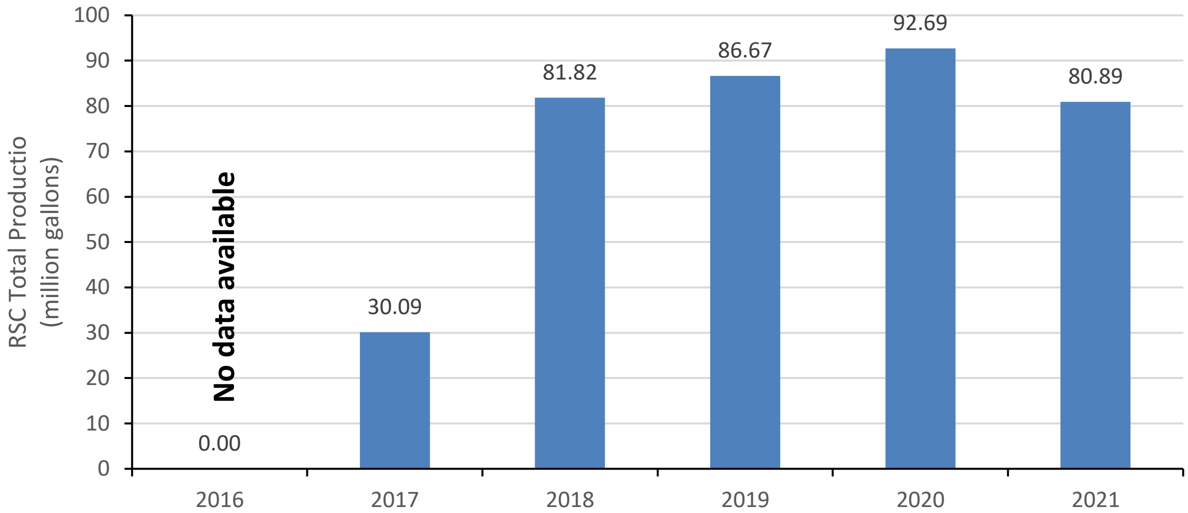

Figure 27: RSC Total Pumping for Water Years 2016 - 2021

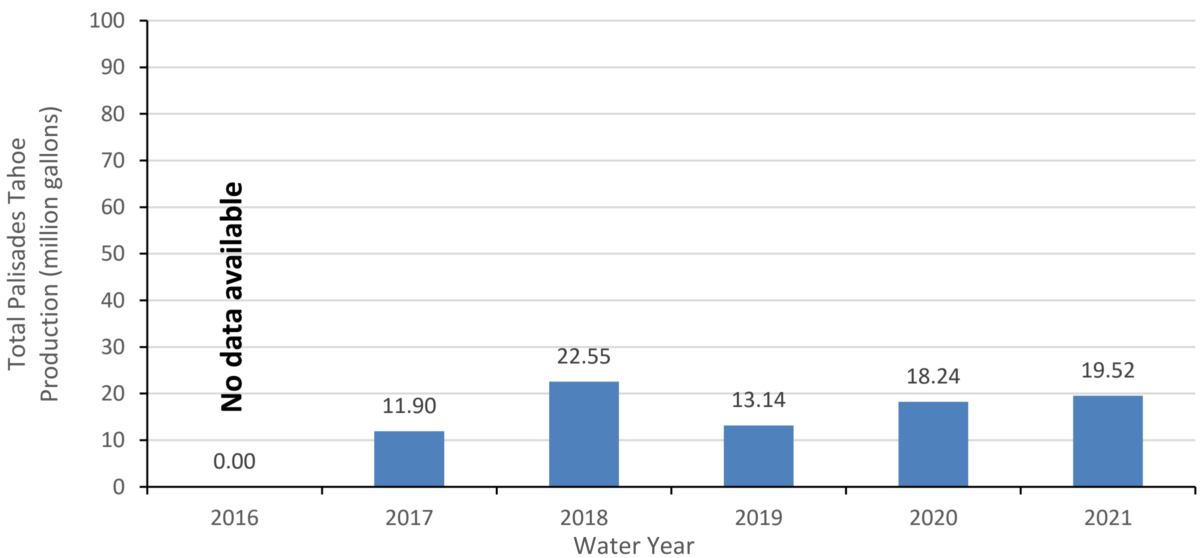

Figure 28: Palisades Tahoe Pumping for Water Years 2016 - 2021

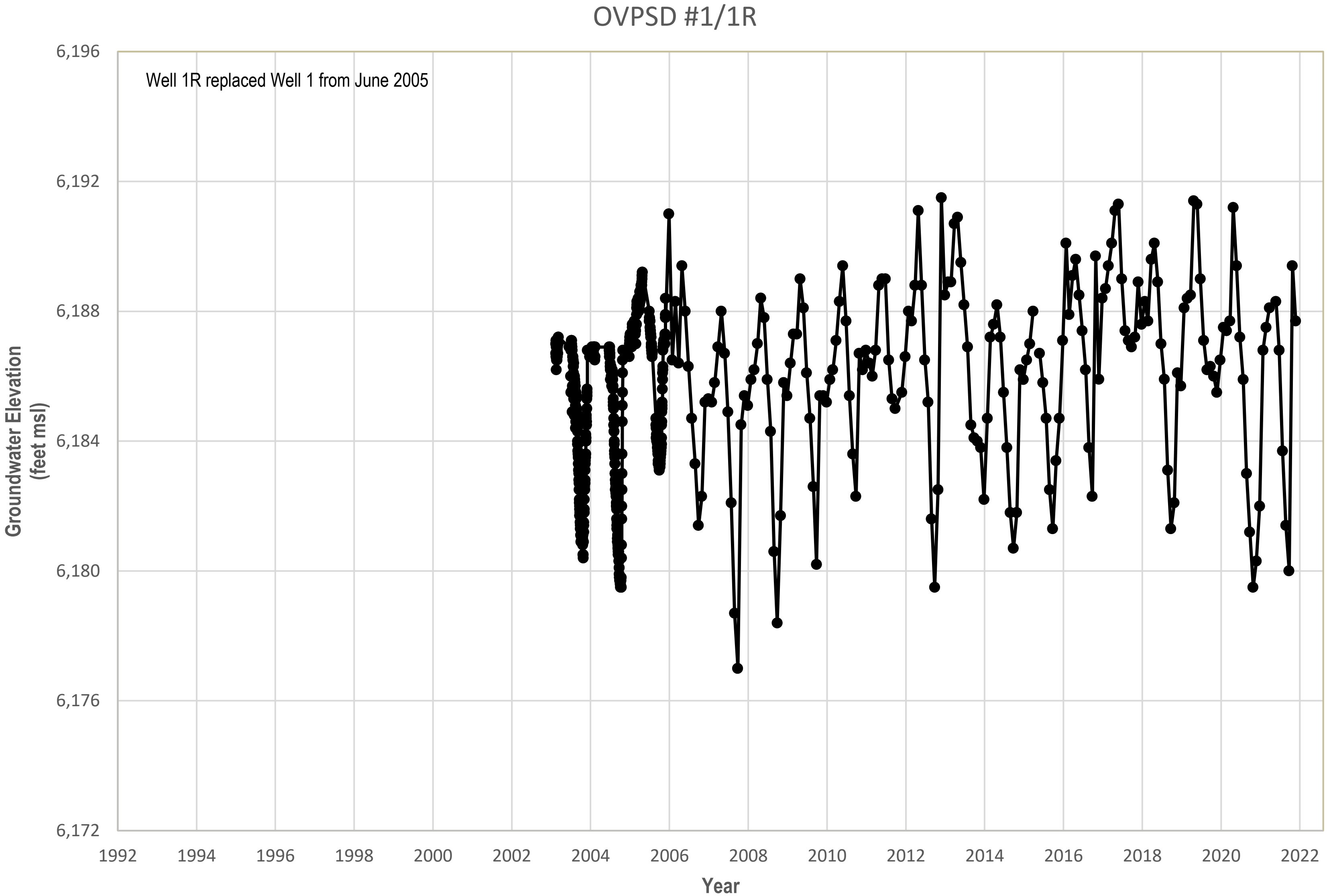

Figure 29: OVPSD#1/1R Groundwater Elevation Hydrograph

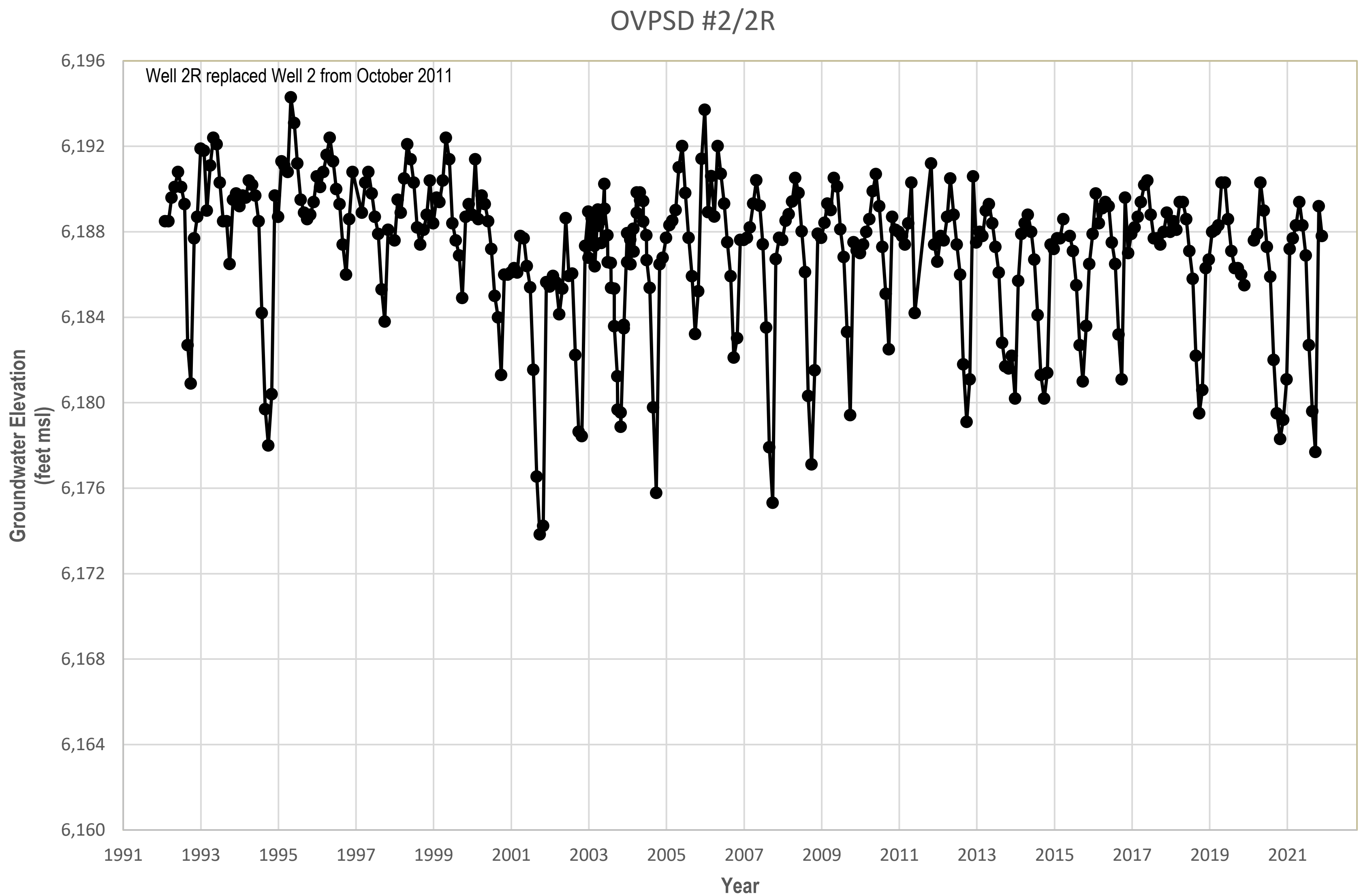

Figure 30: OVPSD#2/2R Groundwater Elevation Hydrograph

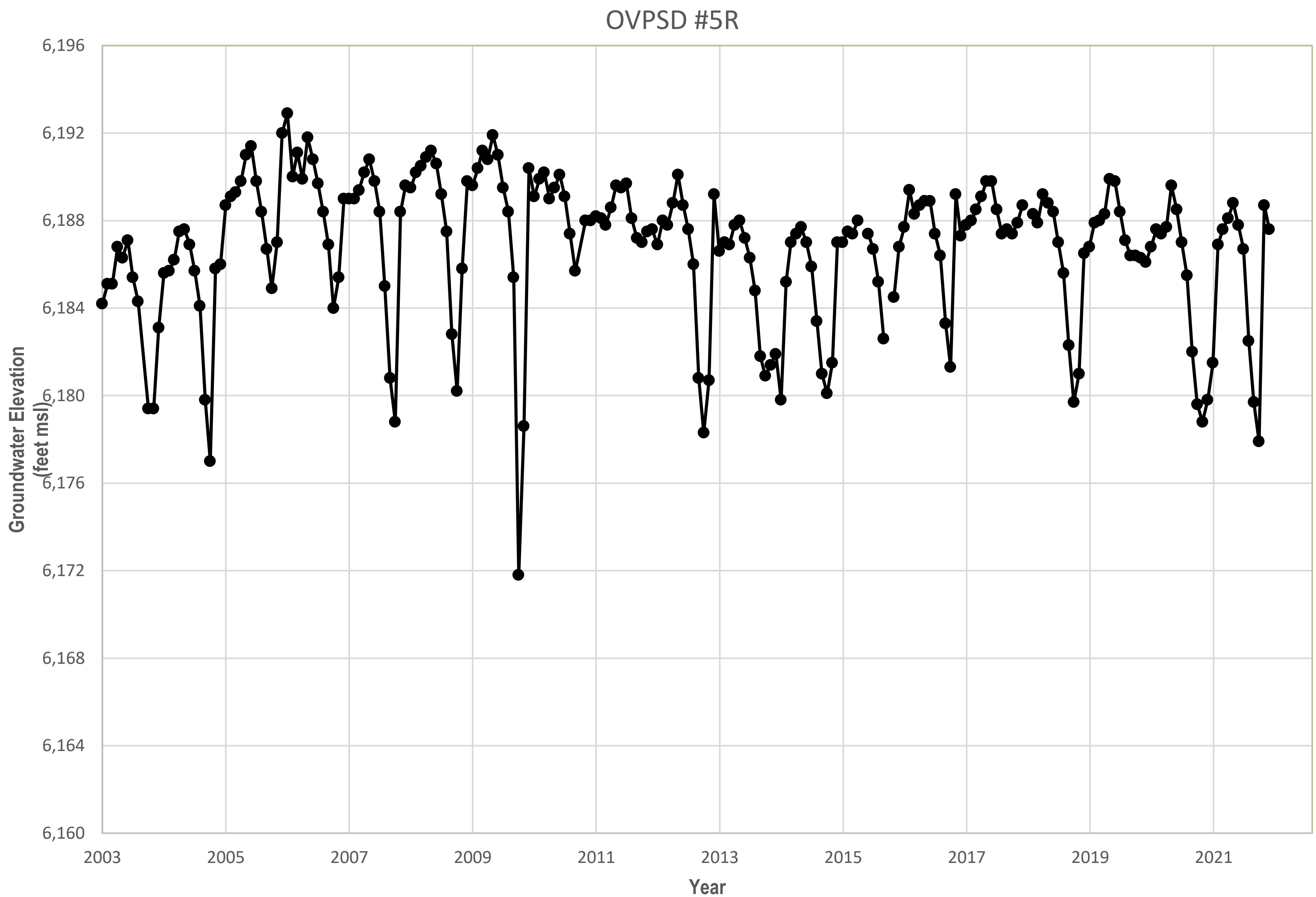

Figure 31: OVPSD#5R Groundwater Elevation Hydrograph

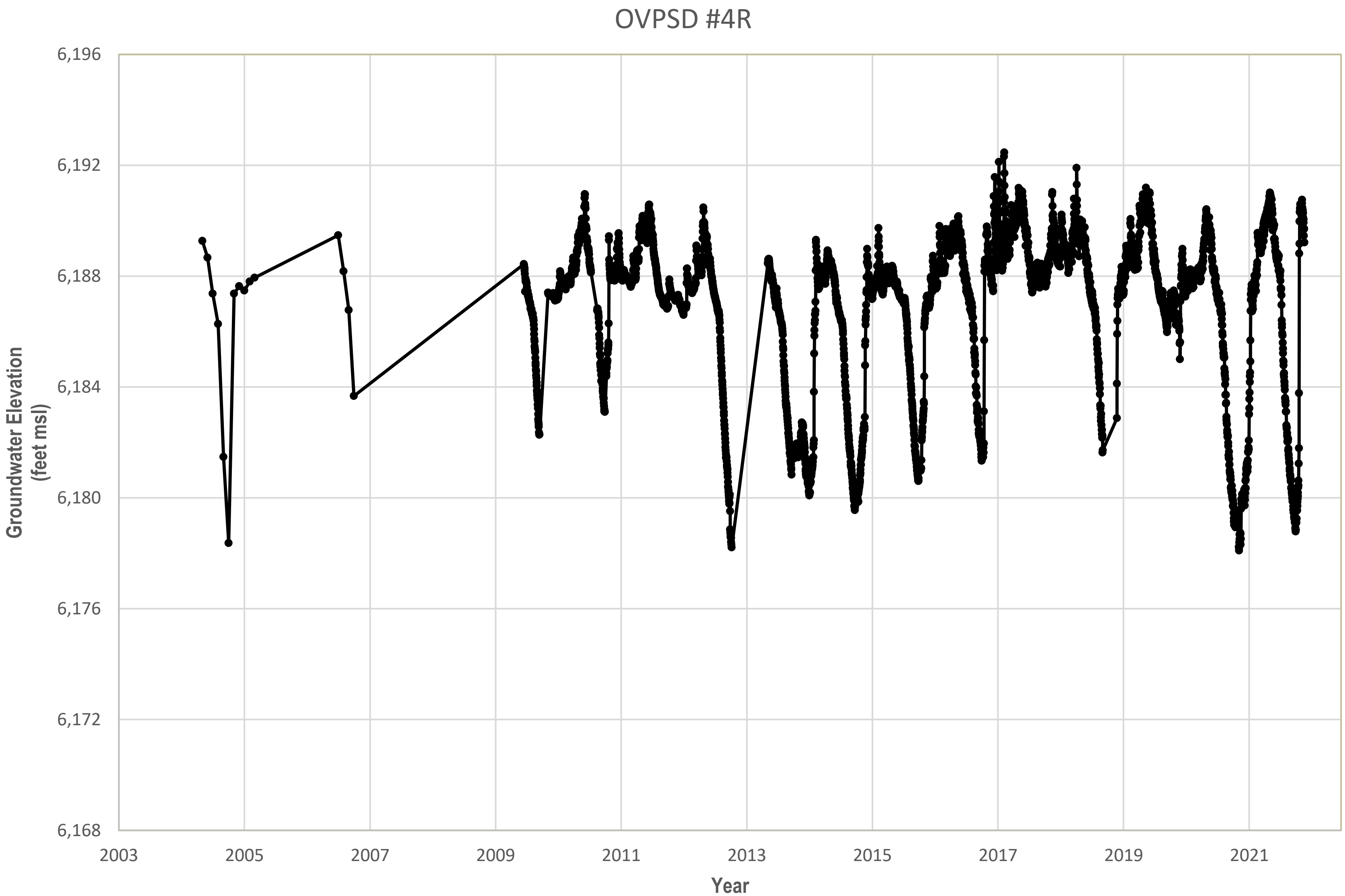

Figure 32: OVPSD #4R Groundwater Elevation Hydrograph

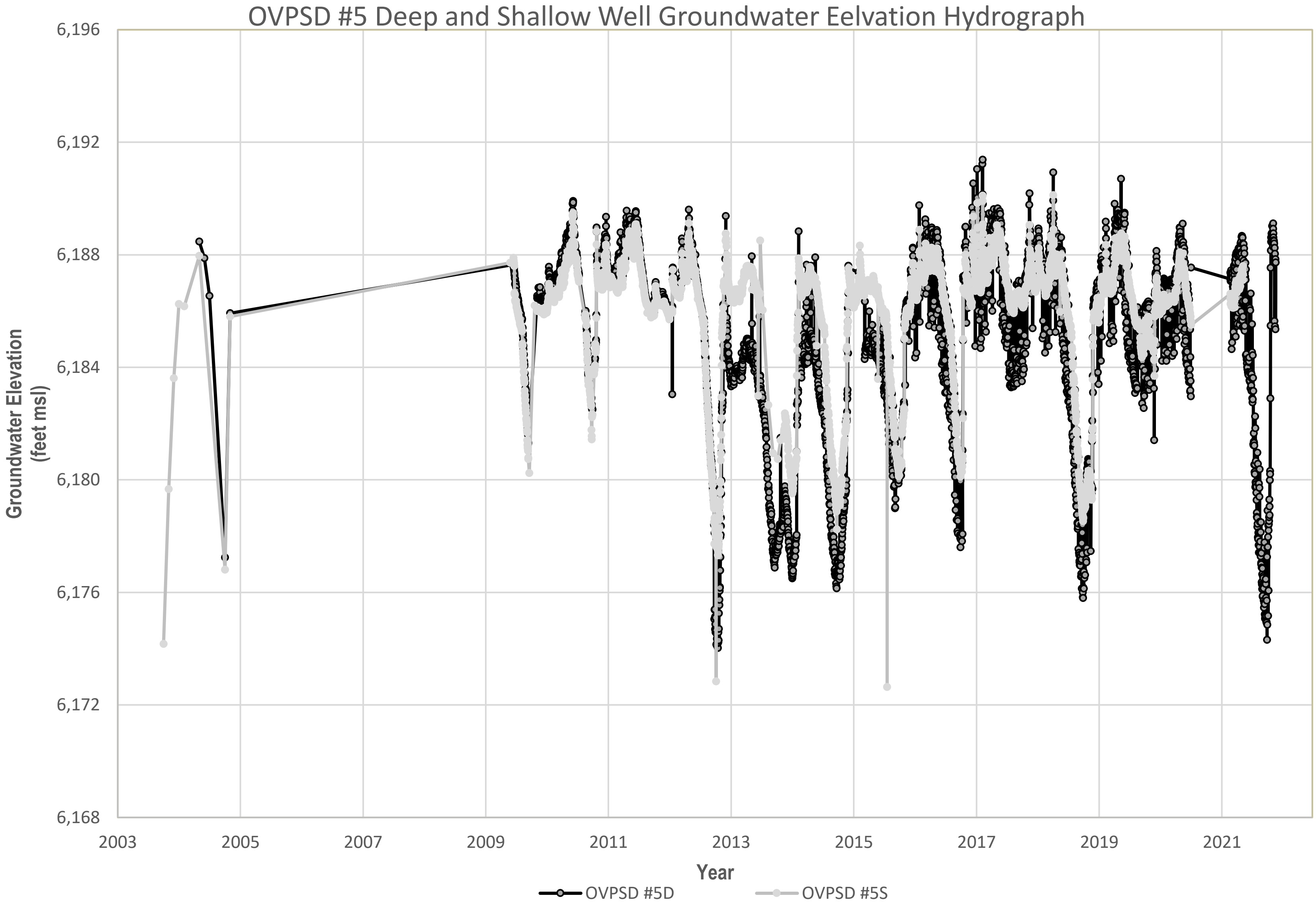

Figure 33: OVPSD #5D and OVPSD #5S Groundwater Elevation Hydrograph

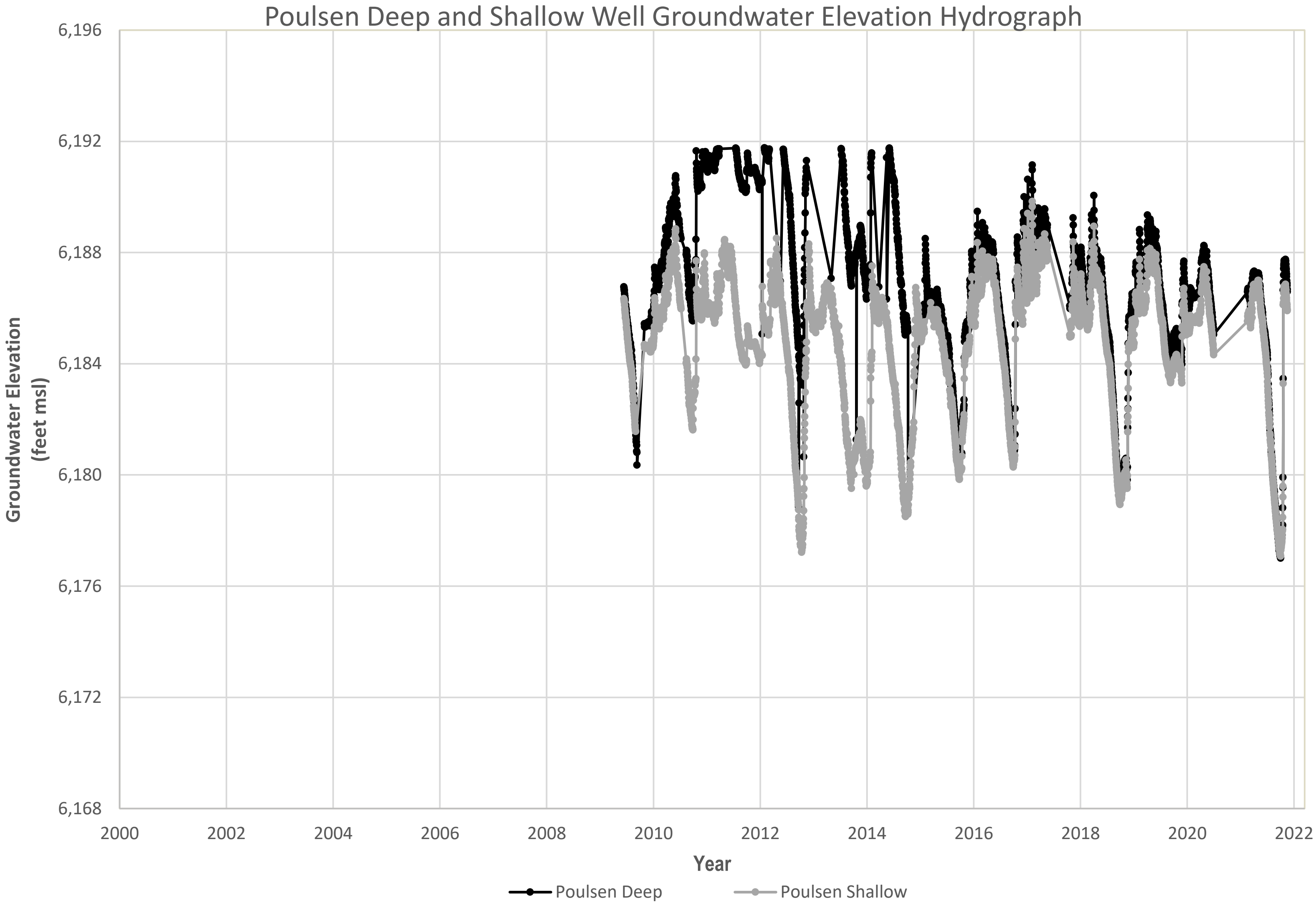

Figure 34: Poulsen Deep and Shallow Well Groundwater Elevation Hydrographs

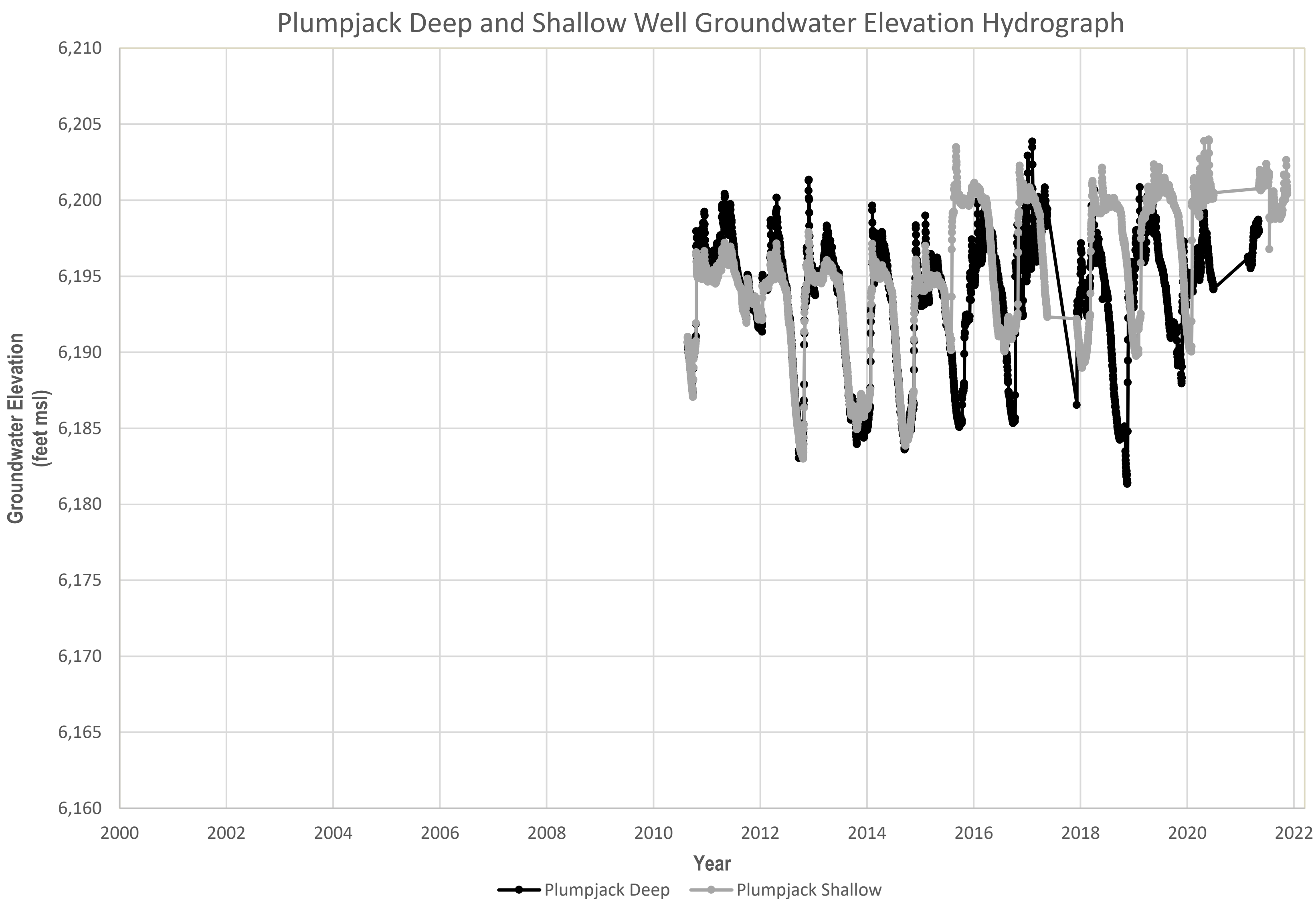

Figure 35: PlumpJack Deep and Shallow Well Groundwater Hydrographs

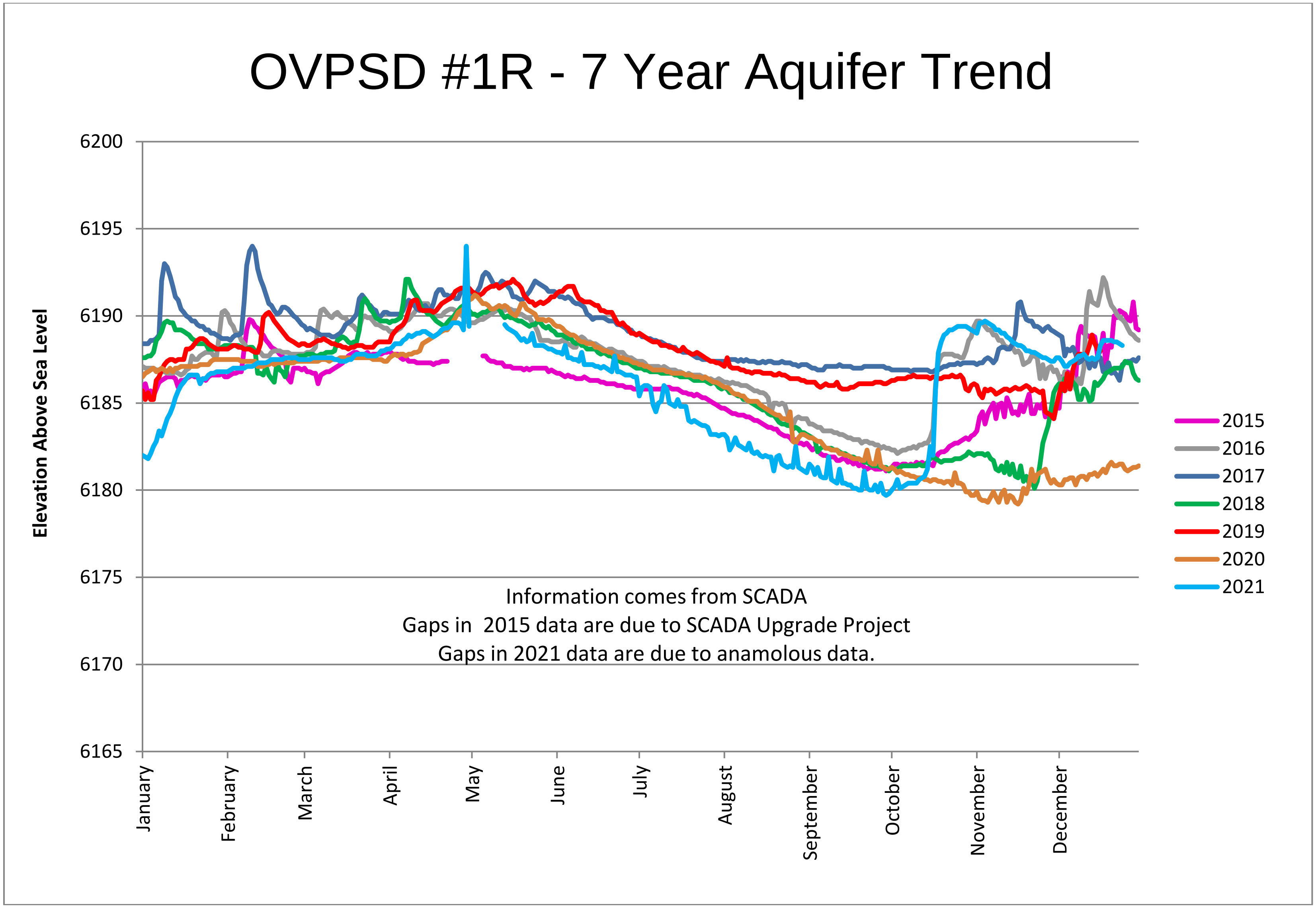

Figure 36: OVPSD Water Well 1R 7 Year Aquifer Trend

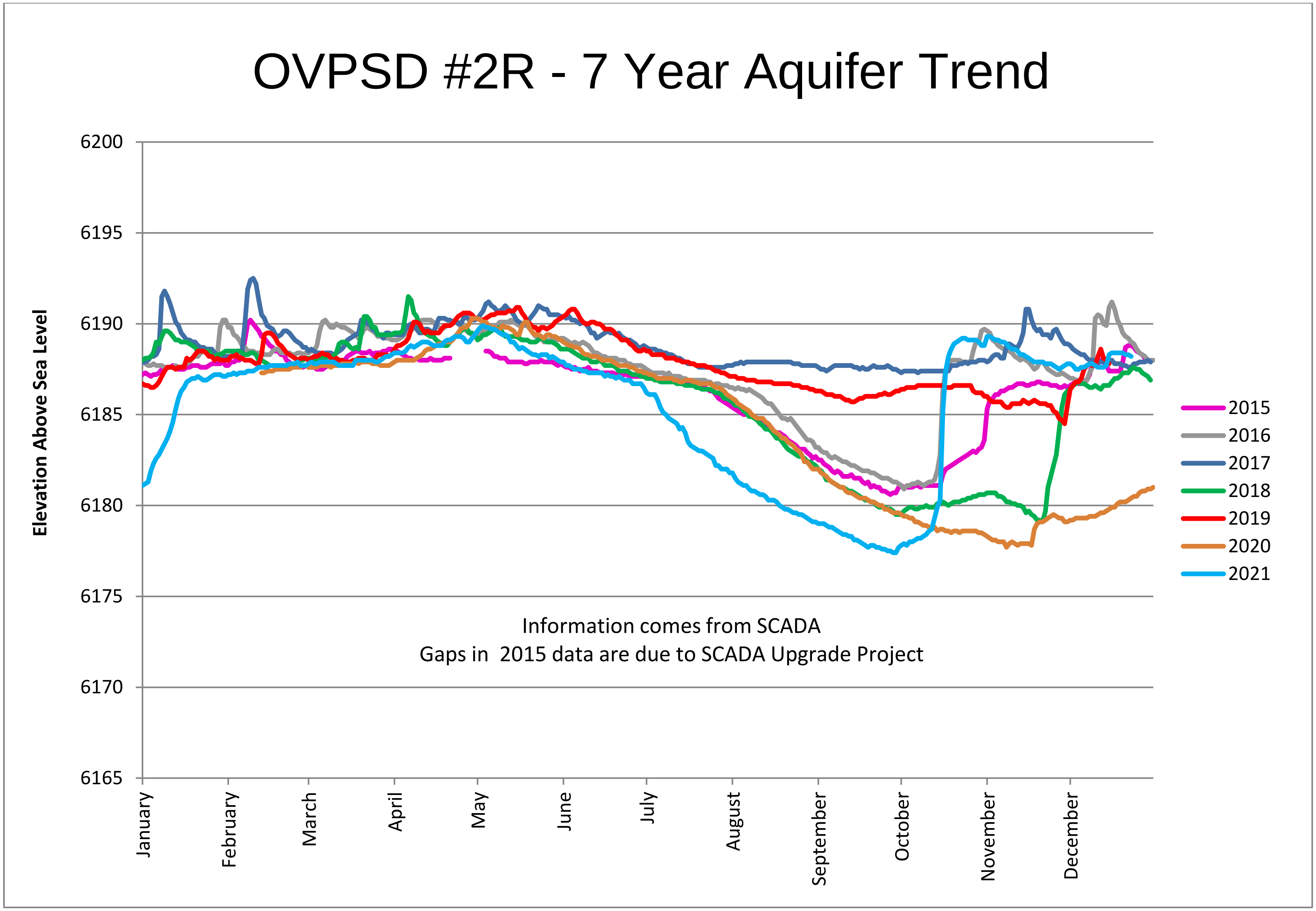

Figure 37: OVPSD Water Well 2R 7 Year Aquifer Trend

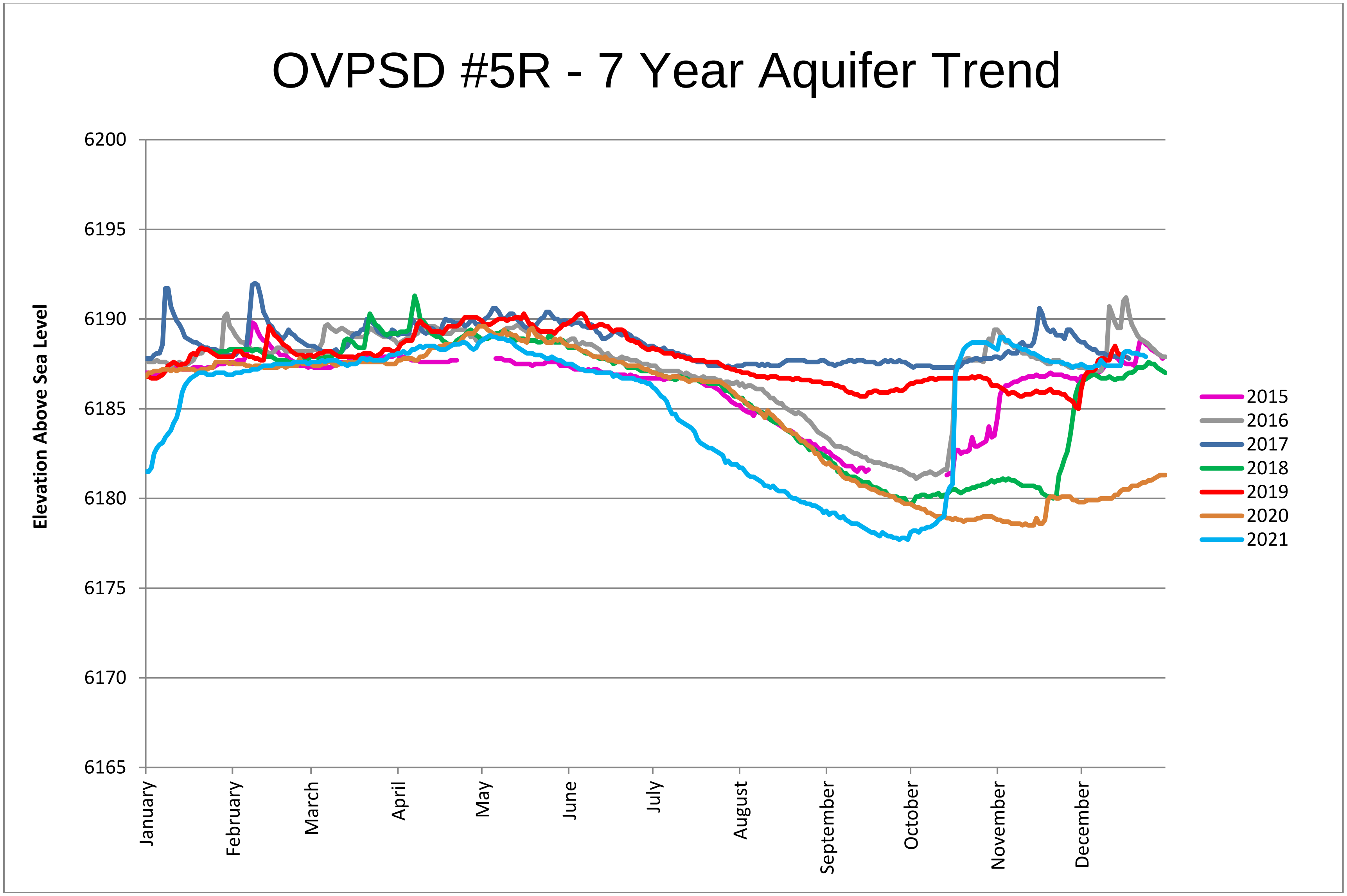

Figure 38: OVPSD Water Well 5R 7 Year Aquifer Trend

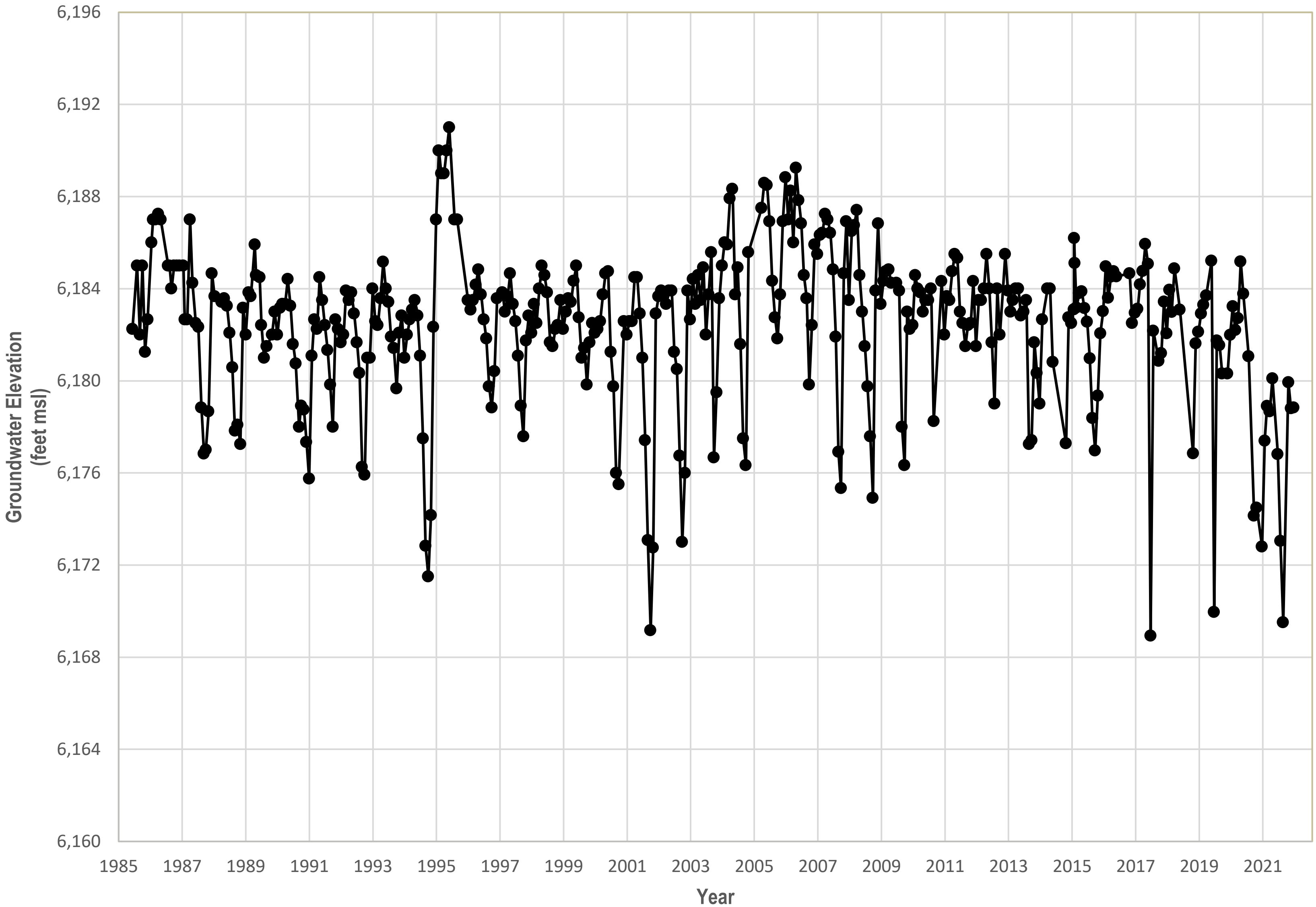

Figure 39: SVMWC #1 Historical Groundwater Elevation Hydrograph

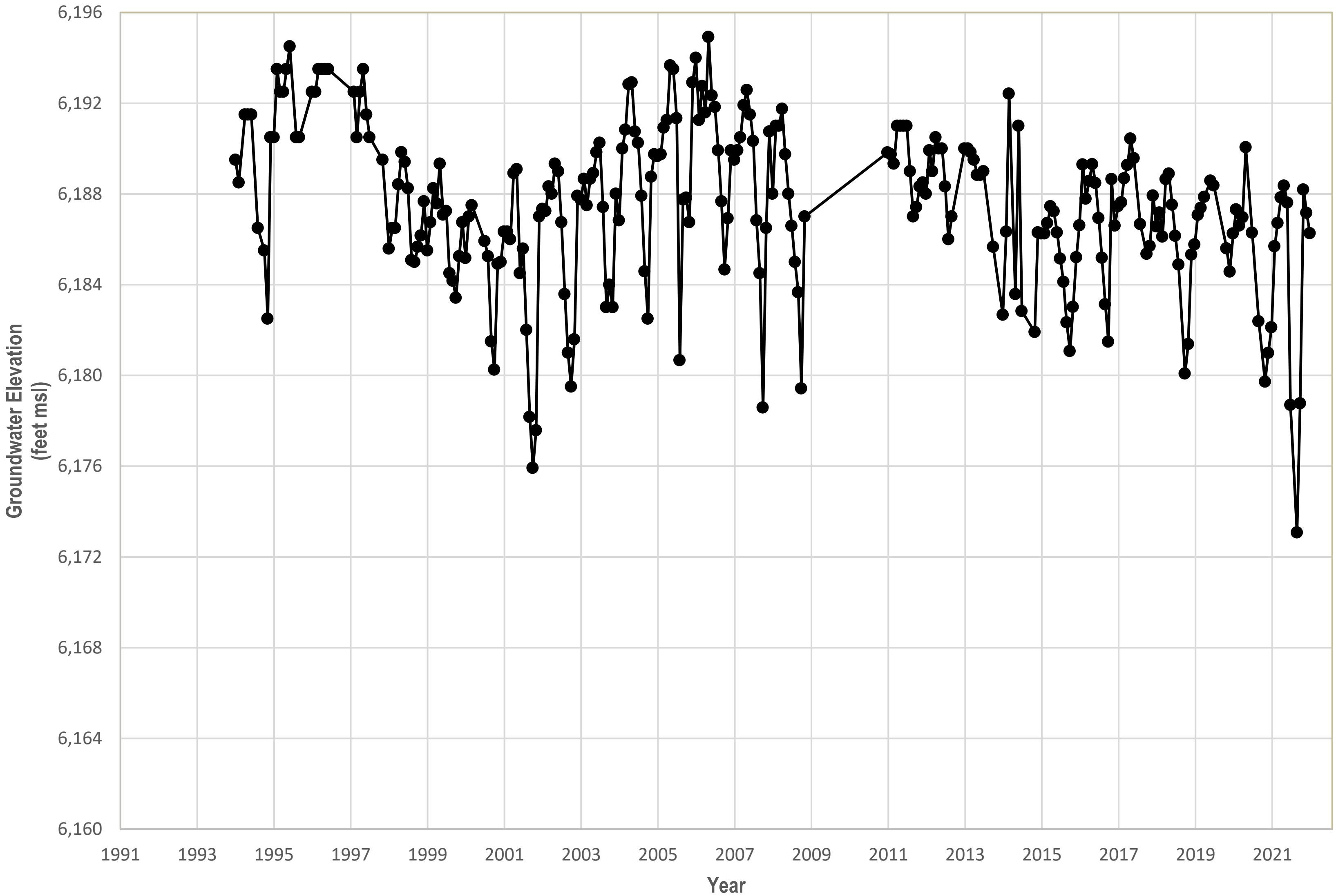

Figure 40: SVMWC #2 Historical Groundwater Elevation Hydrograph

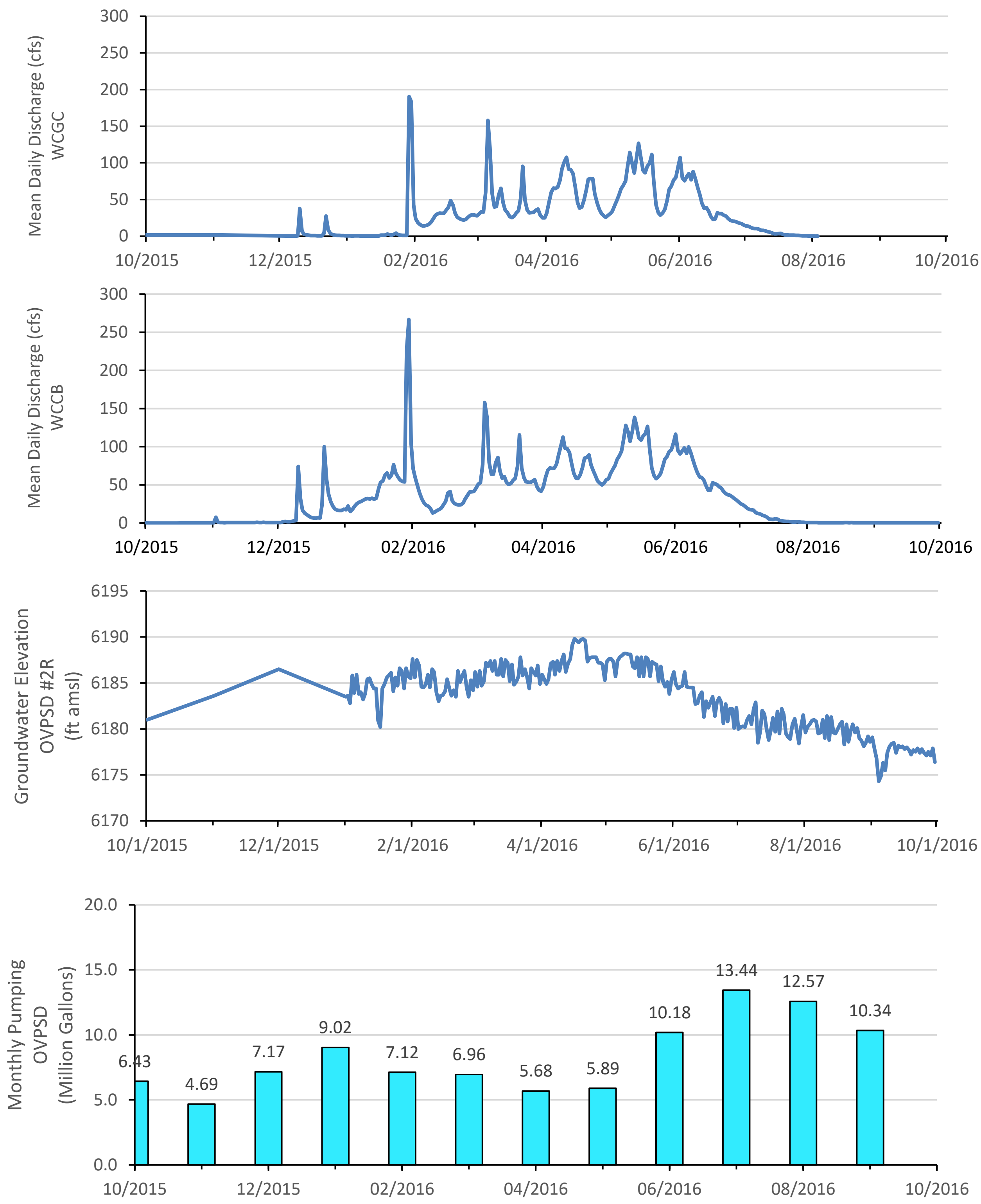

Figure 41: Water Year 2016 Groundwater Elevation, Streamflow, and Total OVPSD Pumping

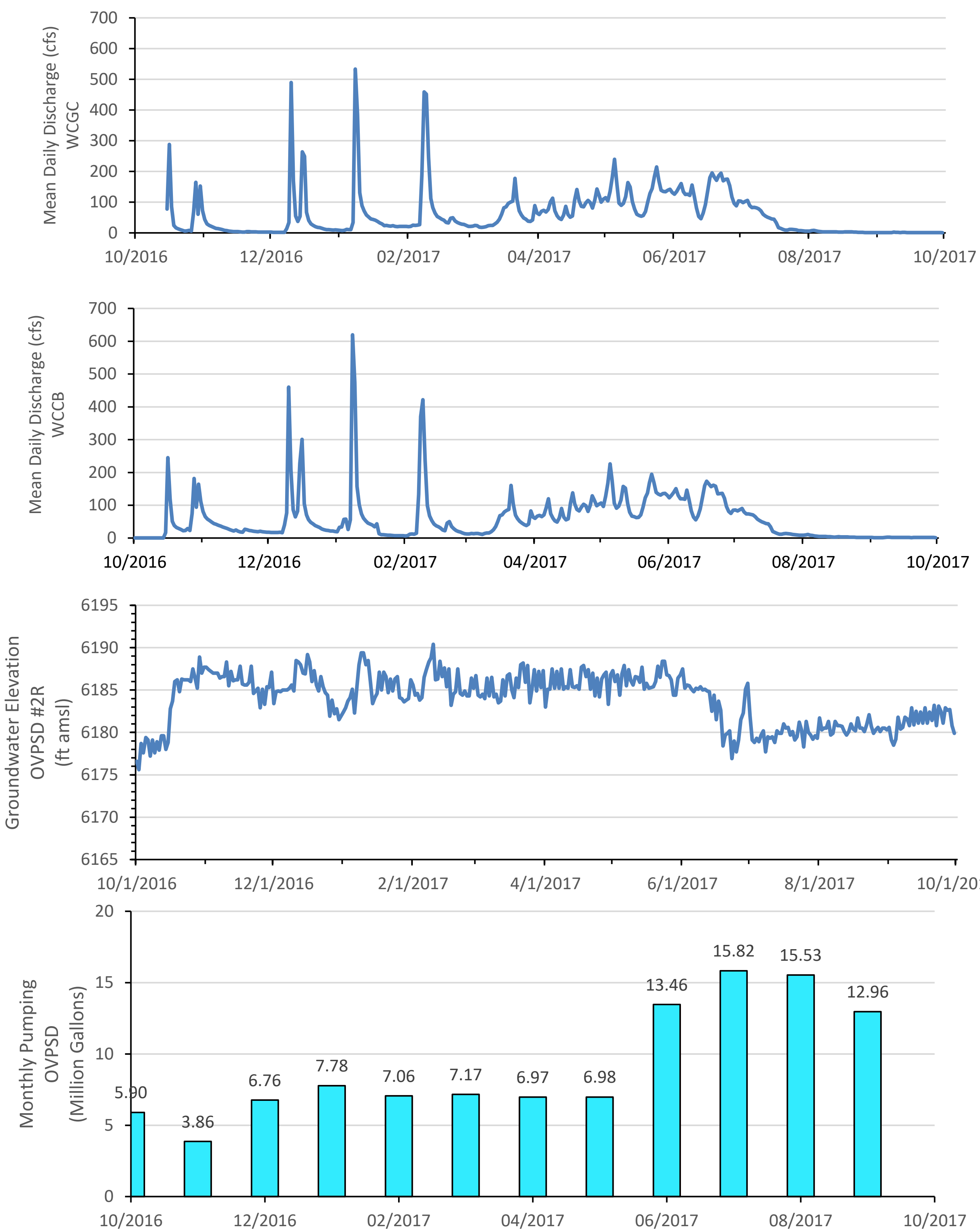

Figure 42: Water Year 2017 Groundwater Elevation, Streamflow, and Total OVPSD Pumping

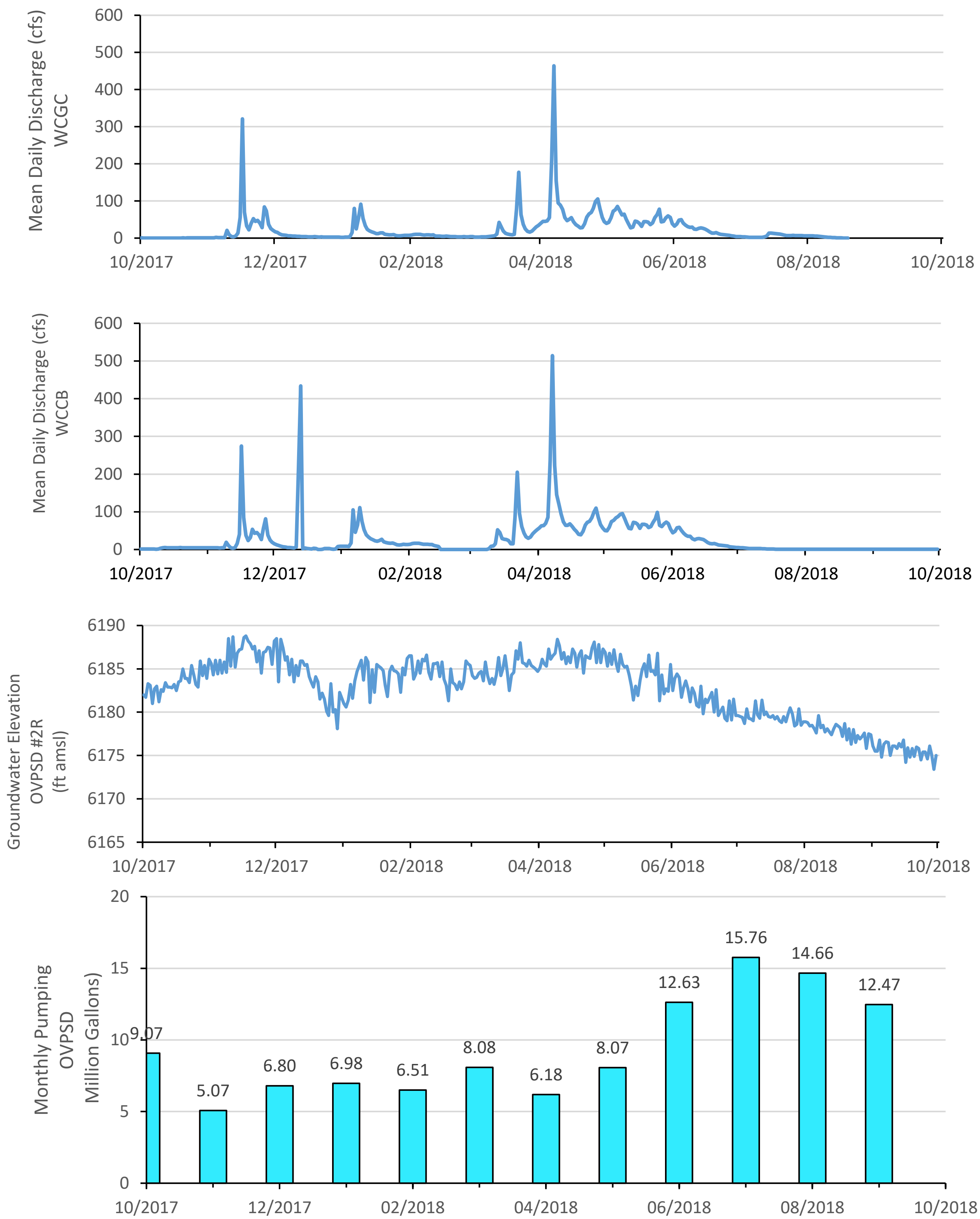

Figure 43: Water Year 2018 Groundwater Elevation, Streamflow, and Total OVPSD Pumping

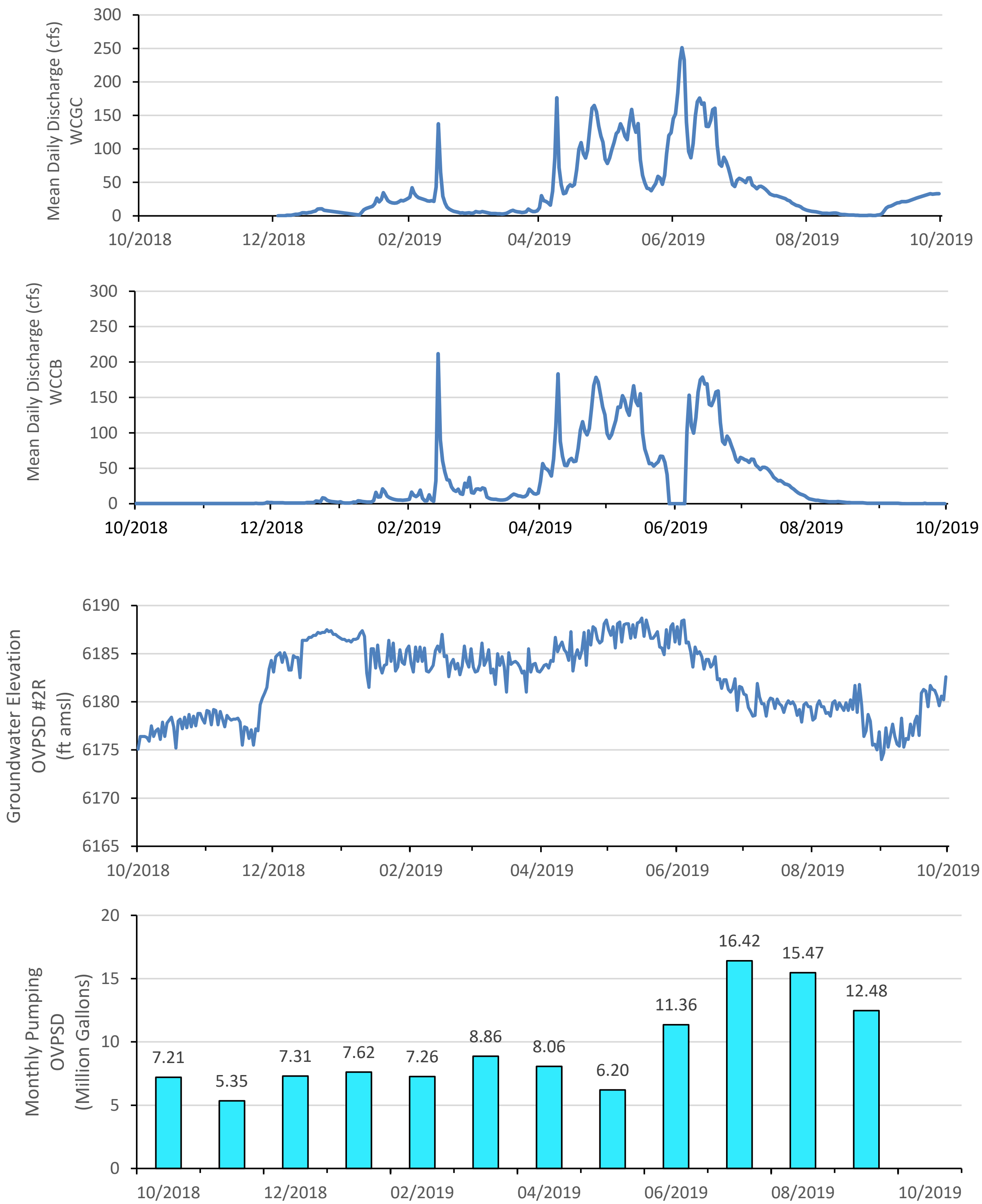

Figure 44: Water Year 2019 Groundwater Elevation, Streamflow, and Total OVPSD Pumping

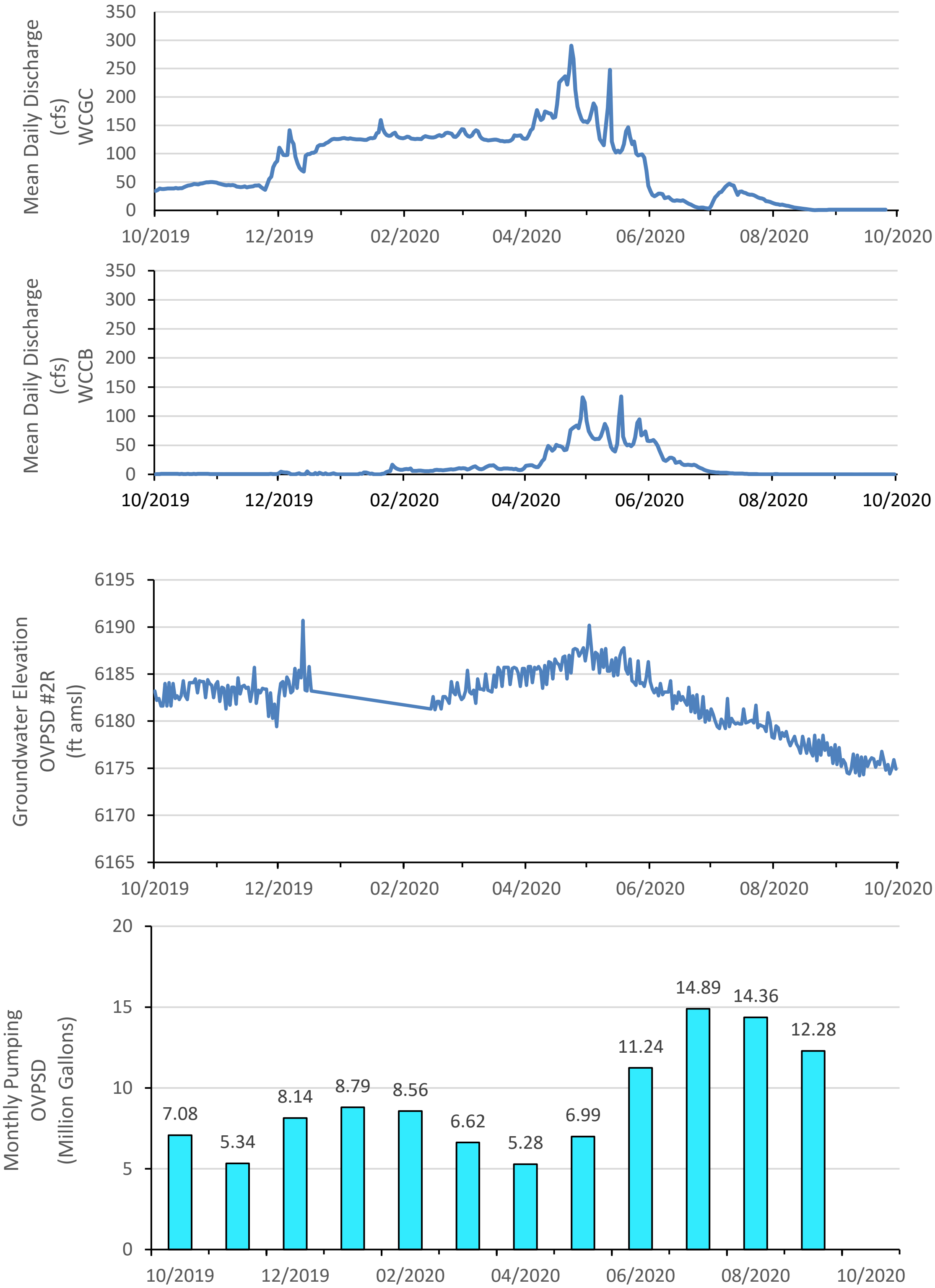

Figure 45: Water Year 2020 Groundwater Elevation, Streamflow, and Total OVPSD Pumping

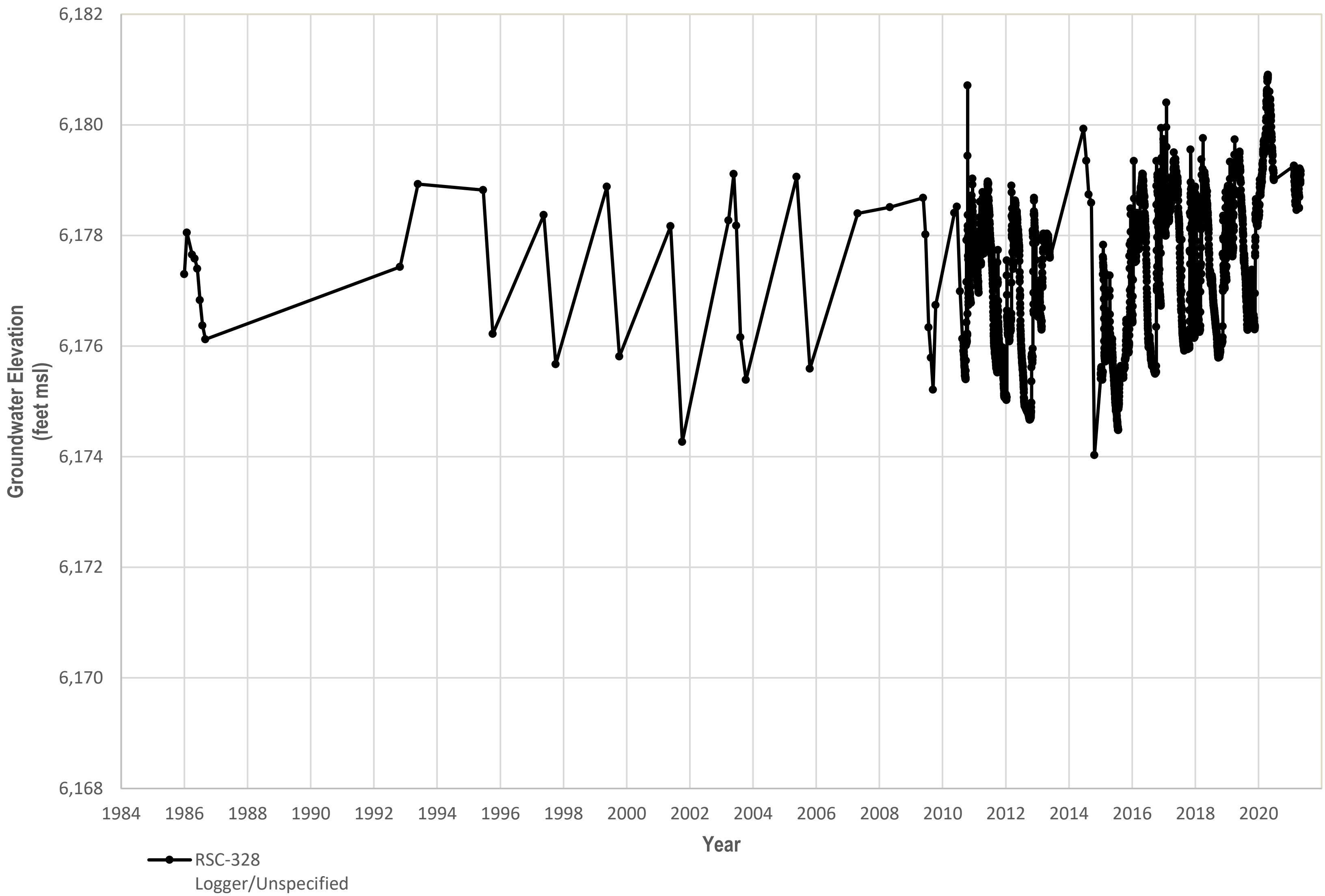

Figure 46: Meadow Groundwater Elevation Hydrograph – Well 328 (shallow)

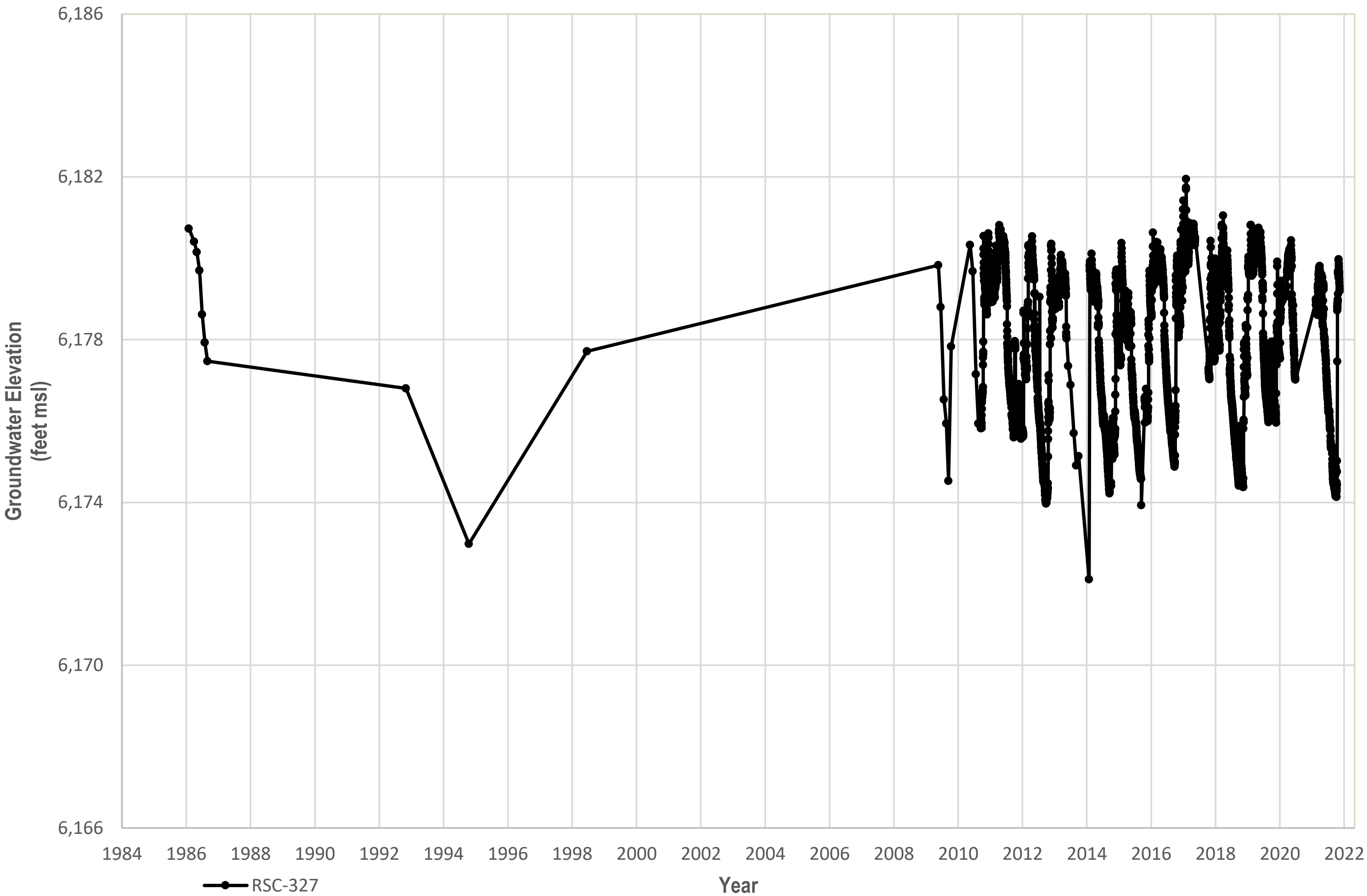

Figure 47: Meadow Groundwater Elevation Hydrograph – Well 327 (deep)

Figure 48: Meadow Groundwater Elevation Hydrograph – Well 324 (shallow)

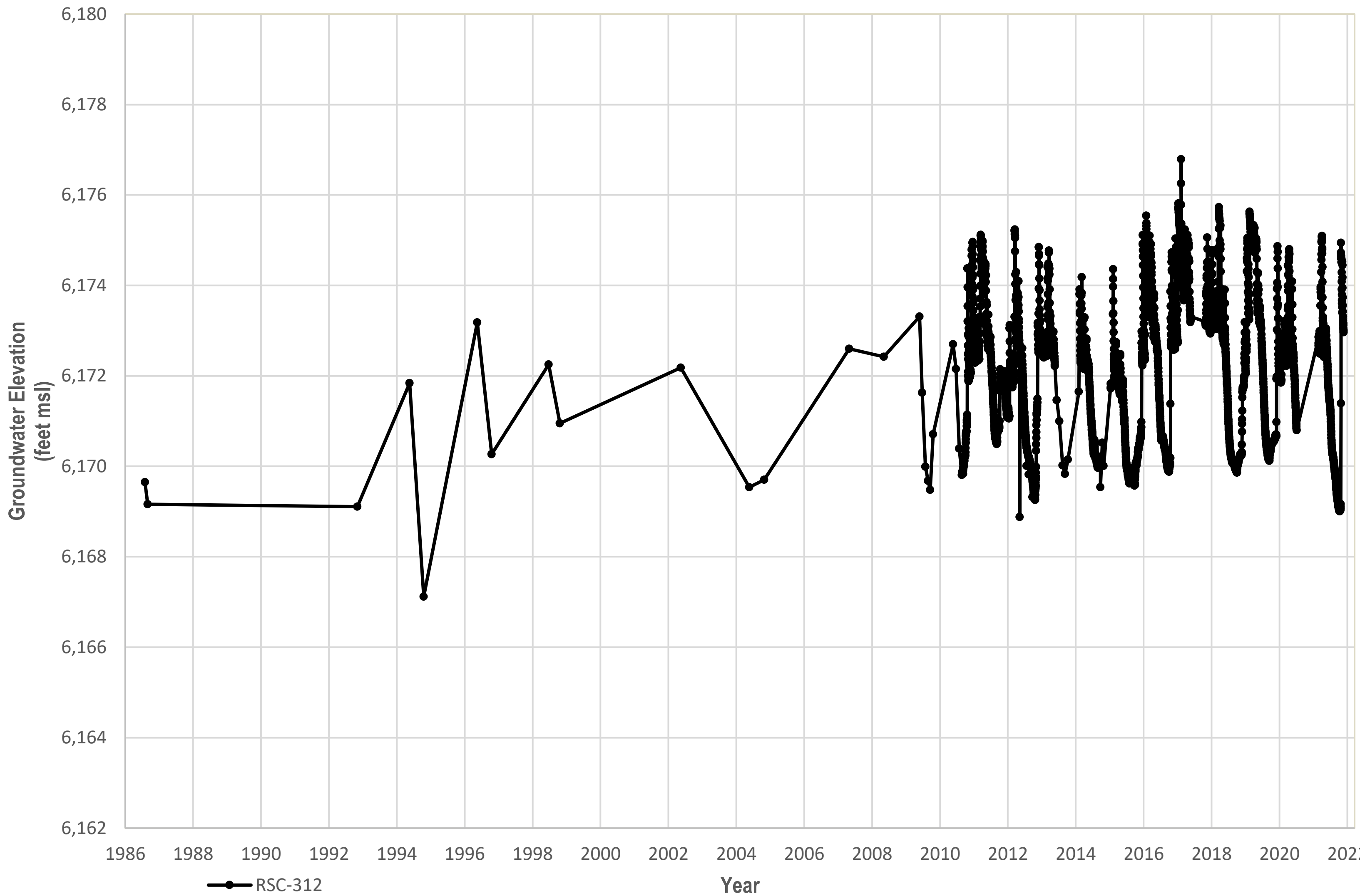

Figure 49: Meadow Groundwater Elevation Hydrograph – Well 312 (shallow)

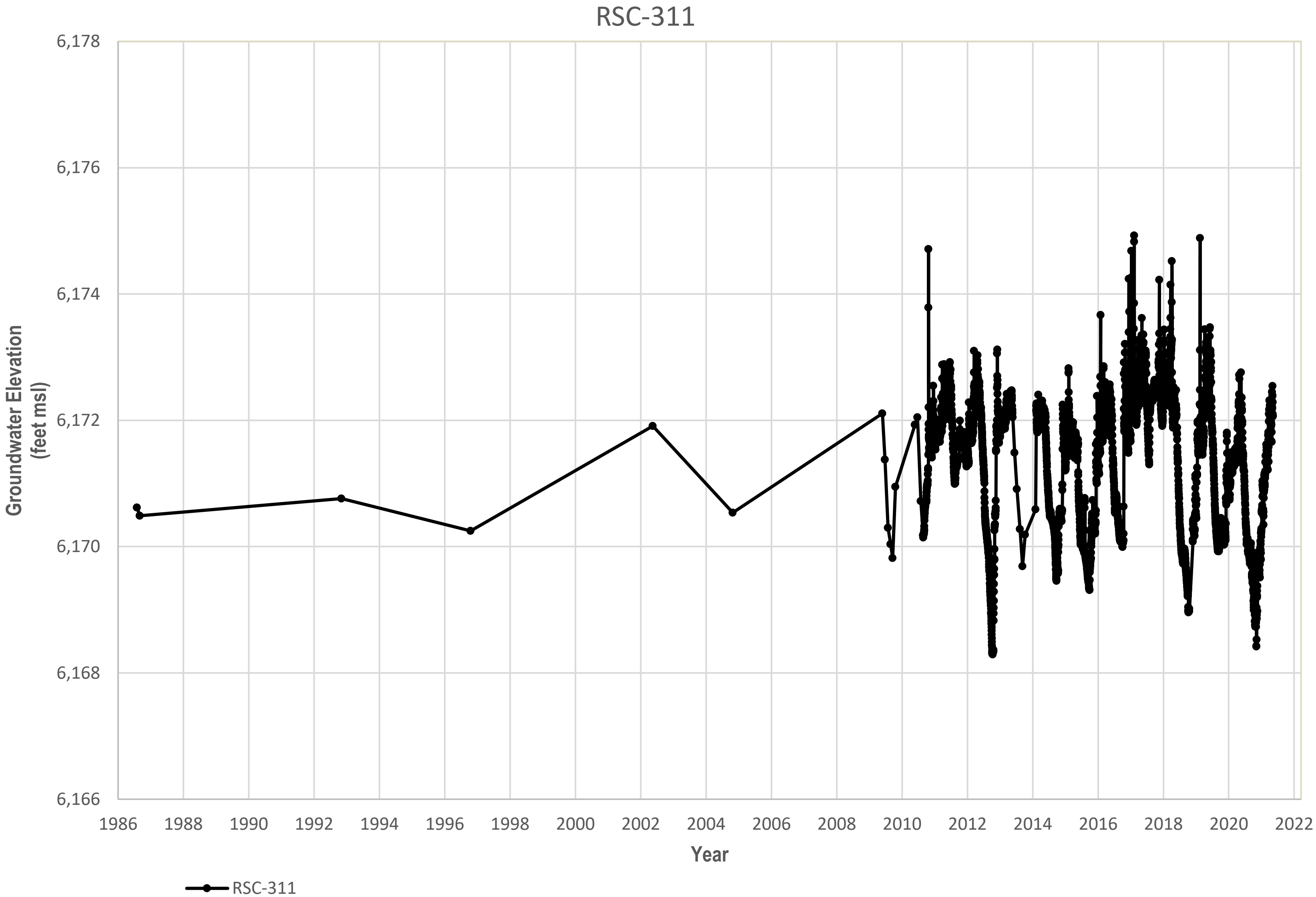

Figure 50: Meadow Groundwater Elevation Hydrograph – Well 311 (deep)

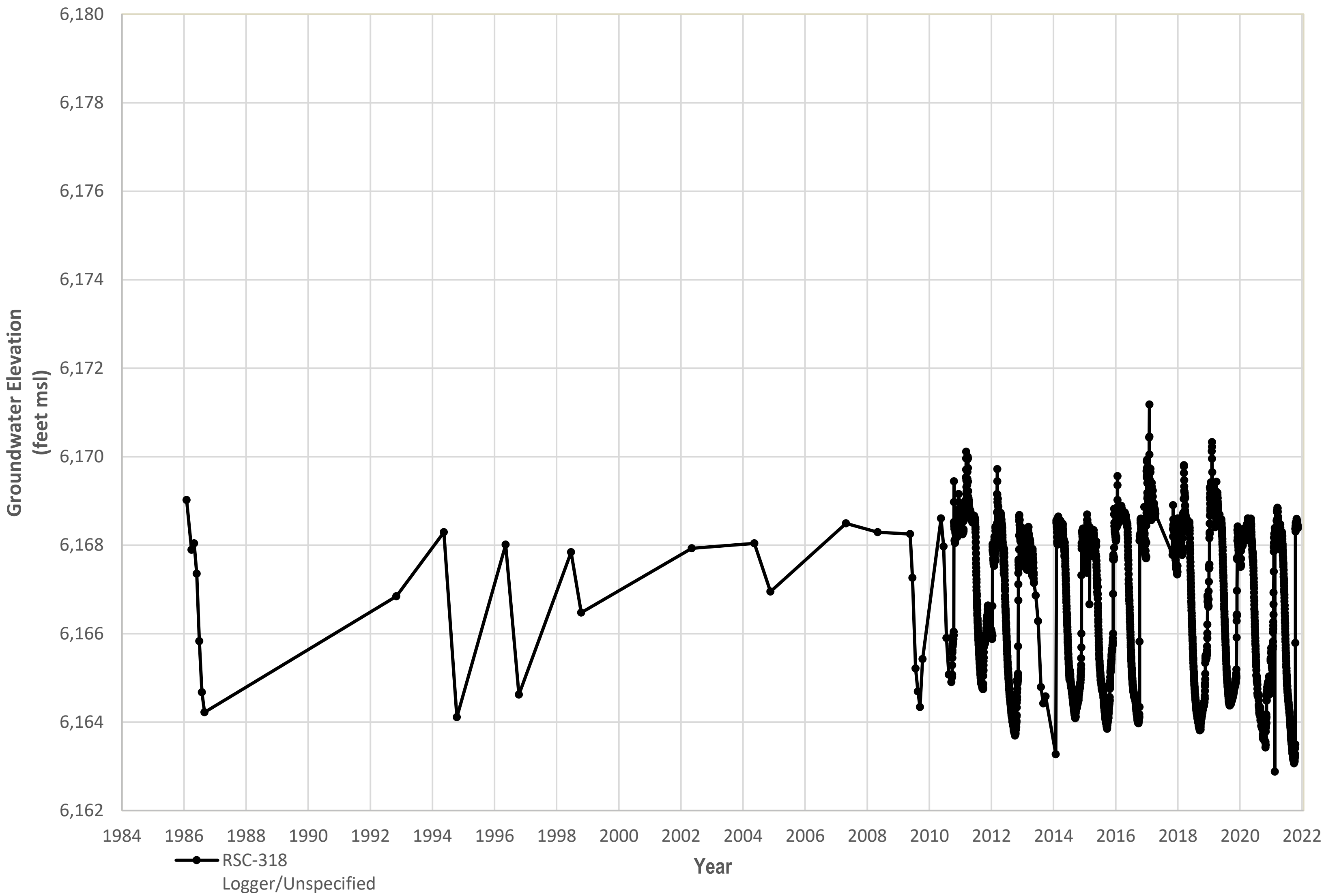

Figure 51: Meadow Groundwater Elevation Hydrograph – Well 318 (shallow)

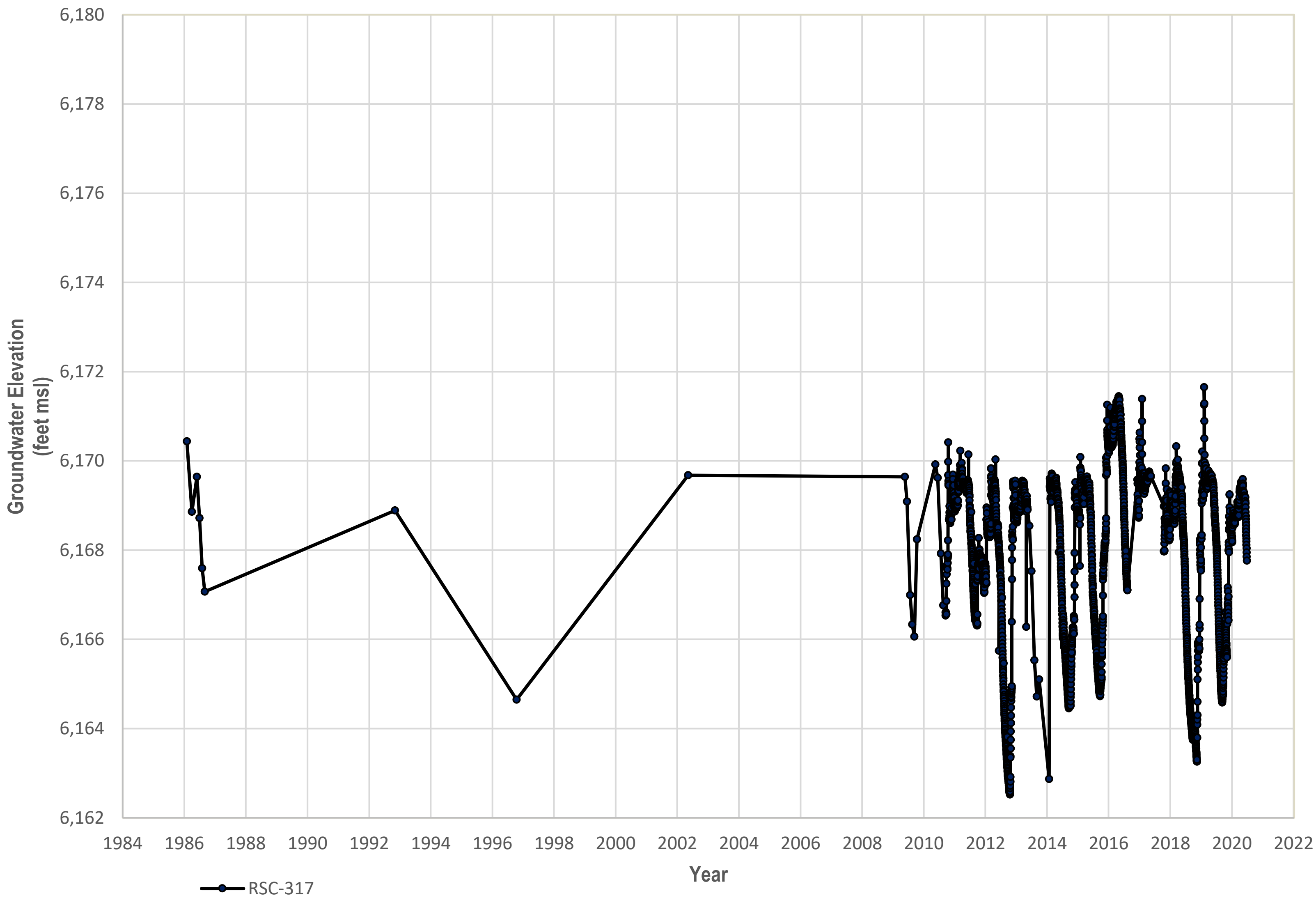

Figure 52: Meadow Groundwater Elevation Hydrographs – Well 317 (deep)

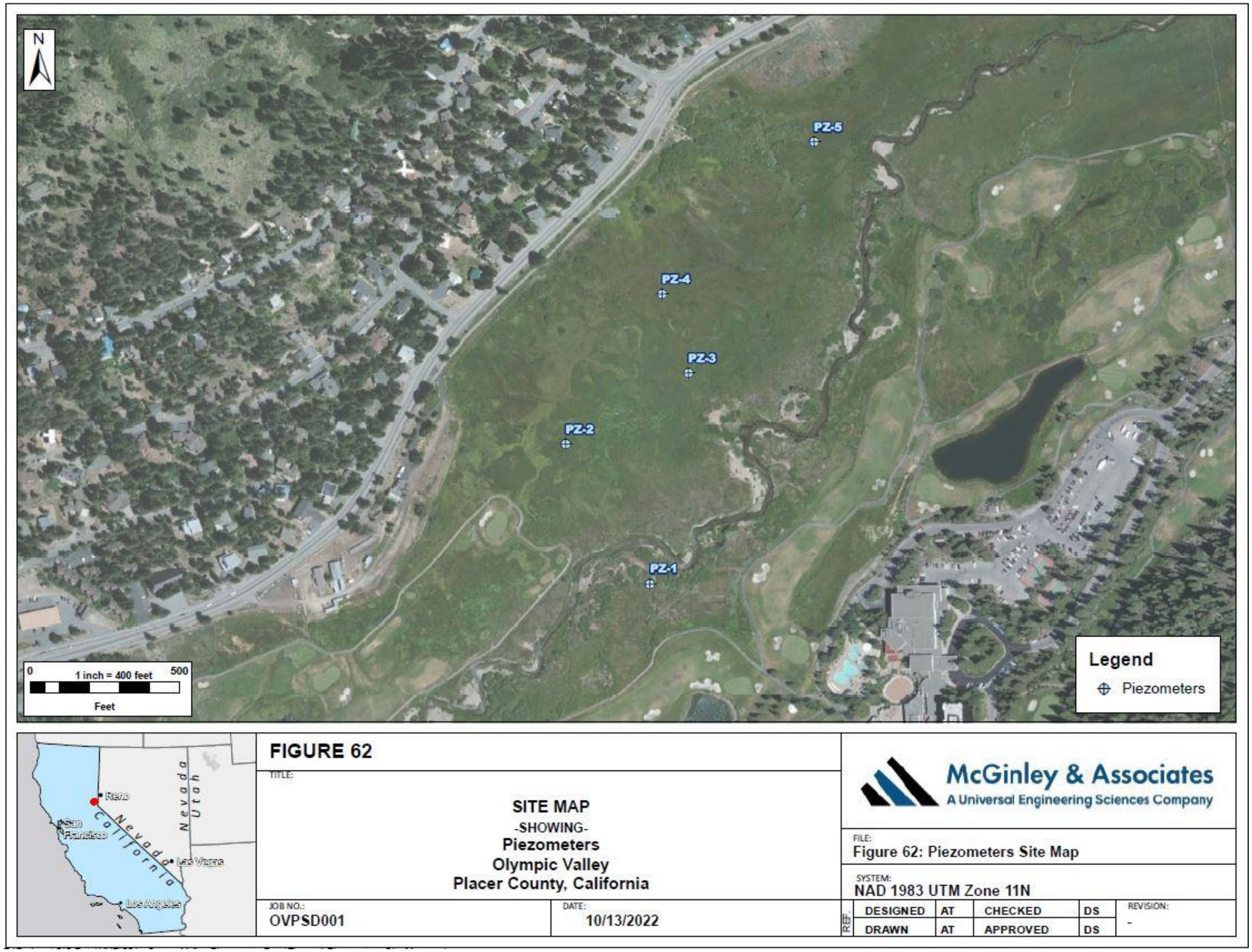

Figure 53: Shallow Piezometer Locations

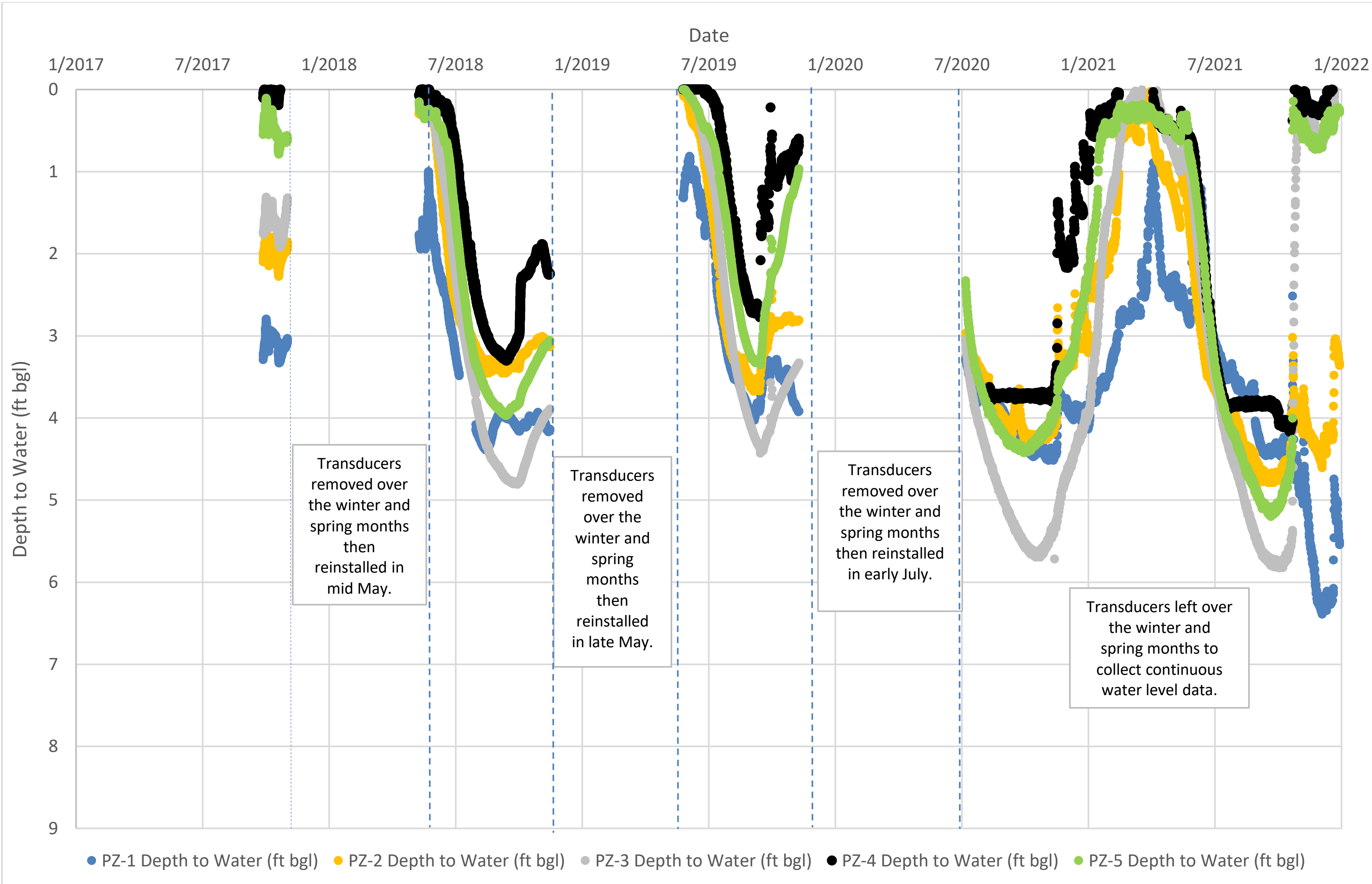

Figure 54: Shallow Piezometer Groundwater Levels for 2017-2021

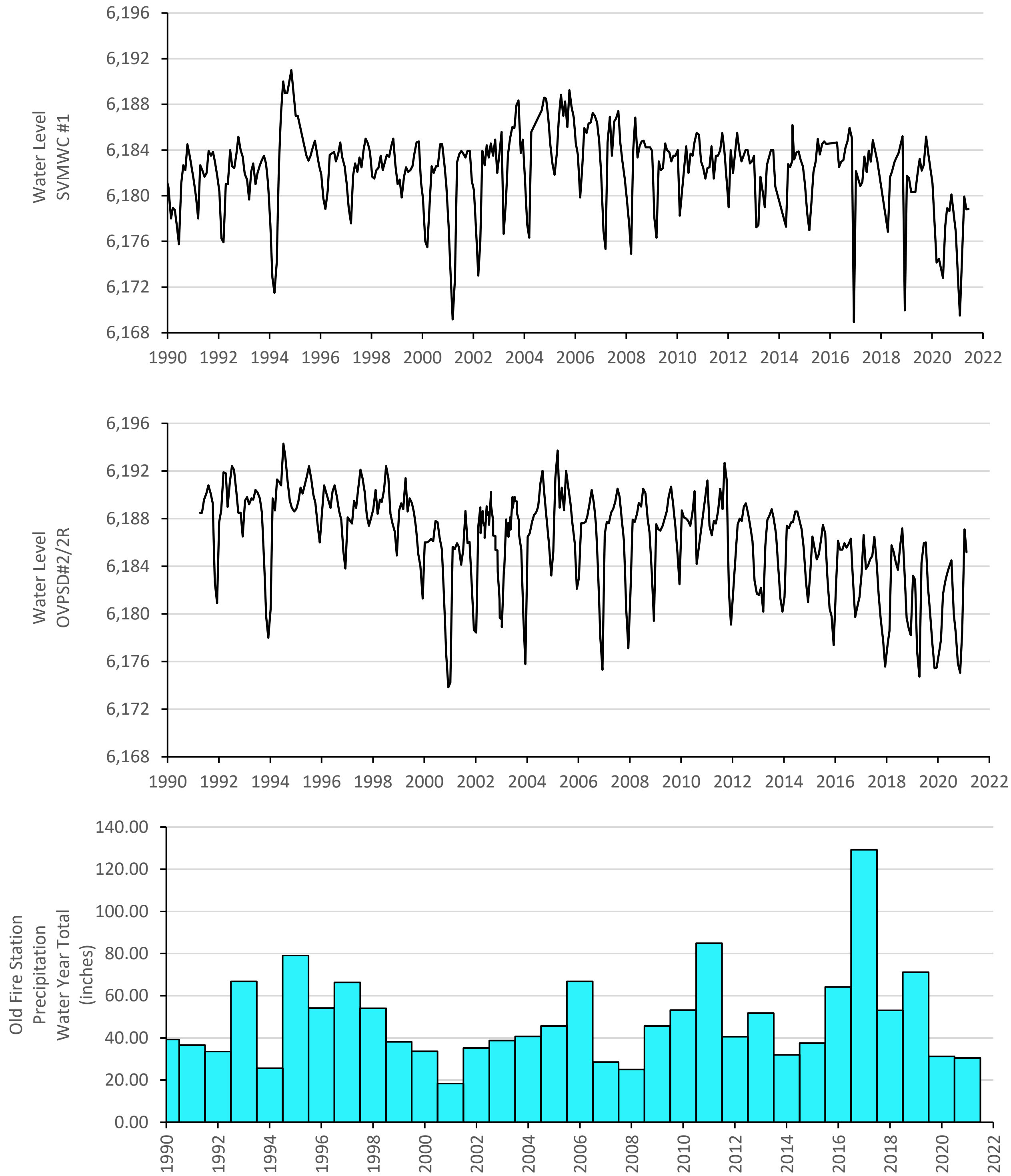

Figure 55: Annual Precipitation Compared to Groundwater Elevation

SECTION 4: GROUNDWATER QUALITY SUMMARY

4.1 MUNICIPAL WATER SUPPLY GROUNDWATER QUALITY

OVPSD and SVMWC routinely test their untreated groundwater to maintain compliance with state regulations. Groundwater quality parameters analyzed by OVPSD and SVMWC include general minerals, general physical parameters, and organic/inorganic compounds. Analyses for these constituents are conducted in accordance with the requirements of the CCR Title 22. The frequency of water quality testing of public water supply wells is conducted in accordance with the DDW schedule provided in Table 7. Individual purveyors also test for certain constituents more regularly than the DDW requirements.

Table 7: Public Water Supply Well Water Quality Schedule

Analysis	OVPSD#1R	OVPSD#2R	OVPSD#3	OVPSD#5R	SVMWC#1	SVMWC#2
Nitrate (as NO3)	1 year	1 year	1 year	1 year	1 year	1 year
Nitrite (as N)	3 years	3 years	3 years	3 years	3 years	3 years
Inorganics	9 years	9 years	9 years	9 years	9 years	9 years
Asbestos	9 years	9 years	9 years	9 years	9 years	9 years
Perchlorate	3 years	3 years	3 years	3 years	3 years	3 years
Gross Alpha	9 years	9 years	9 years	9 years	9 years	9 years
Radium 228	Waived	Waived	Waived	Waived	Waived	Waived
Regulated SOC	Waived	Waived	Waived	Waived	Waived	Waived
Regulated VOC	6 years	6 years	6 years	6 years	6 years	6 years
GM&P	9 years	9 years	9 years	9 years	9 years	9 years
Manganese	3 months	9 years	9 years	9 years	9 years	9 years

Notes: VOC = volatile organic compound, SOC = synthetic organic compound, GM&P = General Mineral and General Physical, * = schedule for different constituents ranges from 3 to 9 years
Water quality schedules for OVPSD and SVMWC can be found at https://sdwis.waterboards.ca.gov/PDWW/

4.1.1 OVPSD AND SVMWC WATER QUALITY

General minerals, general physical parameters, inorganics, and manganese samples were collected and analyzed for OVPSD and SVMWC wells in Water Years 2016 through 2021. Selected sampling results from these wells over this time period are summarized in Table 8. This table summarizes data for analytes that were detected above their respective reporting limits; a full summary of non-detects is not included on the table.

Historically, perchlorate has been detected only once at OVPSD#2R, at a concentration of 4.9 µg/L in June 2009, below the MCL of 6 µg/L. Groundwater at all OVPSD wells was tested for perchlorate in both 2018 and 2021. Exposure to high concentrations of perchlorate can cause complications with healthy function of the thyroid gland. Perchlorate is used in various industrial products including explosives. Possible sources of increased perchlorate concentrations in Olympic Valley include but are not limited to road flares or explosives used in avalanche safety procedures at Palisades Tahoe. No groundwater samples resulted in any detectable perchlorate in the OVPSD wells. Groundwater at the SVMWC wells was tested for perchlorate in 2018 and presumably in 2021, however, no data was provided for the 2021 analysis. The 2018 perchlorate testing on SVMWC Wells 1 and 2 showed detected perchlorate in both wells at 1.6 µg/L and 2.5 µg/L, respectively.

Manganese in Olympic Valley public water supply wells is closely monitored because it is found at elevated concentrations in some wells in the basin, even though concentrations have remained below drinking water MCLs in the municipal production wells. Manganese sample concentrations remained below the MCL during Water Years 2016 through 2021.

4.2 RESORT AT SQUAW CREEK CHAMP PROGRAM

The CHAMP groundwater quality monitoring program historically includes collecting groundwater quality samples from 32 monitoring wells in the Meadow (Figure 2). In 2009, the monitoring requirements were revised to be consistent with the monitoring and reporting required for all golf courses in the Lake Tahoe basin. Groundwater samples are now collected monthly at only 5 wells, from May through October.

Previous ARR’s reported that all constituents tested by the CHAMP program were below the MCLs, with the exception of iron. The 2018 analytical results for SVMWC#1, OVPSD#3 and OVPSD#5R showed pH being slightly below the drinking water standards range of 6.5-8.5. Then in 2020, pH analysis results for OVPSD#2R showed a pH of 6.06 which was again below the California drinking water standards range. This does not pose any immediate health risks but can be harmful to distribution system if left unchecked. No MCLs or other regulatory limits exist for the current analyses, and therefore the only undesirable result is a steady upward trend in any concentrations. Figure 56 through Figure 60 chart the results of the monthly sampling events for Water Years 2009 through 2021. Charts are not included for pH and temperature.

The CHAMP groundwater quality monitoring program includes 32 monitoring wells in Figure 2. Since 2009, samples are collected at 5 wells monthly from May through October. This sampling frequency is consistent with the monitoring and reporting required for all golf courses in the Lake Tahoe basin.

The six-year trend for dissolved constituents monitored by the current CHAMP wells show that for dissolved kjeldahl nitrogen, orthophosphate, and phosphorus, the downgradient well RSC-301 typically has a higher concentration than upgradient wells. During 2021, phosphorus concentrations at RSC-301 were exceeded intermittently by elevated concentrations observed at RSC-322, perhaps as a result of proximal fertilizer application. Seasonal fluctuations are evident in these constituents: concentrations increase over the golf course operational period and then decrease at the end of the season when fertilizer application stops. This suggests some seasonal groundwater quality impacts due to golf course fertilizers.

Kjeldahl nitrogen in the downgradient RSC-301 has been observed at concentrations at least an order of magnitude higher than the other monitoring wells, and this trend continued through Water Years 2016 to 2021, suggesting a localized source for this nitrogen in the vicinity of the well.

Dissolved nitrate as nitrogen has a different distribution compared to the other dissolved constituents. The upgradient well OVPSD#5S has the highest nitrate as nitrogen concentration of the CHAMP wells currently sampled. High levels of nitrate in drinking water can decrease the ability of the blood to distribute oxygen around the body. Young children and infants are particularly at risk of this health risk which can eventually lead to Infant Methemoglobinemia or Blue Baby Syndrome. The seasonal fluctuation in this well is also different from the other constituents: concentrations decrease in August/September before increasing again to higher than pre-August concentrations.

Dissolved nitrite as nitrogen for the five wells was typically below the reporting limit of 0.01 mg/L for Water Years 2016 through 2021, with the exception of two instances where concentrations at RSC-305 and OVPSD#5S were detected at 0.1 mg/L in June, 2016 and 0.012 mg/L in October, 2016, respectively.

4.3 REGULATED CONTAMINATION SITES

There are no existing regulated contamination sites within the GMP area, and no new cases were opened during Water Years 2016 through 2021. California Water Boards' data management system, GeoTracker, was referenced to verify that there were no new or existing contamination sites within the GMP area. GeoTracker retrieves records and data sets from multiple State Water Board programs regarding sites which impact or have the potential to impact groundwater (California Water Boards).

Table 8: OVPSD and SVMWC Sampling Results for Water Years 2016 through 2021

Analysis	Primary/Secondary MCL[1]	Water Year	SVMWC#1	SVMWC#2	OVPSD#1R	OVPSD#2R	OVPSD#3	OVPSD#5R
ALKALINITY (TOTAL) AS CACO32	**NA**	**2017**	--	--	69.2 mg/L	--	--	--
		2018	57 mg/L	63 mg/L			45.7 mg/L	39.9 mg/L
		2020				41.3 mg/L		
BARIUM	**1,000 µg/L**	**2017**	--	--	49.03 µg/L	--	--	--
		2018	0.057 mg/L	0.03 mg/L			49.1 µg/L	35.41 µg/L
BICARBONATE ALKALINITY	**NA**	**2017**	--	--	84.4 mg/L	--	--	--
		2018	57 mg/L	63 mg/L			55.8 mg/L	48.7 mg/L
		2020				41.3 mg/L		
CALCIUM	**NA**	**2017**	--	--	32.5 mg/L	--	17.4 mg/L	13.9 mg/L
		2018	23 mg/L	26 mg/L				
		2020				13.5 mg/L		
GROSS ALPHA	**15 pCi/L**	**2019**	--	--	--	--	--	ND
		2020	--	--	--	ND	--	--
GROSS ALPHA MDA95	**15 pCi/L**	**2020**	--	--	--	3 pCi/L	--	--
HARDNESS (TOTAL) AS CACO3	**NA**	**2017**	--	--	94 mg/L	--	--	--
		2018	69 mg/L	80 mg/L			52 mg/L	42 mg/L
		2020				39.1 mg/L		
IRON	**0.3 mg/L**	**2018**	<0.05	0.31 mg/L	--	--	0.11 mg/L	0.055 mg/L
		2020	--	--	0.13 mg/L	--	--	--
MAGNESIUM	**NA**	**2017**	--	--	3.2 mg/L	--	--	--
		2018	2.8 mg/L	3.8 mg/L			2.2 mg/L	1.7 mg/L
		2020				1.31 mg/L		
MANGANESE	**0.05 mg/L**	**2017**	--	--	0.038 mg/L	--	0.003 mg/L	0.007 mg/L
		2018	<0.001 mg/L	0.011 mg/L	--	--	--	--
NITRATE (AS N)	**10 mg/L**	**2016**	0.47 mg/L					
		2017	--	--	0.14 mg/L	--	--	--
		2018	<0.4 mg/L	<0.4 mg/L	--	0.17 mg/L	0.26 mg/L	0.15 mg/L
		2019	0.20 mg/L	0.17 mg/L	--	0.20 mg/L	0.25 mg/L	0.26 mg/L
		2020	0.25 mg/L	0.23 mg/L	--	--	--	--
NITRITE (AS N)	**1 mg/L**	**2018**	<0.4 mg/L	<0.4 mg/L	--	--	--	--
PH, LABORATORY	**6.5 - 8.5**	**2017**	--	--	6.9	--	--	--
		2018	6.42	6.62			6.37	6.31
		2020				6.06		
		2022			6.96	6.82	7.03	6.56
SODIUM	**NA**	**2017**	--	--	7.0 mg/L	--	--	--
		2018	7.0 mg/L	5.2 mg/L			4.9 mg/L	5.2 mg/L
		2020				6.07 mg/L		

Table 8: OVPSD and SVMWC Sampling Results for Water Years 2016 through 2021

Analysis	Primary/Secondary MCL[1]	Water Year	SVMWC#1	SVMWC#2	OVPSD#1R	OVPSD#2R	OVPSD#3	OVPSD#5R
SPECIFIC CONDUCTANCE	**1600 umhos**	**2017**	--	--	238 umhos	--	--	--
		2018	160 umhos	180 umhos	--	--	140 umhos	116 umhos
		2020				116 umhos		
SULFATE	**500 mg/L**	**2017**	--	--	35.5 mg/L	--	--	--
		2018	12 mg/L	17 mg/L			13.1 mg/L	13.4 mg/L
		2020				9.21 mg/L		
TOTAL DISSOLVED SOLIDS	**1000 mg/L**	**2017**	--	--	120 mg/L	--	--	--
		2018	58 mg/L	93 mg/L			68 mg/L	64 mg/L
TURBIDITY, LABORATORY	**5 NTU**	**2018**	0.2 NTU	3.7 NTU	--	--	0.65 NTU	0.28 NTU
		2020				0.25 NTU		

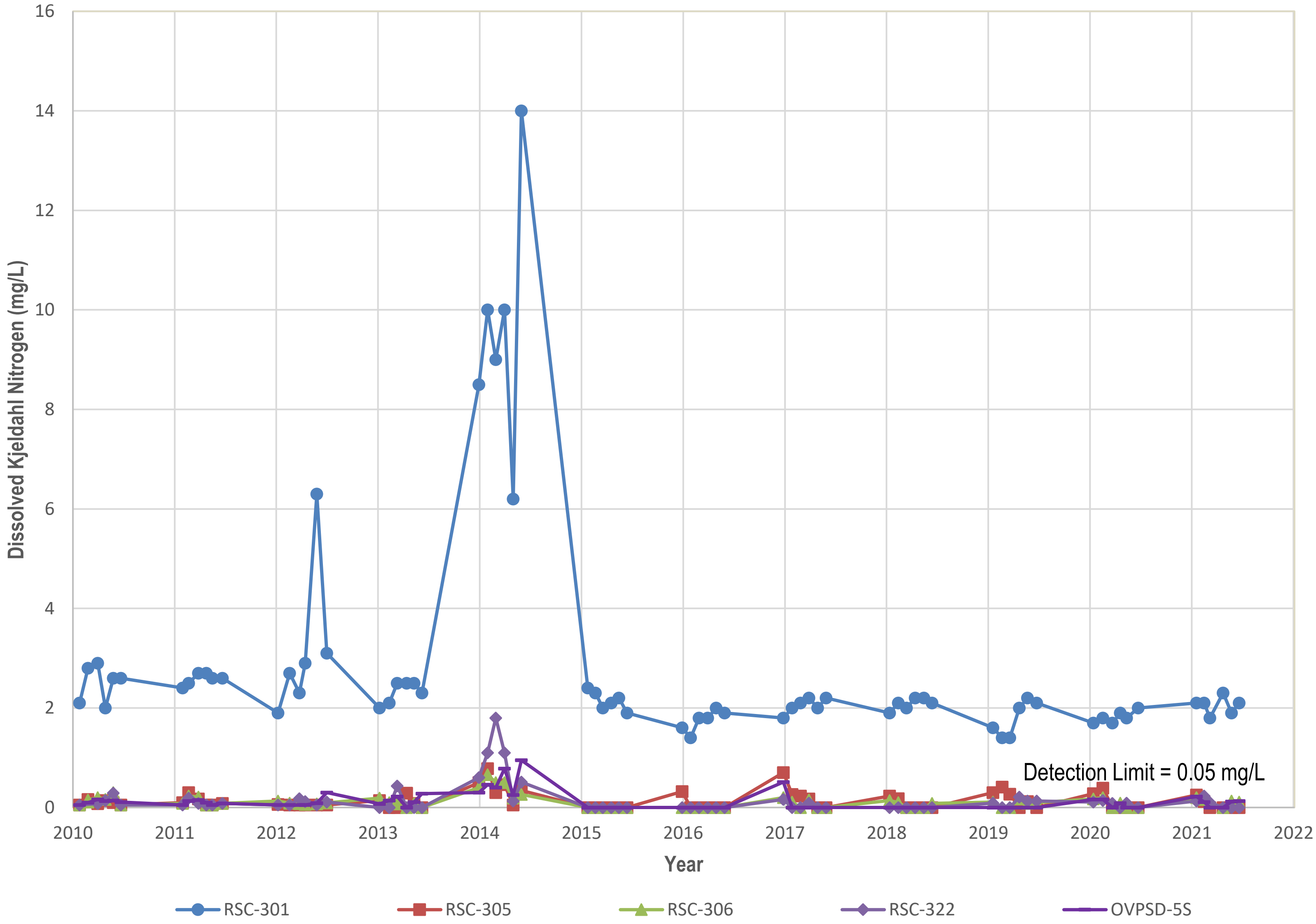

Figure 56: Water Year 2016 through 2021 Dissolved Kjeldahl Nitrogen for CHAMPS Wells

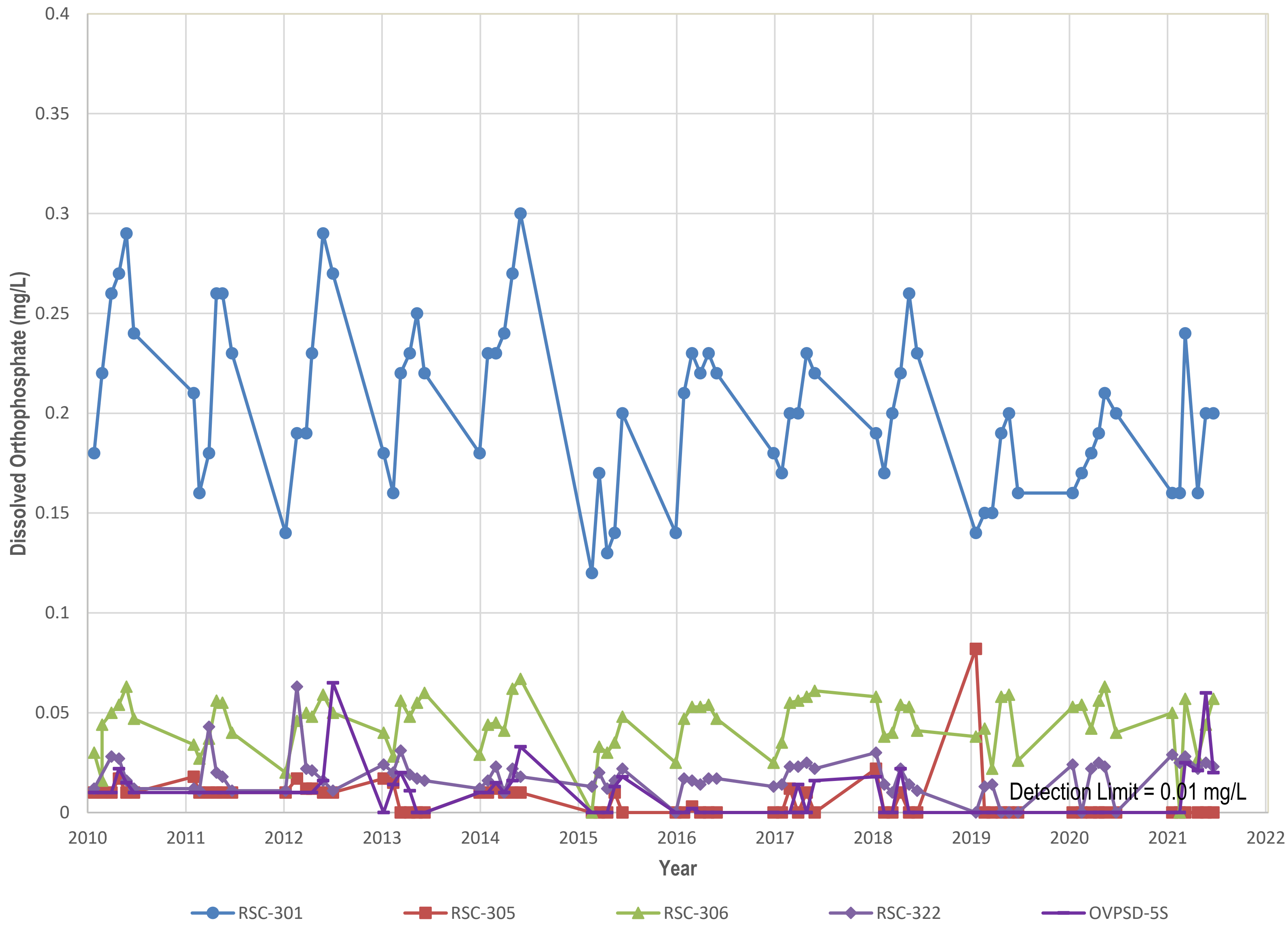

Figure 57: Water Year 2016 through 2021 Dissolved Orthophosphate for CHAMPS Wells

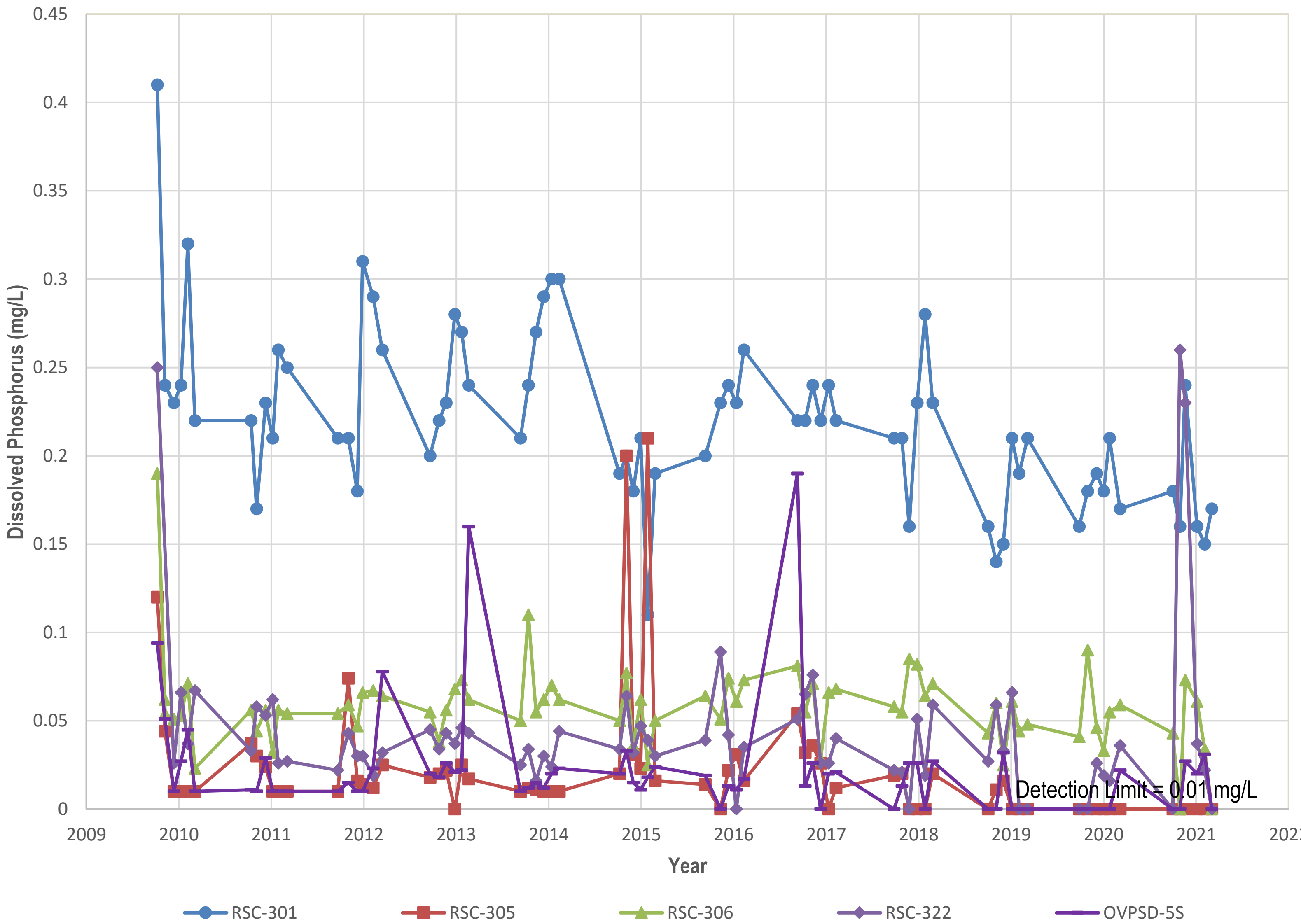

Figure 58: Water Year 2016 through 2021 Dissolved Phosphorous for CHAMPS Wells

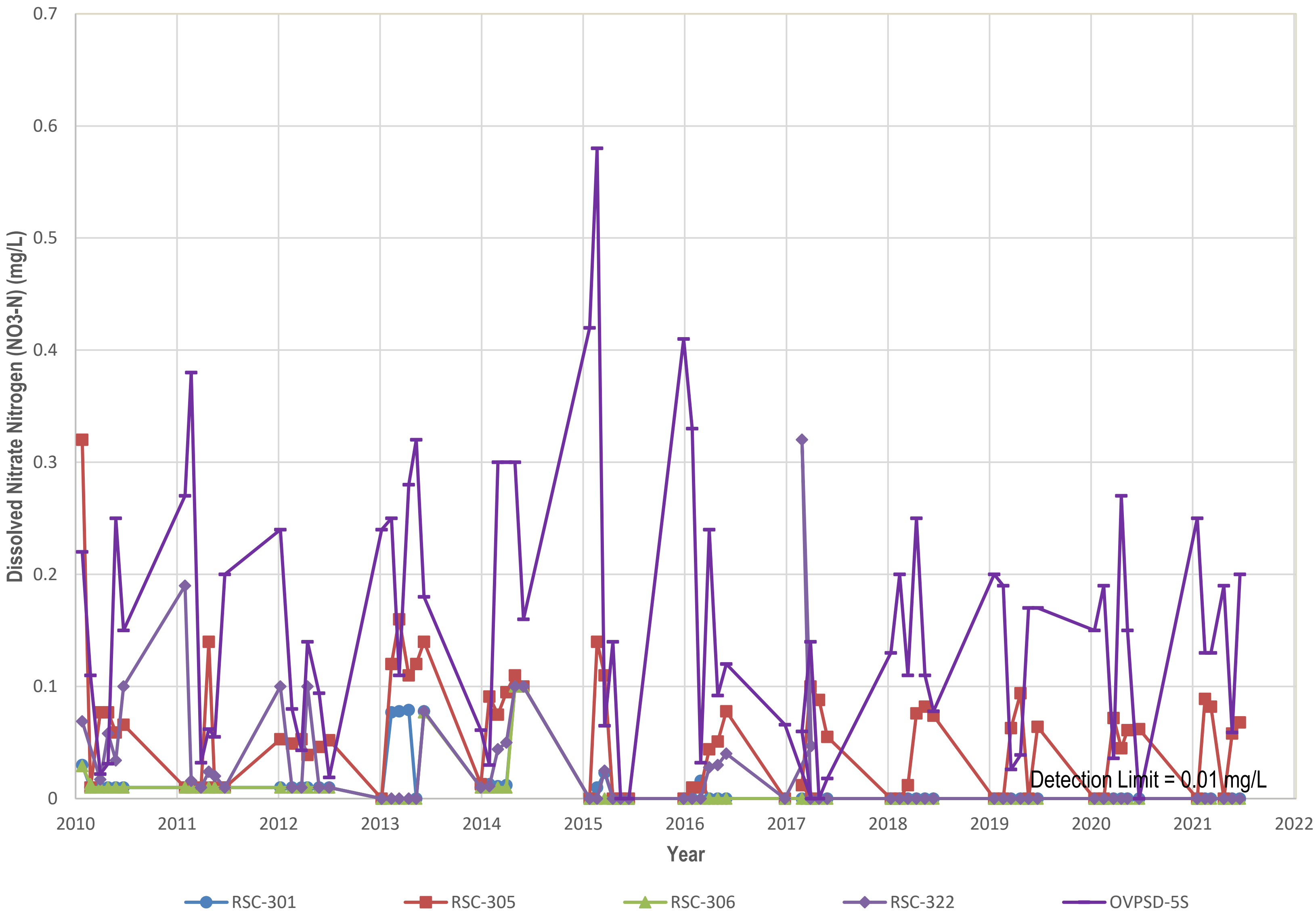

Figure 59: Water Year 2016 through 2021 Dissolved Nitrate as Nitrogen (NO_3-N) for CHAMPS Wells

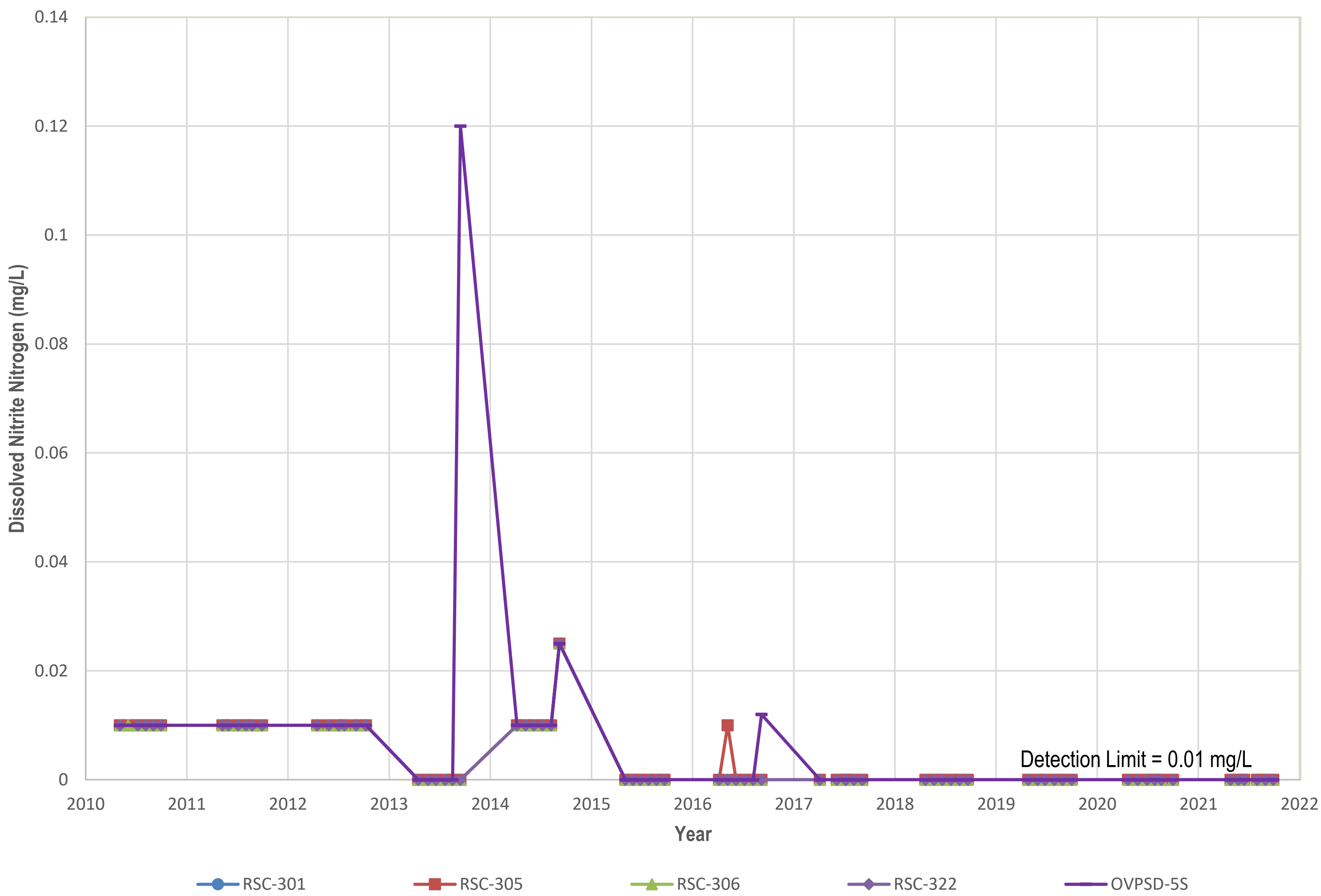

Figure 60: Water Year 2016 through 2021 Dissolved Nitrite as Nitrogen for CHAMPS Wells

SECTION 5: GROUNDWATER MANAGEMENT ACCOMPLISHMENTS AND BMO STATUS

This section continues the history of active implementation of the projects and programs suggested in the GMP. Progress made on each of the projects during the past 6 years are detailed below.

5.1 Groundwater Data Collection and Sharing Activities

In 2010, a coordinated groundwater monitoring plan was presented to the Olympic Valley Advisory Group. This plan outlined the methodology and timing for collecting coordinated groundwater elevation data. Data loggers were deployed beginning in the fall of 2010, and continue to operate in the western basin and meadow area. Successful coordination between OVPSD and other well owners in Water Years 2016 through 2021 allowed for continued collection of valuable groundwater elevation data that are presented in the sections above.

This coordination and sharing of data collection address the following BMOs:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future domestic, municipal, commercial, private, and fire protection uses during summer and autumn of the second consecutive year of low rainfall.

BMO 1-2 – Minimize drawdown and maximize basin storage.

5.2 Maintenance of Groundwater Data Logger Network

Fourteen groundwater level data loggers were installed in 2010. This equipment has continued to be maintained through WY 2016 to 2021. The fourteen wells equipped monitoring wells with data loggers are shown in Figure 2. Successful maintenance of this data logger network in conjunction with the activities described in Section 5.1, continued through Water Years 2016 to 2021, and this data added valuable insight to the other groundwater investigations summarized in this section.

The BMOs addressed by the use of this data logger network are:

BMO 1-2 – Minimize drawdown and maximize basin storage.

BMO 3-2 – Promote viable and healthy riparian and aquatic habitats by avoiding or minimizing future impacts from pumping on streamflow.

BMO 3-3 – Minimize future impacts from pumping on identified wetlands.

5.3 Meadow Piezometers and Water Level Monitoring

As described in Section 2.4.3.3, RSC installed five shallow water table monitoring piezometers in the valley-floor meadow and has commenced monitoring of groundwater levels. This work is being done for baseline data collection in advance of any water supply changes for golf course irrigation and snow-making water supply that may be associated with the Phase 2 RSC expansion and dedication of Well

18-3R to OVPSD for municipal water supply.

The BMOs addressed by the use of this piezometer network are:

BMO 3-2 – Promote viable and healthy riparian and aquatic habitats.

BMO 3-3 – Minimize future impacts from pumping on identified wetlands.

5.4 Washeshu Creek Restoration Project

In July 2015, Balance Hydrologics prepared the Advanced Conceptual Design and Design Basis Report for the Squaw Creek Restoration on behalf of Trout Unlimited and the Friends of Squaw Creek. The primary objectives of the restoration project are:

- Increase the area of wetland, riparian, and aquatic habitat within the Valley.
- Reduce the amount of fine-grained sediment transport to the downstream reaches of the creek and into the Truckee River.
- Maintain or increase water storage within the floodplain.
- Improve the aesthetics of the creek.
- Stabilize channel banks.
- Improve fish habitat.
- Maintain regulatory compliance.
- Create a recreational and education resource for the community.

In October of 2017, 75 volunteers helped Trout Unlimited and Friends of Squaw Creek, in collaboration with the Truckee River Watershed Council, to construct and install several in-stream debris structures known as Beaver Dam Analogs (BDAs) in the adjacent meadow area of Washeshu Creek. These structures, built from natural material harvested on site, help reestablish the connection of the creek to the surrounding floodplain (Kloehn, 2017). They also slow the flow of the creek in order to promote deposition of sediment within the stream channel to reverse incision.

Numerous creek restoration activities were also completed within the Washeshu Creek meadow area in 2020. Restoration work included creek bank stabilization, construction and installation of in-stream BDAs, and redirection of tributary flows to the Washeshu Creek Meadow (Balance Hydrologics, 2021). The anticipated culminating effect of these restoration activities is a reduction of channel erosion.

Additional restoration measures which have been designed but not yet implemented aim to further reduce suspended-sediment loading to the Truckee River, restore surface-groundwater connectivity within the valley, and enhance meadow vegetation communities. These restoration approaches include increasing streambed elevations, re-directing flows from Washeshu Creek to reactivate relict abandoned secondary channels, and creating inset floodplains (Balance Hydrologics, 2021).

This restoration design and implementation addresses the following BMOs:

BMO 3-2 – Promote viable and healthy riparian and aquatic habitats by avoiding or minimizing future impacts from pumping on streamflow.

BMO 3-4 – Support ongoing stream restoration efforts as they relate to groundwater management.

5.5 Aquifer Monitoring Program

OVPSD has initiated an aquifer monitoring program. The goal of this program is to monitor both groundwater levels and groundwater pumping throughout the basin. Part of the program entails assessing the monitoring requirements of each pumping well within the valley, and evaluating the cost to outfit wells with metering equipment and groundwater level monitoring equipment. This monitoring equipment will allow for routine data updates for use in the groundwater model. As of 2021, groundwater level monitoring equipment has been installed in several wells within the basin.

This program will be key in supporting the following BMOs:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future domestic, municipal, commercial, private, and fire protection uses during summer and autumn of the second consecutive year of low rainfall.

BMO 1-2 – Minimize drawdown and maximize basin storage.

BMO 3-1 – Protect the structure and hydraulic characteristics of the groundwater basin by avoiding withdrawals that cause subsidence.

BMO 3-3 – Minimize future impacts from pumping on identified wetlands.

5.6 Stream Monitoring

Friends of Squaw Creek (FOSC) continued responsibility for maintaining the stream gauges on Washeshu Creek in Water Years 2016 through 2020. In addition to maintaining the streamflow gauges, FOSC was responsible for downloading and processing the streamflow data from three gauges previous monitored. Balance Hydrologics was subsequently contracted to carry out streamflow monitoring of Washeshu Creek for the 2018, 2019, and 2020 water years. Most recently, Balance Hydrologics has been maintaining and collecting streamflow data from a total of 5 gauge stations, NFWC (previously referred to as QV1), WCGC, WCFB, OCWC, and WCCB (previously referred to as QV3). The changes in gauge locations are summarized in Section 3.2. Balance Hydrologics ceased to be responsible for streamflow monitoring at the conclusion of the 2020 Water Year.

The stream monitoring supports the following BMO:

BMO 3-2 – Promote viable and healthy riparian and aquatic habitats.

5.7 PlumpJack Well Drilling and Testing

OVPSD drilled and tested the new PlumpJack municipal well in 2017, details for which are summarized by Interflow Hydrology (2018). The well is built with 14-inch diameter stainless steel casing and screen to 112 feet in depth. A 50-ft sanitary seal is placed from 5 to 55 feet in depth below land surface. The screened interval is from 62 to 97 feet. The well is completed in sand and gravel materials, with interbedded silty, clayey and cobbly strata. The top of granite bedrock was encountered at 123 feet.

Maximum yield from the well will be variable, dependent on the static water level. During near and above average static water levels, the well has a sustainable capacity in the range of 450 to 500 gpm. When static water levels fall below average (approximate elevation 6193 ft amsl), then the maximum yield of the well may need to be lower in order to maintain a pumping water level above the well screen. Water quality from the PlumpJack well is good, meeting all Title 22 drinking water standards.

A constant-rate pumping test with multiple observation wells was performed on the new well, with preliminary estimates of the aquifer transmissivity of 3,400 ft^2/day with a storage coefficient of 0.02, indicating a high permeability unconfined aquifer.

The new PlumpJack well has not yet been connected to the OVPSD municipal water system, with future plans for connection tied to expansion and renovation of the PlumpJack Inn.

The following BMOs are supported by efforts associated with the PlumpJack well:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future uses.

BMO 1-2 – Minimize drawdown and maximize use of basin storage.

5.8 RSC Well 18-4 Drilling and Testing

In 2017, RSC drilled and tested the new golf course irrigation Well 18-4, as summarized in Interflow Hydrology (2017b). The well is located to the west of Well 18-3R, and south of the 4th Fairway test well. The purpose of the new well is for future connection as a substitute water source for Well 18-3R, upon future dedication of 18-3R to OVPSD. The future dedication of Well 18-3R to OVPSD is part of a water service agreement for expansion of RSC facilities. To date, Well 18-4 remains unconnected to the water supply system for the golf course (new well not currently in use).

Well 18-4 is built with 10-inch diameter stainless steel casing and screen to 112 feet in depth. A 50-ft sanitary seal is placed down to 50 feet below land surface, and the top of the screened interval is at 62 feet. Based on the pumping tests, the well has a maximum long-term capacity of 100 gpm with an anticipated pumping water level of approximately 60 feet below land surface.

Monitoring wells and springs within 760 feet of the new well were monitored during the pumping test. No pumping response was detected at springs to south of the well, or in shallow water table levels in wetlands to the west. Pumping response was observed at the well 18-3/18-3R and monitoring wells 304 locations. The transmissivity of the aquifer in near proximity to Well 18-4 well is estimated at 1680 ft^2/day, and the storage coefficient is estimated at approximately 9.0×10^{-3}. Based on an observed delayed yield effect, the aquifer tapped by Well 18-4 is interpreted to be mildly confined by a shallow water table aquitard.

The following BMOs are supported by efforts associated with the RSC 18-4 well:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future uses.

BMO 1-2 – Minimize drawdown and maximize use of basin storage.

5.9 Water Management Action Plan (WMAP)

A 1991 Water Management Action Plan (WMAP) (Squaw Valley County Water District, 1991) established triggers and a course of action to prevent adverse impacts to the Basin's water supply based on hydrogeologic data available at the time. Triggers in the 1991 WMAP referred to specific observable events that required a voluntary action such as pumping curtailment, enforcement of conservation goals, or other actions.

In 2015 the OVGMP Advisory Group agreed to update to the 1991 plan to incorporate additional data collection efforts and investigations that have taken place since 1991. The 2015 work was preparation of a technical memorandum that would be used as the basis for preparing a memorandum of agreement amongst the stakeholder groups within the Basin, including OVPSD, SVMWC, RSC, and Palisades Tahoe.

Renewed work on the updated WMAP began in 2016 bringing forward concepts and details for triggers and management actions based on water year assessments and pumping water levels during operation of municipal wells through the summer and fall seasons. Three workshops were held to review the following:

- Workshop No. 1 – Discussion on Thresholds for Aquifer and Well Performance, Preliminary Discussion on Triggers and Actions (June 29, 2016).
- Workshop No. 2 – Discussion on Triggers for Water Management Actions, Preliminary Discussion on Response Actions (July 21, 2016).
- Workshop No. 3 – Discussion on Triggers, Define Water Management Response Actions (August 17, 2016).

Technical details for the workshops are reported in Interflow Hydrology (2016a, 2016b, and 2016c). The renewed WMAP effort was successful in defining technically defensible triggers and response actions, but did not advance to an agreement. Work to advance the WMAP is recommended to continue in 2022-2023, seeking to arrive at a consensus agreement amongst the primary water pumpers in the valley.

When implemented, the WMAP will address the following BMOs:

BMO 1-2 – Minimize drawdown and maximize basin storage.

BMO 1-3 – Encourage water conservation, and manage or reduce water demand.

5.10 Maximum Supply Analysis

In 2016, HydroMetrics WRI performed a maximum supply analysis for OVPSDSVPSD to estimate the maximum groundwater supply available from the current municipal wells in Olympic Valley. This analysis was intended to support planning estimates associated with the ongoing Capacity and Reliability Study being developed by OVPSD. This analysis made use of model simulations using the most recent version of the updated and calibrated basin groundwater model, and is reported in the Maximum Supply Analysis report (HydroMetrics, 2016b).

The results of the simulations indicated that the well with the shallowest screen, well OVPSD#2R, is sensitive to pumping from the other wells, such that its well screen may become unsaturated with increased pumping in the western part of the basin. As a result, only a modest increase in total annual supply is available by operating all wells to maintain screen saturation.

If well OVPSD#2R is non-operational, the remaining OVPSD wells can be operated at their estimated maximum pumping rates without dewatering their screens. The result may be a greater total annual supply available to OVPSD, even with no contribution from well OVPSD#2R.

This maximum supply analysis addressed the following BMOs:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future uses.

BMO 1-2 – Minimize drawdown and maximize use of basin storage.

5.11 Capacity and Reliability Study

The original Capacity and Reliability Study (CRS) was completed by OVPSD in 2003, and was intended to perform an analysis of the District's ability to meet future water demands in Olympic Valley. In June 2016, OVPSD submitted an update to this document, the 2016 Capacity and Reliability Study Update (OVPSD, 2016). This analysis was unrelated to work done for the Village at Squaw Valley Specific Plan (VSVSP) Water Supply Analysis (WSA) and EIR analyses, in that it only considered existing infrastructure, not infrastructure related to projected future projects.

The 2016 CRS Update assessed the ability of OVPSD to meet existing and future water demands under normal and dry year scenarios. This was done by comparing historical water demands with simulated maximum potential production from OPVSD's existing wells as described in the Maximum Supply Analysis (see Section 5.12). The ability to meet future demands was assessed based on annual and monthly water supply and demand, as well as maximum daily demands. Based on these analyses, it was determined that OVPSD has the capacity to serve up to an additional 117 single-family residence lots, 447 multi-family bedrooms, 376,000 square feet of commercial floor area, or some combination of each type. A full discussion of this analysis can be found in the 2016 CRS Update document (OVPSD, 2016).

This document addresses the following BMOs:

BMO 1-1 – Maintain groundwater supplies sufficient to provide water for current and future domestic, municipal, commercial, private, and fire protection uses during summer and autumn of the second consecutive year of low rainfall.

BMO 1-4 – Estimate and acknowledge likely future water demands in management decisions.

5.12 Proposed PlumpJack Well Impact Evaluation

In 2016, HydroMetrics WRI evaluated the effects of a proposed water supply well at the PlumpJack property on Washeshu Creek. The well is part of the planned redevelopment of the PlumpJack Inn property. Currently, there are two possible well locations on the property. HydroMetrics WRI reviewed the effects of pumping from each to the two possible well locations. HydroMetrics WRI reviewed location and pumping data for two proposed well locations, added the well data to the most recent version of the calibrated groundwater model, ran model simulations of predicted future conditions, and performed an analysis of the effects of pumping on Washeshu Creek.

The analysis found that pumping from either of the proposed PlumpJack well locations produces a decline in streamflow in Washeshu Creek that is small compared to the seasonally high streamflows in the creek. More significant impacts to the creek were found only to occur in summer months when observed streamflow in Washeshu Creek is also very low. The net pumping impacts during the summer months are only large in proportion to already small seasonal streamflows. This modeling effort is documented in the Proposed PlumpJack Well Impact Evaluation (HydroMetrics WRI, 2016a).

These findings were generally consistent with work performed for the Creek/Aquifer interaction study, and address the following BMOs:

BMO 3-2 - Promote viable and healthy riparian and aquatic habitats by avoiding or minimizing future impacts from pumping on streamflow.

BMO 3-3 – Minimize future impacts from pumping on identified wetlands.

SECTION 6: OTHER HYDROLOGY-RELATED ACTIVITIES

During Water Years 2016 through 2021, there were several other groundwater or surface water-related documents prepared or work performed that do not directly relate to any specific BMO, but contribute to water management in the Olympic Valley and are summarized in the sections below.

6.1 CA Sustainable Groundwater Management Act (SGMA)

Much progress toward sustainable groundwater management in California occurred under SGMA in the Water Year 2016 – 2021 timeframe. The passage of SGMA in 2014 set forth a statewide framework to help protect groundwater resources over the long-term. SGMA is comprised from a three-bill legislative package, including AB 1739, SB 1168, and SB 1319, and subsequent statewide Regulations. SGMA requires local agencies to form groundwater sustainability agencies (GSAs) for the high and medium priority basins. GSAs develop and implement groundwater sustainability plans (GSPs) to avoid undesirable results and mitigate overdraft within 20 years.

In 2016, basins underwent a standardized ranking progress by DWR, and Olympic Valley (6-108) received a Very Low priority ranking. The prioritization was based on several components:

- Population
- Population Growth
- Pubic Supply Wells (as contrasted with private)
- Total Number of Wells
- Irrigated Acres
- Groundwater Reliance
- Impacts (declining water levels, water quality degradation, land subsidence)
- Habitat and Other Information

This ranking does not reflect on the importance of water resources management in the basin, rather was focused on identification of basins with significant over-draft and long-term declining groundwater levels and related issues. In part, the Olympic Valley GMP has created the framework for management to prevent these issues, and is functionally similar to GMP's required state-wide for Medium, High, and Critical priority ranked basins. With the potential addition of a WMAP, the basin will continue along a path of being managed in a similar manner as under SGMA.

6.2 Truckee River Operating Agreement

In September 2008, the states of Nevada and California, the United States Government, the Truckee Meadows Water Authority, and the Pyramid Lake Paiute Tribe signed the Truckee River Operating Agreement (TROA). This agreement follows almost 20 years of negotiations between the states and Truckee River stakeholders related to the earlier Truckee-Carson Pyramid Lake Water Rights Settlement Act (Settlement Act) of 1990. TROA implementation began in December of 2015, following the end of the 2015 Water Year (TROA Planning Office, 2008). This agreement improves management of the waters of Lake Tahoe, and the Truckee and Carson rivers, which has been a contentious issue for several decades. Under TROA, use of reservoir storage and timed released are meant to provide more flexible drought response to demand within the Truckee Meadows, as well as the municipal needs of Reno-Sparks.

Olympic Valley is defined as Special Zone of the Truckee River Basin under TROA, so wells constructed within the Basin are required to be drilled more than 500 feet from the centerline of the Truckee River to minimize any short-term reductions of surface streamflows to the maximum extent feasible. Prior to constructing new wells within 500 feet from the centerline of the Truckee River, a Notice of Intent to Construct a Well must be filed with the TROA Administrator.

In 2016, the first TROA application was initiated for the drilling of the RSC Well 18-4. Working with Placer County Health department, the Watermaster's office for the Truckee River, and CA DWR, the framework for new well drilling applications was developed.

6.3 RSC Testing of Perini and 4th Fairway Test Wells

In the fall of 2015, RSC conducted a pumping test of the 4th Fairway test well located on the north side of the valley. This test well is completed in fractured granite bedrock just outside the basin boundary. The transmissivity of the fractured granite "aquifer" was estimated at between 15-26 ft^2/day (Interflow Hydrology, 2015).

Also in the fall of 2015, the RSC conducted a pumping test of the Perini test well located on the north side of the meadow (Interflow Hydrology, 2015b). Testing was conducted at 77 gpm with several observation wells nearby for monitoring. The aquifer transmissivity was estimated at approximately 2,900 ft^2/day and a storage coefficient of 0.04. Water quality was elevated in iron and manganese concentrations.

6.4 RSC Testing of Wells 18-1 and 18-2

During 2018 inspection and rehabilitation of Wells 18-1 and 18-2, the RSC conducted pumping tests of the wells from which aquifer transmissivity and storage coefficient parameters can be computed (Interflow Hydrology, 2018b). The transmissivity of the aquifer at Well 18-1 averages approximately 3,300 ft^2/day, with an aquifer storage coefficient of approximately 0.01 (unconfined aquifer conditions). The aquifer transmissivity value at Well 18-2 is a little higher at approximately 3,700 ft^2/day, with a storage coefficient of approximately $5x10^{-4}$, representative of a leaky confined aquifer.

Well 18-1 was found to have a limited pumping capacity of 25 gallons per minute due to partial casing collapse (open well depth to 50 ft below land surface). After rehabilitation, Well 18-2 which is completed to 75 ft in depth (top of granite bedrock at 71 ft), indicated a sustainable yield of 125 gpm.

SECTION 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Groundwater Pumping

Groundwater pumping in Olympic Valley by the major producers of the Water Years 2016 to 2021, OVPSD, SVMWC, and RSC pumped a combined average of approximately 211 MG per year. This represents an overall slight increase from the historical period of Water Year 2011 through 2015, when the combined average of these three entities was approximately 203 MG per year. However, the pumped totals are less than historically observed (225-260 MG per year) owing to conservation measures, metering, and infrastructure (leaking pipelines) repairs.

7.1.2 Groundwater Levels

OVPSD and SVMWC wells have exhibited stable trends in Water Year 2016 to 2021, as contrasted with the QRR Water Year 2011 to 2015 data. Water levels exhibit seasonal variance related to wet and dry weather and climatic conditions. Groundwater levels in the meadow area appear to show stable trends. Shallow water levels in the western basin monitoring well pairs indicate stable to increasing shallow water levels, and stable to decreasing deep water levels (Poulson well appears decreasing). Washeshu Creek stream restoration efforts may be affecting shallow water table levels, and pumping or climate (2020 and 2021 dry years) may be affecting deep water levels.

7.1.3 Groundwater Quality

Groundwater quality samples were collected at OVPSD and SVMWC, as well as in CHAMPs program monitoring wells, during Water Years 2016 through 2021. Due to the established monitoring schedule, most water quality data for OVPSD and SVMWC are available in Water Year 2018 and 2021.

In a single prior monitoring event in 2009, perchlorate had been detected at well OVPSD#2. No perchlorate samples had detectable concentrations from any well during Water Year 2016 through 2021. Small detections were present at concentrations below drinking water maximum in SVMWC #1 and #2 in 2018.

Downgradient well RSC-301 continued to have elevated concentrations of dissolved kjeldahl nitrogen, orthophosphate, and phosphorus compared to other CHAMPs wells farther upgradient. This well also exhibited elevated concentrations of nitrogen. These trends suggest potential for transport of fertilizer chemicals to groundwater in this area. Dissolved nitrite as nitrogen for the five wells was typically below the reporting limit of 0.01 mg/L for Water Years 2016 through 2021, with the exception of two instances where concentrations at RSC-305 and OVPSD#5S were detected at 0.1 mg/L in June, 2016 and 0.012 mg/L in October, 2016, respectively.

No hazardous waste sites exist within the GMP, and none were identified during Water Year 2016 through 2021.

7.1.4 Groundwater Management

Several significant groundwater management activities were completed during Water Years 2016 through 2021. These are summarized in Section 5.0 and include:

- Completion of a segment of Washeshu Creek restoration.
- Continued successful coordination of pumping and groundwater level and monitoring data.
- Advancement of the WMAP to definition of thresholds and triggers for management actions.
- Completion of a new municipal water supply at PlumpJack for future water system integration by OVPSD.
- Completion of a replacement irrigation at RSC, in support of future dedication of RSC Well 18-3R to the OVPSD.

7.2 Recommended Actions for Water Years 2022-2026

Based on the analyses and conclusions presented above, the following recommendations are made for future groundwater management activities. Our recommendations are grouped by priority.

7.2.1 High Priority Recommendations

High priority recommendations are those that should be initiated within the next six to twelve months. The high priority recommendations include:

- Initiate stakeholder communications to renew and finalize the WMAP effort. Technical components of the WMAP have been developed, with preliminary climate and water level triggers and management/conservation actions that support several BMOs and improve collaborative groundwater management within the basin. The WMAP should be completed in the forthcoming year, if consensus can be reached.

- Reactivate Washeshu Creek stream gaging, at a minimum of two key locations: Western main channel below the confluence of primarily tributaries, and down-stream of the basin at the bridge crossing (historical measurement location for outflow). Continuing to collect stream flow data is necessary for future assessments of basin water yield, stream function and health, and to conduct audits of the numerical flow model. It is suggested that primary stakeholders in the valley arrive at a financial agreement to fund and share the costs of gauge maintenance and data collection.

- Complete a climate change assessment for water supply planning and long-term aquifer management considerations. CA DWR has developed guidance documents, tools, and climatic and hydrologic datasets to facilitate making climate change assessments for projected aquifer water budget determinations (DWR, 2018). These resources include monthly streamflow change factors that can be applied to historical data and used to estimate future water budgets and climate conditions by 2070. Data available from DWR include specific values for unimpaired streamflow (up-stream of dams) for watersheds tributary to the Truckee River from Lake Tahoe to the CA-NV Stateline (HUC8 Watershed #16050102), which includes the Olympic Valley aquifer and watershed. Climate datasets also include future (2030 and 2070) projections of precipitation and reference evapotranspiration. The climate change datasets include a central tendency developed as an ensemble of 20 climate change predictive models for the west coast, and two extreme scenarios (one drier-warmer, and one wetter-moderately warmer) for 2070. A climate change analysis could be completed using the numerical flow model for Olympic Valley, using change factors applied to Washeshu Creek flows input to the model. A focus on the predicted 2070 central tendency projection is recommended, although the climate extremes could be run in the model also for general knowledge.

- Conservation efforts and demand reductions resulted in favorable declines in total pumping during Water Year 2016-2021 compared to previous periods. OVPSD and SVMWC should continue to encourage residential water use audits and conservation efforts. Palisades and RSC should likewise implement / adopt conservation practices.

- Continue to pursue metering all pumping wells, installing water level transducers in pumping wells, equipping monitoring wells with transducers, and adding wells to the CASGEM reporting program. At present, there appears to be seven active wells with water level data reporting in CASGEM, on the western side of the basin. Groundwater level data from these wells in the central and eastern basin should be added to that program. Addition of water level transducers and flow meters at individual wells used by RSC and Palisades wells are recommended to improve understanding of aquifer performance at these locations.

7.2.2 Medium Priority Recommendations

Medium priority recommendations are those that should be completed within the next year to two years. These recommendations are important for long-term groundwater management.

- Conduct an audit and review of the numerical flow model, last updated in 2015 during evaluations completed for the Village at Squaw Valley Specific Plan, Water Supply Assessment (WSA). Transmissivity and storage coefficient data derived from aquifer testing completed in Water Years 2016 and 2021 provides additional data for comparison with model calibrated values, and can provide constraint to modeled parameters if additional calibration work is completed.

- Update the WMAP for new municipal wells that may be added to the water supply system, such as PlumpJack or 18-3R.

- Develop and implement a pumping management plan as additional wells become integrated into the water supply systems (for example 18-3R, PlumpJack, or 18-4). As noted in the WSA Pumping Management Plan (2016), there is sufficient groundwater supply in Olympic Valley to meet future anticipated demand. However, alternative pumping configurations (timing and distribution of pumping amongst wells) may slightly improve creek flows, support several creek-related BMOs and may also provide for prolonged available aquifer storage in drought conditions. A pumping management plan review should complement assessments of future water services to new development, and could be considered along with integration of additional wells into municipal or recreational water supply systems. The pumping management plan can utilize the numerical flow model as a tool of analysis. A pumping management plan would partially complement and build off concepts developed for the WMAP.

- Support future Washeshu Creek restoration programs. OVPSD should, through resolution or other means, support ongoing Washeshu Creek restoration efforts to the extent that they do not interfere with the District’s primary water supply responsibilities.

7.2.3 Low Priority Recommendations

Low priority recommendations are those that could be initiated within the next two years, but could be deferred. These include:

- For future management actions, and general consistency with current state SGMA policies, groundwater dependent ecosystems (GDEs) could be more officially mapped and defined for the basin. Historical work in Olympic Valley has recognized the importance of the GDE resources, and water level and water quality monitoring are on-going throughout the GDE environment, so the mapping and definition recommendation is presented as a low priority, but beneficial item.

- For future management actions, and general consistency with current state SGMA policies, updated reviews of interconnected surface waters (ISWs) could be performed, notably as the interconnection relates to changes in the stream or meadow restoration efforts that have occurred and may advance in the future. The interconnection of surface water resources with groundwater has been a specific item of study in Olympic Valley, as summarized in the 2011-2015 QRR report (HydroMetrics, 2017).

- The GMP identifies avoiding groundwater withdrawals that cause subsidence of the aquifer as one BMO. We believe that the risk of subsidence in Olympic Valley is extremely small; however, this BMO could be addressed at some point. OVPSD could investigate low-cost opportunities for either establishing a subsidence monitoring program, or demonstrating that subsidence has not occurred in the valley.

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