PUEBLO
water resources

SUMMARY OF OPERATIONS

MONTEREY PENINSULA ASR PROJECT

WATER YEAR 2020

Prepared for:

Monterey Peninsula Water Management District

JUNE 2021

DRAFT

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June 27, 2021
Project No. 18-0097

Monterey Peninsula Water Management District
Post Office Box 85
Monterey, California 93942-0085

Attention: Mr. Jonathan Lear, Senior Hydrogeologist

Subject: Monterey Peninsula ASR Project; Draft Water Year 2020 Summary of Operations Report

Dear Jon:

For your review and comments, we are transmitting one digital image (PDF) of the subject draft report documenting operations of the Monterey Peninsula ASR Project during Water Year 2020 (WY 2020). WY 2020 was classified as a "Normal" Water Year on the on the Monterey Peninsula and volume of water totaling approximately 917 acre-feet (af) was able to be diverted from the Carmel River system for recharge in the Seaside Groundwater Basin (SGB) via the ASR-2 through ASR-4 wells. To date, a total volume of approximately **10,216 af** of excess Carmel River system water has been successfully recharged into the SBG since the ASR project was initiated in 2001.

We appreciate the opportunity to provide ongoing assistance to the District on this important community water-supply project. Please contact me with any questions.

Sincerely,

PUEBLO WATER RESOURCES, INC.

Robert C. Marks, P.G., C.Hg.
Principal Hydrogeologist

Copies submitted: 1 digital (PDF)

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INTRODUCTION

GENERAL STATEMENT

Presented in this report is a summary of operations of the Monterey Peninsula Aquifer Storage and Recovery (ASR) Project during Water Year 2020 (WY 2020)[1]. During WY 2020, approximately 917 acre-feet (af) of excess flows were diverted from the Carmel River system for recharge, storage, and subsequent recovery in the Seaside Groundwater Basin (SGB). This report presents a summary of the project operations during WY 2020, an assessment of ASR well performance, aquifer response and water-quality data, and provides recommendations for ongoing operation of the project.

BACKGROUND

The Monterey Peninsula ASR Project is cooperatively implemented by the Monterey Peninsula Water Management District (MPWMD or District) and California American Water (CAW) and involves the diversion of excess winter and spring time flows from the Carmel River system for recharge and storage in the Seaside Groundwater Basin (SGB). The excess water is captured by CAW wells in the Carmel Valley during periods when flows in the Carmel River exceed fisheries bypass flow requirements, treated to potable drinking water standards, and then conveyed through CAW's distribution system to ASR facilities in the SGB.

Aquifer recharge is accomplished via injection of these excess flows into specially designed ASR wells drilled in the SGB. The locations of the ASR wells and associated project monitoring wells in the SGB are shown on **Figure 1**. The recharged water is temporarily stored underground utilizing the available storage space within the aquifer system. During periods of high demand, other existing CAW production wells in the SGB and/or the ASR wells can be used to recover the previously recharged water, which in turn allows for reduced extractions from the Carmel River system during seasonal dry periods.

The District and CAW have been cooperatively developing an ASR project on the Monterey Peninsula since 1996. These efforts have evolved over time, from the performance of various technical feasibility investigations, leading to the construction and testing of pilot- and then full-scale ASR test wells to demonstrate the viability and operational parameters for ASR wells in the SGB.

The Phase 1 ASR Project includes two ASR wells (ASR-1 and ASR-2) located at the Santa Margarita (SM) ASR Facility at 1910 General Jim Moore Blvd. in Seaside. The Phase 1 Project is capable of recharging up to the State Water Resources Control Board (SWRCB) water right[2] maximum annual diversion limit of 2,426 acre-feet per year (afy) at a combined permitted injection rate of approximately 3,000 gallons per minute ([gpm] maximum diversion rate of 6.7

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[1] Water Year 2020 is the period of October 1, 2019 through September 30, 2020.

cubic feet per second [cfs]), with an average annual yield of approximately 920 afy. ASR-1 is designed for an injection capacity of 1,000 gpm and ASR-2 is designed for an injection capacity of 1,500 gpm. As-built schematics of ASR-1 and ASR-2 are presented on **Figures 2 and 3**, respectively.

The Phase 2 ASR Project also includes two ASR wells (ASR-3 and ASR-4) located at the Seaside Middle School (SMS) ASR Facility at 2111 General Jim Moore Blvd. in Seaside. The Phase 2 Project is designed to be capable of recharging up to the SWRCB water right[3] maximum annual diversion limit of 2,900 afy at a combined permitted injection rate of approximately 3,600 gpm (maximum diversion rate of 8.0 cfs), with an average annual yield of approximately 1,000 afy. ASR-3 and ASR-4 are both designed for injection capacities of 1,500 gpm. As-built schematics of ASR-3 and ASR-4 are presented on **Figures 4 and 5**, respectively.

A graphical summary of historical ASR operations in the SGB is shown on **Figure 6**. Shown are the annual injection and recovery volumes since the inception of injection operations at the Santa Margarita ASR Facility in WY 2001 through the current period of WY 2020. Also presented is a delineation of the various phases of project implementation, starting with the Santa Margarita Test Injection Well (SMTIW) in 2001, which became ASR-1 as the project transitioned from a testing program to a permanent project in WY 2008 (Phase 1 ASR Project), through construction and operation of the second well (ASR-2) at the facility in 2010. As shown, having the Santa Margarita Facility in full operation with both ASR-1 and ASR-2 injecting simultaneously in WY 2010 and WY 2011 (combined with above normal rainfall and Carmel River flows during those years) resulted in significant increases in the annual volume injected. WY 2017 was the first year of above normal rainfall and Carmel River flows with all four ASR wells in full operation, and as shown on **Figure 6** over 2,300 af of excess river flows were captured and successfully injected into the SGB that year.

PURPOSE AND SCOPE

The overall purpose of the ongoing ASR program is to recharge the SGB with excess treated Carmel River system water when it is available during wet periods for storage and later extraction (recovery) during dry periods. ASR benefits the resources of both systems by raising water levels in the SGB during the recharge and storage periods and reducing extractions from the Carmel River System during dry periods.

The scope of the ongoing data collection, analysis, and reporting program for the ASR program can be categorized into issues generally associated with:

1) ASR well hydraulics and performance;
2) Aquifer response to injection, and;

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[2] SWRCB water right 20808A for the Phase 1 ASR Project is held jointly by MPWMD and CAW.
[3] The SWRCB water right 20808C for the Phase 2 ASR Project is held jointly by MPWMD and CAW.

3) Water-quality issues associated with geochemical interaction and mixing of injected and native groundwaters.

The ongoing data collection and reporting program is intended to monitor and track ASR well performance and aquifer response to injection (both hydraulic and water quality) and to comply with the requirements of the Central Coast Regional Water Quality Control Board (RWQCB) for submitting annual technical reports for the project pursuant to Section 13267 of the California Water Code[4] and the existing General Waiver for Specific Types of Discharges (Resolution R3-2019-0089).

FINDINGS

WY 2020 ASR OPERATIONS

General Recharge Procedures

Recharge of the SGB occurs via injection of diverted flows from the CAW distribution system into ASR wells during periods of available excess Carmel River system flows. The ASR recharge source water is potable (treated) water provided from the CAW distribution system. The water is currently diverted by various production well sources in Carmel Valley and (after treatment and disinfection to potable standards) then conveyed through the Segunda-Crest pipeline network to the ASR Pipeline in General Jim Moore Blvd and then to the Santa Margarita and Seaside Middle School ASR facilities.

Injection water is introduced into the ASR wells via the pump columns. Injection rates are controlled primarily by downhole flow control valves (FCV's) installed on the pump columns, and secondarily by modulating the automatic flow control valves (Cla-Vals) installed on the ASR wellhead piping. Injection flow rates and total injected volumes are measured with rate and totalizing meters at each of the wellheads. Positive gauge pressures are maintained at the wellheads during injection to prevent cascading of water into the wells (which can lead to air-binding). Continuous water-level data at each of the ASR wells are collected with submersible pressure transducer data loggers.

Injection generally occurs at each of the ASR wells on a continuous basis when excess Carmel River flows are available, interrupted only for periodic backflushing, which typically occurs on an approximate weekly basis. Most sources of injection water contain trace amounts of solids that slowly accumulate in the pore spaces in the well's gravel pack and adjacent aquifer materials, and the CAW source water is no exception. Periodic backflushing of the ASR wells is therefore necessary to maintain well performance by removing materials deposited/accumulated around the well bore during injection. The procedure is similar to backwashing a media filter to remove accumulated material deposited during filtration.

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[4] Letter from Roger W. Briggs, Executive Officer of the Central Coast RWQCB, to Joseph Oliver, Water Resources Manager for MPWMD, dated April 29, 2009.

The adopted trigger for backflushing is when the amount of water-level drawup during injection equals the available drawdown (as measured from the static water level to the top of the pump bowls) in the well for backflushing, or one week of continuous injection, whichever occurs first. This helps to avoid over-pressurization and compression of plugging materials, thereby maximizing the efficiency of backflushing and limiting the amount of residual plugging. This factor is the basis for the maximum recommended drawup levels referenced in the following section.

The general procedure consists of temporarily stopping injection and then pumping the wells at rates of approximately 2,000 to 3,000 gpm (i.e., at least twice the rate of injection) for a period of approximately 15 to 20 minutes and repeated as necessary to effectively remove particulates from the well screen / gravel pack / aquifer matrix. Backflush water is discharged to the Santa Margarita ASR Facility backflush pit, where it percolates back into the groundwater basin.

Injection Operations Summary

A summary of injection operations at the four ASR wells is presented in **Table 1** below. Field data collected during injection operations are presented in **Appendix A** (not included in draft).

Table 1. WY 2020 Injection Operations Summary

	Injection Season		Active	Injection Rate (gpm)			Total Vol
Well	**Start**	**End**	**Days**	**Min**	**Max**	**Avg**	**(af)**
ASR-1	NA	NA	0	NA	NA	NA	0.00
ASR-2	12/3/19	5/2/20	80	1262	1850	1488	502.65
ASR-3	12/11/19	3/18/20	13	495	969	740	41.34
ASR-4	12/17/19	5/2/20	64	560	1500	1383	372.50
						Total	**916.49**

Notes:

NA - Not Applicable

As shown in **Table 1**, recharge operations were performed during the period December 3, 2019 through May 2, 2020. WY 2020 was classified as a "Normal" Water Year[5] on the Carmel River with up to 80 days of active injection and a total volume of approximately 917 acre-feet (af) of water was available for diversion from the CAW system for recharge in the SGB. The recharge water was injected at three of the four ASR wells[6] into the Santa Margarita Sandstone aquifer with per-well average injection rates ranging from approximately 495 to 1,850 gpm.

[5] Based on 46,212 af of unimpaired Carmel River flow at the Sleepy Hollow Weir in WY 2020.
[6] ASR-1 was non-operational during WY 2020.

It is noted that the variability in injection rates at the ASR wells during the injection season is controlled by various factors, including the number of active sources to the CAW system, customer demands on the CAW system, and the ability of CAW's distribution system to maintain piping pressure at the ASR wellheads.

Water-level data collected at ASR-1 through ASR-4 during WY 2020 are presented in **Figures 7 through 10**, respectively, and briefly summarized below:

- ASR-1: This well was non-operational during WY 2020 and did not have a water-level transducer installed.

- ASR-2: The injection water-levels ranged between approximately 260 to 300 feet bgs. As shown, the injection water-levels were maintained below the minimum recommended water level of 250 feet bgs throughout the injection season.

- ASR-3: The injection water-levels ranged between approximately 280 to 310 feet bgs and were maintained below the minimum recommended water level of 190 feet bgs.

- ASR-4: The injection water-levels ranged between approximately 230 to 270 feet bgs. As shown, the injection water-levels were maintained below the minimum recommended water level of 160 feet bgs throughout the injection season.

In summary, injection water levels at ASR-2 through ASR-4 were maintained below the respective maximum drawup levels throughout the WY 2020 injection season. The effects of these injection water levels on residual well plugging and well performance is discussed below.

Recovery Operations Summary

When the injected water is recovered via delivery through the CAW system, the recovered water is offset by reduced pumping by CAW from the Carmel River system during the low-flow, high demand periods of the year. Historically, both ASR-1[7] and other CAW production wells in the SGB have been utilized to varying degrees for recovery of previously injected water. In WY 2020, ASR-1 was non-operational and CAW production wells recovered 753 af of recharged water into the CAW system, leaving 164 af of the WY 2020 injection volume (917 af) in basin storage at the end of the water year.

It is noted that ASR recovery in the SGB is essentially an accounting / allocation of CAW's various water rights and pumping from the basin, SGB and does not represent a "molecule-for-molecule" recovery of the injected water; rather, the volume recharged in any given year increases the operational yield of the SGB by a commensurate amount and can be "recovered" by any of CAW's wells in the SGB and / or the ASR wells themselves.

[7] To date, ASR-1 is the only ASR well permitted by Division of Drinking Water (DDW) to recover water into the CAW distribution system.

WELL PERFORMANCE

Well performance is generally measured by specific capacity (pumping) and / or specific injectivity (injection), which is the ratio of flow rate (pumping or injection) to water-level change in the well (drawdown or drawup) over a specific elapsed time. The value is typically expressed as gallons per minute per foot of water level change (gpm/ft). The value normalizes well performance by considering the differing static water levels and flow rates. As such, specific capacity / injectivity data are useful for comparing well performance over time and at differing flow rates. Decreases in specific capacity / injectivity are indicative of decreases in the hydraulic efficiency of a well due to the effects of plugging and/or particle rearrangement.

Injection Performance

Injection performance has been tracked at ASR-1 since the inception of the ASR program in WY 2002 by measurement and comparison of 24-hour injection specific injectivities (a.k.a. injection specific capacity), and summaries of 24-hour specific injectivity for ASR-1 through ASR-4 through WY 2019 are presented in **Tables 2 through 5** below:

Table 2. Injection Performance Summary - ASR-1

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY2002					
Beginning Period	1,570	81.7	19.2		FCV not installed yet in WY2002. No recovery pumping performed.
Ending Period	1,164	199.8	6.4	-67%	
WY2003					
Beginning Period	1,070	70.0	15.5		Recovery pumping performed following WY2003 Injection
Ending Period	1,007	49.7	20.3	+31%	
WY2004					
Beginning Period	1,383	183.4	7.5		Recovery pumping performed following WY2004 Injection
Ending Period	1,072	67.4	15.9	+112%	
WY2005					
Beginning Period	1,045	46.6	22.4		Injectate dechlorinated in WY2005. No recovery pumping performed.
Ending Period	976	94.1	10.4	-54%	
WY2006					
Beginning Period	1,039	71.5	15.0		Injection procedures consistent and performance stable in WY2006. No recovery pumping performed.
Ending Period	1,008	62.2	17.5	+17%	

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY2007					
Beginning Period	1,098	92.4	11.9	--	Only one injection period in WY2007. No recovery pumping performed.
Ending Period	--	--	--		
WY2008					
Beginning Period	979	25.5	38.4	-17%	Formal rehabilitation performed prior to WY2008 injection
Ending Period	1,063	33.4	31.8		
WY 2009					
Beginning Period	1,119	56.1	19.9	+56%	Beginning period low specific injectivity due to high plugging rate during initial injection period. No recovery pumping performed.
Ending Period	1,069	34.3	31.1		
WY 2010					
Beginning Period	1,080	35.6	30.3	-19%	Observed decline in performance due to residual plugging.
Ending Period	1,326	54.0	24.6		
WY 2011					
Beginning Period	1,367	53.0	25.8	-10%	Observed slight decline in performance due to residual plugging.
Ending Period	1,454	63.7	22.8		
WY 2012					
Beginning Period	NA	NA	NA	NA	No injection at this well this year.
Ending Period	NA	NA	NA		
WY 2013					
Beginning Period	NA	NA	NA	NA	No injection at this well this year.
Ending Period	NA	NA	NA		
WY 2014					
Beginning Period	NA	NA	NA	NA	No injection at this well this year.
Ending Period	NA	NA	NA		
WY 2015					
Beginning Period	NA	NA	NA	NA	No beginning period due to datalogger malfunction.
Ending Period	1,018	40.7	25.0		
WY 2016					
Beginning Period	NA	NA	NA	NA	No beginning period due to datalogger malfunction.
Ending Period	460	14.4	31.9		

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2017					
Beginning Period	970	39.5	24.6		Observed slight decline in performance due to residual plugging.
Ending Period	1,295	60.2	21.5	-13%	
WY 2018					
Beginning Period	NA	NA	NA		No injection at this well this year.
Ending Period	NA	NA	NA	NA	
WY 2019					
Beginning Period	1,083	55.1	19.7		Observed slight increase in performance
Ending Period	1,084	48.7	22.3	+13%	
WY 2020					
Beginning Period	**NA**	**NA**	**NA**		**No injection at this well this year**
Ending Period	**NA**	**NA**	**NA**	**NA**	

Table 3. Injection Performance Summary - ASR-2

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2010					
Beginning Period	1,017	156.5	6.5		Significant residual plugging.
Ending Period	237	85.0	2.8	-57%	
WY 2011					
Beginning Period	1,497	39.5	37.9		Significant improvement as a result of well rehabilitation. No residual plugging during year.
Ending Period	1,292	34.3	37.7	-0.5%	
WY 2012					
Beginning Period	1,830	56.1	32.6		Observed decline in performance due to residual plugging.
Ending Period	1,817	63.4	28.7	-12%	
WY 2013					
Beginning Period	1,087	32.7	33.2		No residual plugging during year.
Ending Period	1,508	44.2	34.1	+3%	
WY 2014					
Beginning Period	NA	NA	**NA**		No injection at this well this year.
Ending Period	NA	NA	**NA**	**NA**	

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2015					
Beginning Period	1,456	38.9	37.4		Observed decline in performance due to residual plugging.
Ending Period	1,574	49.1	32.1	-14%	
WY 2016					
Beginning Period	1,270	34.9	36.4		Observed significant decline in performance due to residual plugging.
Ending Period	1,620	63.9	25.4	-30%	
WY 2017					
Beginning Period	822	24.2	33.9		Observed decline in performance due to residual plugging.
Ending Period	907	30.7	29.5	-13%	
WY 2018					
Beginning Period	950	30.5	31.1		Observed decline in performance due to residual plugging.
Ending Period	1,537	53.7	28.6	-8%	
WY 2019					
Beginning Period	1,390	58.3	23.8		Observed decline in performance due to residual plugging.
Ending Period	933	59.8	15.6	-34%	
WY 2020					
Beginning Period	1,517	63.9	**23.7**		**See discussion below**
Ending Period	1,500	58.8	**25.5**	**+8**	

Table 4. Injection Performance Summary – ASR-3

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2013					
Beginning Period	1,044	87.0	12.0		Observed significant decline in performance due to residual plugging.
Ending Period	822	99.6	8.3	-31%	
WY 2014					
Beginning Period	NA	NA	NA		No injection at this well this year.
Ending Period	NA	NA	NA	NA	
WY 2015					
Beginning Period	NA	NA	NA		No beginning period data.
Ending Period	892	90.3	9.9	NA	

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2016					
Beginning Period	948	83.6	11.3		Slight increase observed.
Ending Period	897	74.1	12.1	+7%	
WY 2017					
Beginning Period	936	107.5	8.7		Slight increase observed.
Ending Period	986	105.2	9.4	+8%	
WY 2018					
Beginning Period	1,050	64.8	16.2		Observed significant decline in performance due to residual plugging.
Ending Period	1,440	115.4	12.5	-23%	
WY 2019					
Beginning Period	1,063	108.9	9.8		Increase observed.
Ending Period	1,091	93.8	11.6	+18%	
WY 2020					
Beginning Period	495	24.8	**20.0**		**See discussion below**
Ending Period	600	36.0	**16.7**	**-17%**	

Table 5. Injection Performance Summary – ASR-4

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2017					
Beginning Period	1,506	91.3	16.5		Significant increase.
Ending Period	1,068	41.3	25.9	+58%	
WY 2018					
Beginning Period	920	38.1	24.1		Insufficient data for comparison.
Ending Period	NA	NA	NA	NA	
WY 2019					
Beginning Period	1,375	258.4	5.3		Significant increase.
Ending Period	1,491	74.6	19.9	+275%	
WY 2020					
Beginning Period	560	23.1	**24.2**		**See discussion below.**
Ending Period	1,500	54.0	**27.8**	**+15%**	

Injection Performance Summary. As shown in **Table 2,** no data are available for ASR-1 as it was non-operational during WY 2020. As shown in **Table 3**, at ASR-2 the 24-hour specific injectivity at the beginning of WY 2020 was 23.7 gpm/ft and at the end was 25.5 gpm/ft, representing a slight increase approximately 8 percent. As shown in **Table 4**, at the beginning of WY 2020 the ASR-3 specific injectivity was 20.0 gpm/ft and at the end was 16.7 gpm/ft, representing a significant decrease of approximately 17 percent. As shown in **Table 5**, at ASR-4 the 24-hour specific injectivity at the beginning of WY 2020 was 24.2 gpm/ft and at the end was 27.8 gpm/ft, representing a slight increase approximately 15 percent.

Pumping Performance and Residual Plugging

Experience at injection well sites around the world shows that all injection wells are subject to some amount of plugging because no water source is completely free of particulates, bionutrients, or oxidants, all of which can contribute to well plugging; the CAW source water is no exception. During injection, trace amounts of suspended solids are continually being deposited in the gravel pack and aquifer pore spaces, much as a media filter captures particulates in the filter bed. The effect of plugging is to impede the flow of water from the injection well into the aquifer, causing increased injection heads in the well to maintain a given injection rate, or reduced injection rates at a given head level. Well plugging reduces injection and extraction capacity and can result in decreased useful well life if not mitigated.

Relative measurements of the particulate matter in the injectate have historically been made at the Santa Margarita site through Silt Density Index (SDI) testing during the injection season. The SDI was originally developed to quantitatively assess particulate concentrations in reverse-osmosis feed waters. The SDI test involves pressure filtration of source water through a 0.45-micron membrane, and observation of the decrease in flow rate through the membrane over time; the resulting (dimensionless) value of SDI is used as a comparative value for tracking relative declines in well plugging rates associated with particulate plugging during an injection season (i.e., plugging rates tend to increase directly with SDI).

During WY 2020 injection operations, the injectate SDI ranged between 2.08 to 3.58, averaging 2.92, values that are consistent with recent previous years (i.e., since the Monterey Pipeline has been installed by CAW) and indicative of a relatively low particulate load and, therefore, plugging potential.

Following routine backflushing operations and periods of water-level recovery, controlled 10-minute specific-capacity tests are typically performed to track well pumping performance, similar to the tracking of injection performance from 24-hour specific injectivity discussed above. Residual plugging is the plugging that remains following backflush pumping. Residual plugging increases drawdown during pumping and drawup during injection and is manifested as declining specific capacity / injectivity. The presence of residual plugging is indicative of incomplete removal of plugging particulates during backflushing and has the cumulative effect of reducing well performance and capacity over time.

As discussed previously, routine 10-minute specific capacity tests were performed at the ASR wells as part of backflushing events during WY 2020. Presented in **Table 6** below is a summary of the residual plugging calculations for the ASR wells during WY 2020.

Table 6. Pumping Performance and Residual Plugging Summary

Well	Test	Pumping Rate (gpm)	10-min Drawdown (ft)	10-min Q/s[1] (gpm/ft)	Normalization Ratio[2]	Normalized Drawdown[2] (ft)	Residual Plugging (ft)
ASR-1	Pre-Injection	NA	NA	NA	NA	NA	--
	Post-Injection	NA	NA	NA	NA	NA	NA
ASR-2	Pre-Injection	2,700	80.7	33.5	1.11	89.7	--
	Post-Injection	1,800	57.1	31.5	1.67	95.2	5.5
ASR-3	Pre-Injection	2,000	135.6	14.7	1.50	203.4	--
	Post-Injection	2,000	235.5	8.5	1.50	353.3	149.9
ASR-4	Pre-Injection	2,600	143.1	18.2	1.15	165.1	--
	Post-Injection	2,500	118.8	21.0	1.20	142.6	-22.6

Notes:
NA - Not Applicable
1 - Specific Capacity. Ratio of pumping rate to drawdown.
2 - Normalized based on ratio of 3,000 gpm to actual test pumping rate.

As shown on **Figures 8 through 9**, injection water levels at ASR-2 through ASR-4 were maintained below the recommended maximum available drawup levels during WY 2020, and as shown in **Table 6**, ASR-2 and ASR-4 did not experience significant residual plugging. ASR-3, however, did observe a significant amount of residual plugging and an associated decline in both pumping and injection performance (refer to **Table 4**). The reason(s) for the loss in performance at ASR-3 compared to the other two wells is not known at this time. The WY 2020 results continue to indicate that injection water levels at all of the ASR wells should be maintained below the recommended minimum levels below ground surface during the injection season to avoid excessive drawup and over pressurization of plugging constituents.

AQUIFER RESPONSE TO INJECTION

The response of the regional aquifer system to injection has been monitored since the SMTIW project was initiated in WY 2002. Submersible water-level transducer/data logger units have been installed at seven offsite monitoring well locations in the SGB as well as three onsite monitoring wells. The locations of each offsite monitoring well are shown on **Figure 1**, and water-level hydrographs for the monitoring wells during WY 2020 are graphically presented on **Figures 11 through 18**. A summary of the regional water-level observations during the WY 2020 injection season is presented in **Table 7** below:

Table 7. Aquifer Response Summary

Well ID	Distance from Nearest Active ASR Well (feet)	Aquifer Monitored	Fig. No.	Pre-Injection DTW (ft. bgs)	Shallowest Injection DTW (ft. bgs)	Maximum Drawup Response (ft.)
SMS (Shallow)	25 (ASR-3)	QTp	**11**	No Discernable Response		
SMS (Deep)		Tsm		368.6	329.8	**38.8**
SM MW-1	190 (ASR-2)	Tsm	**12**	373.9	332.8	**41.1**
Paralta Test	650 (ASR-2)	QTp & Tsm	**13**	353.1	332.9	**20.2**
Ord Terrace (Shallow)	2,550 (ASR-2)	Tsm	**14**	260.5	NA	**NA**
FO-7 (Shallow)	3,700 (ASR-3)	QTp	**15**	No Discernable Response		
FO-7 (Deep)		Tsm		494.9	477.5	**17.4**
FO-9 (Deep)	6,130 (ASR-3)	Tsm	**16**	143.1	127.5	**15.6**
PCA East (Shallow)	6,200 (ASR-3)	QTp	**17**	No Discernable Response		
PCA East (Deep)		Tsm		93.8	77.7	**16.1**
FO-8 (Deep)	6,450 (ASR-3)	Tsm	**18**	403.6	388.5	**15.1**

Notes:
QTp – Quaternary / Tertiary-age Paso Robles Formation aquifer
Tsm – Tertiary-age Santa Margarita Sandstone aquifer
DTW – Depth to Water
NA – Not Available

As shown on **Figures 11 through 18**, water levels in the Santa Margarita Sandstone (Tsm) aquifer at the start of the WY 2020 recharge season ranged between approximately 20 to 40 feet below sea level. Positive response to injection during WY 2020 was observed at all 7 of the monitored wells completed in the Tsm aquifer, with apparent water-level responses ranging between approximately 15 to 40 feet, generally decreasing with distance from the ASR wells, which is the typical and expected aquifer response to hydraulic stresses (i.e., injection or pumping).

The water-level data also continue to show that at the majority of the offsite Tsm-only monitoring wells, water levels consistently remained below sea level throughout WY 2020, including during the injection season. In addition, the data for wells completed in the Paso Robles Formation (QTp) also continue to show no discernible direct response to injection and water levels in the QTp aquifer remained higher than the water levels in the underlying Tsm aquifer during WY 2020. Under these overall basin water-level conditions, little to no horizontal flow from the Tsm aquifer to the ocean nor vertically upward flow into the QTp aquifer would be expected to occur; as such, any hydraulic "losses" of injected water from the basin are likely very limited.

WATER QUALITY

General

Source water for injection is supplied from the CAW municipal water system, primarily from Carmel River system wells, which is treated at the CAW Begonia Iron Removal Plant (BIRP) for iron and manganese removal. The BIRP product water is also disinfected and maintains a free chlorine residual. A phosphate-based corrosion inhibitor (zinc orthophosphate) is also added to the filtered water before entering the CAW distribution system. The finished product water meets all California Department of Public Health (CADPH) Primary and Secondary water quality standards.

As in previous years, water quality was routinely monitored at the ASR well sites during WY 2020 injection and aquifer storage operations. Far-field water quality was also monitored at the PCE-East Deep monitoring well (PCA-E Deep). Summaries of the collected water-quality data during WY 2020 are presented in **Tables 8 through 15** below. Analytic laboratory reports are presented in **Appendix C** (not included in draft). A discussion of the water-quality data collected during WY 2020 is presented below.

Injection Water Quality

Injection water quality from the CAW system during WY 2020 is presented in **Table 8** below, and the data show injection water quality was typical of recent years. Levels of Trihalomethanes (THM) and Haloacetic Acid (HAA) compounds, as well as bionutrients (dissolved oxygen, nitrogen, phosphorous, and organic carbon), were all present at levels similar to previous years.

Water Quality During Aquifer Storage

Tables 9 through 12 present summaries of water-quality data collected at the four ASR wells. **Tables 13 and 14** present similar data collected at the on-site monitoring wells SM MW-1 and SMS Deep, respectively; and **Table 15** presents the water-quality data collected at the off-site monitoring wells Paralta and PCA-E Deep.

Review of water-quality parameters gathered at the ASR wells, including major anions and cations, redox potential (ORP), and conductivity all showed very limited effects of dilution / intermixing of injected water with native groundwater (NGW) during aquifer storage compared to some previous water years.

Disinfection Byproducts (DBPs) parameters for the on-site wells collected during the WY 2020 storage period are graphically presented on **Figures 19 through 24** and are summarized below:

Table 8. Summary of Water Quality Data – Injectate

Parameter	Unit	PQL	MCL	Results			
				CAW Injectate			
				12/4/19	1/6/20	3/16/20	4/21/20
		Sample Description		Injectate			
Major Cations							
Calcium	mg/L	*0.5*		42	37	41	41
Magnesium	mg/L	*0.5*		12.8	12.6	13.2	13.2
Potasium	mg/L	*0.5*		3	2.8	3.1	3
Sodium	mg/L	*0.5*		47	41	44	46
Major Anions							
Alkalinity, Total (as CaCO3)	mg/L	*2*		136	136	138	138
Chloride	mg/L	*1*	*250*	37.3	30.6	27.8	35.2
Sulfate	mg/L	*1*	*250*	72	67	62	71
Nitrate (as N)	mg/L	*1*	*10*	0.1	0.3	0.1	0.7
General Physical							
pH	Std Units			7.3	7.6	7.8	7.8
Specific Conductance (EC)	uS	*1*	*900*	534	486	486	502
Total Dissolved Solids	mg/L	*10*	*500*	296	250	266	310
Metals							
Arsenic (Total)	ug/L	*1*	*10*	0.9	ND	0.8	0.6
Barium (Total)	ug/L	*10*	*1000*	58.9	60.6	61.6	53.8
Iron (Dissolved)	ug/L	*10*		9	ND	15	ND
Iron (Total)	ug/L	*10*	*300*	19	7	15	ND
Lithium	ug/L	*1*		9	5.4	4.9	9.3
Manganese (Dissolved)	ug/L	*10*		< 3	ND	ND	ND
Manganese (Total)	ug/L	*10*	*50*	3	ND	ND	ND
Mercury	ug/L	*0.2*	*2*	0.1	ND	ND	ND
Molybdenum	ug/L	*1*	*1000*	3.5	2.6	2.6	3.2
Nickel	ug/L	*10*	*100*	2.1	4.9	1.9	1.8
Selenium	ug/L	*2*	*50*	1.1	0.8	0.6	0.9
Strontium (Total)	ug/L	*5*		262	210	212	211
Uranium (by ICP/MS)	ug/L	*1*	*30*				
Vanadium (Total)	ug/L	*1*	*1000*	< 0.5	ND	0.5	0.6
Zinc (Total)	ug/L	*10*	*5000*	126	233	203	160
Miscellaneous							
Ammonia-N	mg/L	*0.05*		ND	ND	27	ND
Boron	mg/L	*0.05*		< 0.05	ND	ND	ND
Chloramines	mg/L	*0.05*		ND	0.12	0.08	0.1
Gross Alpha	pCi/L		*15*	2.24 ± 1.97	0.258±1.29	3.98±1.16	2.91±1.25
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND	ND	ND	ND
Methane	ug/L	*0.1*		1.5	1.2	0.55	1
o-Phosphate-P	mg/L	*0.05*		0.2	0.3	0.3	ND
Phosphorous (Total)	mg/L	*0.03*		0.27	0.29	0.34	0.66
Radium 226	pCi/L		*3*	0.055±0.081	0.000±0.117	0.305±0.183	0.096±0.109
Organic Analyses							
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	17	14	23	14
Organic Carbon (Dissolved)	mg/L	*0.2*		1.3	1.2	1.6	1.1
Organic Carbon (Total)	mg/L	*0.2*		1.5	1.5	1.5	1.3
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	50	28	36	22
Field Parameters							
Temperature	^{0}C	*0.1*			15.55	15.9	
Specific Conductance (EC)	uS	*1.0*	*900*		497	505	
pH	Std Units	*0.1*	*6.5 - 8.5*		7.3	7.1	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*		0.9		
H_2S	mg/L	*0.1*			Lo-ND	Lo-ND	
ORP	mV	*1.0*			582	585.8	
Dissolved Oxygen	mg/L	*0.01*			0.13		
Silt Density Index	Std Units	*0.1*				3.53	

Notes:

Constituents exceeding MCLs denoted in **BOLD** type

Table 9. Summary of Water-Quality Data – ASR-1

Parameter	Unit	PQL	MCL	Results								
				SM ASR-1								
				3/21/01	12/2/19	2/20/20	4/21/20	5/27/20	6/30/20	7/29/20	8/25/20	9/22/20
ASR Operational Phase				NGW	WY 2019 Storage	WY 2020 Injection		WY 2020 Storage				
Elapsed Storage Time	Days			--	185	NA	NA	25	59	88	115	143
Major Cations												
Calcium	mg/L	*0.5*		85	44		44		43			
Magnesium	mg/L	*0.5*		19	13.1		11.8		12.2			
Potasium	mg/L	*0.5*		5.3	3.1		2.9		2.9			
Sodium	mg/L	*0.5*		88	46		44		45			
Major Anions												
Alkalinity, Total (as CaCO3)	mg/L	*2*		224	146		139		144			
Chloride	mg/L	*1*	*250*	120	42.9	32.4	33.2	32.0	32.1	64.3	76.1	76.3
Sulfate	mg/L	*1*	*250*	95	71		70		69			
Nitrate (as N)	mg/L	*1*	*10*	ND	0.1		0.1		0.1			
General Physical												
pH	Std Units			7.1	8.3		7.7		7.8			
Specific Conductance (EC)	uS	*1*	*900*	**1015**	581		506		517			
Total Dissolved Solids	mg/L	*10*	*500*	**618**	338		308		308			
Metals												
Arsenic (Total)	ug/L	*1*	*10*	ND	1.3		2.1		1.4			
Barium (Total)	ug/L	*10*	*1000*	52	40.7		34.5		29.8			
Iron (Dissolved)	ug/L	*10*			< 6		ND		8			
Iron (Total)	ug/L	*10*	*300*	120	< 6		154		40			
Lithium	ug/L	*1*			11		10		8.7			
Manganese (Dissolved)	ug/L	*10*			< 3		3		ND			
Manganese (Total)	ug/L	*10*	*50*	40	3		5		ND			
Mercury	ug/L	*0.2*	*2*		0.1	0.19	ND		ND	0.9	0.5	0.5
Molybdenum	ug/L	*1*	*1000*		4.7		3.5		3.8			
Nickel	ug/L	*10*	*100*		2.4		1.5		1.8			
Selenium	ug/L	*2*	*50*	ND	1.1		2.7		1.2			
Strontium (Total)	ug/L	*5*			240		240		221			
Uranium (by ICP/MS)	ug/L	*1*	*30*									
Vanadium (Total)	ug/L	*1*	*1000*		0.5		1.1		1.4			
Zinc (Total)	ug/L	*10*	*5000*	10	49		40		74			
Miscellaneous												
Ammonia-N	mg/L	*0.05*		0.33	ND		ND		0.31			
Boron	mg/L	*0.05*		0.14	< 0.05		ND		ND			
Chloramines	mg/L	*0.05*			ND	< 0.05	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*		1.66±1.75		1.51±0.830		0.408±1.18			
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND		0.5			
Methane	ug/L	*0.1*			1.2		0.2		0.18			
o-Phosphate-P	mg/L	*0.05*		0.46	< 0.0		ND		ND			
Phosphorous (Total)	mg/L	*0.03*			0.11		0.15		0.11			
Radium 226	pCi/L		*3*		0.533±0.200		0.112±0.113		0.182±0.149			
Organic Analyses												
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*		3	3	ND	ND	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*			1.2		1.1		1			
Organic Carbon (Total)	mg/L	*0.2*		6.3	1.4		1.2		0.9			
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*		29	46	51	53	38	26	21	15
Field Parameters												
Temperature	^{0}C	*0.1*			18.44							
Specific Conductance (EC)	uS	*1.0*	*900*	1015	575							
pH	Std Units	*0.1*	*6.5 - 8.5*	7.1	7.18							
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*		0.02							
H_2S	mg/L	*0.1*		1.5	Lo-ND							
ORP	mV	*1*			30.6							
Dissolved Oxygen	mg/L	*0.01*			0.78							

Constituents exceeding MCLs denoted in **BOLD** type

Table 10. Summary of Water Quality Data – ASR-2

Parameter	Unit	PQL	MCL	Results					
				SM ASR-2					
				10/22/19	12/3/19	2/20/20	4/21/20	5/27/20	6/30/20
		ASR Operational Phase		WY 2019 Storage		WY 2020 Injection		WY 2020 Storage	
Elapsed Storage Time	Days			**144**	**186**	**NA**	**NA**	**25**	**59**
Major Cations									
Calcium	mg/L	*0.5*			45		40		39
Magnesium	mg/L	*0.5*			15.6		12.5		12.8
Potasium	mg/L	*0.5*			3.1		2.8		2.8
Sodium	mg/L	*0.5*			45		42		44
Major Anions									
Alkalinity, Total (as CaCO3)	mg/L	*2*			153		135		141
Chloride	mg/L	*1*	*250*	30	43.1	32.4	31.9	31.6	33
Sulfate	mg/L	*1*	*250*		73		62		65
Nitrate (as N)	mg/L	*1*	*10*		0.1		0.2		0.1
General Physical									
pH	Std Units				7.5		7.6		7.9
Specific Conductance (EC)	uS	*1*	*900*		572		486		507
Total Dissolved Solids	mg/L	*10*	*500*		298		282		302
Metals									
Arsenic (Total)	ug/L	*1*	*10*		0.8		0.6		1.3
Barium (Total)	ug/L	*10*	*1000*		62		52.8		46.3
Iron (Dissolved)	ug/L	*10*			29		ND		17
Iron (Total)	ug/L	*10*	*300*		58		186		52
Lithium	ug/L	*1*			9		8.5		7.3
Manganese (Dissolved)	ug/L	*10*			16		ND		ND
Manganese (Total)	ug/L	*10*	*50*		17		16		3
Mercury	ug/L	*0.5*	*2*	0.2	0.2	0.19	ND		ND
Molybdenum	ug/L	*1*	*1000*		4.9		2.3		3.3
Nickel	ug/L	*10*	*100*		2.2		1.9		2.2
Selenium	ug/L	*2*	*50*		1.4		0.8		2.1
Strontium (Total)	ug/L	*5*			241		210		198
Uranium (by ICP/MS)	ug/L	*1*	*30*						
Vanadium (Total)	ug/L	*1*	*1000*		0.5		0.7		1
Zinc (Total)	ug/L	*10*	*5000*		244		165		190
Miscellaneous									
Ammonia-N	mg/L	*0.05*			ND		ND		0.11
Boron	mg/L	*0.05*			< 0.05		ND		ND
Chloramines	mg/L	*0.05*		ND	ND	< 0.05	0.08	ND	ND
Gross Alpha	pCi/L		*15*		3.02±1.40		3.04±1.23		0.502±1.20
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND		0.4
Methane	ug/L	*0.1*			1.1		1		0.85
o-Phosphate-P	mg/L	*0.05*			0.1		0.2		0.3
Phosphorous (Total)	mg/L	*0.03*			0.23		0.33		0.29
Radium 226	pCi/L		*3*		0.000±0.051		0.193±0.133		0.199±0.152
Organic Analyses									
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	3	3	16	32	11
Organic Carbon (Dissolved)	mg/L	*0.2*			1.3		1.1		1.1
Organic Carbon (Total)	mg/L	*0.2*			1.2		1.3		1
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	36	21	46	29	79	68
Field Parameters									
Temperature	^{0}C	*0.1*		17.11	16.99				
Specific Conductance (EC)	uS	*1.0*	*900*	877	578				
pH	Std Units	*0.1*	*6.5 - 8.5*	7.34	7.07				
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	0.03	0.03				
H_2S	mg/L	*0.1*		Lo-ND	Lo-ND				
ORP	mV	*1*		29.9	2				
Dissolved Oxygen	mg/L	*0.01*		3.39	0.14				

Notes:
Constituents exceeding MCLs denoted in **BOLD** type

Table 11. Summary of Water Quality Data – ASR-3

Parameter	Unit	PQL	MCL	Results								
				SMS ASR-3								
				10/22/10	10/29/19	12/3/19	2/21/20	4/21/20	5/27/20	6/30/20	8/25/20	9/22/20
	ASR Operational Phase			**NGW**	**WY 2019 Storage**		**WY 2020 Injection**		**WY 2020 Storage**			
Elapsed Storage Time	Days				**151**	**186**	**NA**	**NA**	**25**	**59**	**115**	**143**
Major Cations												
Calcium	mg/L	*0.5*		76		36		42		40		
Magnesium	mg/L	*0.5*		18		12.5		13.8		13.4		
Potasium	mg/L	*0.5*		5		2.6		3.1		3.1		
Sodium	mg/L	*0.5*		102		38		46		45		
Major Anions												
Alkalinity, Total (as CaCO3)	mg/L	*2*		304		137		139		141		
Chloride	mg/L	*1*	*250*	107	33.9	25.9	32.2	31.6	32.2	31.9	34.7	34.6
Sulfate	mg/L	*1*	*250*	56		58		67		66		
Nitrate (as N)	mg/L	*1*	*10*	1		0.1		0.1		0.1		
General Physical												
pH	Std Units			7.7		7.5		7.6		7.9		
Specific Conductance (EC)	uS	*1*	*900*	**954**		492		492		472		
Total Dissolved Solids	mg/L	*10*	*500*	**575**		246		298		286		
Metals												
Arsenic (Total)	ug/L	*1*	*10*	4		2.9		4.5		3.7		
Barium (Total)	ug/L	*10*	*1000*	50		54.4		67.5		49.9		
Iron (Dissolved)	ug/L	*10*		21		20		6		12		
Iron (Total)	ug/L	*10*	*300*	21		44		96		120		
Lithium	ug/L	*1*		36		6.3		9.1		7.2		
Manganese (Dissolved)	ug/L	*10*		27		14		7		7		
Manganese (Total)	ug/L	*10*	*50*	27		14		9		9		
Mercury	ug/L	*0.5*	*2*			< 0.1		ND		ND	ND	0.2
Molybdenum	ug/L	*1*	*1000*	--	< 0.1	24.3		9.7		9.5		
Nickel	ug/L	*10*	*100*	ND		2.1		1.8		2.5		
Selenium	ug/L	*2*	*50*	ND		3.8		4.2		4.8		
Strontium (Total)	ug/L	*5*		403		199		211		197		
Uranium (by ICP/MS)	ug/L	*1*	*30*	--								
Vanadium (Total)	ug/L	*1*	*1000*	--		0.6		0.7		1.4		
Zinc (Total)	ug/L	*10*	*5000*	--		206		187		207		
Miscellaneous												
Ammonia-N	mg/L	*0.05*		249		ND		ND		0.03		
Boron	mg/L	*0.05*		ND		< 0.05		ND		ND		
Chloramines	mg/L	*0.05*		0.08	ND	ND	< 0.05	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*	--		2.13±1.75		1.83±1.10		1.05±1.43		
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND		ND		ND		0.4		
Methane	ug/L	*0.1*		ND		0.92		1.5		0.79		
o-Phosphate-P	mg/L	*0.05*		ND		0.2		0.2		ND		
Phosphorous (Total)	mg/L	*0.03*		0.03		0.28		0.3		0.28		
Radium 226	pCi/L		*3*	--		0.624±0.216		0.209±0.137		0.215±0.156		
Organic Analyses												
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	4	2	15	10	3	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.71		1.4		1.1		1.2		
Organic Carbon (Total)	mg/L	*0.2*		0.70		1.4		1.3		1.1		
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	ND	**106**	66	**88**	62	72	62	64	53
Field Parameters												
Temperature	^{0}C	*0.1*		26.2	16.24	16.28						
Specific Conductance (EC)	uS	*1.0*	*900*	991	517	498						
pH	Std Units	*0.1*	*6.5 - 8.5*	7.0	7.23	7.02						
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	ND	0	0.03						
H_2S	mg/L	*0.1*		0.6	Lo-ND	Lo-ND						
ORP	mV	*1*		-82	5.6	19.5						
Dissolved Oxygen	mg/L	*0.01*		--	0.46	0.98						

Notes:
Constituents exceeding MCLs denoted in **BOLD** type

Table 12. Summary of Water Quality Data – ASR-4

Parameter	Unit	PQL	MCL	Results								
				ASR-4								
				10/29/19	12/3/19	2/21/20	4/21/20	5/27/20	6/30/20	7/30/20	8/25/20	9/22/20
		ASR Operational Phase		WY 2019 Storage		WY 2020 Injection		WY 2020 Storage				
Elapsed Storage Time	Days			**151**	**186**	**NA**	**NA**	**25**	**59**	**89**	**115**	**143**
Major Cations												
Calcium	mg/L	*0.5*			36		41		40			
Magnesium	mg/L	*0.5*			11.5		13		13			
Potasium	mg/L	*0.5*			2.6		3		2.9			
Sodium	mg/L	*0.5*			38		43		44			
Major Anions												
Alkalinity, Total (as CaCO3)	mg/L	*2*			127		134		138			
Chloride	mg/L	*1*	*250*	31.5	36.4	30.4	31.5	29.5	30.1	33.6	34.3	35
Sulfate	mg/L	*1*	*250*		56		62		64			
Nitrate (as N)	mg/L	*1*	*10*		0.2		0.2		0.1			
General Physical												
pH	Std Units				7.6		7.7		7.9			
Specific Conductance (EC)	uS	*1*	*900*		482		478		493			
Total Dissolved Solids	mg/L	*10*	*500*		250		306		282			
Metals												
Arsenic (Total)	ug/L	*1*	*10*		2.1		0.8		3.9			
Barium (Total)	ug/L	*10*	*1000*		51.7		62.9		47.3			
Iron (Dissolved)	ug/L	*10*			10		ND		10			
Iron (Total)	ug/L	*10*	*300*		76		219		121			
Lithium	ug/L	*1*			8.9		8.3		6.9			
Manganese (Dissolved)	ug/L	*10*			< 3		ND		ND			
Manganese (Total)	ug/L	*10*	*50*		3		20		5			
Mercury	ug/L	*0.5*	*2*	0.1	< 0.1	< 0.1	ND		ND	ND	ND	0.2
Molybdenum	ug/L	*1*	*1000*		8.7		3		14.1			
Nickel	ug/L	*10*	*100*		9.6		4.4		4.5			
Selenium	ug/L	*2*	*50*		2.1		0.6		5.2			
Strontium (Total)	ug/L	*5*			247		206		198			
Uranium (by ICP/MS)	ug/L	*1*	*30*									
Vanadium (Total)	ug/L	*1*	*1000*		1.6		0.8		1.2			
Zinc (Total)	ug/L	*10*	*5000*		99		176		194			
Miscellaneous												
Ammonia-N	mg/L	*0.05*			ND		ND		0.02			
Boron	mg/L	*0.05*			< 0.05		ND		ND			
Chloramines	mg/L	*0.05*		ND	ND	< 0.05	ND	0.05	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*		1.34±1.63		2.78±1.33		1.12±1.45			
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND		0.5			
Methane	ug/L	*0.1*			0.49		1		1.3			
o-Phosphate-P	mg/L	*0.05*			< 0.0		0.2		ND			
Phosphorous (Total)	mg/L	*0.03*			0.15		0.34		0.27			
Radium 226	pCi/L		*3*		0.202±0.130		0.160±0.126		0.232±0.159			
Organic Analyses												
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	2	4	46	16	32	7	3	5	ND
Organic Carbon (Dissolved)	mg/L	*0.2*			1.1		1.3		1.2			
Organic Carbon (Total)	mg/L	*0.2*			1		1.4		1.2			
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	37	38	**91**	25	75	60	73	79	60
Field Parameters												
Temperature	^{0}C	*0.1*		17.72	18.15							
Specific Conductance (EC)	uS	*1.0*	*900*	516	500							
pH	Std Units	*0.1*	*6.5 - 8.5*	7.29	7.21							
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	0.02	0.03							
H_2S	mg/L	*0.1*		Lo-ND	Lo-ND							
ORP	mV	*1*		-0.03	9.7							
Dissolved Oxygen	mg/L	*0.01*		0.21	0.86							

Notes:
Constituents exceeding MCLs denoted in **BOLD** type

Table 13. Summary of Water Quality Data – SM MW-1

Parameter	Unit	PQL	MCL	Results SM MW-1 10/21/19	12/2/19	12/18/19	1/6/20	2/20/20	4/21/20	5/27/20	6/30/20	7/29/20	8/25/20	9/22/20
		Sample Description		WY 2019 Storage		WY 2020 Injection				WY 2020 Storage				
Elapsed Storage Time	Days			**143**	**185**	**NA**	**NA**	**NA**	**NA**	**25**	**59**	**88**	**115**	**143**
Major Cations														
Calcium	mg/L	*0.5*			41		41		43		42			
Magnesium	mg/L	*0.5*			12.4		12.9		13.6		13.3			
Potasium	mg/L	*0.5*			2.6		2.9		3.1		3			
Sodium	mg/L	*0.5*			40		43		46		46			
Major Anions														
Alkalinity, Total (as CaCO3)	mg/L	*2*			133		141		136		141			
Chloride	mg/L	*1*	*250*	27.6	29.6		32.6	30.7	32.7	33.6	32.5	31.2	95	113
Sulfate	mg/L	*1*	*250*		67		69		64		67			
Nitrate (as N)	mg/L	*1*	*10*		0		0.2		0.1		0.1			
General Physical														
pH	Std Units				8.3		7.7		7.7		7.9			
Specific Conductance (EC)	uS	*1*	*900*		510		503		493		508			
Total Dissolved Solids	mg/L	*10*	*500*		296		262		292		282			
Metals														
Arsenic (Total)	ug/L	*1*	*10*		0.8		1.4		1.3		1.6			
Barium (Total)	ug/L	*10*	*1000*		45.4		39.3		43.7		37.1			
Iron (Dissolved)	ug/L	*10*			< 6		ND		ND		8			
Iron (Total)	ug/L	*10*	*300*		< 6		ND		26		ND			
Lithium	ug/L	*1*			6.7		5.9		11.9		7.3			
Manganese (Dissolved)	ug/L	*10*			4		ND		13		ND			
Manganese (Total)	ug/L	*10*	*50*		4		ND		9		ND			
Mercury	ug/L	*0.5*	*2*	ND	0.1		0.1	0.23	1.5		0.2	1.2	ND	**4.4**
Molybdenum	ug/L	*1*	*1000*		5.7		3.1		2.8		3.4			
Nickel	ug/L	*10*	*100*		4.9		2.8		3.3		2.7			
Selenium	ug/L	*2*	*50*		1.1		1.3		0.8		1.9			
Strontium (Total)	ug/L	*5*			204		224		220		209			
Uranium (by ICP/MS)	ug/L	*1*	*30*								1.2			
Vanadium (Total)	ug/L	*1*	*1000*		< 0.5		0.6		ND		1.6			
Zinc (Total)	ug/L	*10*	*5000*		31		12		ND		13			
Miscellaneous														
Ammonia-N	mg/L	*0.05*			ND		ND		ND		0.02			
Boron	mg/L	*0.05*			< 0.05		ND		ND		ND			
Chloramines	mg/L	*0.05*		ND	ND	< 0.05	ND		0.06	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*		3.62±1.10		1.72±1.84		2.27±1.17		1.71±1.82			
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND		ND		ND			
Methane	ug/L	*0.1*			0.43		0.71		1.4		0.19			
o-Phosphate-P	mg/L	*0.05*			0.1		0.1		ND		0.1			
Phosphorous (Total)	mg/L	*0.03*			0.23		0.06		0.08		0.19			
Radium 226	pCi/L		*3*		0.422±0.180		0.162±0.169		0.257±0.147		0.249±0.162			
Organic Analyses														
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	3	11	15	3	18	25	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*			1.4		1.2		1		1			
Organic Carbon (Total)	mg/L	*0.2*			1.3		1.3		1.5		1			
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	6	16	50	54	32	54	75	36	11	ND	ND
Field Parameters														
Temperature	^{0}C	*0.1*		18.82	18.2	18.24	17.94							
Specific Conductance (EC)	uS	*1.0*	*900*	487	493	528	518							
pH	Std Units	*0.1*	*6.5 - 8.5*	7.3	7.2	7.31	7.38							
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	0.01	0.04	0.04	0.16							
H_2S	mg/L	*0.1*		Lo-ND	Lo-ND	Lo-ND	Lo-ND							
ORP	mV	*1*		72.1	178.8	401	519.1							
Dissolved Oxygen	mg/L	*0.01*		3.29	0.38	0.01	0.47							

Notes:
Constituents exceeding MCLs denoted in **BOLD** type

Table 14. Summary of Water Quality Data – SMS Deep

Parameter	Unit	PQL	MCL	Results SMS Deep 10/21/19	12/2/19	12/18/19	1/6/20	2/21/20	4/21/20	5/27/20	6/30/20	7/29/20	8/25/20	9/22/20
		Sample Description		WY 2019 Storage		WY 2020 Injection				WY 2020 Storage				
Elapsed Storage Time	Days			**143**	**185**	**NA**	**NA**	**NA**	**NA**	**25**	**59**	**88**	**115**	**143**
Major Cations														
Calcium	mg/L	*0.5*			43		41		43		43			
Magnesium	mg/L	*0.5*			11.8		12.6		12.8		12.6			
Potasium	mg/L	*0.5*			2.6		2.9		3		2.8			
Sodium	mg/L	*0.5*			40		42		46		44			
Major Anions														
Alkalinity, Total (as CaCO3)	mg/L	*2*			143		125		142		149			
Chloride	mg/L	*1*	*250*	28.5	29.7		33	31.4	31.6	31.6	30.2	31.8	35.4	34.6
Sulfate	mg/L	*1*	*250*		64		68		67		65			
Nitrate (as N)	mg/L	*1*	*10*		0.2		0.1		0.1		0.2			
General Physical														
pH	Std Units				8.3		7.6		7.8		8			
Specific Conductance (EC)	uS	*1*	*900*		517		504		507		510			
Total Dissolved Solids	mg/L	*10*	*500*		274		284		310		312			
Metals														
Arsenic (Total)	ug/L	*1*	*10*		3.5		4.1		5.6		3			
Barium (Total)	ug/L	*10*	*1000*		48.1		51.4		55.6		40.5			
Iron (Dissolved)	ug/L	*10*			< 6		ND		ND		ND			
Iron (Total)	ug/L	*10*	*300*		< 6		ND		ND		ND			
Lithium	ug/L	*1*			6.1		6.1		9.7		7.2			
Manganese (Dissolved)	ug/L	*10*			< 3		ND		ND		ND			
Manganese (Total)	ug/L	*10*	*50*		< 3		ND		ND		ND			
Mercury	ug/L	*0.5*	*2*	ND	< 0.1		ND	< 0.1	0.1		ND	0.3	ND	ND
Molybdenum	ug/L	*1*	*1000*		10.3		11.3		7.8		5.2			
Nickel	ug/L	*10*	*100*		3.8		3.2		1.6		2.1			
Selenium	ug/L	*2*	*50*		3.3		3.9		5.6		3.2			
Strontium (Total)	ug/L	*5*			228		241		234		229			
Uranium (by ICP/MS)	ug/L	*1*	*30*											
Vanadium (Total)	ug/L	*1*	*1000*		0.8		0.9		1.1		1.9			
Zinc (Total)	ug/L	*10*	*5000*		83		90		45		60			
Miscellaneous														
Ammonia-N	mg/L	*0.05*			ND		ND		ND		0.02			
Boron	mg/L	*0.05*			< 0.05		ND		ND		ND			
Chloramines	mg/L	*0.05*		ND	ND		ND	< 0.05	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*		2.28±1.90		2.16±1.97		2.35±1.12		3.34±0.813			
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND		ND		ND			
Methane	ug/L	*0.1*			0.99		0.99		1.1		1.1			
o-Phosphate-P	mg/L	*0.05*			0.1		0.2		0.2		ND			
Phosphorous (Total)	mg/L	*0.03*			0.19		0.21		0.21		0.17			
Radium 226	pCi/L		*3*		0.165±0.119		0.090±0.153		0.128±0.118		0.099±0.130			
Organic Analyses														
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	2	3	17	15	18	7	ND	1	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*			1.4		1.2		1		1			
Organic Carbon (Total)	mg/L	*0.2*			1.3		1.4		1.3		1.1			
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	**89**	48	39	61	78	70	67	63	67	45	36
Field Parameters														
Temperature	^{0}C	*0.1*		17.15	16.9	17.27	17.41							
Specific Conductance (EC)	uS	*1.0*	*900*	501	502	512	517							
pH	Std Units	*0.1*	*6.5 - 8.5*	7.36	7.25	7.5	7.49							
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	0.03	0.01	0.57	0.07							
H_2S	mg/L	*0.1*		Lo-ND	Lo-ND	Lo-ND	Lo-ND							
ORP	mV	*1*		226.1	218.2	545.9	484.7							
Dissolved Oxygen	mg/L	*0.01*		3.38	1.85	1.98	0.05							

Notes:
Constituents exceeding MCLs denoted in **BOLD** type

Table 15. Summary of Water Quality Data – Off-Site Monitoring Wells

Parameter	Unit	PQL	MCL	Results		Results	
				Paralta		PCA-E Deep	
				12/12/19	5/29/20	9/16/19	9/17/20
		ASR Operational Phase		WY 2019 Storage	WY 2020 Storage	WY 2019 Storage	WY 2020 Storage
Major Cations							
Calcium	mg/L	*0.5*		45	43	63	67
Magnesium	mg/L	*0.5*		11.7	10.9	12	14.4
Potasium	mg/L	*0.5*		3.4	3	4.3	5.4
Sodium	mg/L	*0.5*		60	50	92	122
Major Anions							
Alkalinity, Total (as CaCO3)	mg/L	*2*		140	159	211	216
Chloride	mg/L	*1*	*250*	66.6	53.8	123	124
Sulfate	mg/L	*1*	*250*	66	65	36	38
Nitrate (as N)	mg/L	*1*	*10*	0.3	0.2	ND	ND
General Physical							
pH	Std Units			7.6	7.5	7.6	7.7
Specific Conductance (EC)	uS	*1*	*900*	596	572	853	858
Total Dissolved Solids	mg/L	*10*	*500*	324	370	480	510
Metals							
Arsenic (Total)	ug/L	*1*	*10*	3.3	3		3.5
Barium (Total)	ug/L	*10*	*1000*	47	41.3	105	121
Iron (Dissolved)	ug/L	*10*		12	13	74	12
Iron (Total)	ug/L	*10*	*300*	19	37	96	177
Lithium	ug/L	*1*		14.6	17.2		31.5
Manganese (Dissolved)	ug/L	*10*		6	11	171	322
Manganese (Total)	ug/L	*10*	*50*	6	11	176	333
Mercury	ug/L	*0.5*	*2*	< 0.1	ND		ND
Molybdenum	ug/L	*1*	*1000*	14.8	14.6		11.3
Nickel	ug/L	*10*	*100*	1.7	1		8.4
Selenium	ug/L	*2*	*50*	1.5	1.7		0.7
Strontium (Total)	ug/L	*5*		226	245		350
Uranium (by ICP/MS)	ug/L	*1*	*30*				
Vanadium (Total)	ug/L	*1*	*1000*	1.6	1.5		ND
Zinc (Total)	ug/L	*10*	*5000*	< 10	ND		ND
Miscellaneous							
Ammonia-N	mg/L	*0.05*		0.11	ND	ND	ND
Boron	mg/L	*0.05*		0.06	0.06	0.11	0.13
Chloramines	mg/L	*0.05*		ND	ND		ND
Gross Alpha	pCi/L		*15*	0.765±0.505	**28.6±4.23**		2.04±2.15
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND	ND		ND
Methane	ug/L	*0.1*		1.7	1.9		2.3
o-Phosphate-P	mg/L	*0.05*		< 0.0	ND	ND	ND
Phosphorous (Total)	mg/L	*0.03*		0.05	0.04		0.02
Radium 226	pCi/L		*3*	0.187±0.120	0.154±0.154		0.226±0.184
Organic Analyses							
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	2	ND		ND
Organic Carbon (Dissolved)	mg/L	*0.2*		1	0.9		0.5
Organic Carbon (Total)	mg/L	*0.2*		0.9	0.9	0.6	0.6
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	10	13		ND
Field Parameters							
Temperature	^{0}C	*0.1*		22.33			
Specific Conductance (EC)	uS	*1.0*	*900*	873			
pH	Std Units	*0.1*	*6.5 - 8.5*	7.26			
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	0.05			
H_2S	mg/L	*0.1*		Lo-ND			
ORP	mV	*1*		-23			
Dissolved Oxygen	mg/L	*0.01*		0.67			

Notes:

Constituents exceeding MCLs denoted in **BOLD** type

PCA-E is located on Seaside High School property and in May 2020 the school was not allowing persons non-essential to school function on school grounds due to COVID-19.

- ASR-1 (**Figure 19**): After the conclusion of the WY 2020 injection season, ASR-1 showed modest ingrowth of THMs to 53 micrograms per liter (ug/L) after 25 days, followed by a steady decline after 143 days of storage to 15 mg/L; it is noted, however, that no injection occurred at ASR-1 during WY 2020 and was essentially operated as a monitoring well and was influenced by the approximate 502 af of injection that occurred at ASR-2.
- ASR-2 (**Figure 20**): Two samples were collected at ASR-2 during the storage period, which showed ingrowth of THMs over a period of 26 days reaching a peak level of 79 ug/L, just below the MCL, followed by a decline after 60 days of storage to a level of 68 ug/L.
- ASR-3 (**Figure 21**): Four samples were collected at ASR-3 on an approximate monthly basis during the storage period, which showed ingrowth of THMs approaching the MCL within a period of 25 days reaching a level of 72 ug/L, followed by a decline after 143 days of storage to a level of 53 ug/L.
- ASR-4 (**Figure 22**): Five samples were collected at ASR-4 on an approximate monthly basis during the storage period, which also showed somewhat uneven ingrowth of THMs over a period of 115 days reaching a maximum level of 79 ug/L, followed by decline after 143 days of storage to a level of 60 ug/L.
- SM MW-1 (**Figure 23**): Five samples were collected at MW-1 during the storage period, which showed initial ingrowth of THMs over a period of 25 days reaching a peak level of 75 ug/L, followed by a steady decline reaching non-detect levels after 115 days of storage.
- SMS Deep (**Figure 24**): Five samples were collected at SMS Deep on an approximate monthly basis during the storage period, which showed ingrowth of THMs over a period of 88 days reaching a level of 67 ug/L, followed by a decline after 143 days of storage to a level of 36 ug/L.

Historically, THMs at the ASR wells typically show an initial and significant ingrowth during the storage period, which is a result of reactions between free chlorine and trace levels of organic compounds in the injected water and/or the aquifer matrix. THM ingrowth typically peaks in concentration approximately 30 to 90 days after the cessation of injection, followed by a gradual decline during the remainder of the storage period. After approximately 120 to 180 days of storage, THMs typically degrade to below the MCL (or even the initial injection levels in most cases). It is noted that evidence from historical ASR well operations in the SGB, as well as other ASR facilities, suggests that the onset of THM degradation does not commence until anoxic/anaerobic redox conditions occur within the aquifer.

As described above and shown on **Figures 19 through 24**, the results during WY 2020 generally followed this historically observed pattern, with THM ingrowth generally peaking in concentration after approximately 30 days of storage, followed by a gradual decline during the remainder of the water year.

HAA levels at the well also generally showed their typical pattern of limited (if any) ingrowth during the initial storage period, followed by complete to near-complete degradation by the end of the storage season. Unlike THM's, HAA compounds are known to degrade under aerobic redox conditions, which are already present in the oxygenated and chlorinated recharge water. In addition, HAA's are much less stable compounds than THM's; therefore, their significant degradation is to be expected.

Water Quality at Off-Site Monitoring Wells

Water-quality data collected from the Paralta and PCA-E Deep off-site monitoring wells in WY 2020 are presented in **Table 15**. As shown, at PCA-E Deep the absence of DBP's and the consistent and high level of chloride ion during the period suggest that this area is comprised of intact NGW, and the influence of recharge operations is negligible to date at this location. Paralta is the nearest CAW production well to the ASR wells, and it displayed TTHM levels of 10 and 13 ug/L at the beginning of the injection and storage periods, respectively, reflecting the influence of injectate from the nearby ASR wells.

Hg Investigation

As discussed in several recent annual Summary of Operations Reports (SORs), at the commencement of WY 2013 recovery pumping of ASR-1, a sample collected by CAW[8] had a Mercury (Hg) concentration of 4 µg/L, exceeding the State MCL of 2 µg/L. Hg is a member of the family of elements known as Transition Metals, which also includes Iron (Fe), Zinc (Zn), Copper, (Cu), and Cadmium (Cd); the family of transition metals have similar chemical and reactive characteristics, and often react with one another under varying redox and geochemical conditions. The fact that detectable Hg was identified, and at levels above historical NGW and injectate concentrations, led to the development of an ongoing investigation of Hg occurrence at the 4 ASR wells.

Discussion of the possible mechanisms causing sporadic Hg detections at the ASR project wells, and the various steps in the investigation that have been implemented to date, have been presented in previous SORs and will not be repeated here; however, as described in the most recent WY 2019 SOR, a protocol has recently been developed for sampling of backflushing discharge waters and sludge from the ASR wells, and to collect and analyze stored water samples for Transition Metals and related parameters (ORP, DO, Cl, and pH). The protocol consists of monitoring raw water concentrations for Hg, and if concentrations increased to above 8 ug/L, to collect a sludge sample for analysis that would allow for speciation of the Hg that can be used for geochemical modeling of the reactions that may be occurring during the various phases of ASR operations; however, during WY 2020 all water samples collected were at less than this concentration (the only significant Hg detection during WY 2020 was at SM MW-1 on 9/22/20 with a level of 4.4 ug/L); therefore, none of the collected sludge samples were considered usable for further analysis during WY 2020.

Next Steps. Similar to the recommendations presented in the WY 2019 SOR, sampling of backflushing water and sludge during injection operations, as well as sampling purge waters and sludge during storage periods, should continue to be performed at all ASR wells on a monthly basis (as feasible). The collected water samples should be analyzed for Transition Metals and related parameters (ORP, DO, Cl, and pH). In the event that water samples contain sufficient concentrations of Hg, it is recommended that the associated sludge samples are pre-screened for elemental/bulk Hg content prior to quantitative speciation analysis. Once such speciation is confirmed, geochemical modeling can be leveraged to ascertain the specific reaction mechanism(s) resulting in mobilization.

[8] Collected on October 24, 2013.

CONCLUSIONS

Based on the findings developed from operation of Monterey Peninsula ASR Project during WY 2020, we conclude the following:

WY 2020 Recharge Operations

WY 2020 was classified as a "Normal" Water Year on the Monterey Peninsula and a modest total volume of 917 af of water was recharged into the Seaside Groundwater Basin at the Santa Margarita and Seaside Middle Schools ASR Facilities during the WY 2020 injection season.

ASR Well Performance

ASR-1. ASR-1 was non-operational during WY 2020; therefore, no well performance conclusions could be developed.

ASR-2. Pertinent well performance conclusions for ASR-2 during WY 2020 are summarized below:

- Injection Rates: Ranged between approximately 1,260 to 1,850 gpm, averaging approximately 1,490 gpm.
- Water Levels: Maintained below 250 feet bgs and did not exceed the recommended maximum drawup level of 130 feet at any time.
- Specific Injectivity: Ranged between approximately 23.7 to 25.5 gpm/ft with a slight increase (8 percent) in 24-hr specific injectivity.
- Residual Plugging: A modest amount (5.5 feet) of residual plugging occurred.
- General Conclusions: ASR-2 performed well during WY 2020, suggesting the injection rate at this well should continue to be maintained at or below the design rate of 1,500 gpm.

ASR-3. Pertinent well performance conclusions for ASR-3 during WY 2020 are summarized below:

- Injection Rates: Ranged between approximately 495 to 970 gpm, averaging approximately 740 gpm.
- Water Levels: During the limited periods of injection at this well, watrer levels were maintained below 190 feet bgs and the recommended maximum drawup level of 170 feet.

- Specific Injectivity: Ranged between approximately 16.7 to 20.0 gpm/ft and a modest decline in 24-hr specific injectivity of approximately 17 percent.

- Residual Plugging: A significant amount (149.9 feet) or residual plugging.

- General Conclusions: ASR-3 performed experienced significant residual plugging during WY 2020. The well's relatively poor performance suggests the injection rate at this well should be reduced below the previously recommended (WY 2018) rate of 1,250 gpm to 1,000 gpm.

ASR-4. Pertinent well performance conclusions for ASR-4 during WY 2020 are summarized below:

- Injection Rates: Ranged between approximately 560 to 1,500 gpm, averaging approximately 1,380 gpm.

- Water Levels: Maintained below 160 feet bgs and did not exceed the recommended maximum drawup level of 200 feet at any time.

- Specific Injectivity: Ranged between approximately 24.2 to 27.8 gpm/ft with a slight increasing trend (15%).

- Residual Plugging: No residual plugging occurred.

- General Conclusions: ASR-4 generally performed well during WY 2020, suggesting the injection rate at this well should continue to be maintained at or below the design rate of 1,500 gpm.

Water Quality

Significant conclusions regarding the water-quality investigation during WY 2020 include the following:

- Consistent with previous observations, no significant ion exchange, acid-base, or precipitation reactions were observed at the ASR sites.
- The injectate consistently had low SDI values, indicative of low particulate concentrations and associated well plugging potential.
- THMs were below the MCL of 80 ug/L at all project wells during WY 2020, and generally followed the historical pattern for the project, with ingrowth generally peaking after approximately 30 days of aquifer storage, followed by a gradual decline during the remainder of the water year.

- HAAs also showed their typical pattern of limited (if any) ingrowth during the initial storage period, followed by complete to near-complete degradation by the end of the WY 2020 storage season.

RECOMMENDATIONS

Based on the results of the WY 2020 ASR program and our experience with similar ASR projects, we offer the following recommendations for continued and future operations of the Monterey Peninsula ASR Project wells:

ASR-1 Well Operational Parameters

Since ASR-1 was non-operational during WY 2020, the recommendations provided in the WY 2019 SOR are still applicable and are as follows:

- Injection Rate: Based on the overall good performance during WY 2020, the injection rate should continue to be limited to the design rate of **1,500 gpm or less**.
- Water-Level Drawup: Under the present local water-level conditions, the amount of water-level drawup should be limited to approximately 100 feet and injection water levels should be maintained **greater than 260 feet bgs** at all times in order to limit residual plugging and maintain long-term performance.
- Backflushing Frequency: During the recharge season, routine backflushing should continue to be performed on an approximate weekly basis, or when the amount of water-level drawup in the casing reaches a depth to water level of approximately **260 feet bgs**, whichever occurs first. Backflushing should consist of the triple-flush procedure initiated in WY 2017.

ASR-2 Well Operational Parameters

- Injection Rate: Based on the performance during WY 2020, we recommend the injection rate continue to be maintained at the design rate of approximately **1,500 gpm or less**.
- Water-Level Drawup: The amount of water-level drawup should be limited to approximately 130 feet and injection water levels should be maintained **greater than 250 feet bgs** at all times in order to limit residual plugging and maintain long-term performance.
- Backflushing Frequency: During the recharge season, routine backflushing should continue to be performed on an approximate weekly basis, or when the amount of water-level drawup in the casing reaches a depth to water level of approximately **250 feet bgs**, whichever occurs first. Backflushing should consist of the triple-flush procedure initiated in WY 2017.

ASR-3 Well Operational Parameters

- Injection Rate: Based on the poor performance during WY 2020, we recommend the injection rate continue to be limited to **1,000 gpm**.
- Water-Level Drawup: The amount of water-level drawup should be limited to approximately 170 feet and injection water levels should be maintained **greater than**

190 feet bgs at all times in order to limit residual plugging and maintain long-term performance.

- Backflushing Frequency: During the recharge season, routine backflushing should continue to be performed on an approximate weekly basis, or when the amount of water-level drawup in the casing reaches a depth to water level of approximately **190 feet bgs**, whichever occurs first. Backflushing should consist of the triple-flush procedure initiated in WY 2017.

ASR-4 Well Operational Parameters

- Injection Rate: Based on the relative good performance during WY 2020, we recommend the injection rate continue to be limited to the design rate of approximately **1,500 gpm or less**.
- Water-Level Drawup: The amount of water-level drawup should be limited to approximately 200 feet and injection water levels should be maintained **greater than 160 feet bgs** at all times in order to limit residual plugging and maintain long-term performance.
- Backflushing Frequency: During the recharge season, routine backflushing should continue to be performed on an approximate weekly basis, or when the amount of water-level drawup in the casing reaches a depth to water level of approximately **160 feet bgs**, whichever occurs first. Backflushing should consist of the triple-flush procedure initiated in WY 2017.

Hg Investigation

Although the investigation was not able to be advanced during WY 2020, the investigation of the potential mechanisms of Hg solubilization and/or mobilization within the Tsm aquifer mineralogy should be continued in WY 2021. This should include the ongoing sampling of both backflushing waters during the injection season and water-quality purging/sampling during the storage periods be performed at all ASR wells on a monthly basis, including the collection and storage of associated sludge materials for potential subsequent analysis. The water samples should be analyzed for Transition Metals and related parameters (ORP, DO, Cl, and pH). Any sludge samples collected during WY 2021 associated with elevated Hg concentrations in the discharge water samples be pre-screened for elemental/bulk Hg content to determine those that contain a sufficiently high concentration of Hg/transition metals to allow quantitative speciation analysis. Once such speciation is confirmed, geochemical modeling can then be leveraged to ascertain the specific reaction mechanism(s) resulting in mobilization.

CLOSURE

This report has been prepared exclusively for the Monterey Peninsula Water Management District for the specific application to the ASR Project on the Monterey Peninsula. The findings and conclusions presented herein were prepared in accordance with generally accepted hydrogeologic and engineering practices. No other warranty, express or implied, is made.

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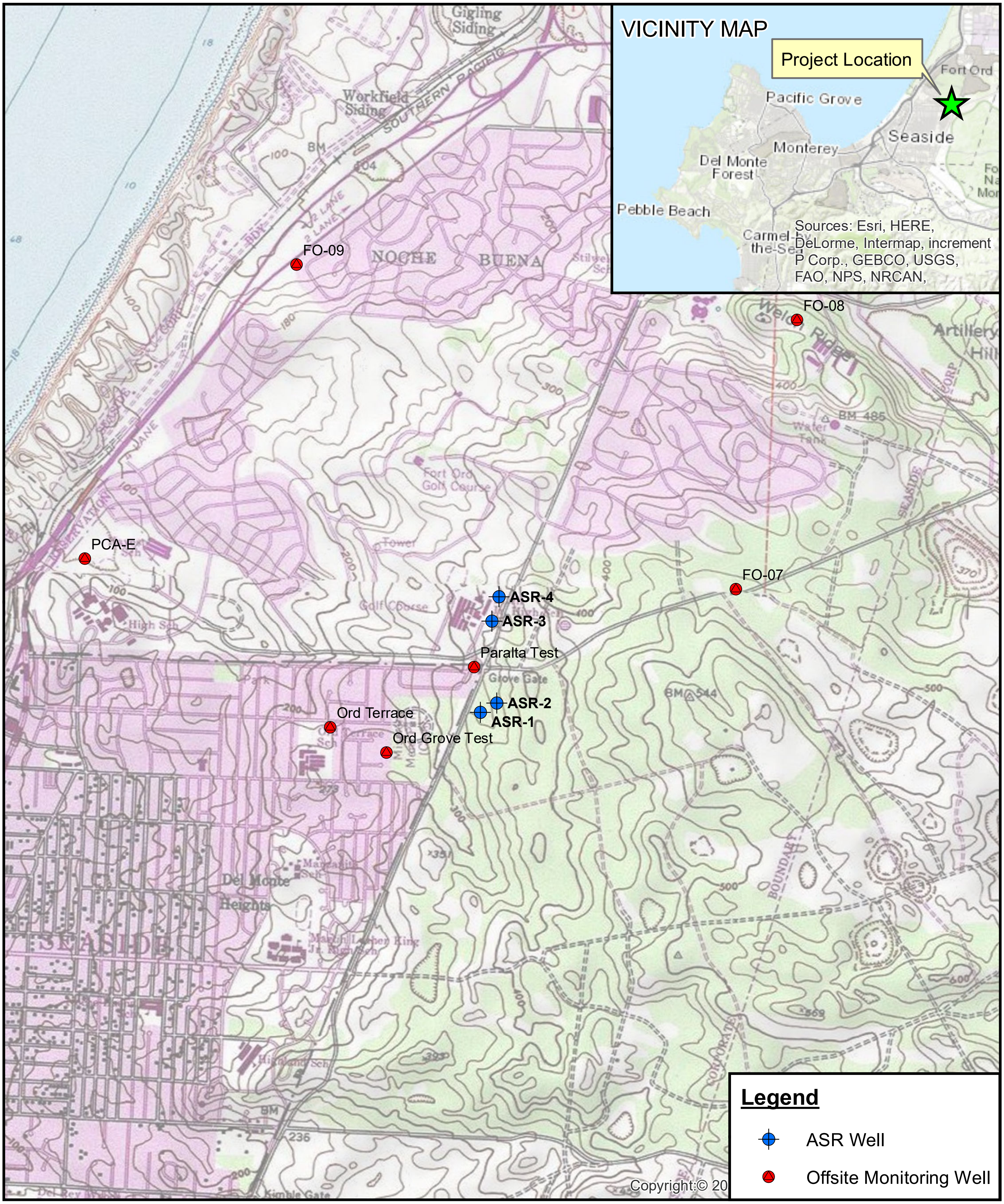
FIGURES

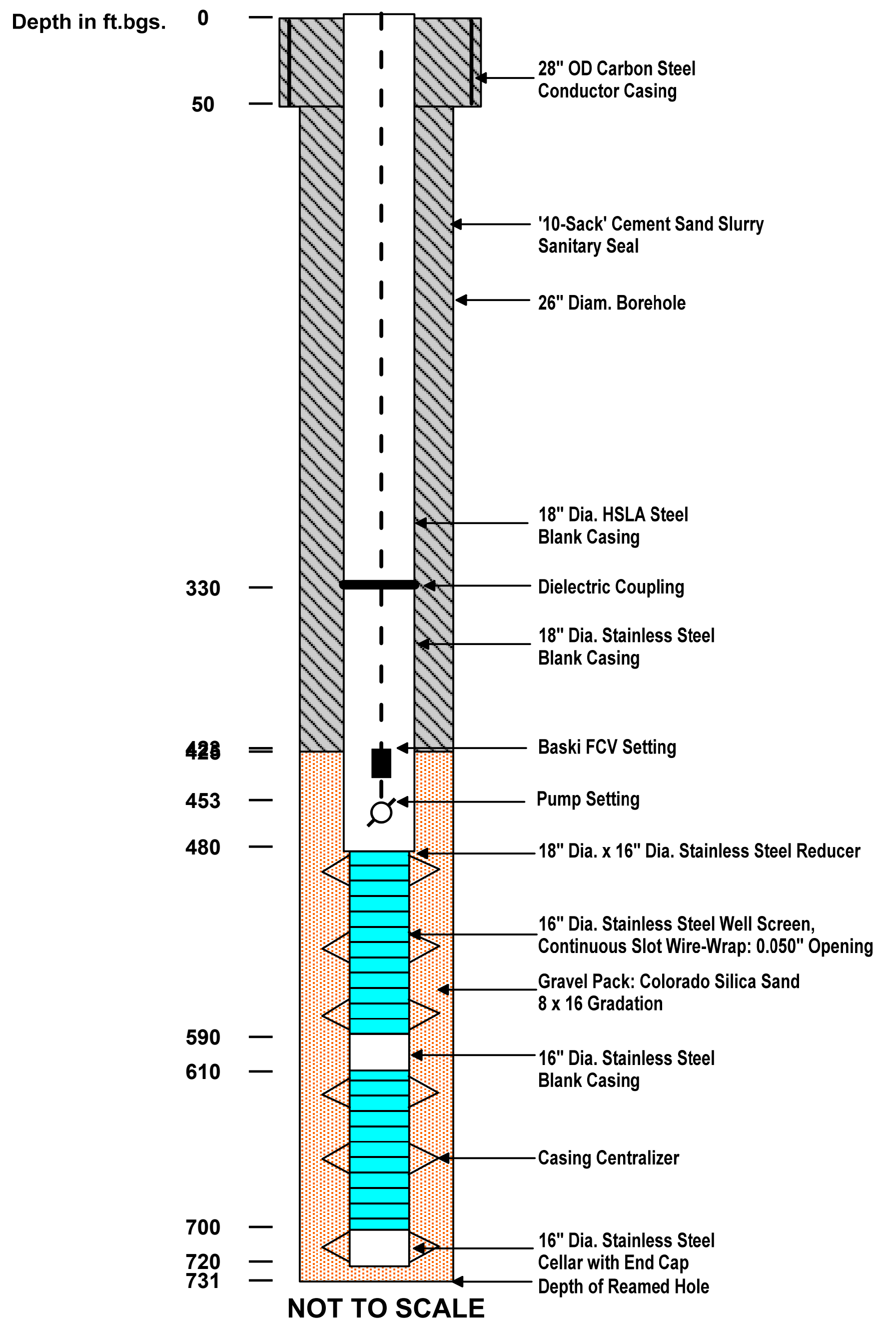
June 2021
Project No. 18-0097



PUEBLO water resources

FIGURE 1. SITE LOCATION MAP
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

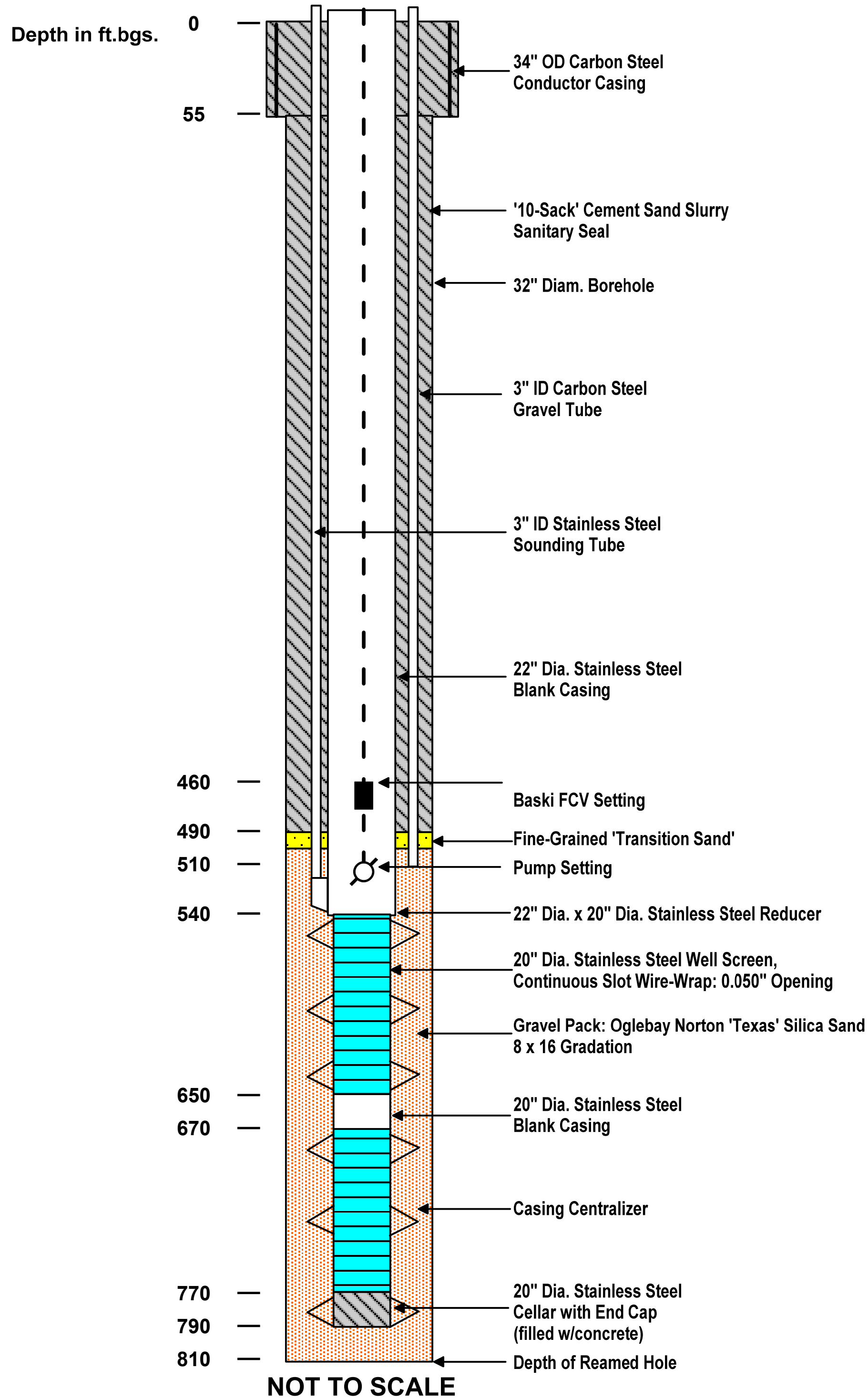


<u>Pump Assembly Notes:</u>
Hp: 600
Bowls: 16ENL, 7 stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Lube/Open Shaft
Baski FCV Setting: 423' - 433'
Top of Bowls: 453'
Bowl Length: 10.5'
Suction Length: 10'
Bottom of Intake: 473.5'

PUEBLO
water resources

FIGURE 2. ASR-1 AS-BUILT SCHEMATIC
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

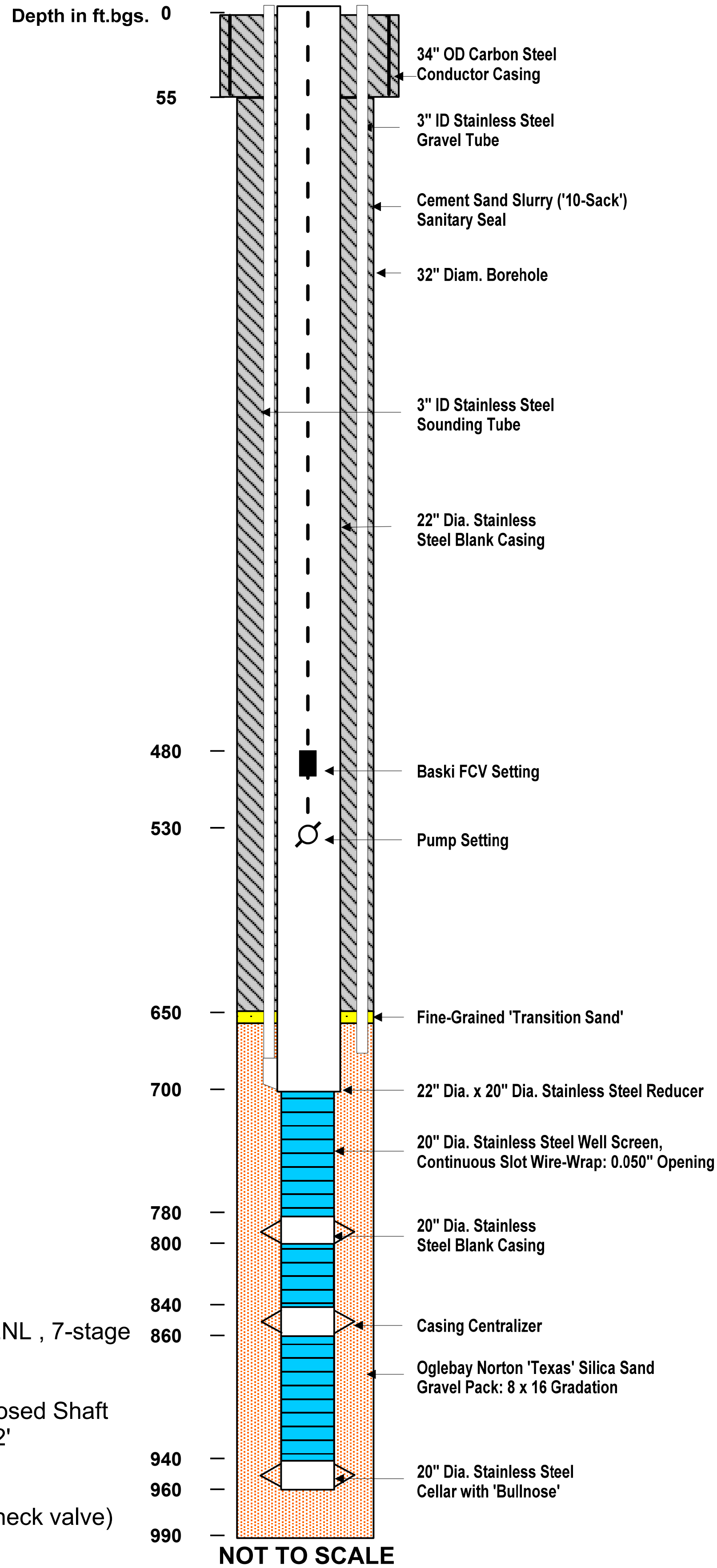


<u>Pump Assembly Notes:</u>
Hp: 600
Bowls: 16ENL, 7 stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 460' - 470'
Top of Bowls: 510'
Bowl Length: 10.5'
Suction Length: 10'
Intake: 530.5'

PUEBLO water resources

FIGURE 3. ASR-2 AS-BUILT SCHEMATIC
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

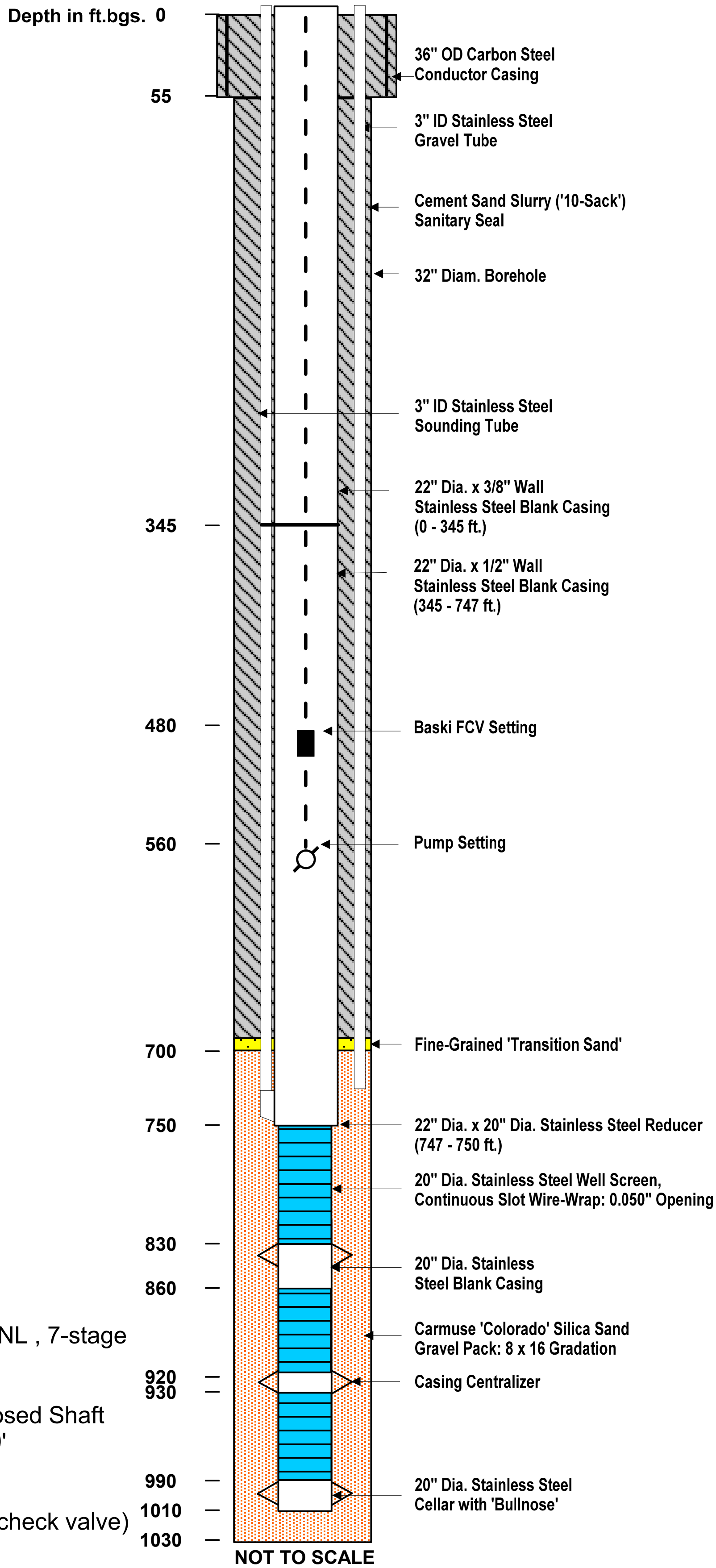


Pump Assembly Notes:
Hp: 600
Bowls: Flowserve Model 16 ENL , 7-stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 482' to 492'
Top of Bowls: 532'
Bowl Length: 10.5'
Suction Length: 8'(including check valve)
Intake: 550.5'

PUEBLO water resources

FIGURE 4. ASR-3 AS-BUILT SCHEMATIC
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097



Pump Assembly Notes:
Hp: 600
Bowls: Flowserve Model 16 ENL , 7-stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 480' to 490'
Top of Bowls: 562'
Bowl Length: 10.4'
Suction Length: 10' (including check valve)
Intake: 582.4'

PUEBLO water resources

FIGURE 5. ASR-4 AS-BUILT SCHEMATIC
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

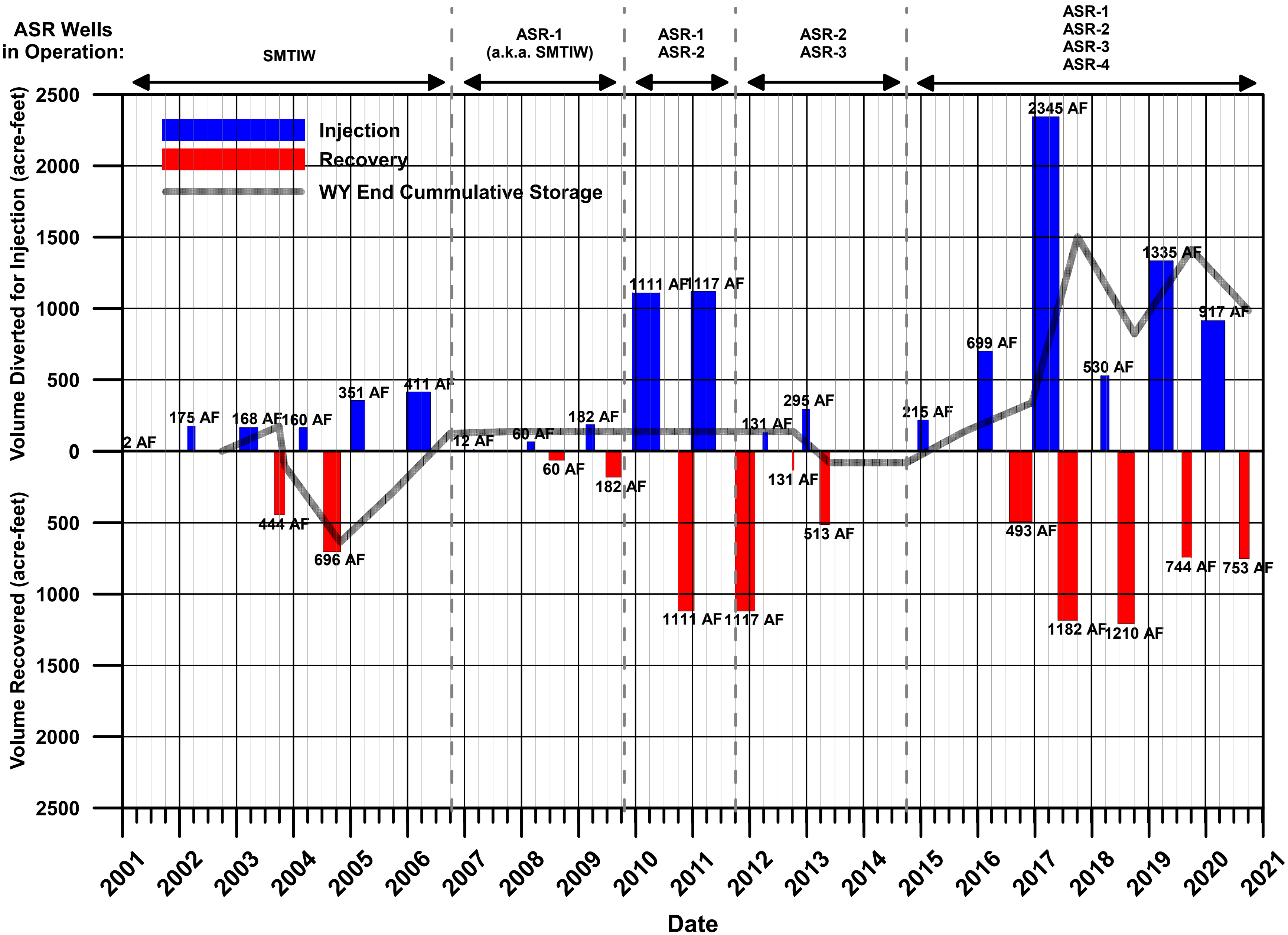


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FIGURE 6. SUMMARY OF ASR OPERATIONS (WY 2001 - WY 2020)
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

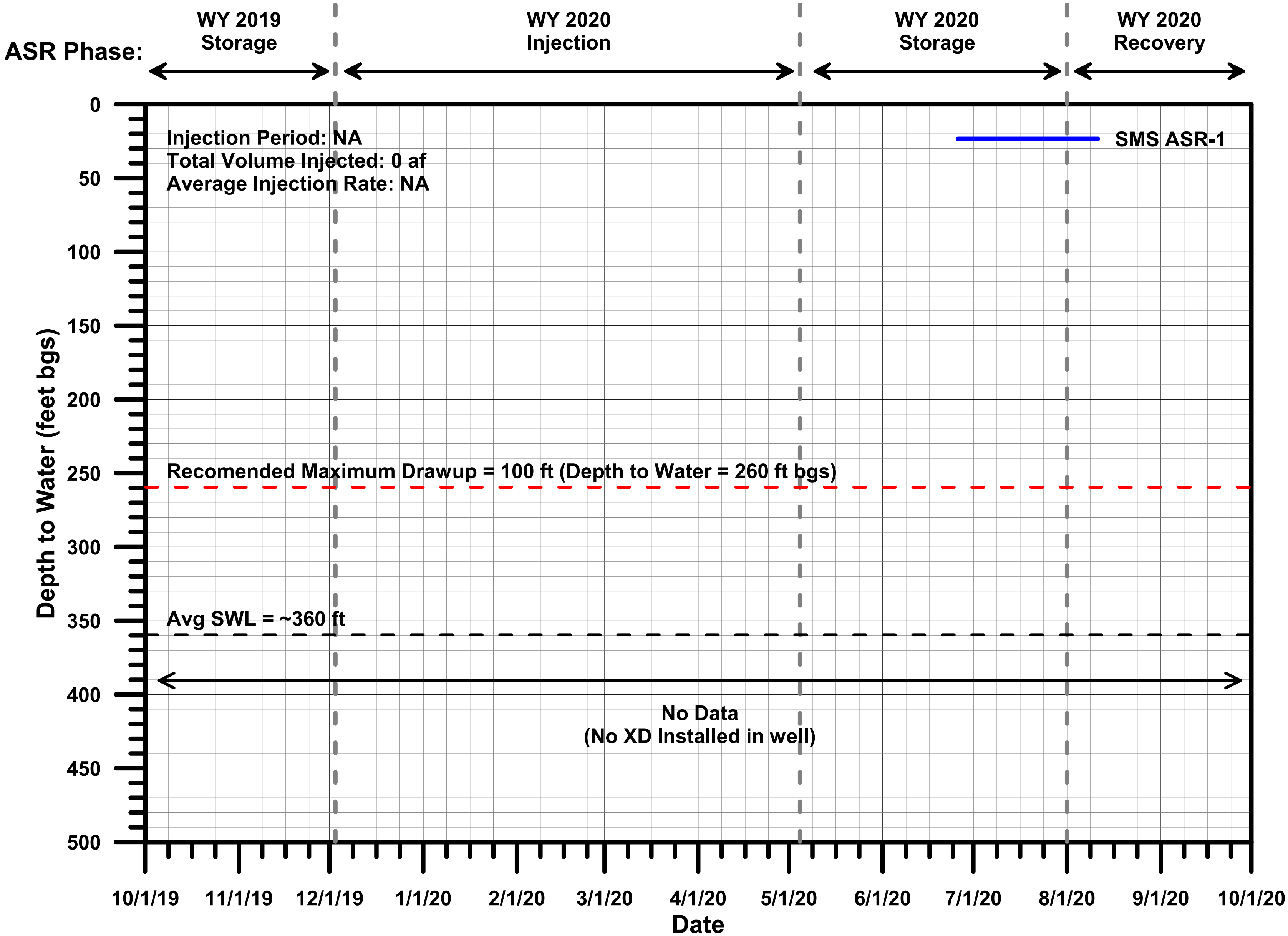

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FIGURE 7. ASR-1 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

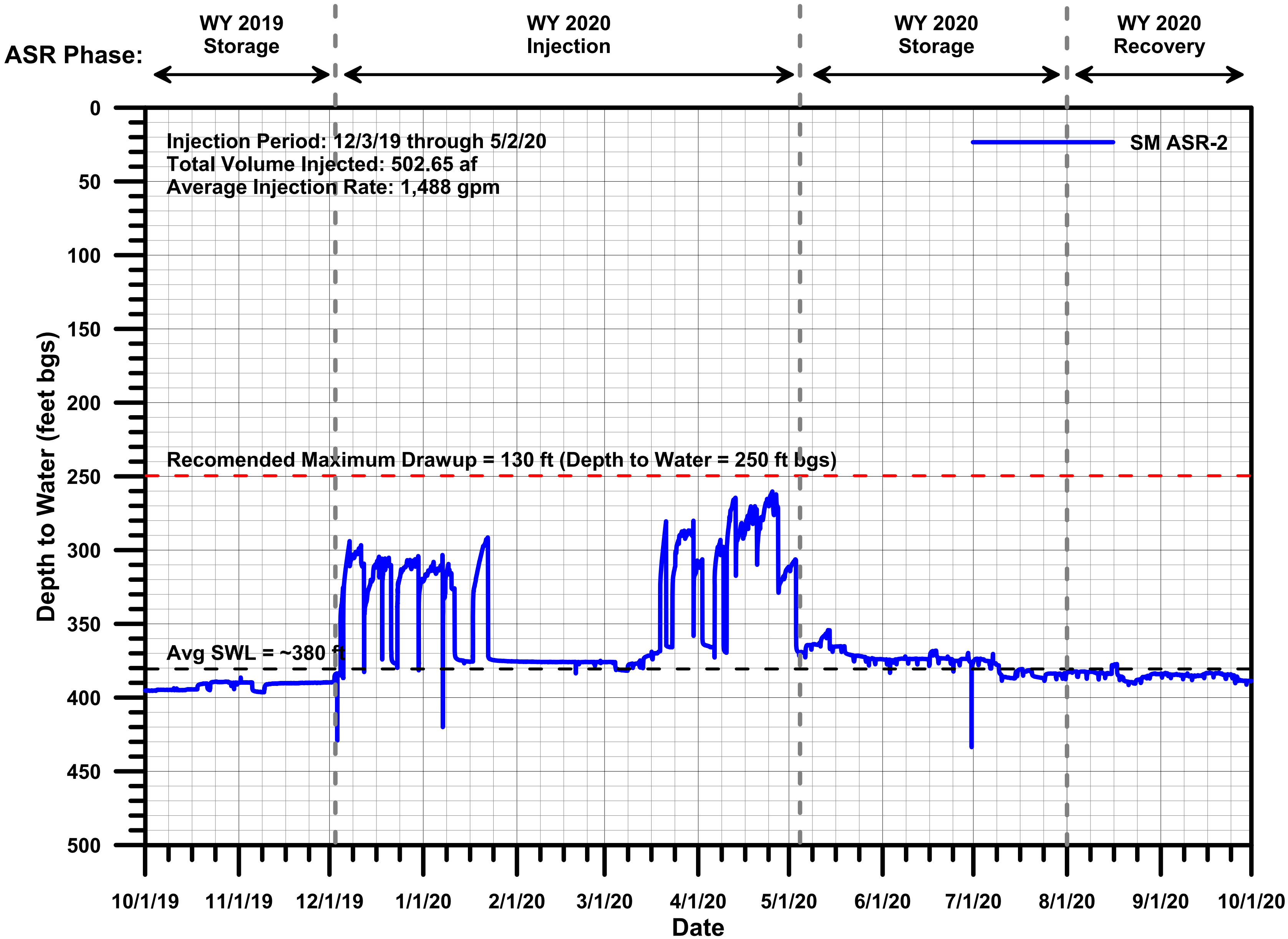

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FIGURE 8. ASR-2 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

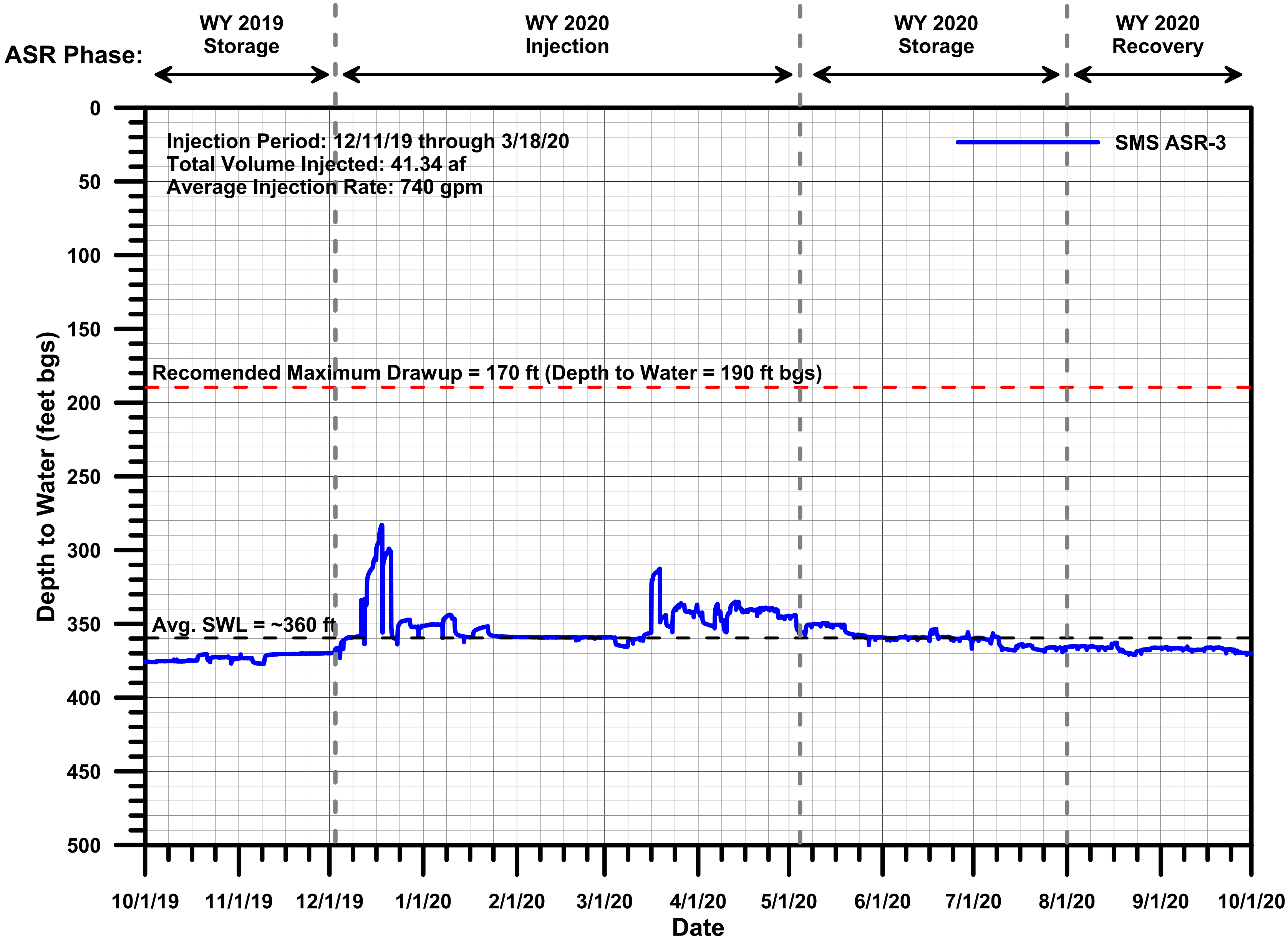

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FIGURE 9. ASR-3 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

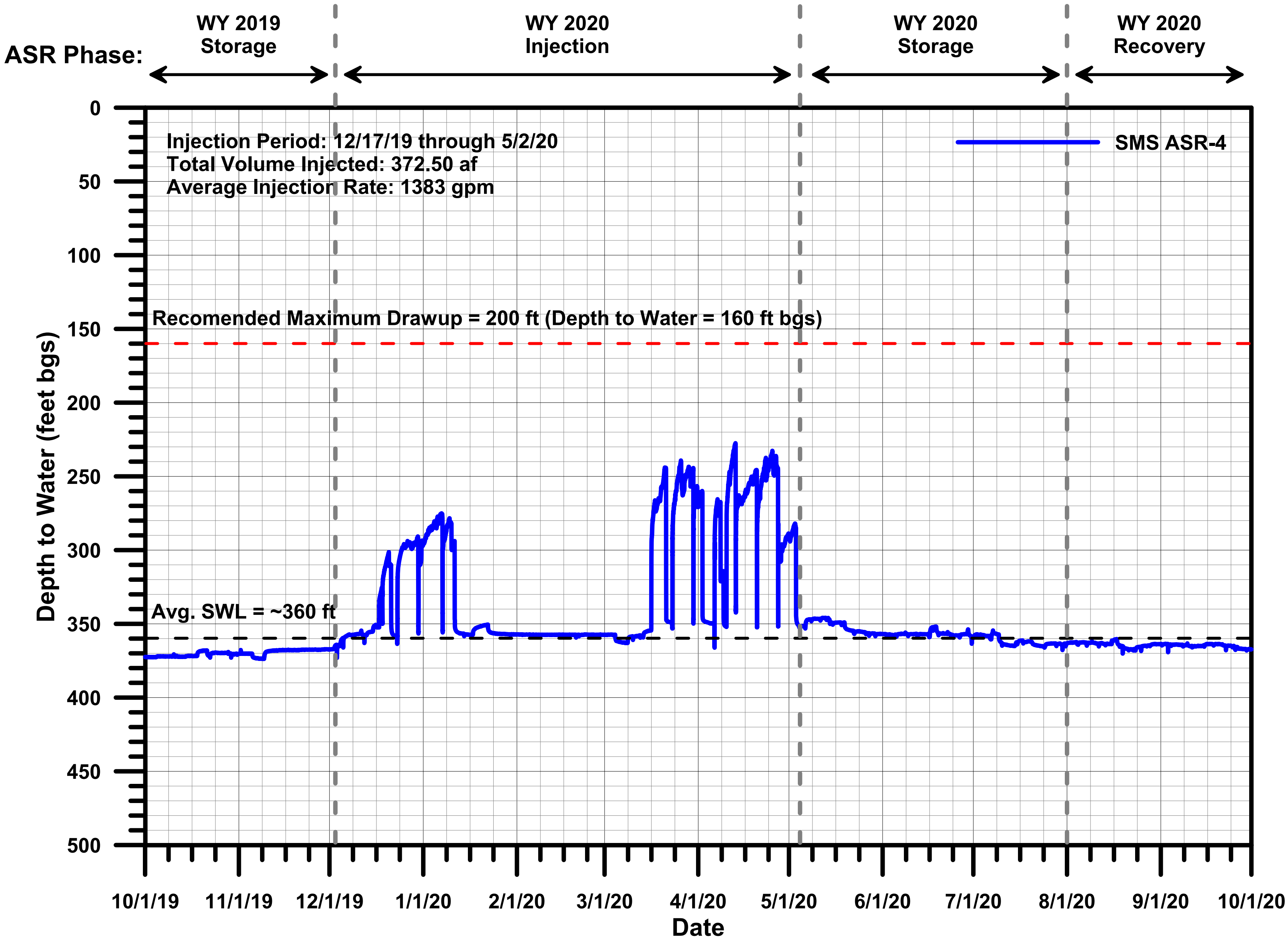

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FIGURE 10. ASR-4 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

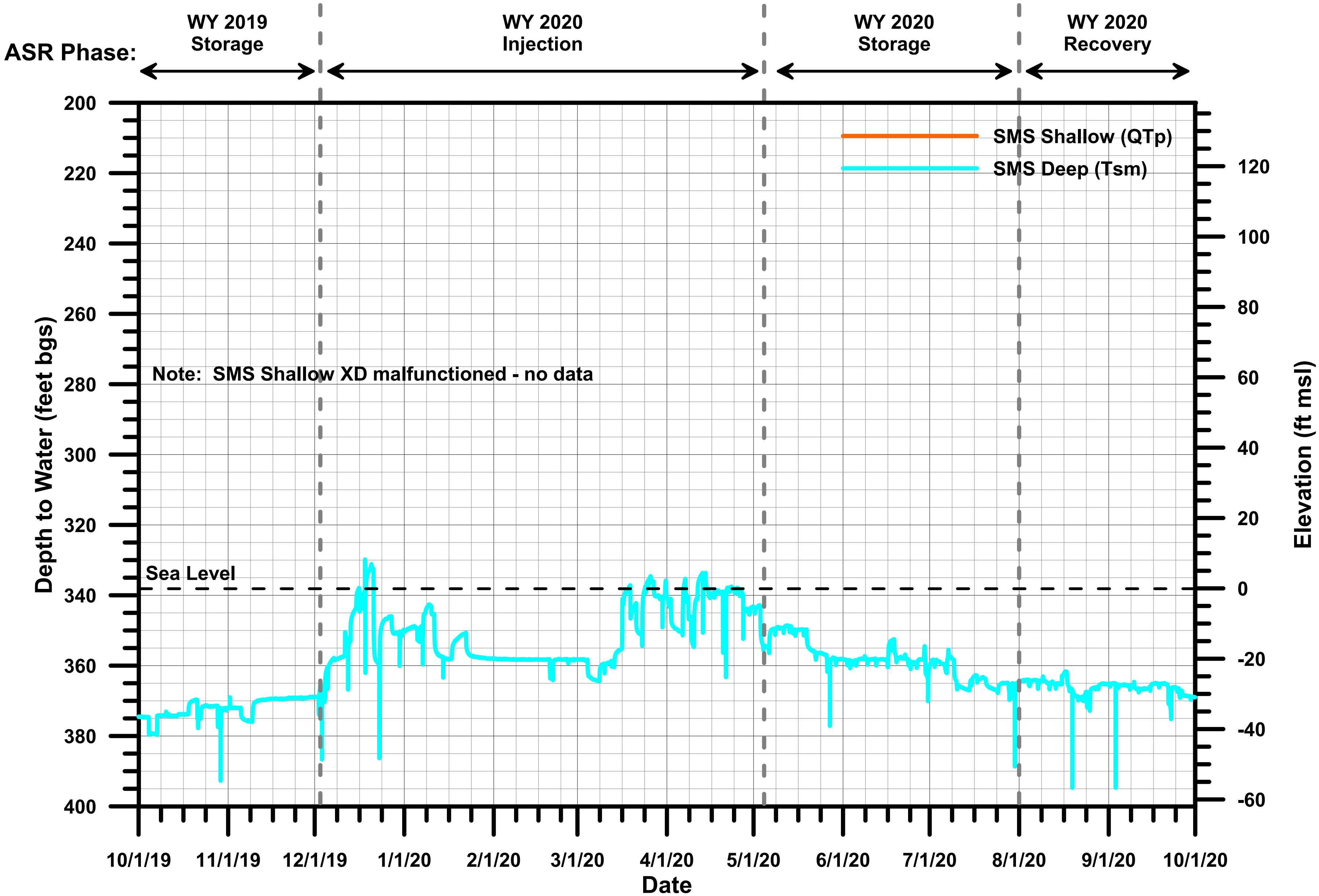

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FIGURE 11. SMS MW WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

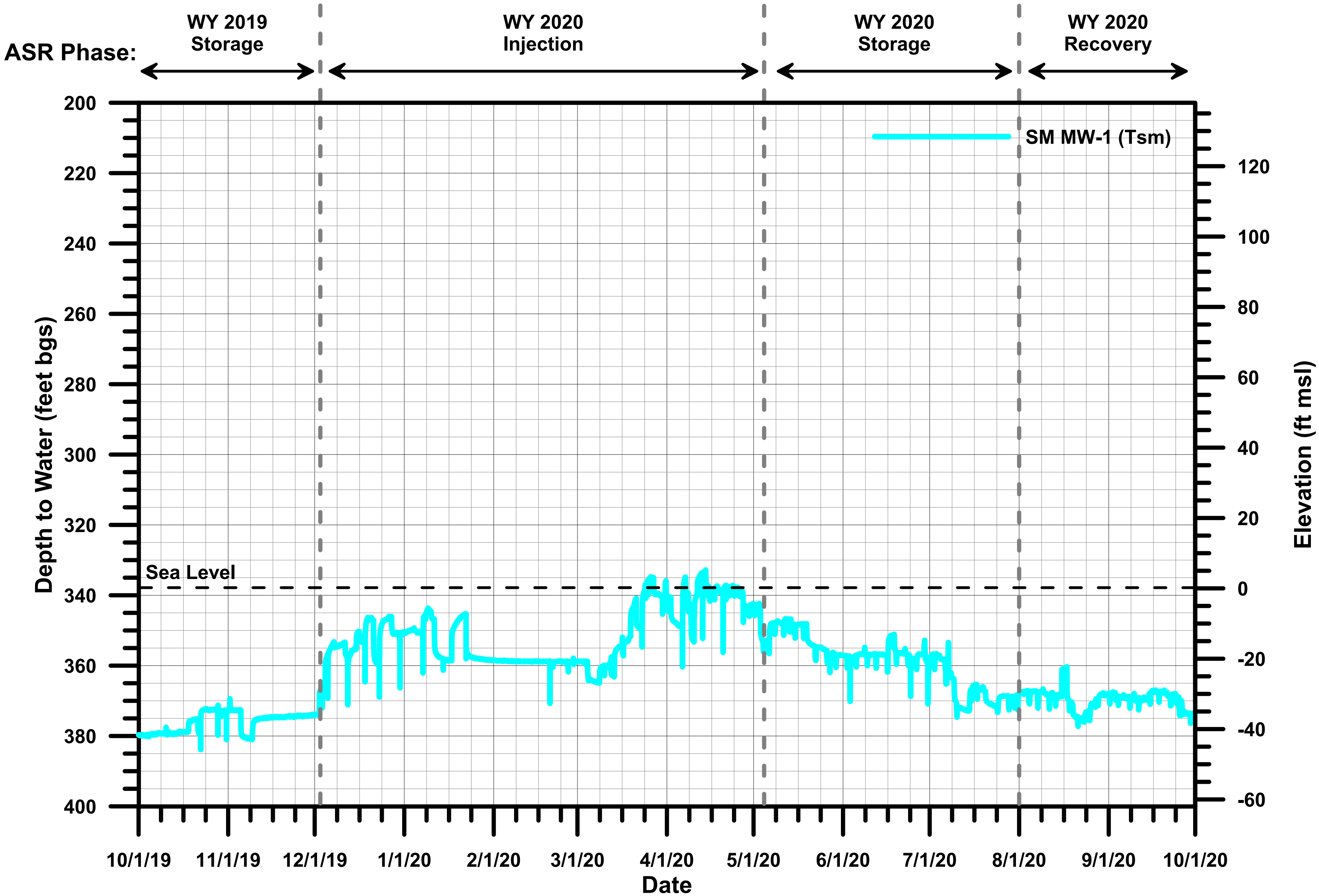

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FIGURE 12. SM MW-1 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

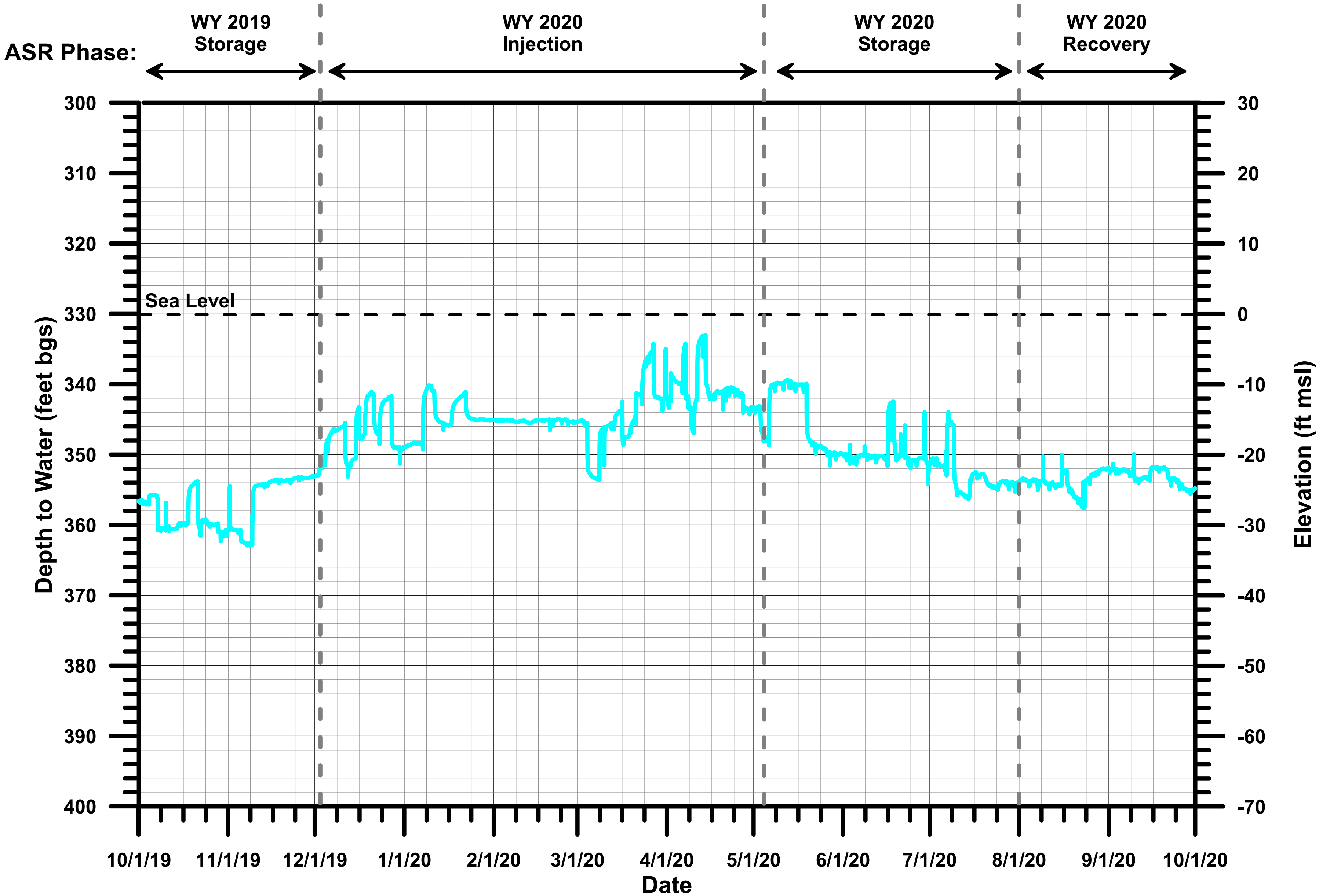

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FIGURE 13. PARALTA TEST WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

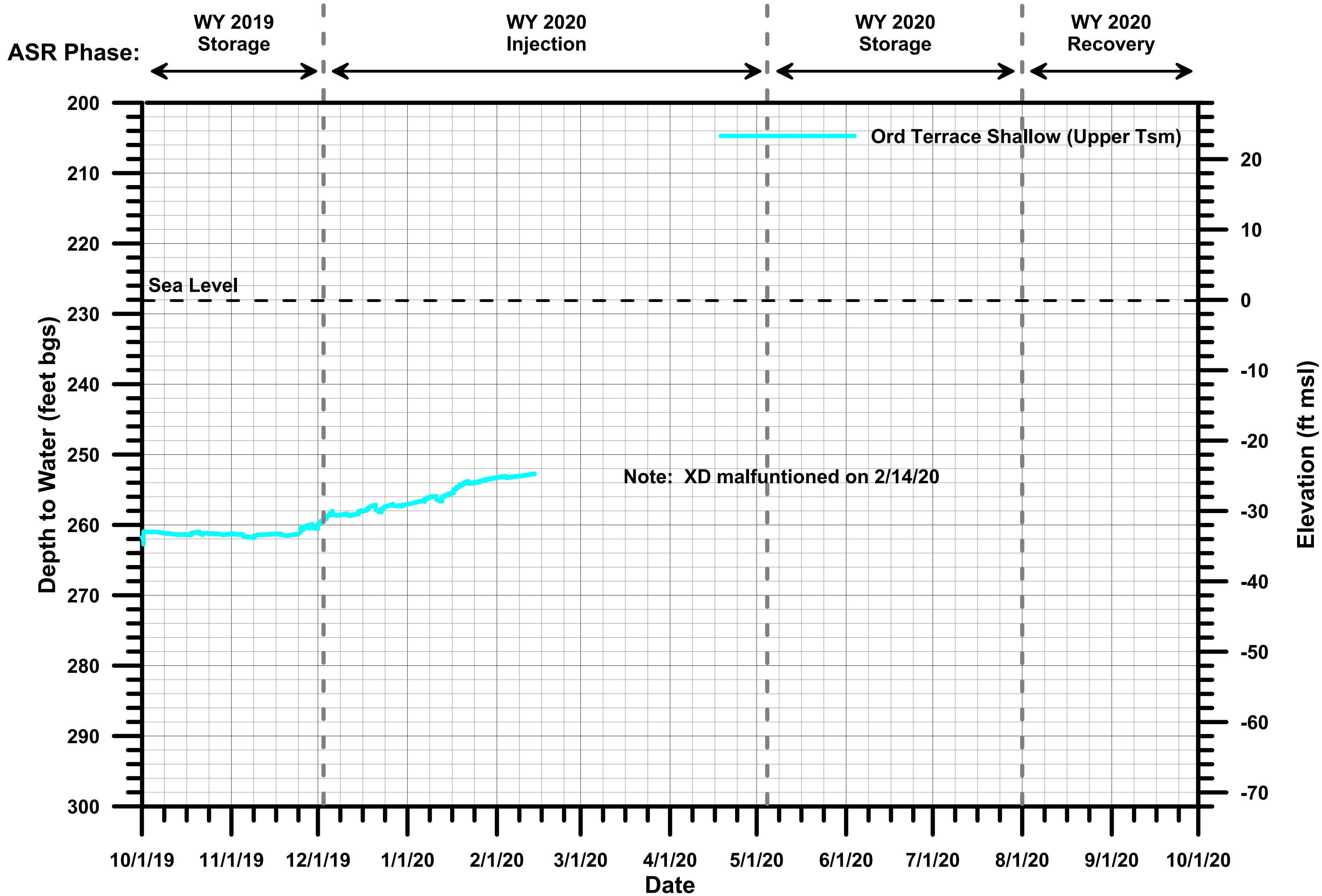

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FIGURE 14. ORD TERRACE WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

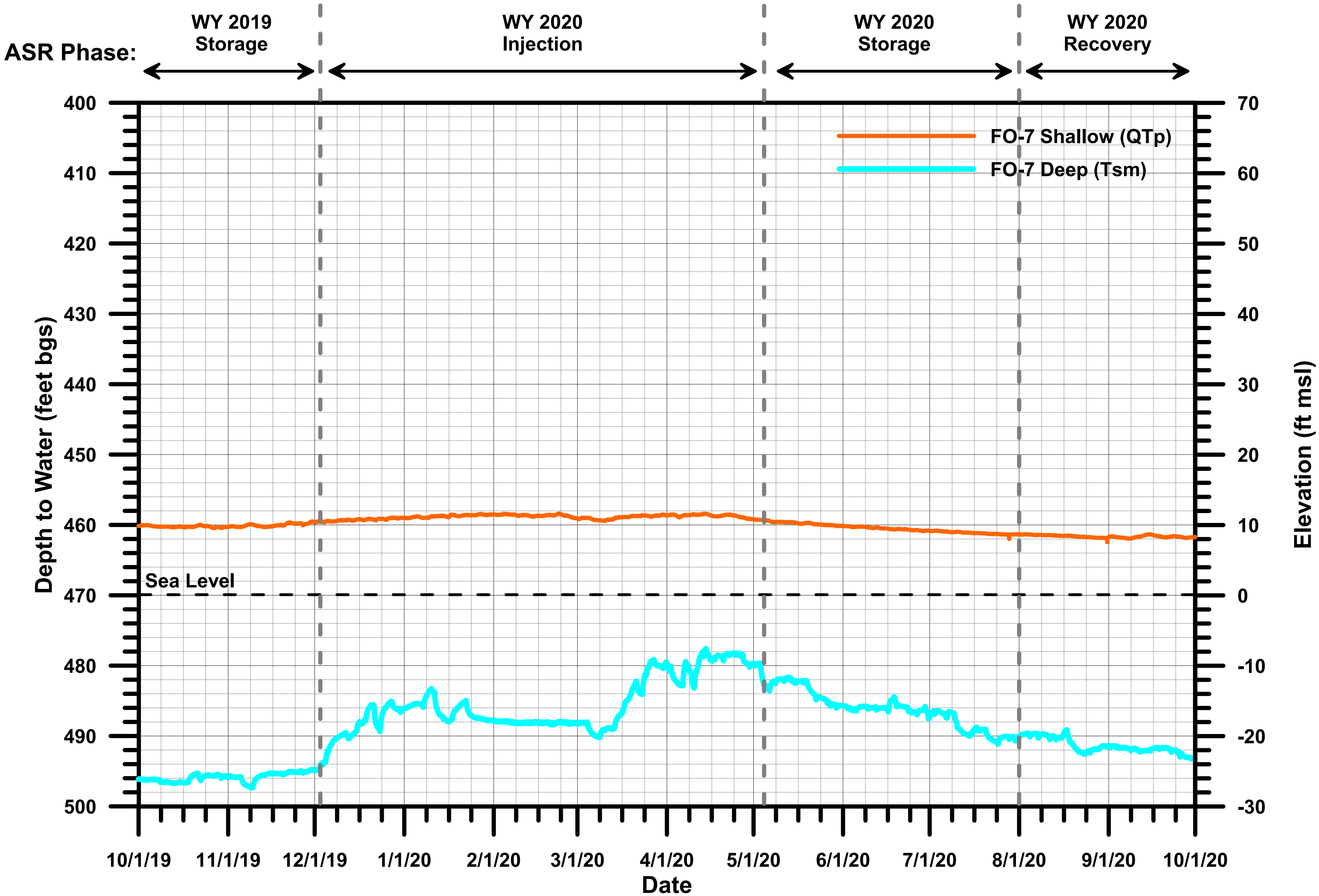

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FIGURE 15. FO-7 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

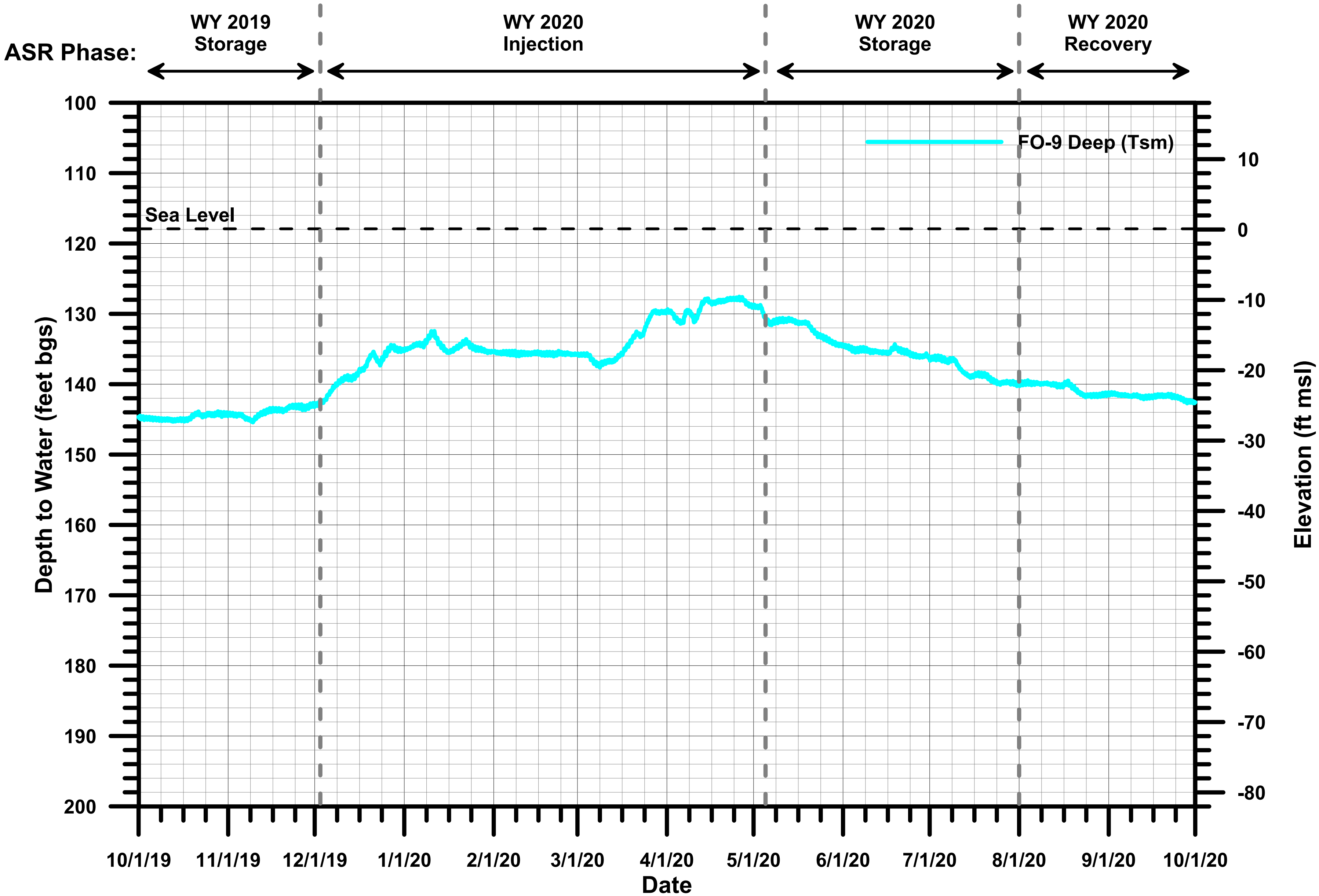

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FIGURE 16. FO-9 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

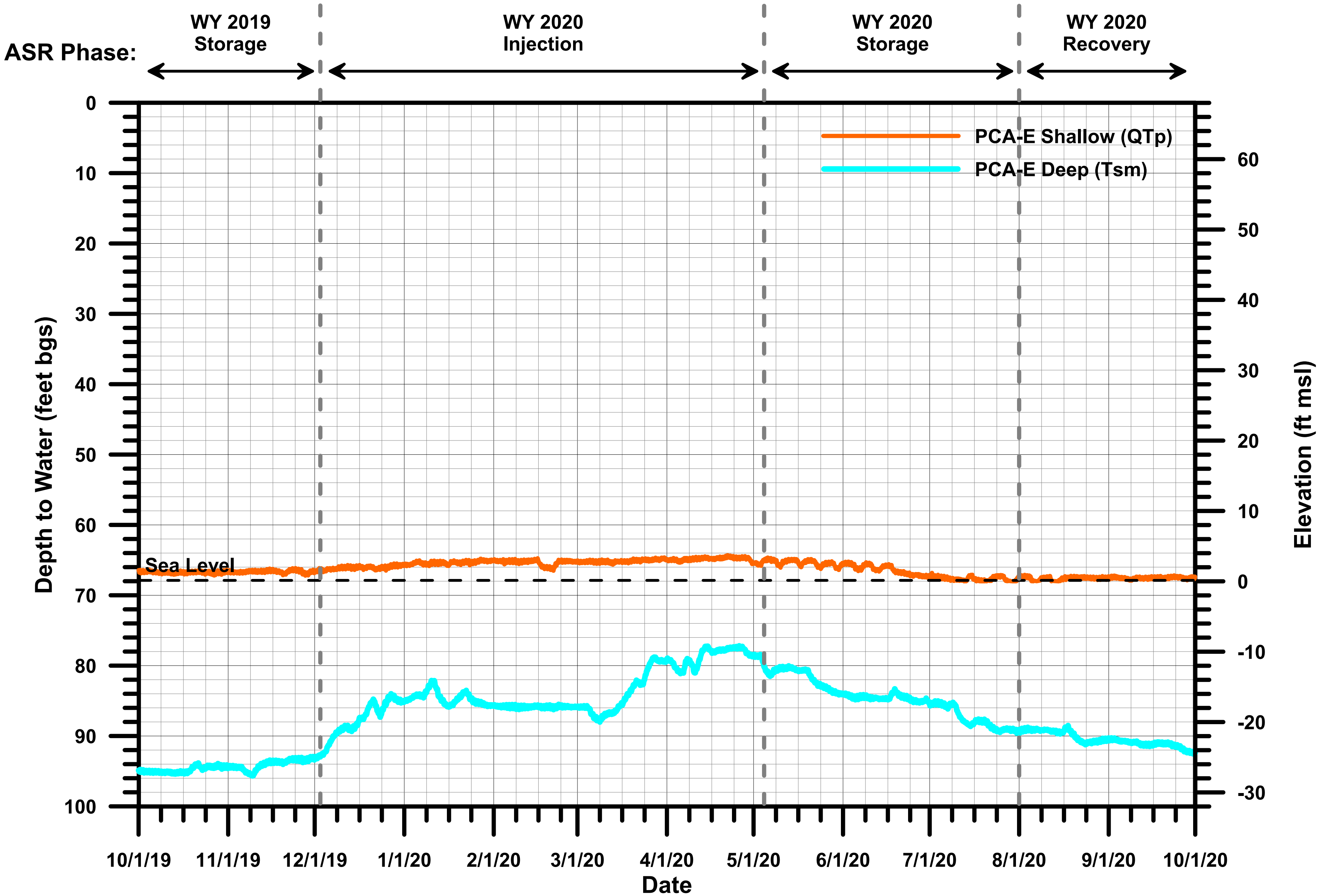

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FIGURE 17. PCA-EAST WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

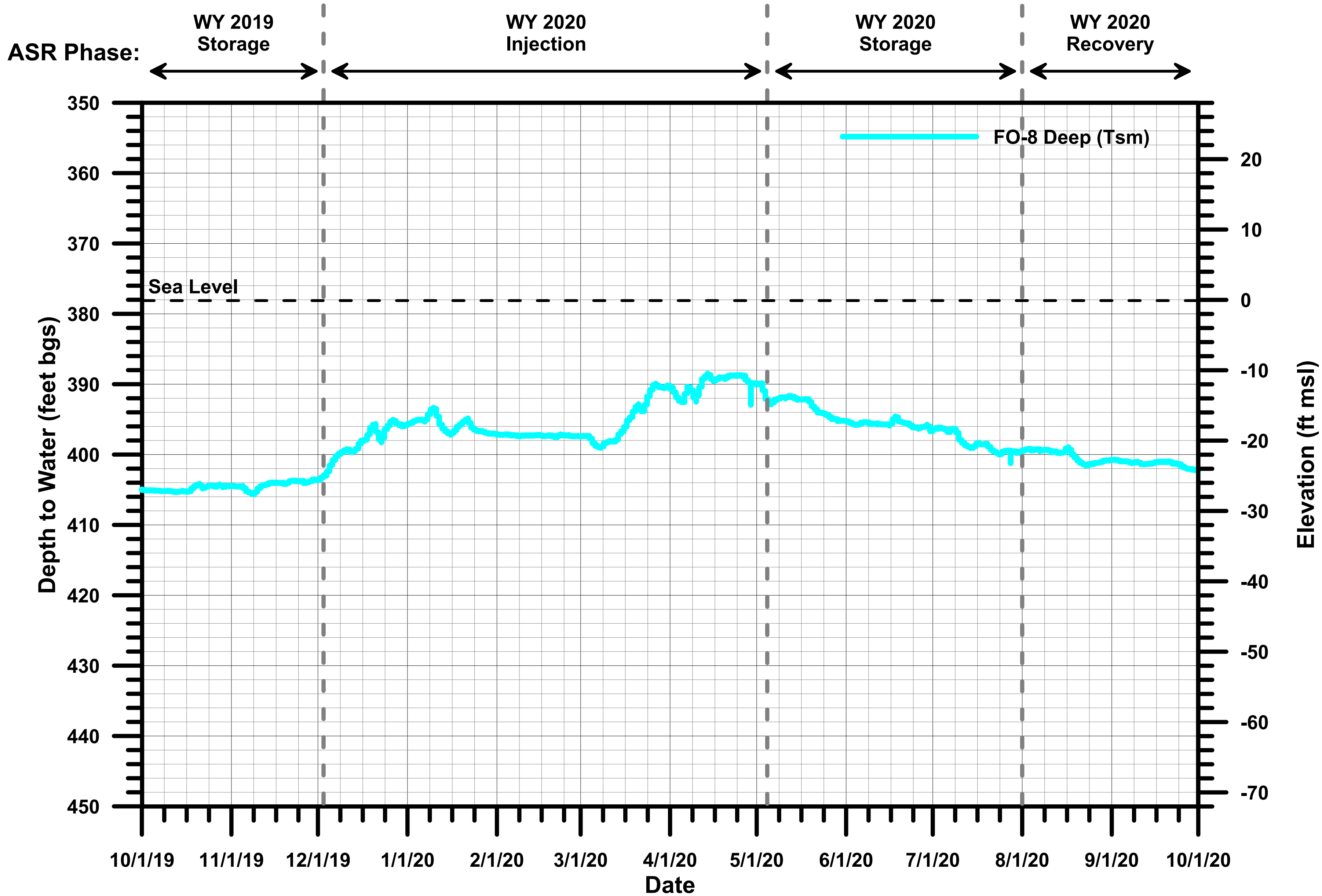

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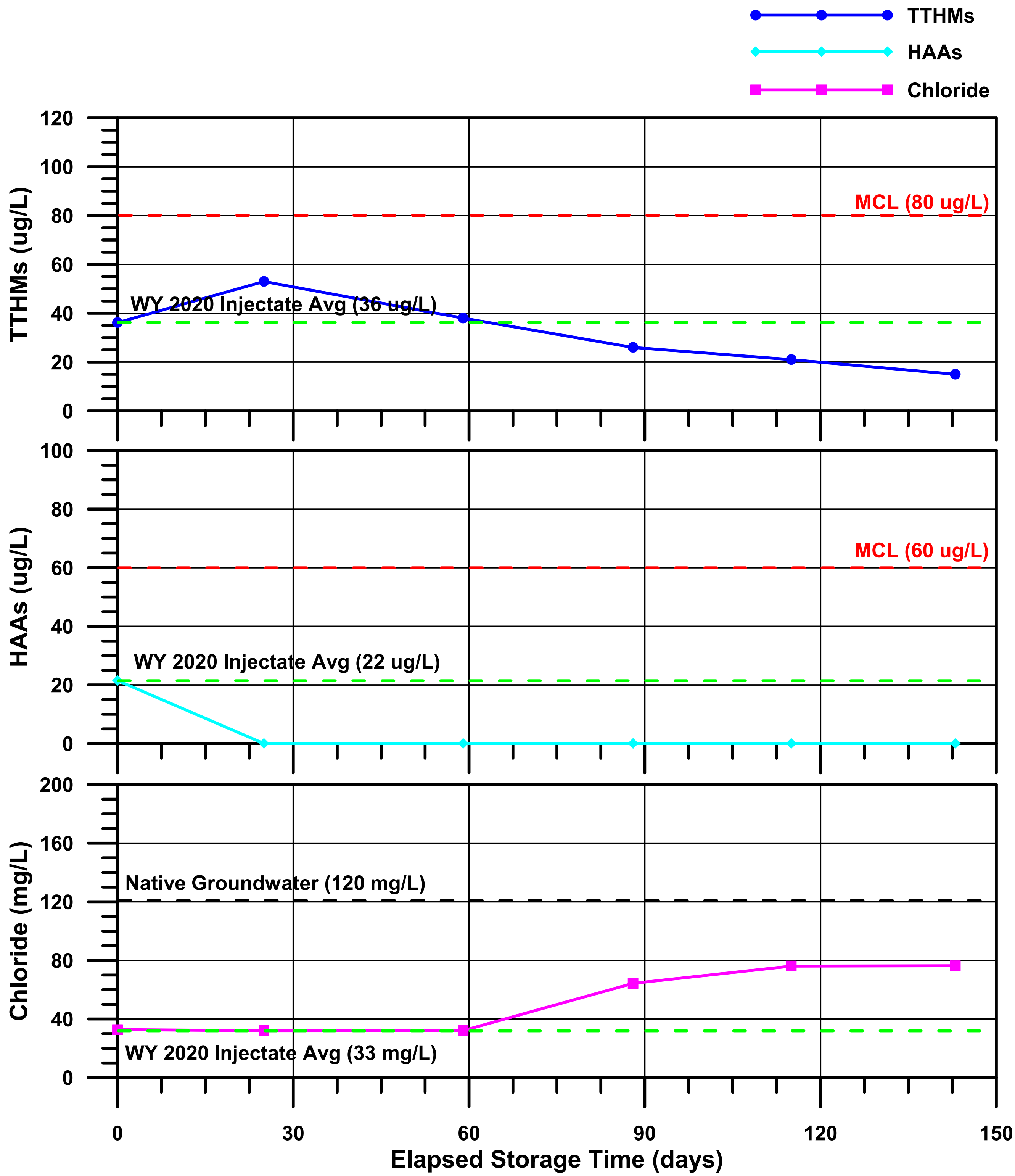
FIGURE 18. FO-8 WATER-LEVEL DATA
WY 2020 ASR Program
Monterey Peninsula Water Management District



PUEBLO water resources

FIGURE 19. ASR-1 DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

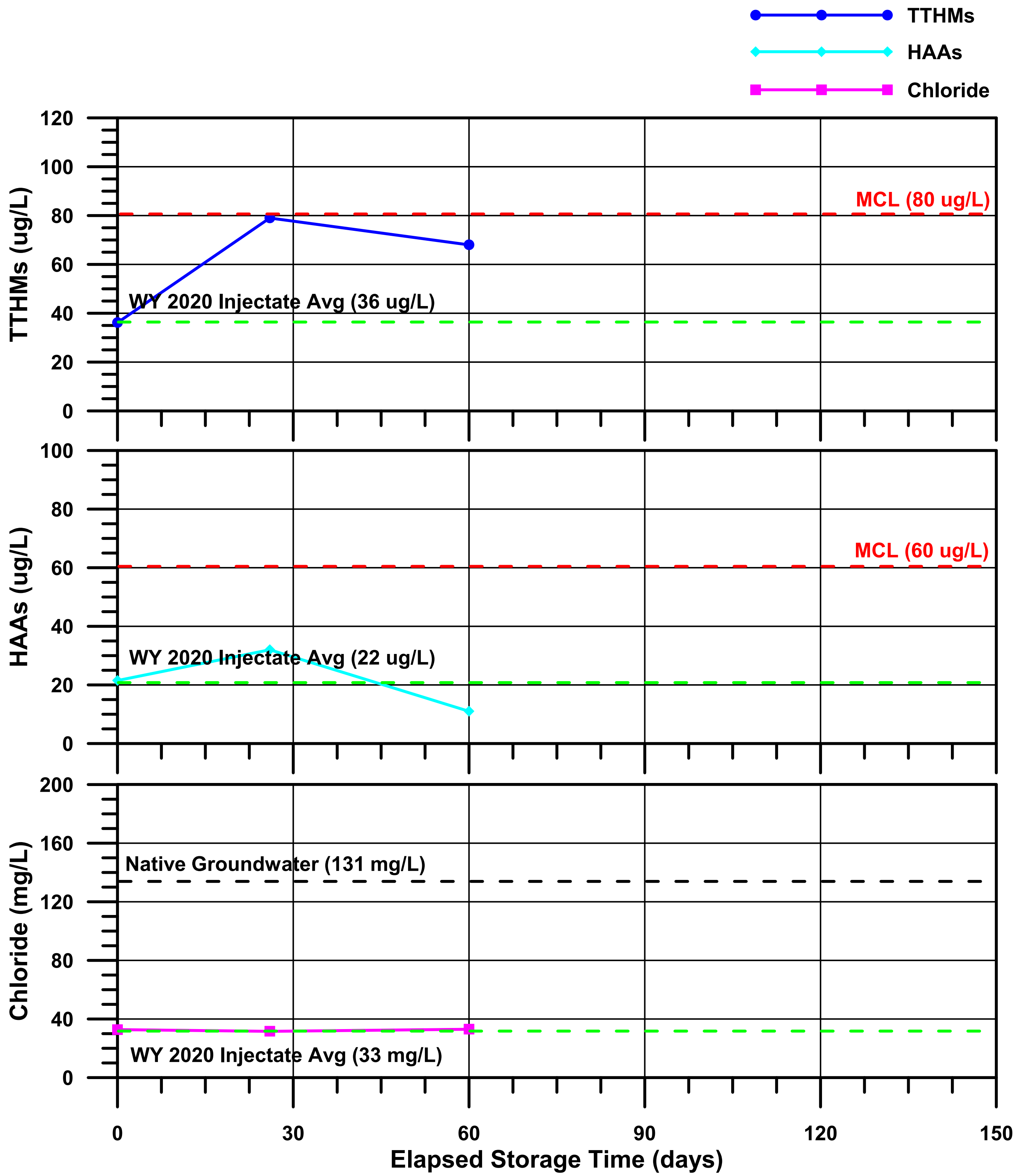


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FIGURE 20. ASR-2 DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

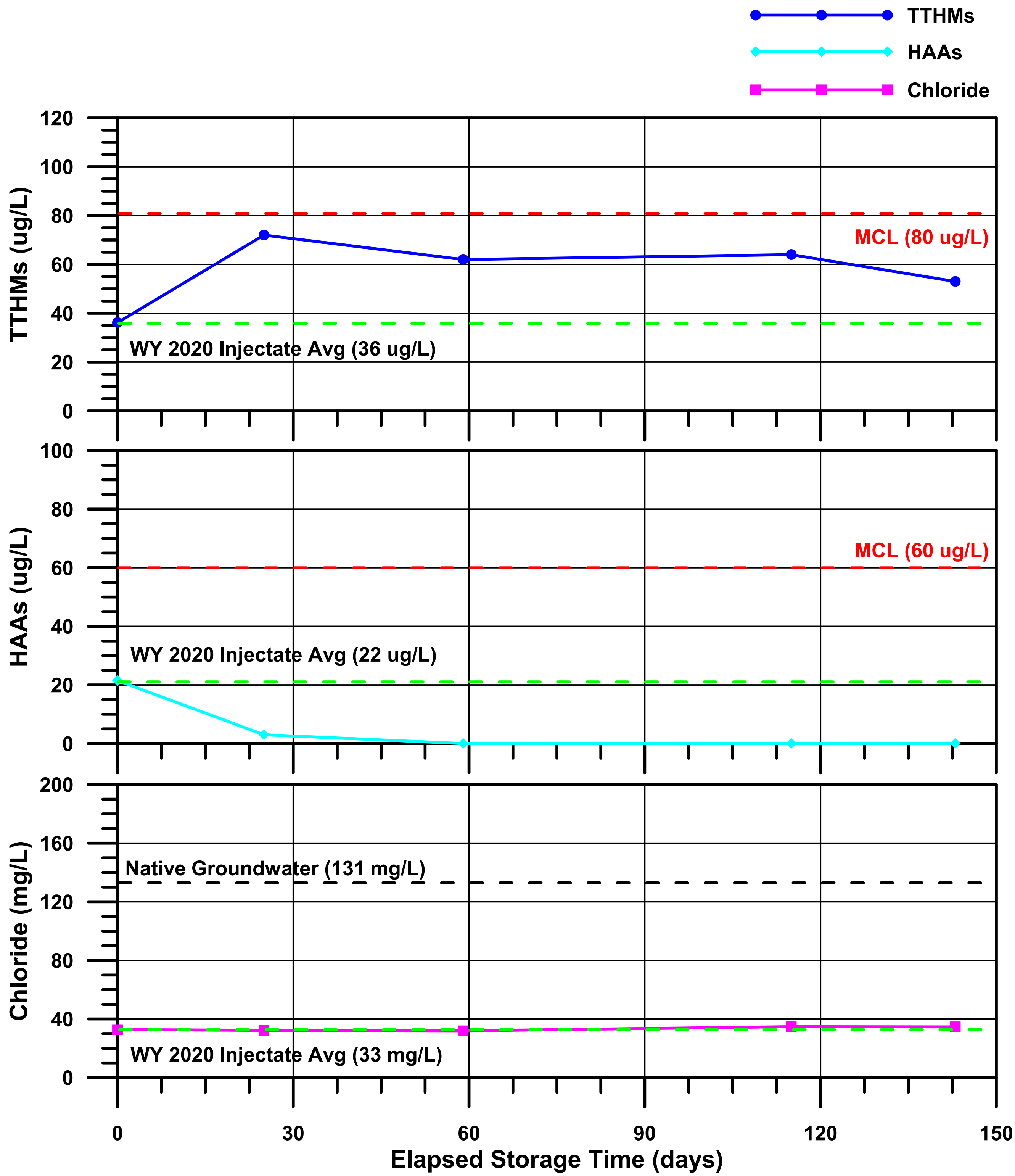

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FIGURE 21. ASR-3 DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

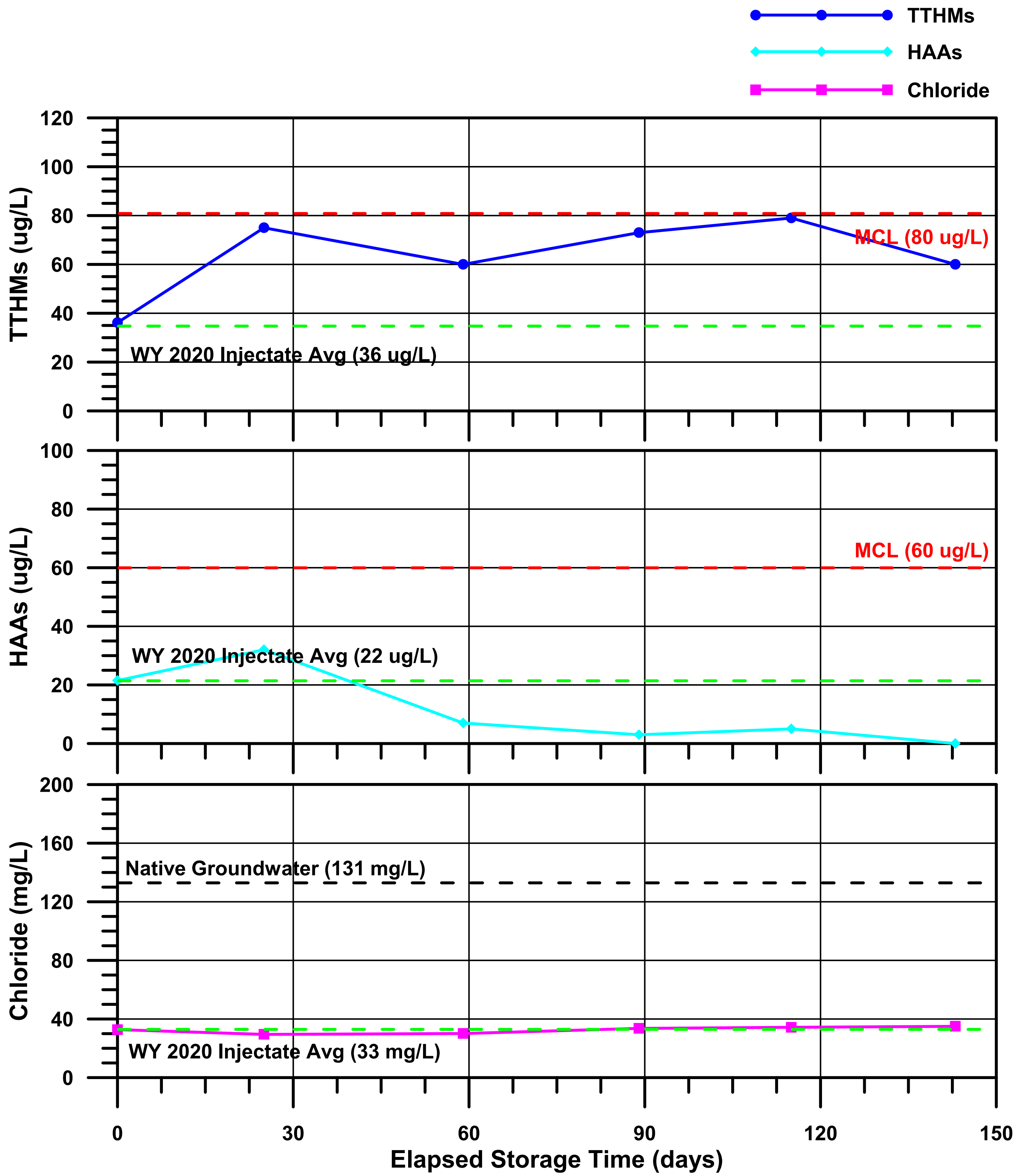

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FIGURE 22. ASR-4 DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

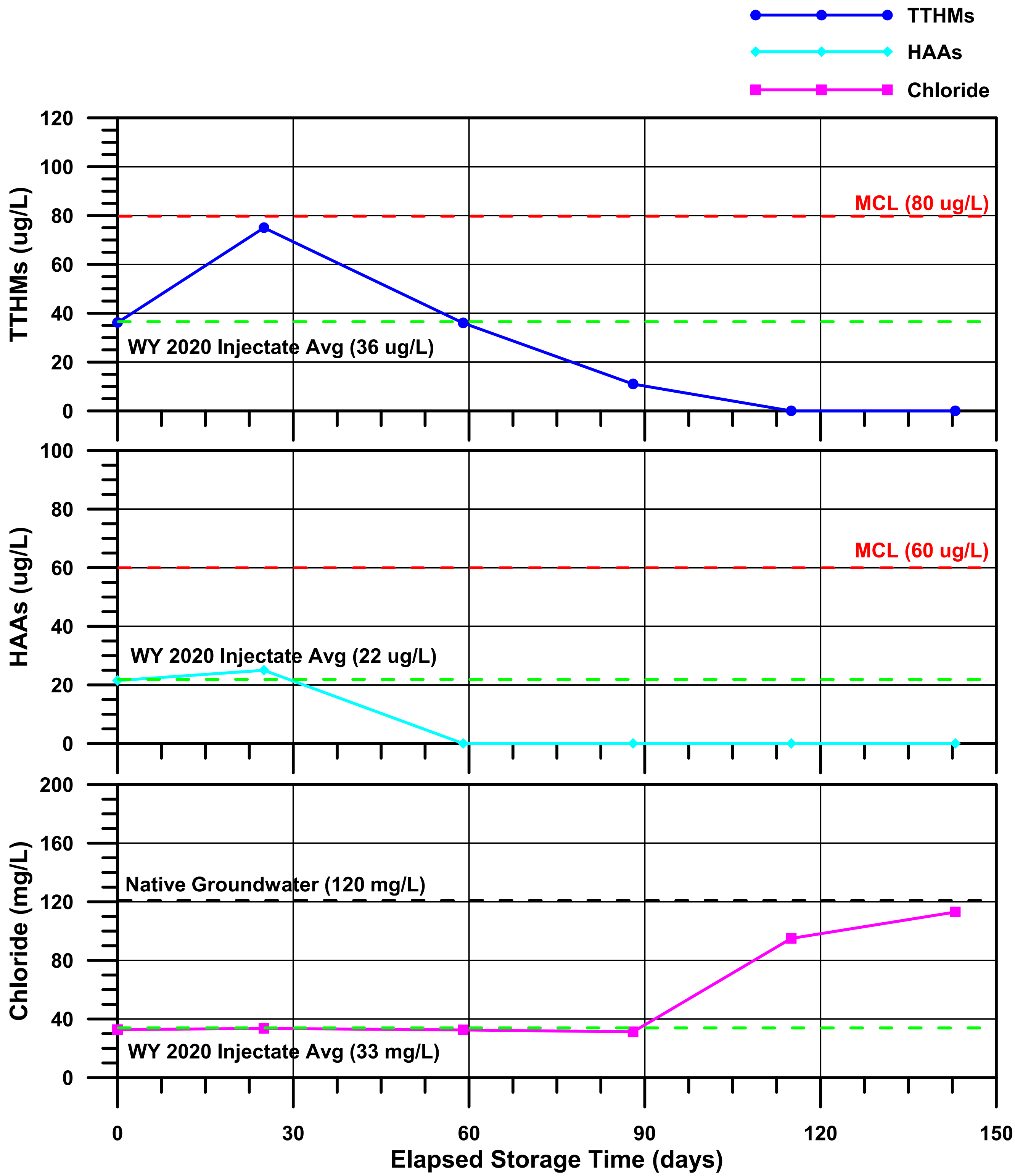

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FIGURE 23. SM MW-1 DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

June 2021
Project No. 18-0097

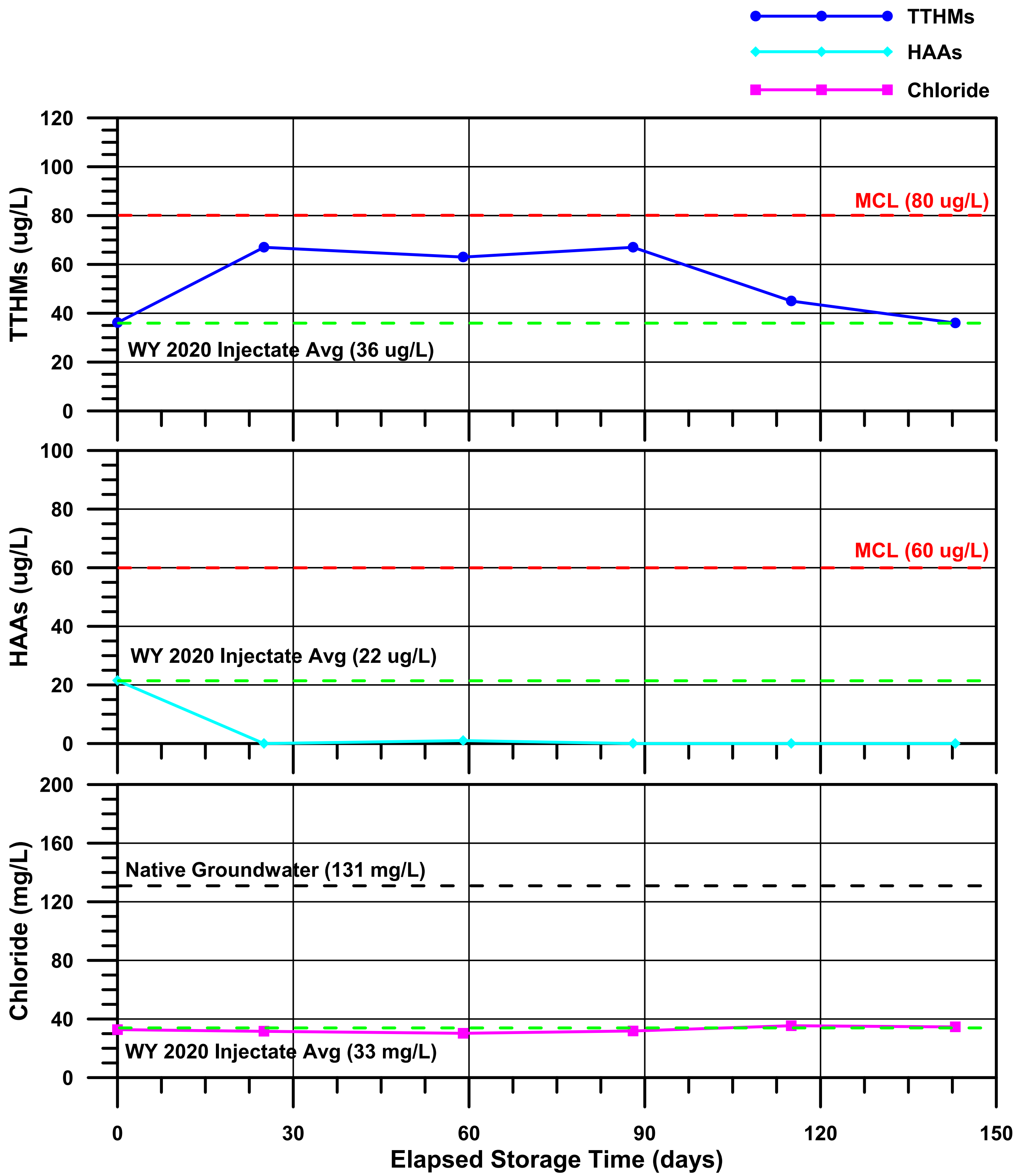

FIGURE 24. SMS DEEP DISINFECTION BYPRODUCTS PARAMETERS
WY 2020 ASR Program
Monterey Peninsula Water Management District

APPENDIX A - FIELD DATA
(not included in draft)

APPENDIX B – WATER-QUALITY LABORATORY REPORTS
(not included in draft)