SUMMARY OF OPERATIONS

MONTEREY PENINSULA ASR PROJECT

WATER YEAR 2021

Prepared for:

Monterey Peninsula Water Management District

JUNE 2022
DRAFT

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June 26, 2022
Project No. 18-0098

Monterey Peninsula Water Management District
Post Office Box 85
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Attention: Mr. Jonathan Lear, Senior Hydrogeologist

Subject: Monterey Peninsula ASR Project; **Draft** Water Year 2021 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 2021 (WY 2021). WY 2021 was classified as a "Dry" Water Year on the on the Monterey Peninsula and a limited volume of water totaling approximately 66 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 **10,282 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 2021 (WY 2021)[1]. During WY 2021, a limited volume of approximately 66 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 2021, 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

[1] Water Year 2021 is the period of October 1, 2020 through September 30, 2021.

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 2021. 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 2021 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 2021 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	NA	NA	0	NA	NA	NA	0.00
ASR-3	1/28/21	2/2/21	6	800	1220	940	26.18
ASR-4	1/28/21	2/2/21	6	1485	1575	1540	39.88
						Total	**66.06**

Notes:
NA - Not Applicable

As shown in **Table 1**, recharge operations were performed during the period January 28 through February 2, 2021. WY 2021 was classified as a “Dry” Water Year[5] on the Carmel River with only 6 days of active injection and a limited total volume of approximately 66 acre-feet (af) of water was available for diversion from the CAW system for recharge in the SGB. The recharge water was injected at two of the four ASR wells[6] into the Santa Margarita Sandstone aquifer with per-well average injection rates ranging from approximately 800 to 1,575 gpm.

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

[5] Based on 16,193 af of unimpaired Carmel River flow at the Sleepy Hollow Weir in WY 2021.
[6] ASR-1 and ASR-2 were non-operational during WY 2021.

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 2021 are presented in **Figures 7 through 10**, respectively, and briefly summarized below:

- ASR-1: This well was non-operational during WY 2021 and did not have a water-level transducer installed.
- ASR-2: This well was non-operational during WY 2021; however, the well displayed a response to injection at ASR-3 and ASR-4, with approximately 13 feet of water-level increase.
- ASR-3: The injection water-levels ranged between approximately 250 to 290 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 290 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-3 and ASR-4 were maintained below the respective maximum drawup levels throughout the WY 2021 injection season.

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 2021, the District decided to leave the WY 2021 injection volume (66 af) in basin storage at the end of the water year and no recovery pumping was recorded.

It is noted that ASR recovery in the SGB is essentially an accounting / allocation of CAW's various water rights and pumping from the 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 2021 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		Formal rehabilitation performed prior to WY2008 injection
Ending Period	1,063	33.4	31.8	-17%	
WY 2009					
Beginning Period	1,119	56.1	19.9		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	+56%	
WY 2010					
Beginning Period	1,080	35.6	30.3		Observed decline in performance due to residual plugging.
Ending Period	1,326	54.0	24.6	-19%	
WY 2011					
Beginning Period	1,367	53.0	25.8		Observed slight decline in performance due to residual plugging.
Ending Period	1,454	63.7	22.8	-10%	
WY 2012					
Beginning Period	NA	NA	NA		No injection at this well this year.
Ending Period	NA	NA	NA	NA	
WY 2013					
Beginning Period	NA	NA	NA		No injection at this well this year.
Ending Period	NA	NA	NA	NA	
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 due to datalogger malfunction.
Ending Period	1,018	40.7	25.0	NA	
WY 2016					
Beginning Period	NA	NA	NA		No beginning period due to datalogger malfunction.
Ending Period	460	14.4	31.9	NA	

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 2021					
Beginning Period	NA	NA	NA		No injection at this well this year.
Ending Period	NA	NA	NA	NA	
WY 2021					
Beginning Period	**NA**	**NA**	**NA**		**No injection occurred 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%	

Water Year	Injection Rate (gpm)	24-hour DUP (feet)	Specific Injectivity (gpm/ft)	Water Year Change	Comments
WY 2014					
Beginning Period	NA	NA	**NA**		No injection at this well this year.
Ending Period	NA	NA	**NA**	**NA**	
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 2021					
Beginning Period	1,517	63.9	23.7		Slight increase in performance.
Ending Period	1,500	58.8	25.5	+8	
WY 2021					
Beginning Period	**NA**	**NA**	**NA**		**No injection occurred this year.**
Ending Period	**NA**	**NA**	**NA**	**NA**	

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	-31%	Observed significant decline in performance due to residual plugging.
Ending Period	822	99.6	8.3		
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 data.
Ending Period	892	90.3	9.9		
WY 2016					
Beginning Period	948	83.6	11.3	+7%	Slight increase observed.
Ending Period	897	74.1	12.1		
WY 2017					
Beginning Period	936	107.5	8.7	+8%	Slight increase observed.
Ending Period	986	105.2	9.4		
WY 2018					
Beginning Period	1,050	64.8	16.2	-23%	Observed significant decline in performance due to residual plugging.
Ending Period	1,440	115.4	12.5		
WY 2019					
Beginning Period	1,063	108.9	9.8	+18%	Increase observed.
Ending Period	1,091	93.8	11.6		
WY 2021					
Beginning Period	495	24.8	20.0	-17%	Observed significant decline in performance due to residual plugging.
Ending Period	600	36.0	16.7		
WY 2021					
Beginning Period	1220	88.6	**13.7**	**NA**	**Insufficient data for comparison**
Ending Period	NA	NA	**NA**		

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 2021					
Beginning Period	560	23.1	24.2		Slight increase in performance
Ending Period	1,500	54.0	27.8	+15%	
WY 2021					
Beginning Period	1,562	64.8	**24.1**		**Insufficient data for comparison.**
Ending Period	NA	NA	**NA**	**NA**	

Injection Performance Summary. As shown in **Table 2,** no data are available for ASR-1 or ASR-2, as they were both non-operational during WY 2021. As shown in **Tables 3 and 4**, the data for WY 2021 are insufficient for comparing beginning and ending specific injection capacities, because there was only one period of continuous injection this year.

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 2021 injection operations, which were limited to 6 days of active injection, the injectate SDI was measured just prior to initiating injection at ASR-4 at 3.18 (dimensionless), a value that is consistent with recent previous years (i.e., since the Monterey Pipeline has been installed by CAW) and indicative of a relatively low to moderate 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.

Unfortunately, due to the short duration injection season and staff limitations, specific capacity data were not collected during WY 2021 at the active ASR wells; however, as discussed previously and as shown on **Figures 9 and 10**, injection water levels at ASR-3 and ASR-4 were maintained below the recommended maximum available drawup levels during WY 2021, which limits the amount of residual plugging that could occur.

It is noted that ASR-1 underwent formal rehabilitation during WY 2021 to improve performance and maintain ASR capacity. Rehabilitation was performed during the period January through March, 2021 and consisted of both mechanical and chemical methods. During pre- and post-rehabilitation performance testing, consisting of 100-minute constant-rate pumping tests, the well displayed specific capacities of 26.5 and 49.3 gpm/ft, respectively. These results show an approximate 86 percent improvement in well performance as a result of rehabilitation.

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 2021 are graphically presented on **Figures 11 through 18**. A summary of the regional water-level observations during the WY 2021 injection season is presented in **Table 7** below:

Table 6. 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		376.5	310.8	**65.7**
SM MW-1	190 (ASR-2)	Tsm	**12**	355.1	340.9	**14.2**
Paralta Test	650 (ASR-2)	QTp & Tsm	**13**	339.2	330.4	**8.8**
Ord Terrace (Shallow)	2,550 (ASR-2)	Tsm	**14**	259.2	256.9	**2.3**
FO-7 (Shallow)	3,700 (ASR-3)	QTp	**15**	No Discernable Response		
FO-7 (Deep)		Tsm		487.9	480.3	**7.6**
FO-9 (Deep)	6,130 (ASR-3)	Tsm	**16**	138.8	133.0	**5.8**
PCA East (Shallow)	6,200 (ASR-3)	QTp	**17**	No Discernable Response		
PCA East (Deep)		Tsm		88.3	82.1	**6.2**
FO-8 (Deep)	6,450 (ASR-3)	Tsm	**18**	397.6	391.2	**6.4**

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 2021 recharge season ranged between approximately 20 to 40 feet below sea level. Positive response to injection during WY 2021 was observed at all 7 of the monitored wells completed in the Tsm aquifer, with apparent water-level responses ranging between approximately 5 to 65 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 2021, 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 2021. 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 SWRCB Division of Drinking Water (DDW) Primary and Secondary water quality standards.

As in previous years, water quality was routinely monitored at the ASR well sites during WY 2021 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 2021 are presented in **Tables 7 through 14** below. Analytic laboratory reports are presented in **Appendix C** (not included in draft). A discussion of the water-quality data collected during WY 2021 is presented below.

Injection Water Quality

Injection water quality from the CAW system during WY 2021 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 and on-site monitoring wells, in particular chloride ion and electrical conductivity, all showed varying effects of dilution / intermixing of Carmel River injected water and/or Pure Water Monterey (PWM) with native groundwater (NGW) during aquifer storage. Because both Carmel River and PWM have comparably low levels of chloride ion relative to the NGW, it has become impossible to distinguish between these two waters and their relative mixes with NGW in the ASR project area utilizing this intrinsic tracer.

Disinfection Byproducts (DBPs) parameters for the on-site wells collected during the WY 2021 storage period are graphically presented on **Figures 19 through 24** and are summarized below:

Table 7. Summary of Water Quality Data – Injectate

Parameter	Unit	PQL	MCL	Results CAW Injectate 2/2/21
		Sample Description		Injectate
Major Cations				
Calcium	mg/L	*0.5*		48
Magnesium	mg/L	*0.5*		15
Potasium	mg/L	*0.5*		3.6
Sodium	mg/L	*0.5*		50
Major Anions				
Alkalinity, Total (as CaCO3)	mg/L	*2*		154
Chloride	mg/L	*1*	*250*	30.3
Sulfate	mg/L	*1*	*250*	70
Nitrate (as N)	mg/L	*1*	*10*	0.1
General Physical				
pH	Std Units			7.8
Specific Conductance (EC)	uS	*1*	*900*	529
Total Dissolved Solids	mg/L	*10*	*500*	317
Metals				
Arsenic (Total)	ug/L	*1*	*10*	1.8
Barium (Total)	ug/L	*10*	*1000*	55
Iron (Dissolved)	ug/L	*10*		ND
Iron (Total)	ug/L	*10*	*300*	ND
Lithium	ug/L	*1*		4.8
Manganese (Dissolved)	ug/L	*10*		ND
Manganese (Total)	ug/L	*10*	*50*	ND
Mercury	ug/L	*0.2*	*2*	ND
Molybdenum	ug/L	*1*	*1000*	2.6
Nickel	ug/L	*10*	*100*	ND
Selenium	ug/L	*2*	*50*	2,7
Strontium (Total)	ug/L	*5*		196
Uranium (by ICP/MS)	ug/L	*1*	*30*	--
Vanadium (Total)	ug/L	*1*	*1000*	ND
Zinc (Total)	ug/L	*10*	*5000*	218
Miscellaneous				
Ammonia-N	mg/L	*0.05*		ND
Boron	mg/L	*0.05*		ND
Chloramines	mg/L	*0.05*		0.05
Gross Alpha	pCi/L		*15*	1.60 +/- 0.655
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND
Methane	ug/L	*0.1*		1.4
o-Phosphate-P	mg/L	*0.05*		0.3
Phosphorous (Total)	mg/L	*0.03*		0.32
Radium 226	pCi/L		*3*	0.561 +/- 0.324
Organic Analyses				
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	11
Organic Carbon (Dissolved)	mg/L	*0.2*		1.1
Organic Carbon (Total)	mg/L	*0.2*		1.0
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	30
Field Parameters				
Temperature	^{0}C	*0.1*		
Specific Conductance (EC)	uS	*1.0*	*900*	
pH	Std Units	*0.1*	*6.5 - 8.5*	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	
H_2S	mg/L	*0.1*		
ORP	mV	*1.0*		
Dissolved Oxygen	mg/L	*0.01*		
Silt Density Index	Std Units	*0.1*		

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

Table 8. Summary of Water-Quality Data – ASR-1

Parameter	Unit	PQL	MCL	Results							
				SM ASR-1							
				3/21/01	10/28/20	12/1/20	1/4/21	7/6/21	8/6/21	8/24/21	9/28/21
	ASR Operational Phase			NGW	WY 2020 Storage			WY 2021 Storage			
Elapsed Storage Time	Days			--	330	364	398	154	185	203	238
Major Cations											
Calcium	mg/L	*0.5*		85	53		40	26			24
Magnesium	mg/L	*0.5*		19	13.6		11.6	6.7			5.9
Potasium	mg/L	*0.5*		5.3	4.7		3.6	2.7			2.8
Sodium	mg/L	*0.5*		88	68		54	41			47
Major Anions											
Alkalinity, Total (as CaCO3)	mg/L	*2*		224	158		141	86			69
Chloride	mg/L	*1*	*250*	120	63.8	61.1	58.2	58.3	55.8	49.8	52.9
Sulfate	mg/L	*1*	*250*	95	64		52	29			21
Nitrate (as N)	mg/L	*1*	*10*	ND	0.2		0.4	0.8			1.1
General Physical											
pH	Std Units			7.1	7.3		6.1	7.4			7.5
Specific Conductance (EC)	uS	*1*	*900*	**1015**	646		524	437			385
Total Dissolved Solids	mg/L	*10*	*500*	**618**	386		296	216			234
Metals											
Arsenic (Total)	ug/L	*1*	*10*	ND	1.3		2.0	1.5			ND
Barium (Total)	ug/L	*10*	*1000*	52	42.6		41	41			42.3
Iron (Dissolved)	ug/L	*10*			ND		ND	277			49
Iron (Total)	ug/L	*10*	*300*	120	ND		ND	**2650**			161
Lithium	ug/L	*1*			19.8		13.2	22.3			13.8
Manganese (Dissolved)	ug/L	*10*			ND		ND	29			17
Manganese (Total)	ug/L	*10*	*50*	40	ND		ND	31			18
Mercury	ug/L	*0.2*	*2*		0.4	ND	0.3	ND	ND	ND	ND
Molybdenum	ug/L	*1*	*1000*		16.6		13.3	10.1			6.9
Nickel	ug/L	*10*	*100*		ND		ND	ND			ND
Selenium	ug/L	*2*	*50*	ND	1.0		1.5	ND			ND
Strontium (Total)	ug/L	*5*			259		283	161			120
Uranium (by ICP/MS)	ug/L	*1*	*30*		--		--	--			--
Vanadium (Total)	ug/L	*1*	*1000*		ND		ND	ND			ND
Zinc (Total)	ug/L	*10*	*5000*	10	37		42	ND			ND
Miscellaneous											
Ammonia-N	mg/L	*0.05*		0.33	ND		ND	ND			ND
Boron	mg/L	*0.05*		0.14	0.08		0.11	0.11			0.13
Chloramines	mg/L	*0.05*			ND		ND	ND			ND
Gross Alpha	pCi/L		*15*		1.81 +/- 1.91		5.15 +/- 0.805	1.67 +/- 1.38			4.42 +/- 10.941
Kjehldahl Nitrogen (Total)	mg/L	*0.5*			ND		ND	ND			ND
Methane	ug/L	*0.1*			1.8		2.7	6.0			1.3
o-Phosphate-P	mg/L	*0.05*		0.46	0.09		0.1	0.2			0.2
Phosphorous (Total)	mg/L	*0.03*			0.1		0.09	28			0.19
Radium 226	pCi/L		*3*		0.128 +/- 0.148		0.157 +/- 0.210	0.259 +/- 0.179			0.221 +/- 0.181
Organic Analyses											
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*		ND	ND	ND	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*			0.4		1.0	0.6			0.5
Organic Carbon (Total)	mg/L	*0.2*		6.3	0.6		0.9	0.6			0.3
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*		12	15	11	1	2	ND	ND
Field Parameters											
Temperature	^0C	*0.1*			18.72		18.22	18.1	17.68	17.4	
Specific Conductance (EC)	uS	*1.0*	*900*	1015	585		576	479	438	444	
pH	Std Units	*0.1*	*6.5 - 8.5*	7.1	7.01		7.07	7.61	7.71	7.56	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*		ND		ND	ND	ND	ND	
H_2S	mg/L	*0.1*		1.5	Lo-ND		Lo-ND	Lo-ND	Lo-ND	Lo-ND	
ORP	mV	*1*						52.6	48.8	51.9	
Dissolved Oxygen	mg/L	*0.01*									

Constituents exceeding MCLs denoted in **BOLD** type

Table 9. Summary of Water Quality Data – ASR-2

Parameter	Unit	PQL	MCL	Results							
				SM ASR-2							
				10/27/20	1/14/21	1/26/21	3/16/21	7/6/21	8/6/21	8/24/21	9/28/21
ASR Operational Phase				WY 2020 Storage			WY 2021 Storage				
Elapsed Storage Time	Days			**329**	**408**	**420**	**42**	**154**	**185**	**203**	**238**
Major Cations											
Calcium	mg/L	*0.5*		52	22			21			24
Magnesium	mg/L	*0.5*		16.9	7.0			6.8			7.4
Potasium	mg/L	*0.5*		4.2	2.1			2.4			2.6
Sodium	mg/L	*0.5*		66	37			31			35
Major Anions											
Alkalinity, Total (as CaCO3)	mg/L	*2*		181	89			74			70
Chloride	mg/L	*1*	*250*	76.3	39.8	46.2	48.3	46.5	46.5	45.7	47.4
Sulfate	mg/L	*1*	*250*	51	22			20			16
Nitrate (as N)	mg/L	*1*	*10*	0.1	0.4			1.2			1.7
General Physical											
pH	Std Units			7.6	7.4			7.5			7.6
Specific Conductance (EC)	uS	*1*	*900*	696	374			358			361
Total Dissolved Solids	mg/L	*10*	*500*	411	208			178			182
Metals											
Arsenic (Total)	ug/L	*1*	*10*	1.3	3.4			ND			1.0
Barium (Total)	ug/L	*10*	*1000*	89.3	43.2			50.3			58.1
Iron (Dissolved)	ug/L	*10*		ND	ND			39			ND
Iron (Total)	ug/L	*10*	*300*	**319**	154			115			86
Lithium	ug/L	*1*		21.6	14.5			16.4			15.2
Manganese (Dissolved)	ug/L	*10*		11	ND			ND			ND
Manganese (Total)	ug/L	*10*	*50*	14	ND			ND			ND
Mercury	ug/L	*0.5*	*2*	**6.1**	**4.0**	**2.0**	1.2	ND	0.3	ND	ND
Molybdenum	ug/L	*1*	*1000*	26.8	27.6			14.5			6.2
Nickel	ug/L	*10*	*100*	ND	ND			ND			ND
Selenium	ug/L	*2*	*50*	1.2	1.8			1.0			1.0
Strontium (Total)	ug/L	*5*		279	130			124			123
Uranium (by ICP/MS)	ug/L	*1*	*30*	--	--			--			--
Vanadium (Total)	ug/L	*1*	*1000*	ND	ND			ND			ND
Zinc (Total)	ug/L	*10*	*5000*	287	129			87			93
Miscellaneous											
Ammonia-N	mg/L	*0.05*		ND	ND			ND			ND
Boron	mg/L	*0.05*		0.08	ND			0.16			0.15
Chloramines	mg/L	*0.05*		ND	ND	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*	3.57 ± 1.15	1.29 ± 1.48			0.785 ± 1.44			1.29 ± 0.682
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND	ND			ND			ND
Methane	ug/L	*0.1*		1.1	1.0			2.0			0.43
o-Phosphate-P	mg/L	*0.05*		0.23	0.2			0.1			0.1
Phosphorous (Total)	mg/L	*0.03*		0.28	0.21			0.11			0.09
Radium 226	pCi/L		*3*	0.141 ± 0.148	0.374 ± 0.254			0.119 ± 0.146			0.262 ± 0.198
Organic Analyses											
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	ND	ND	3	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.4	0.4			0.5			0.5
Organic Carbon (Total)	mg/L	*0.2*		0.4	0.4			0.4			0.3
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	4	1	1	2	4	5	4	4
Field Parameters											
Temperature	^{0}C	*0.1*		16.58	16.94	16.9	18.8	18.4	17.48	17.04	
Specific Conductance (EC)	uS	*1.0*	*900*	458	457	460	408	358	375	369	
pH	Std Units	*0.1*	*6.5 - 8.5*	7.14	7.25	7.16	7.57	7.55	7.48	7.55	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*				ND	ND	ND	ND	
H_2S	mg/L	*0.1*		Lo-ND	Lo-ND	Lo-ND	Lo-ND	Lo-ND	Lo-ND	Lo-ND	
ORP	mV	*1*					25.2	69.8	66	55.3	
Dissolved Oxygen	mg/L	*0.01*									

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

Table 10. Summary of Water Quality Data – ASR-3

Parameter	Unit	PQL	MCL	Results									
				SMS ASR-3									
				10/22/10	10/27/20	12/20/20	1/6/21	1/26/21	3/16/21	7/6/21	8/6/21	8/24/21	9/28/21
	ASR Operational Phase			NGW	WY 2020 Storage				WY 2021 Storage				
Elapsed Storage Time	Days				**329**	**383**	**400**	**420**	**42**	**154**	**185**	**203**	**238**
Major Cations													
Calcium	mg/L	*0.5*		76	40		38			49			58
Magnesium	mg/L	*0.5*		18	12.9		13			15.4			16.1
Potasium	mg/L	*0.5*		5	3.3		3.1			3.5			3.8
Sodium	mg/L	*0.5*		102	47		46			58			69
Major Anions													
Alkalinity, Total (as CaCO3)	mg/L	*2*		304	143		149			179			187
Chloride	mg/L	*1*	*250*	107	34.6	35.5	35.4	44.6	34.0	66.2	68.8	71.3	72.8
Sulfate	mg/L	*1*	*250*	56	64		64			67			61
Nitrate (as N)	mg/L	*1*	*10*	1	0.2		0.1			0.1			0.1
General Physical													
pH	Std Units			7.7	7.8		7.6			7.6			7.8
Specific Conductance (EC)	uS	*1*	*900*	**954**	520		525			694			718
Total Dissolved Solids	mg/L	*10*	*500*	**575**	300		352			396			454
Metals													
Arsenic (Total)	ug/L	*1*	*10*	4	4.3		8.5			4.2			2.9
Barium (Total)	ug/L	*10*	*1000*	50	63.1		64.7			63.1			57.3
Iron (Dissolved)	ug/L	*10*		21	ND		ND			ND			ND
Iron (Total)	ug/L	*10*	*300*	21	261		ND			31			ND
Lithium	ug/L	*1*		36	8.3		8.4			18.9			20.0
Manganese (Dissolved)	ug/L	*10*		27	10		ND			ND			ND
Manganese (Total)	ug/L	*10*	*50*	27	12		ND			ND			ND
Mercury	ug/L	*0.5*	*2*	--	ND	ND	ND	0.7	ND	ND	0.8	0.7	0.7
Molybdenum	ug/L	*1*	*1000*	--	16.2		11.4			7.7			11.7
Nickel	ug/L	*10*	*100*	ND	ND		ND			ND			ND
Selenium	ug/L	*2*	*50*	ND	4.5		8.8			2			1.4
Strontium (Total)	ug/L	*5*		403	219		298			291			293
Uranium (by ICP/MS)	ug/L	*1*	*30*	--	--		--			--			--
Vanadium (Total)	ug/L	*1*	*1000*	--	ND		ND			ND			ND
Zinc (Total)	ug/L	*10*	*5000*	--	187		167			79			59
Miscellaneous													
Ammonia-N	mg/L	*0.05*		0.249	ND		ND			ND			ND
Boron	mg/L	*0.05*		ND	ND		ND			ND			ND
Chloramines	mg/L	*0.05*		0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*	--	2.55 ± 1.23		3.99 ± 0.878			2.21 ± 2.33			3.45 ± 0.988
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND	ND		ND			ND			ND
Methane	ug/L	*0.1*		ND	0.9		0.8			1.2			0.66
o-Phosphate-P	mg/L	*0.05*		ND	0.27		0.2			0.1			0.1
Phosphorous (Total)	mg/L	*0.03*		0.03	0.27		0.24			0.12			0.10
Radium 226	pCi/L		*3*	--	0.088 ± 0.124		0.089 ± 0.196			0.179 ± 0.161			0.322 ± 0.201
Organic Analyses													
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	ND	ND	ND	12	14	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.71	0.7		1.0			0.9			0.6
Organic Carbon (Total)	mg/L	*0.2*		0.70	0.7		0.9			0.7			0.8
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	ND	49	53	45	45	76	28	25	22	19
Field Parameters													
Temperature	^{0}C	*0.1*		26.2			22		18.04	18.04	17.52	17.06	
Specific Conductance (EC)	uS	*1.0*	*900*	991			757		533	657	688	701	
pH	Std Units	*0.1*	*6.5 - 8.5*	7.0			7.2		7.53	7.6	7.63	7.78	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*	ND					ND	ND	ND	ND	
H_2S	mg/L	*0.1*		0.6					Lo-ND	Lo-ND	Lo-ND	Lo-ND	
ORP	mV	*1*		-82			63		73.4	50.4	61	64.1	
Dissolved Oxygen	mg/L	*0.01*		--			0.0						

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

Table 11. Summary of Water Quality Data – ASR-4

Parameter	Unit	PQL	MCL	Results ASR-4 10/27/20	12/2/20	1/5/21	1/26/21	3/16/21	7/6/21	8/6/21	8/24/21	9/28/21
	ASR Operational Phase			WY 2020 Storage				WY 2021 Storage				
Elapsed Storage Time	Days			**329**	**365**	**399**	**420**	**42**	**154**	**185**	**203**	**238**
Major Cations												
Calcium	mg/L	*0.5*		42		42			75			77
Magnesium	mg/L	*0.5*		13.2		13.9			23.5			23.9
Potasium	mg/L	*0.5*		3.7		3.7			4.5			5.6
Sodium	mg/L	*0.5*		50		51			85			103
Major Anions												
Alkalinity, Total (as CaCO3)	mg/L	*2*		144		149			246			234
Chloride	mg/L	*1*	*250*	33.7	34.9	31.3	40.0	31.1	116	123	127	128
Sulfate	mg/L	*1*	*250*	62		56			72			70
Nitrate (as N)	mg/L	*1*	*10*	0.1		0.1			ND			ND
General Physical												
pH	Std Units			7.9		7.5			7.6			7.6
Specific Conductance (EC)	uS	*1*	*900*	514		481			**962**			**1030**
Total Dissolved Solids	mg/L	*10*	*500*	314		324			**550**			**566**
Metals												
Arsenic (Total)	ug/L	*1*	*10*	5.0		3.6			4.8			3.5
Barium (Total)	ug/L	*10*	*1000*	62.2		65.8			109			124
Iron (Dissolved)	ug/L	*10*		ND		ND			ND			63
Iron (Total)	ug/L	*10*	*300*	145		161			189			291
Lithium	ug/L	*1*		8.1		8.1			28.1			37.7
Manganese (Dissolved)	ug/L	*10*		ND		ND			ND			22
Manganese (Total)	ug/L	*10*	*50*	12		ND			ND			25
Mercury	ug/L	*0.5*	*2*	ND	ND	ND	0.3	ND	1.7	**5.9**	**5.6**	**3.4**
Molybdenum	ug/L	*1*	*1000*	9.3		12.4			10.5			7.3
Nickel	ug/L	*10*	*100*	5.5		5.4			6.1			11.2
Selenium	ug/L	*2*	*50*	7.7		2.2			1.7			1.6
Strontium (Total)	ug/L	*5*		217		290			386			381
Uranium (by ICP/MS)	ug/L	*1*	*30*	--		--			--			--
Vanadium (Total)	ug/L	*1*	*1000*	ND		ND			ND			ND
Zinc (Total)	ug/L	*10*	*5000*	169		181			318			282
Miscellaneous												
Ammonia-N	mg/L	*0.05*		ND		ND			ND			ND
Boron	mg/L	*0.05*		ND		ND			0.1			0.11
Chloramines	mg/L	*0.05*		ND	ND	ND	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*	1.92 ± 1.19		1.75 ± 0.688			2.12 ± 1.24			2.34 ± 0.954
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND		ND			ND			0.7
Methane	ug/L	*0.1*		0.2		0.53			2.7			1.4
o-Phosphate-P	mg/L	*0.05*		0.19		0.2			0.2			0.2
Phosphorous (Total)	mg/L	*0.03*		0.23		0.22			0.21			0.19
Radium 226	pCi/L		*3*	0.088 ± 0.124		0.199 ± 0.218			0.219 ± 0.170			0.342 ± 0.205
Organic Analyses												
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	ND	ND	ND	11	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.8		1.0						0.8
Organic Carbon (Total)	mg/L	*0.2*		0.7		0.9						0.6
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	38	49	45	13	55	2	5	1	1
Field Parameters												
Temperature	^{0}C	*0.1*				24.6		18.74	18.3	17.82	17.28	
Specific Conductance (EC)	uS	*1.0*	*900*			697		484	973	958	986	
pH	Std Units	*0.1*	*6.5 - 8.5*			7.01		7.63	7.52	7.63	7.85	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*					ND	ND	ND	ND	
H_2S	mg/L	*0.1*						Lo-ND	Lo-ND	Lo-ND	Lo-ND	
ORP	mV	*1*				35		82.4	25	15.4	7	
Dissolved Oxygen	mg/L	*0.01*				0.04						

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

Table 12. Summary of Water Quality Data – SM MW-1

Parameter	Unit	PQL	MCL	Results SM MW-1 10/28/20	1/4/21	1/26/21	3/16/21	6/1/21	7/6/21	8/6/21	8/17/21	8/24/21	9/14/21	9/28/21
		Sample Description		WY 2020 Storage			WY 2021 Storage							
Elapsed Storage Time	Days			**330**	**398**	**420**	**42**	**119**	**154**	**185**	**196**	**203**	**224**	**238**
Major Cations														
Calcium	mg/L	*0.5*		18	7			54	35		21	53	18	50
Magnesium	mg/L	*0.5*		5.3	2.3			17.2	11.4		6.3	16.2	5.5	13.8
Potasium	mg/L	*0.5*		2.9	2.0			4.8	3.5		2.6	4.1	2.7	3.1
Sodium	mg/L	*0.5*		43	25			69	52		40	67	36	52
Major Anions														
Alkalinity, Total (as CaCO3)	mg/L	*2*		89	47			174	128		69	144	65	150
Chloride	mg/L	*1*	*250*	21.6	13.3	26.5	30.2	81.0	59.8	60.7	47.1	67.5	43.2	57.6
Sulfate	mg/L	*1*	*250*	34	12			76	54		24	54	22	55
Nitrate (as N)	mg/L	*1*	*10*	ND	ND			ND	0.1		0.2	0.7	0.3	0.6
General Physical														
pH	Std Units			7.5	7.0			7.1	7.5		7.5	7.6	7.5	7.8
Specific Conductance (EC)	uS	*1*	*900*	323	164			745	560		328	625	329	606
Total Dissolved Solids	mg/L	*10*	*500*	211	130			454	258		212	426	220	330
Metals														
Arsenic (Total)	ug/L	*1*	*10*	0.9	1.1				1.5					2.1
Barium (Total)	ug/L	*10*	*1000*	26.1	14.0				55.5			40.6	25.5	41.2
Iron (Dissolved)	ug/L	*10*		ND	ND			ND	ND		ND	ND	ND	ND
Iron (Total)	ug/L	*10*	*300*	ND	ND			ND	ND		ND	ND	ND	ND
Lithium	ug/L	*1*		15.9	9.1				20.7					10.7
Manganese (Dissolved)	ug/L	*10*		ND	ND			ND	ND		ND	ND	ND	ND
Manganese (Total)	ug/L	*10*	*50*	ND	ND			ND	ND		ND	ND	ND	ND
Mercury	ug/L	*0.5*	*2*	0.2	ND	0.3	ND		ND	ND		ND		ND
Molybdenum	ug/L	*1*	*1000*	93	61.5				10.0					6.0
Nickel	ug/L	*10*	*100*	ND	ND				ND					ND
Selenium	ug/L	*2*	*50*	ND	ND				ND					2.1
Strontium (Total)	ug/L	*5*		92.8	35.4				196					234
Uranium (by ICP/MS)	ug/L	*1*	*30*	--	--				--					--
Vanadium (Total)	ug/L	*1*	*1000*	ND	ND				ND					ND
Zinc (Total)	ug/L	*10*	*5000*	42	ND				ND					ND
Miscellaneous														
Ammonia-N	mg/L	*0.05*		ND	ND			ND	ND		ND	ND	ND	ND
Boron	mg/L	*0.05*		0.1	0.11			0.1	ND		ND	ND		ND
Chloramines	mg/L	*0.05*		ND	ND	ND	ND		ND	ND				ND
Gross Alpha	pCi/L		*15*	1.87 ± 1.72	1.60 ± 0.364				3.33 ± 1.42					1.97 ± 0.932
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND	ND				ND					ND
Methane	ug/L	*0.1*		1.5	0.73				1.8					0.16
o-Phosphate-P	mg/L	*0.05*		0.4	0.3				0.1					0.1
Phosphorous (Total)	mg/L	*0.03*		0.37	0.28				0.08					0.07
Radium 226	pCi/L		*3*	0.091 ± 0.139	0.201 ± 0.219				0.139 ± 0.151					0.282 ± 0.193
Organic Analyses														
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	ND	1	3		ND	ND		ND		ND
Organic Carbon (Dissolved)	mg/L	*0.2*		1.2	0.7				0.6					0.7
Organic Carbon (Total)	mg/L	*0.2*		1.3	0.6			0.7	0.5		0.3	0.5		0.60
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	ND	ND	ND	18		3	15		ND		20
Field Parameters														
Temperature	°C	*0.1*					18.1	18.36	18.1	17.2		16.92	17.58	
Specific Conductance (EC)	uS	*1.0*	*900*				406	795	573	335		636	299	
pH	Std Units	*0.1*	*6.5 - 8.5*				7.69	7.59	7.45	7.56		7.45	7.68	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*				ND	ND	ND	ND		ND	ND	
H_2S	mg/L	*0.1*					Lo-ND	Lo-ND	Lo-ND	Lo-ND		Lo-ND	Lo-ND	
ORP	mV	*1*					32.2	32.4	38.4	59.8		28	43.5	
Dissolved Oxygen	mg/L	*0.01*												

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

Table 13. Summary of Water Quality Data – SMS Deep

Parameter	Unit	PQL	MCL	Results								
				SMS Deep								
				10/27/20	12/1/20	1/5/21	1/28/21	3/17/21	7/6/21	8/6/21	8/24/21	9/28/21
		Sample Description		WY 2020 Storage				WY 2021 Storage				
Elapsed Storage Time	Days			**329**	**364**	**399**	**422**	**43**	**154**	**185**	**203**	**238**
Major Cations												
Calcium	mg/L	*0.5*		44		42			41			48
Magnesium	mg/L	*0.5*		13.9		13.4			13.6			13.0
Potasium	mg/L	*0.5*		3.7		3.4			3.2			3.7
Sodium	mg/L	*0.5*		50		49			44			52
Major Anions												
Alkalinity, Total (as CaCO3)	mg/L	*2*		142		131			142			154
Chloride	mg/L	*1*	*250*	34.0	33.6	32.0	31.3	30.9	34.2	33.8	33.6	39.1
Sulfate	mg/L	*1*	*250*	62		60			64			68
Nitrate (as N)	mg/L	*1*	*10*	0.1		0.1			ND			ND
General Physical												
pH	Std Units			7.8		7.7			7.7			7.7
Specific Conductance (EC)	uS	*1*	*900*	478		476			522			563
Total Dissolved Solids	mg/L	*10*	*500*	309		320			306			310
Metals												
Arsenic (Total)	ug/L	*1*	*10*	9.6		5.0			4.6			3.0
Barium (Total)	ug/L	*10*	*1000*	57.1		58.8			53.7			55.2
Iron (Dissolved)	ug/L	*10*		ND		ND			ND			ND
Iron (Total)	ug/L	*10*	*300*	ND		ND			56			**911**
Lithium	ug/L	*1*		8.0		7.1			8.5			13.1
Manganese (Dissolved)	ug/L	*10*		ND		ND			ND			ND
Manganese (Total)	ug/L	*10*	*50*	ND		ND			ND			85
Mercury	ug/L	*0.5*	*2*	0.8	ND	ND		ND	ND	ND	ND	0.3
Molybdenum	ug/L	*1*	*1000*	13.9		10.5			30.9			39.0
Nickel	ug/L	*10*	*100*	ND		ND			ND			ND
Selenium	ug/L	*2*	*50*	12.2		3.8			9.3			ND
Strontium (Total)	ug/L	*5*		218		298			218			234
Uranium (by ICP/MS)	ug/L	*1*	*30*	--		--			--			--
Vanadium (Total)	ug/L	*1*	*1000*	ND		ND			ND			ND
Zinc (Total)	ug/L	*10*	*5000*	127		90			91			53
Miscellaneous												
Ammonia-N	mg/L	*0.05*		ND		ND			ND			0.16
Boron	mg/L	*0.05*		ND		ND			ND			ND
Chloramines	mg/L	*0.05*		ND	ND	ND	ND	ND	ND	ND	ND	ND
Gross Alpha	pCi/L		*15*	3.71 ± 0.884		5.96 ± 1.07			1.78 ± 1.88			1.98 ± 0.804
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND		ND			ND			ND
Methane	ug/L	*0.1*		0.49		0.44			6.7			24
o-Phosphate-P	mg/L	*0.05*		0.16		0.1			0.1			0.3
Phosphorous (Total)	mg/L	*0.03*		0.19		0.17			0.41			0.42
Radium 226	pCi/L		*3*	0.106 ± 0.129		0.100 ± 0.195			0.298 ± 0.187			0.302 ± 0.197
Organic Analyses												
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND	ND	ND	ND	17	ND	ND	ND	ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.8		ND			1.1			1.0
Organic Carbon (Total)	mg/L	*0.2*		0.7		0.9			0.9			1.0
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	35	37	50	40	49	ND	2	2	ND
Field Parameters												
Temperature	^{0}C	*0.1*						18.42	18.14	17.02	17.16	
Specific Conductance (EC)	uS	*1.0*	*900*					474	487	528	498	
pH	Std Units	*0.1*	*6.5 - 8.5*					7.56	7.52	7.77	7.46	
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*					ND	ND	ND	ND	
H_2S	mg/L	*0.1*						Lo-ND	Lo-ND	Lo-ND	Lo-ND	
ORP	mV	*1*						9.8	10.2	20.2	42.2	
Dissolved Oxygen	mg/L	*0.01*										

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

Table 14. Summary of Water Quality Data – Off-Site Monitoring Wells

Parameter	Unit	PQL	MCL	Results		Results	
				Paralta		PCA-E Deep*	
				10/13/20			10/29/21
			ASR Operational Phase	WY 2020 Storage	WY 2021 Storage	WY 2020 Storage	WY 2021 Storage
Major Cations							
Calcium	mg/L	*0.5*		49			62
Magnesium	mg/L	*0.5*		12.0			12.6
Potasium	mg/L	*0.5*		4.0			4.4
Sodium	mg/L	*0.5*		70			96
Major Anions							
Alkalinity, Total (as CaCO3)	mg/L	*2*		180			214
Chloride	mg/L	*1*	*250*	67.6			114
Sulfate	mg/L	*1*	*250*	67			34
Nitrate (as N)	mg/L	*1*	*10*	0.1			ND
General Physical							
pH	Std Units			7.6			7.5
Specific Conductance (EC)	uS	*1*	*900*	658			919
Total Dissolved Solids	mg/L	*10*	*500*	437			520
Metals							
Arsenic (Total)	ug/L	*1*	*10*	2.5			4.2
Barium (Total)	ug/L	*10*	*1000*	44			125
Iron (Dissolved)	ug/L	*10*		ND			187
Iron (Total)	ug/L	*10*	*300*	19			399
Lithium	ug/L	*1*		19.2			31.8
Manganese (Dissolved)	ug/L	*10*		14			326
Manganese (Total)	ug/L	*10*	*50*	17			324
Mercury	ug/L	*0.5*	*2*	ND			ND
Molybdenum	ug/L	*1*	*1000*	11.4			11.6
Nickel	ug/L	*10*	*100*	ND			20.8
Selenium	ug/L	*2*	*50*	1.6			ND
Strontium (Total)	ug/L	*5*		258			355
Uranium (by ICP/MS)	ug/L	*1*	*30*	--			--
Vanadium (Total)	ug/L	*1*	*1000*	ND			ND
Zinc (Total)	ug/L	*10*	*5000*	ND			ND
Miscellaneous							
Ammonia-N	mg/L	*0.05*		0.1			ND
Boron	mg/L	*0.05*		0.07			0.1
Chloramines	mg/L	*0.05*		ND			ND
Gross Alpha	pCi/L		*15*	5.73 ± 2.09			3.55 ± 1.22
Kjehldahl Nitrogen (Total)	mg/L	*0.5*		ND			ND
Methane	ug/L	*0.1*		3.7			1.4
o-Phosphate-P	mg/L	*0.05*		ND			ND
Phosphorous (Total)	mg/L	*0.03*		ND			0.04
Radium 226	pCi/L		*3*	0.406 ± 0.233			0.275 ± 0.158
Organic Analyses							
Haloacetic Acids (Total)	ug/L	*1.0*	*60.0*	ND			ND
Organic Carbon (Dissolved)	mg/L	*0.2*		0.8			0.7
Organic Carbon (Total)	mg/L	*0.2*		0.9			0.5
Trihalomethanes (Total)	ug/L	*1.0*	*80.0*	8			ND
Field Parameters							
Temperature	^{0}C	*0.1*					
Specific Conductance (EC)	uS	*1.0*	*900*				
pH	Std Units	*0.1*	*6.5 - 8.5*				
Free Chlorine Residual	mg/L	*0.1*	*2 - 5*				
H_2S	mg/L	*0.1*					
ORP	mV	*1*					
Dissolved Oxygen	mg/L	*0.01*					

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.
The above sample collected at PCA-E in October 2021 is used as a proxy for WY 2021 Storage period / 2021 Q3.

- ASR-1 (**Figure 19**): No injection occurred at ASR-1 during WY 2021 and it was essentially operated as a monitoring well. As shown, following completion of the WY 2021 injection season, both THMs and HAAs were essentially undetected during the storage phase.
- ASR-2 (**Figure 20**): Similar to ASR-1, no injection occurred at ASR-2 during WY 2021 and it was essentially operated as a monitoring well and both THMs and HAAs were essentially undetected during the storage phase at this well.
- ASR-3 (**Figure 21**): Five samples were collected at ASR-3 during the storage period, which showed ingrowth of THMs approaching the MCL within a period of 34 days reaching a level of 76 ug/L, followed by a decline during the remaining 204 days of storage to a level of 19 ug/L.
- ASR-4 (**Figure 22**): Five samples were collected at ASR-4 during the storage period, which also showed ingrowth of THMs over a period of 42 days reaching a maximum level of 55 ug/L, followed by decline during the remaining 196 days of storage to a level of 1 ug/L.
- SM MW-1 (**Figure 23**): No injection occurred at the Santa Margarita site (ASR-1 and ASR-2) where SM MW-1 is located. As shown, THMs varied during the storage period between approximately 0 to 20 ug/L. It also noted that chloride varied during the same period between approximately 43 to 81 mg/L. Given no ASR operations occurred at the site, these observations suggest that the operation of the PWM injection wells is likely to be influencing the water chemistry at the site.
- SMS Deep (**Figure 24**): Five samples were collected at SMS Deep during the storage period, which showed ingrowth of THMs over a period of 43 days reaching a level of 49 ug/L, followed by a decline after the remaining 195 days of storage to a level of 0 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 2021 generally followed this historically observed pattern, with THM ingrowth generally peaking in concentration after approximately 30 to 50 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 2021 are presented in **Table 15**. As shown, only one sample was collected from the Paralta well in October 2020. Paralta is the nearest CAW production well to the ASR wells, and it displayed a THM level of 8 ug/L, reflecting the influence of injectate from the nearby ASR wells during the previous WY 2020 injection season. PCA-E Deep could not be sampled during WY 2021 due to site access restrictions on school property during the COVID pandemic; however, a sample was able to be collected in October 2021 and is presented in **Table 15** as a proxy for the WY 2021 Q3 sample. As shown, the absence of DBP's at this well and the high level of chloride ion during the period suggest that this area of the aquifer system is comprised of intact NGW, and the influence of recharge operations is negligible to date at this location.

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.

During WY 2021, Hg was detected at levels exceeding the MCL at both ASR-2 and ASR-4. At ASR-2, levels exceeding the MCL in the range of 2.0 to 6.1 ug/L were detected at the beginning of the water year, followed by a decline to non-detect levels by the end of the water year. At ASR-4, Hg was detected at a level of 5.9 ug/L 85 days following cessation of the WY 2021 injection season, declining to a level of 3.4 ug/L by the end of the water year.

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 2020 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

[8] Collected on October 24, 2013.

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 2021 all water samples collected were at less than this concentration; therefore, none of the collected sludge samples were considered usable for further analysis during WY 2021.

Next Steps. Similar to the recommendations presented in the WY 2020 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 used to ascertain the specific reaction mechanism(s) resulting in mobilization.

CONCLUSIONS

Based on the findings developed from operation of Monterey Peninsula ASR Project during WY 2021, we conclude the following:

WY 2021 Recharge Operations

WY 2021 was classified as a "Dry" Water Year on the Monterey Peninsula and limited total volume of 66 af of water was recharged into the Seaside Groundwater Basin at the Seaside Middle Schools ASR Facility during the WY 2021 injection season.

ASR Well Performance

ASR-1. ASR-1 was non-operational during WY 2021; therefore, no well performance conclusions could be developed.

ASR-2. ASR-1 was non-operational during WY 2021; therefore, no well performance conclusions could be developed.

ASR-3. Pertinent well performance conclusions for ASR-3 during WY 2021 are summarized below:

- Injection Rates: Ranged between approximately 800 to 1,220 gpm, averaging approximately 940 gpm.

- Water Levels: During the limited periods of injection at this well, water levels were maintained below 190 feet bgs and the recommended maximum drawup level of 170 feet.

- Specific Injectivity: The initial 24-hr specific injectivity was approximately 13.7 gpm/ft, which is approximately 18 percent lower than the specific injectivity observed at the end of WY 2020 of 16.7 gpm/ft.

- Residual Plugging: Insufficient data were available to determine residual plugging during WY 2021.

- General Conclusions: ASR-3 performed more poorly during WY 2021 than the end of WY 2020. The well's performance suggests the injection rate at this well should continue to be limited to 1,000 gpm.

ASR-4. Pertinent well performance conclusions for ASR-4 during WY 2021 are summarized below:

- Injection Rates: Ranged between approximately 1,485 to 1,574 gpm, averaging approximately 1,450 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: The initial 24-hr specific injectivity was approximately 24.1 gpm/ft, which is comparable to the specific injectivity observed at the beginning of WY 2020 of 24.2 gpm/ft..

- Residual Plugging: Insufficient data were available to determine residual plugging during WY 2021.

- General Conclusions: Based on the available data, ASR-4 generally performed well during WY 2021, 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 2021 include the following:

- Consistent with previous observations, no significant ion exchange, acid-base, or precipitation reactions were observed at the ASR sites.

- THMs were below the MCL of 80 ug/L at all project wells during WY 2021, and generally followed the historical pattern for the project, with ingrowth generally peaking after approximately 30 to 50 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 2021 storage season.

- Hg was detected at levels exceeding the MCL at both ASR-2 and ASR-4. At ASR-2, levels exceeding the MCL in the range of 2.0 to 6.1 ug/L were detected at the beginning of the water year, followed by a decline to non-detect levels by the end of the water year. At ASR-4, Hg was detected at a level of 5.9 ug/L 85 days following cessation of the WY 2021 injection season, declining to a level of 3.4 ug/L by the end of the water year.

RECOMMENDATIONS

Based on the results of the WY 2021 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 2021, the recommendations provided in the WY 2020 SOR are still applicable and are as follows:

- <u>Injection Rate</u>: The injection rate should continue to be limited to the design rate of **1,500 gpm or less**.
- <u>Water-Level Drawup</u>: 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.
- <u>Backflushing Frequency</u>: 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

Since ASR-2 was non-operational during WY 2021, the recommendations provided in the WY 2020 SOR are still applicable and are as follows:

- <u>Injection Rate</u>: The injection rate continue to be maintained at the design rate of approximately **1,500 gpm or less**.
- <u>Water-Level Drawup</u>: 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.
- <u>Backflushing Frequency</u>: 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

- <u>Injection Rate</u>: Based on the continued poor performance during WY 2021, 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 apparently good performance during WY 2021, 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 2021, the investigation of the potential mechanisms of Hg solubilization and/or mobilization within the Tsm aquifer mineralogy should be continued in WY 2022. This should include the ongoing sampling of both backflushing waters during the injection season, and water-quality purging/sampling during the storage periods, 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 2022 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 utilized 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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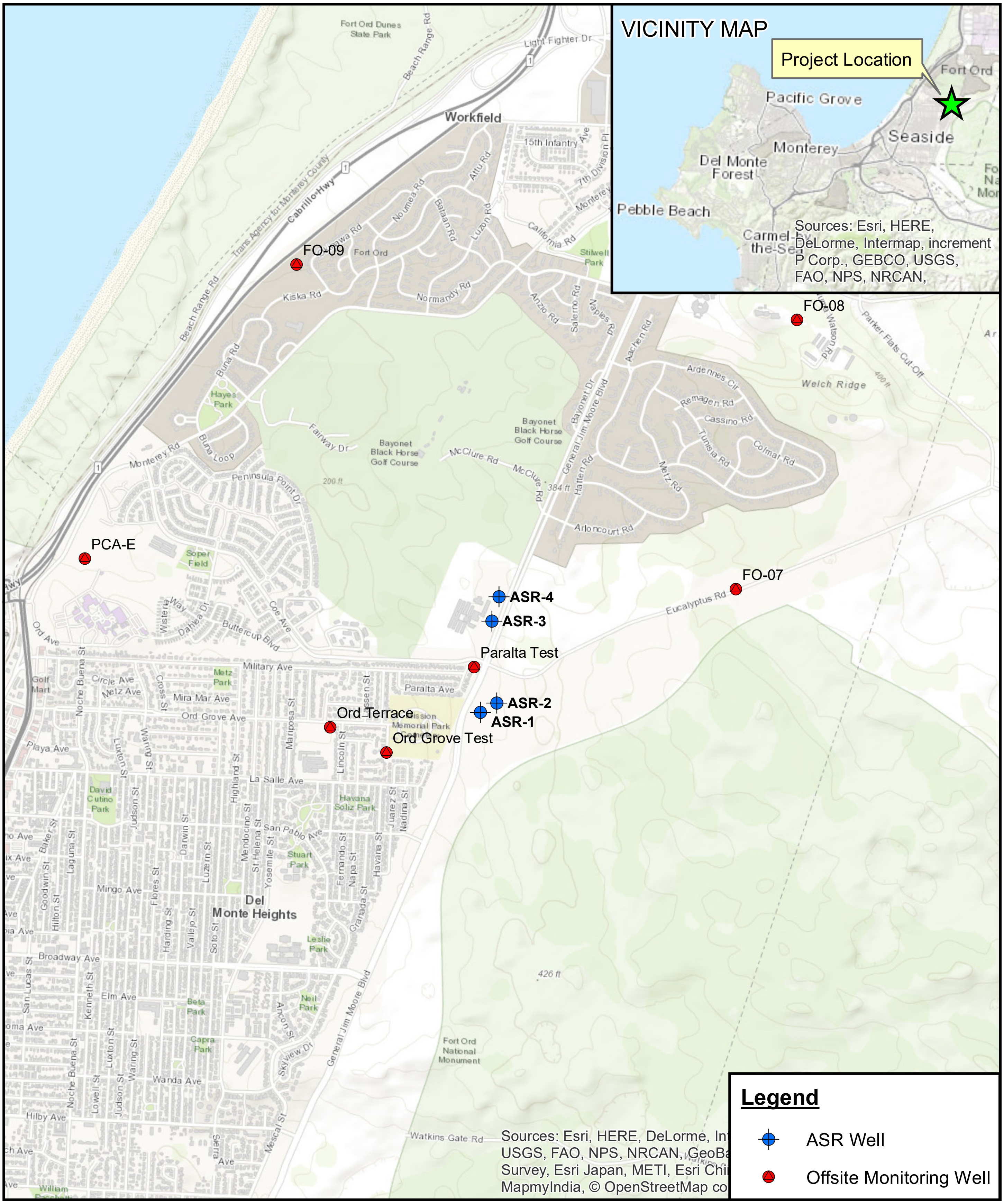
FIGURES

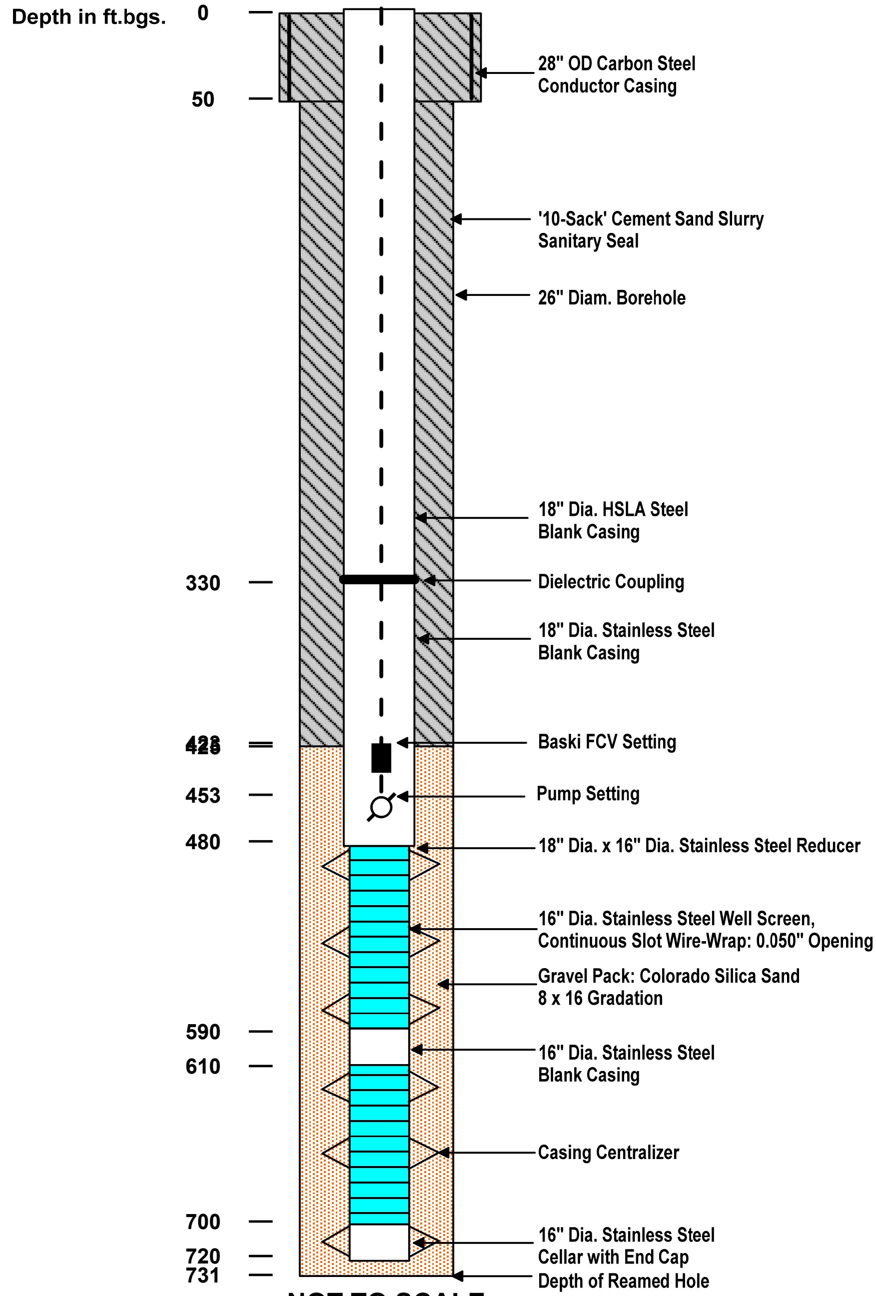
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 1. SITE LOCATION MAP
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098



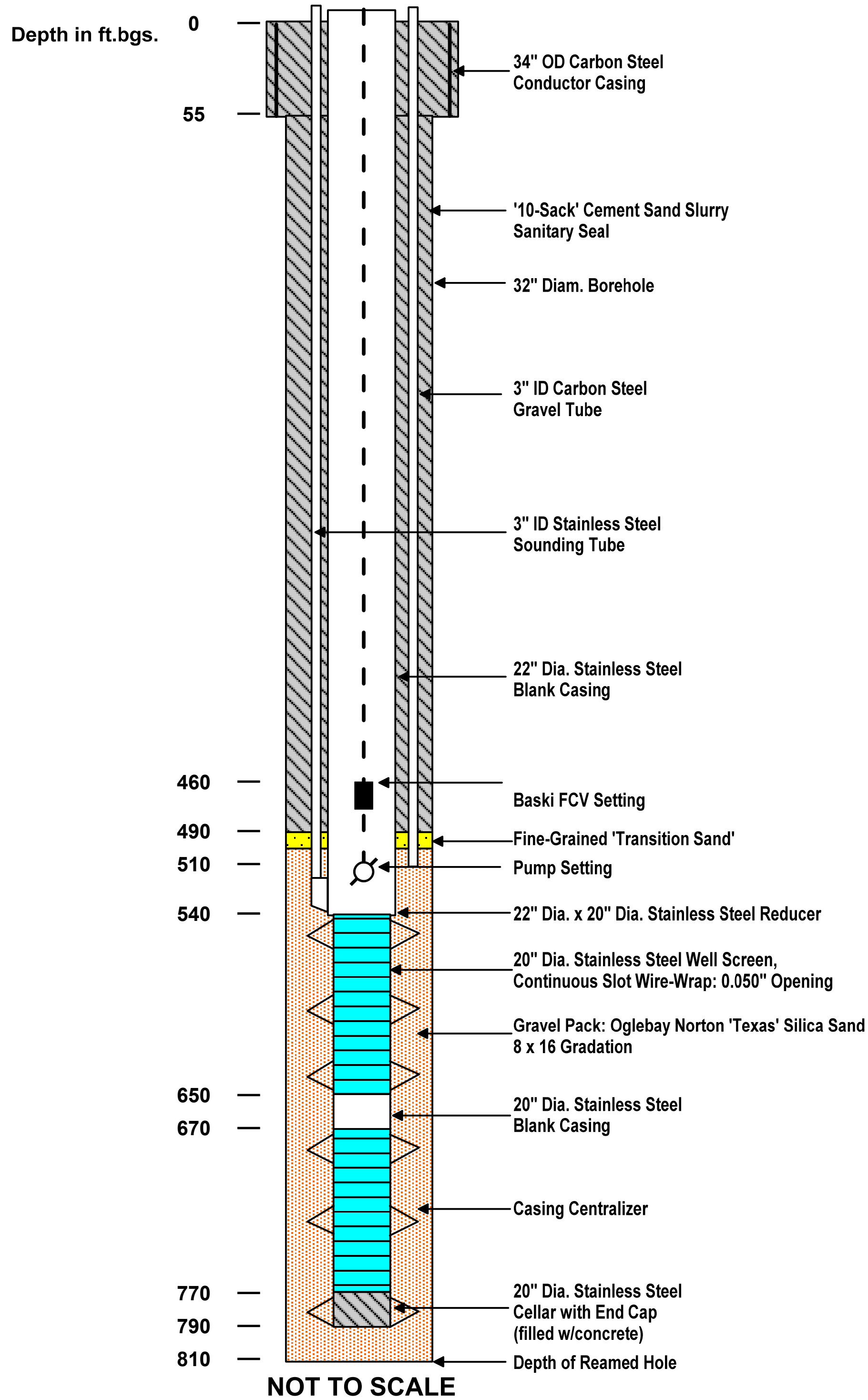
NOT TO SCALE

<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 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

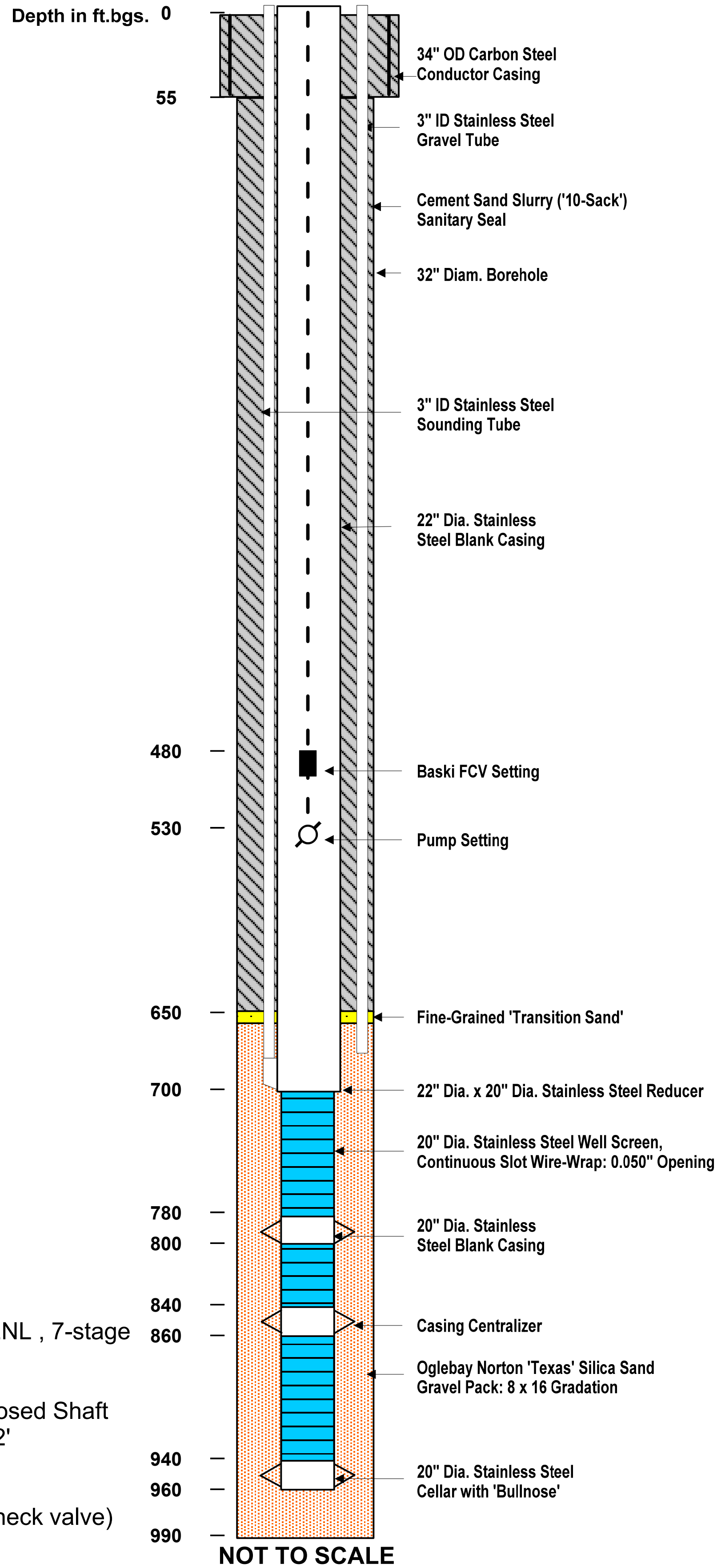


<u>Pump Assembly Notes:</u>
Hp: 600
Bowls: 16ENL, 7 stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 460' - 470'
Top of Bowls: 510'
Bowl Length: 10.5'
Suction Length: 10'
Intake: 530.5'

PUEBLO water resources

FIGURE 3. ASR-2 AS-BUILT SCHEMATIC
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

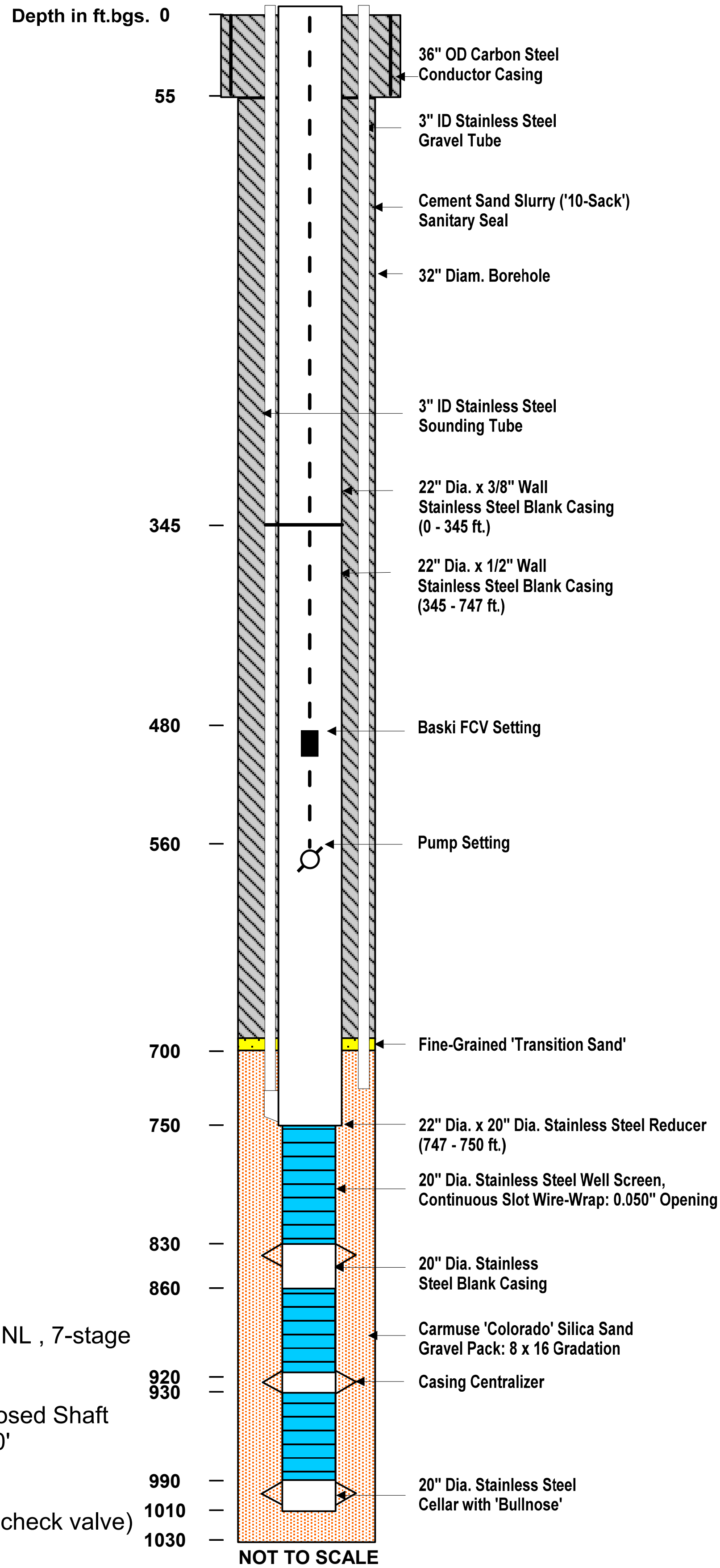


Pump Assembly Notes:
Hp: 600
Bowls: Flowserve Model 16 ENL , 7-stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 482' to 492'
Top of Bowls: 532'
Bowl Length: 10.5'
Suction Length: 8'(including check valve)
Intake: 550.5'

PUEBLO water resources

FIGURE 4. ASR-3 AS-BUILT SCHEMATIC
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

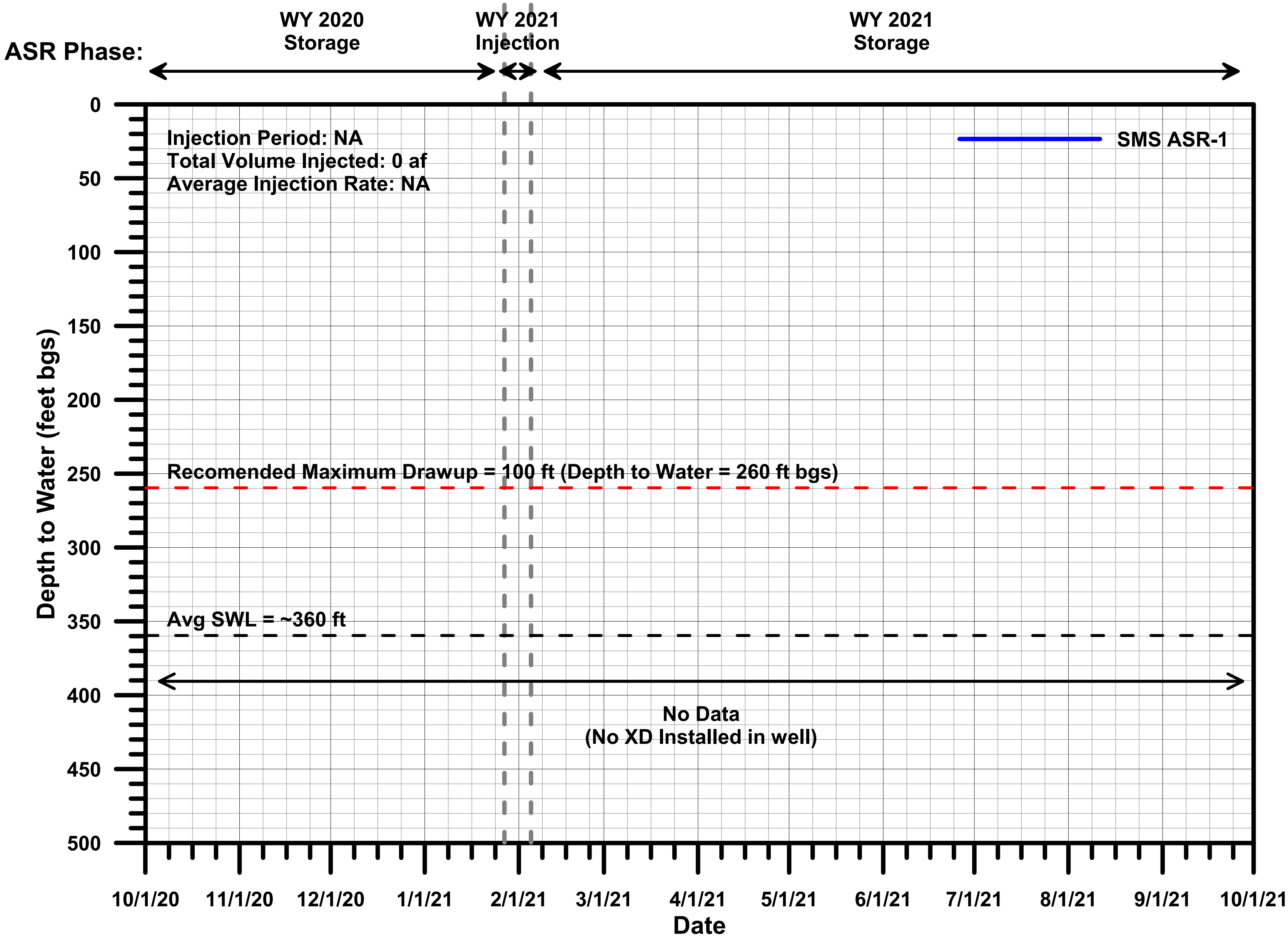


Pump Assembly Notes:
Hp: 600
Bowls: Flowserve Model 16 ENL , 7-stage
Col. Pipe Dia: 12"
Col. Pipe Length: 20'
Assy. Type: Water Flush/Enclosed Shaft
Baski FCV Setting: 480' to 490'
Top of Bowls: 562'
Bowl Length: 10.4'
Suction Length: 10' (including check valve)
Intake: 582.4'

PUEBLO water resources

FIGURE 5. ASR-4 AS-BUILT SCHEMATIC
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 7. ASR-1 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

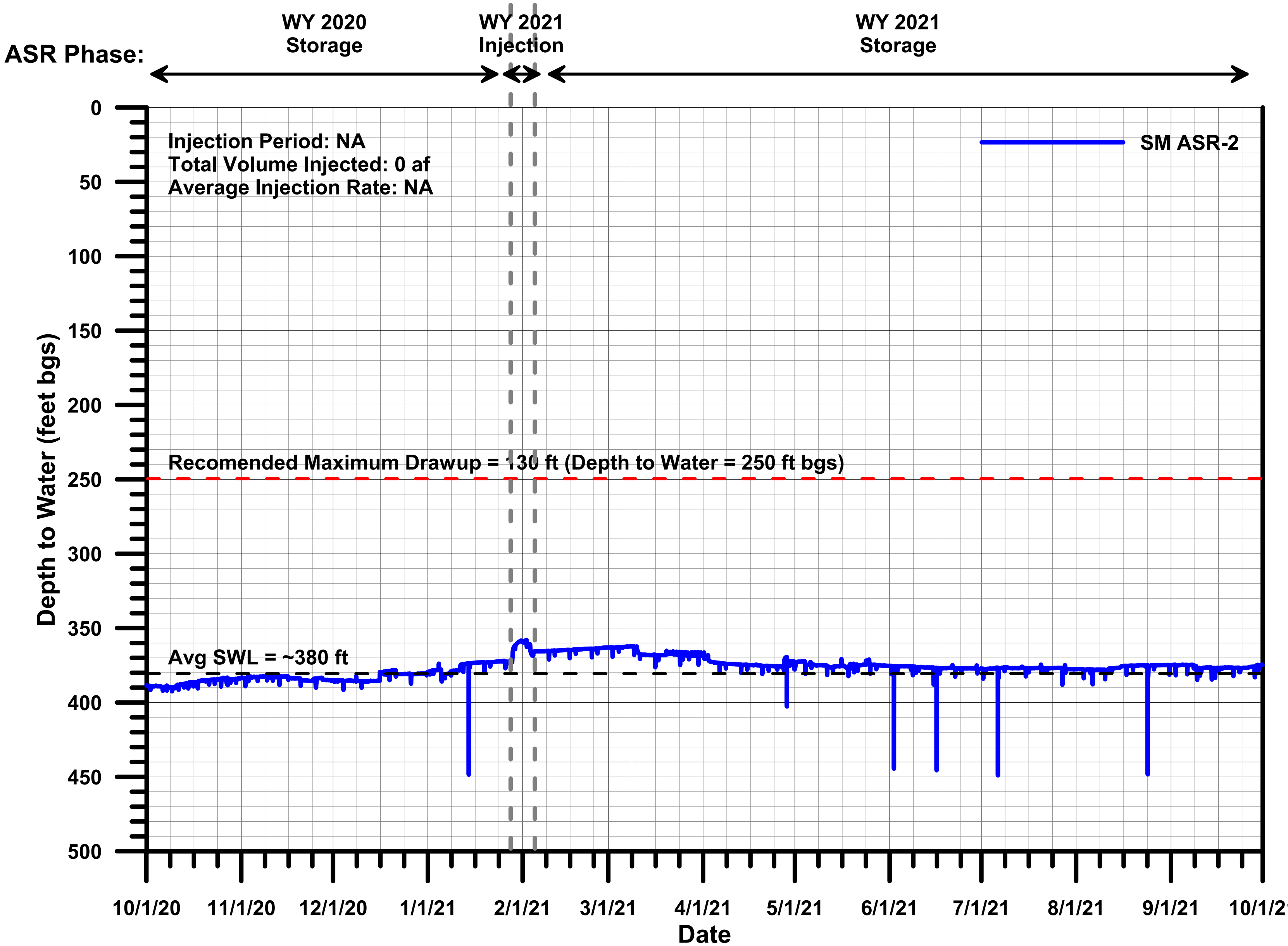
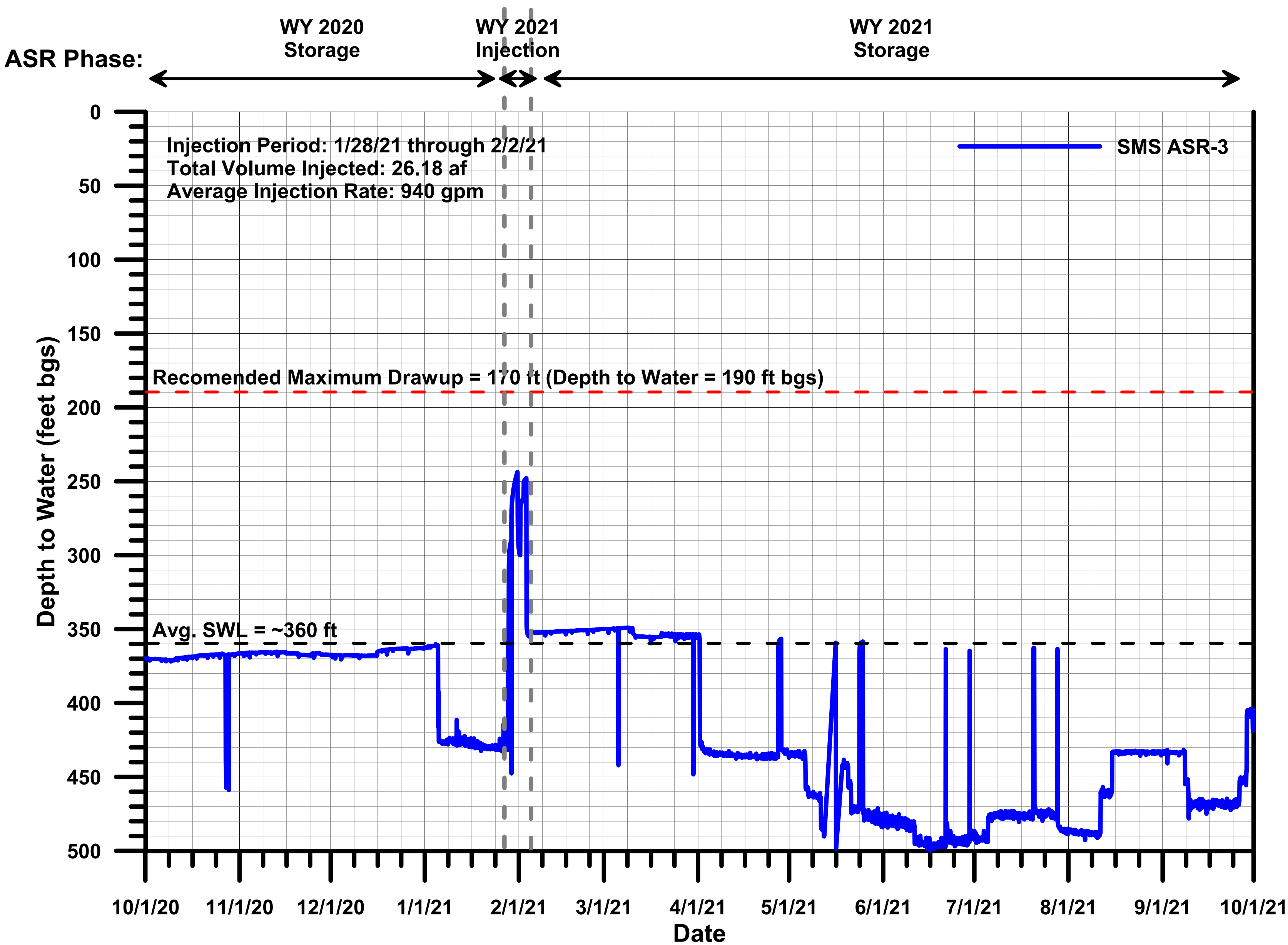


FIGURE 8. ASR-2 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

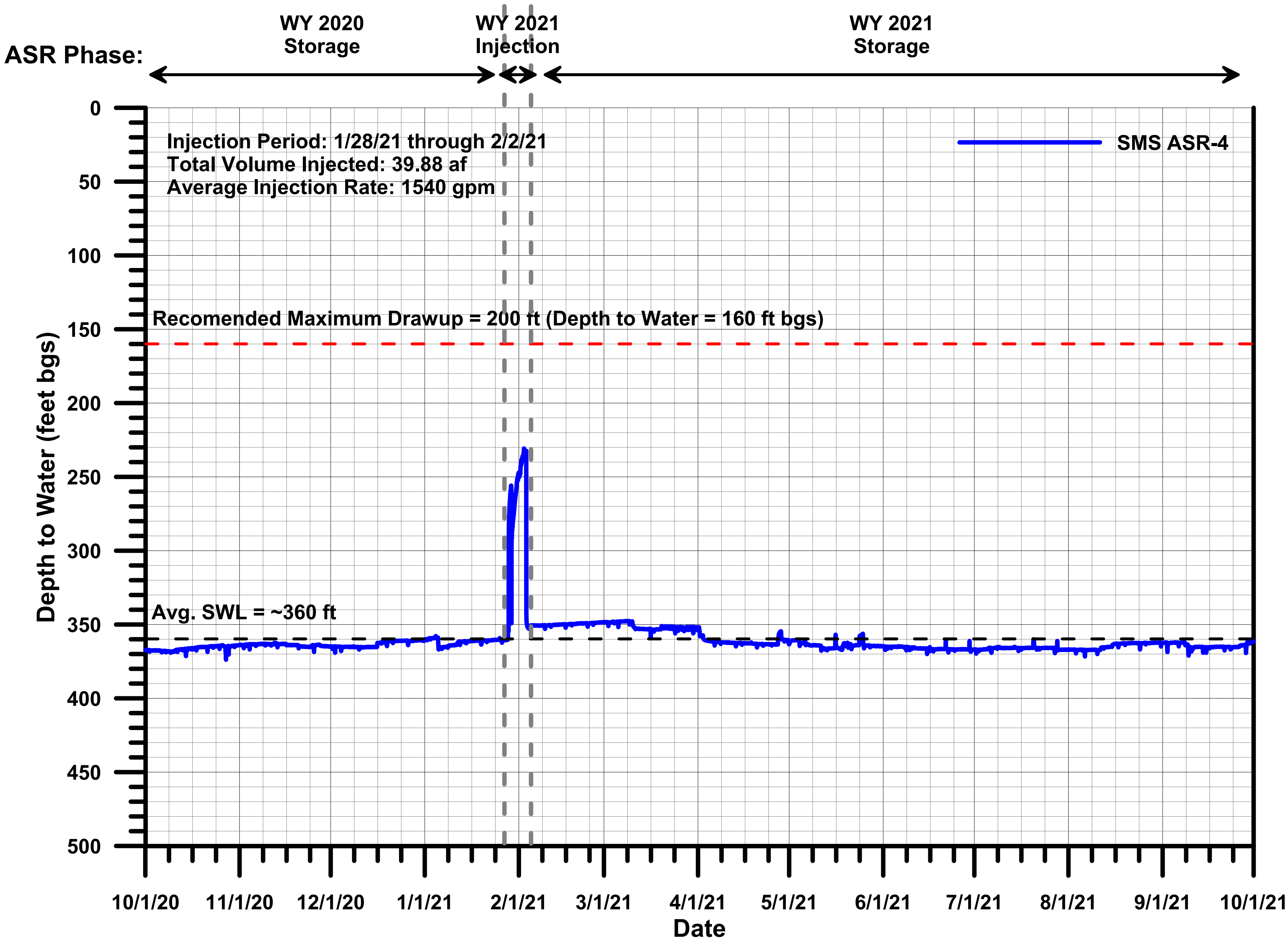
June 2022
Project No. 18-0098



PUEBLO
water resources

FIGURE 9. ASR-3 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

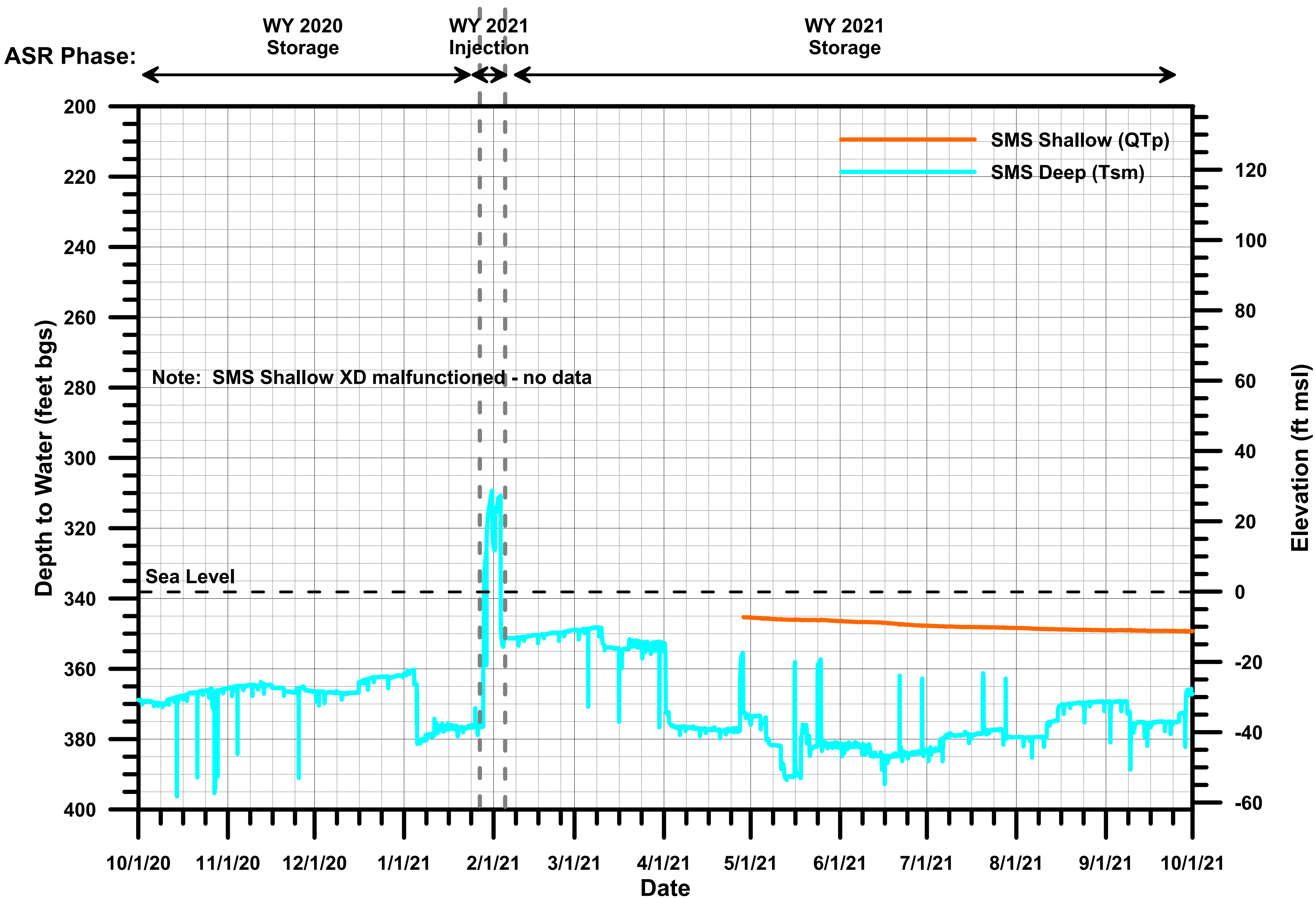
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 10. ASR-4 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 11. SMS MW WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

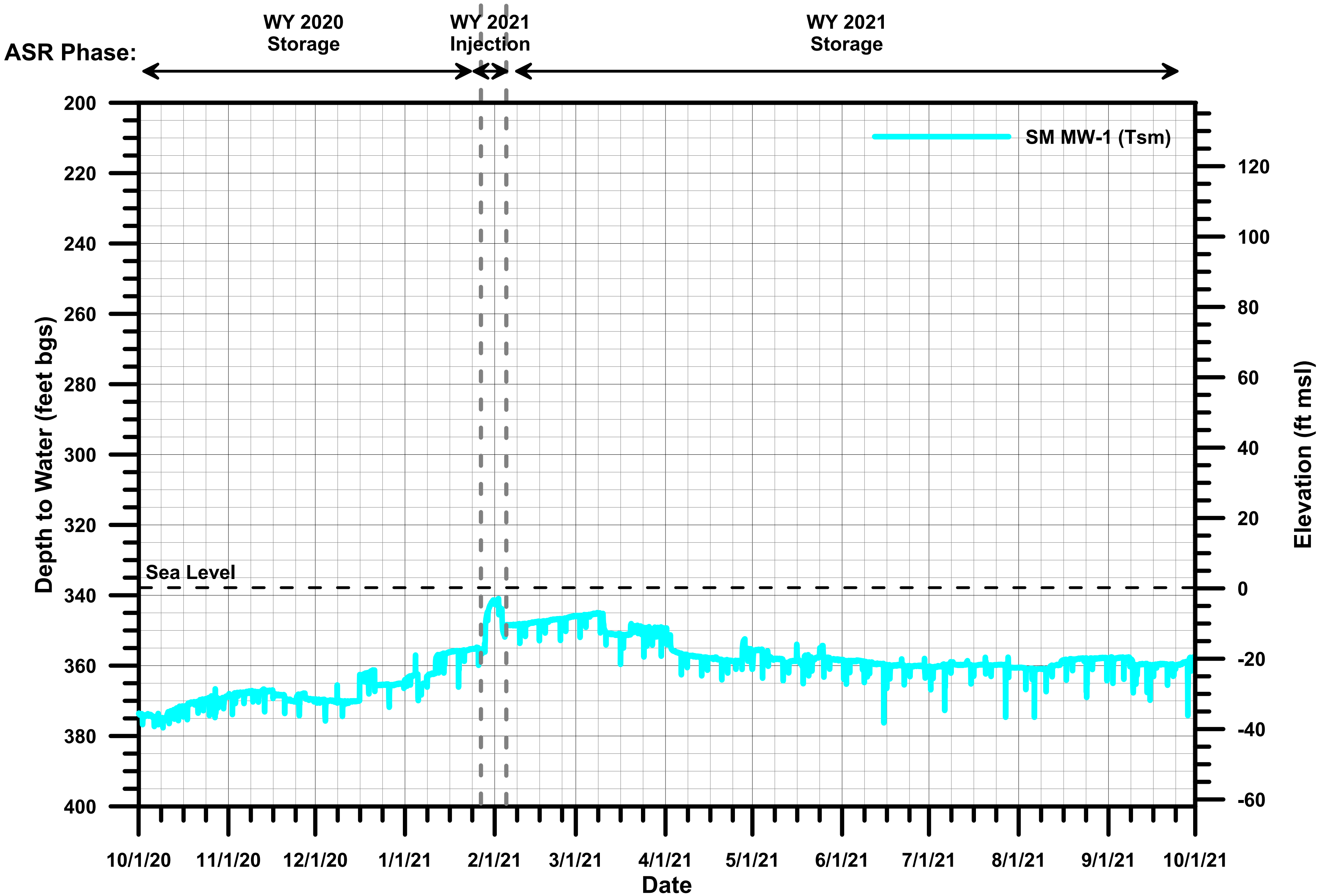


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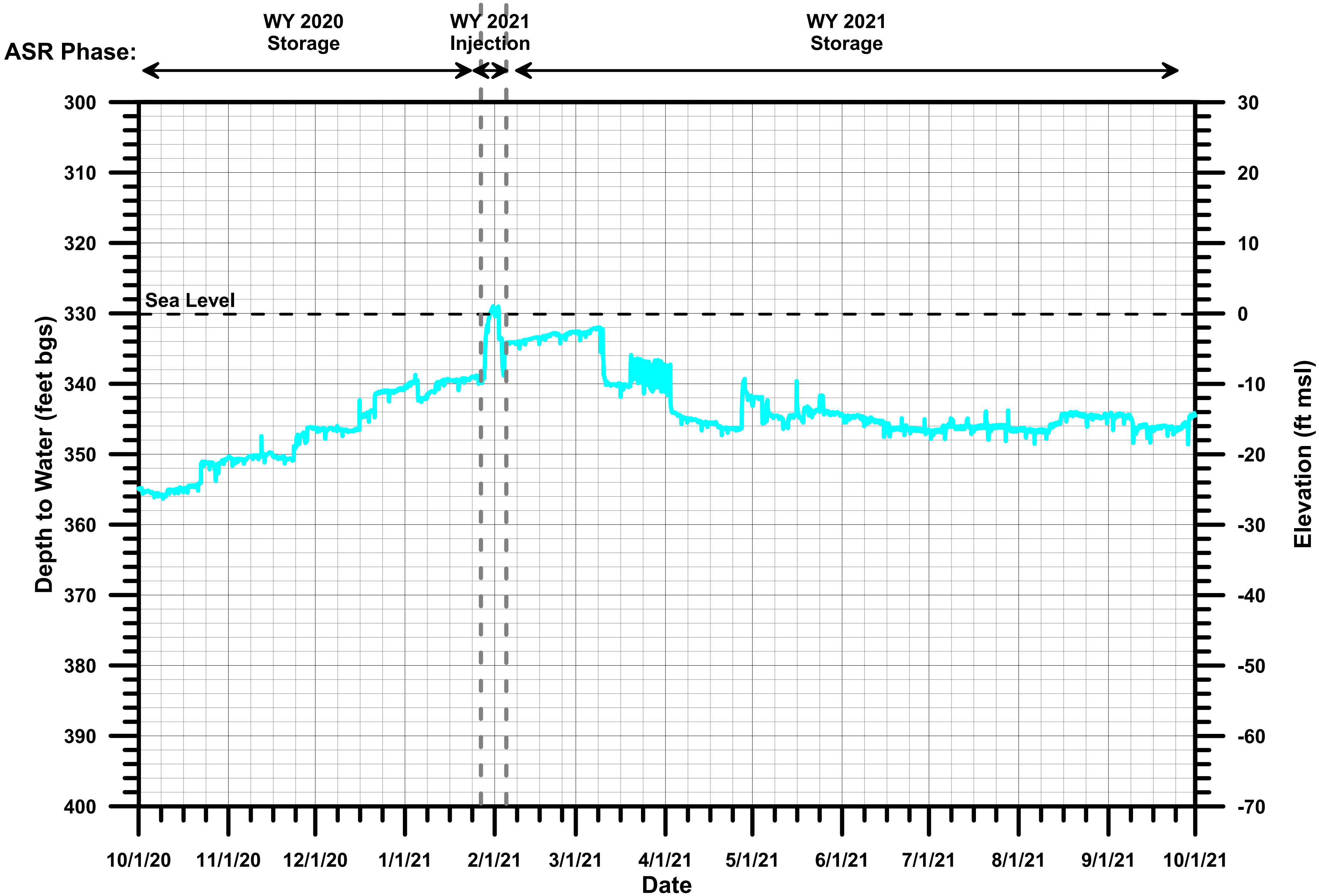
FIGURE 12. SM MW-1 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

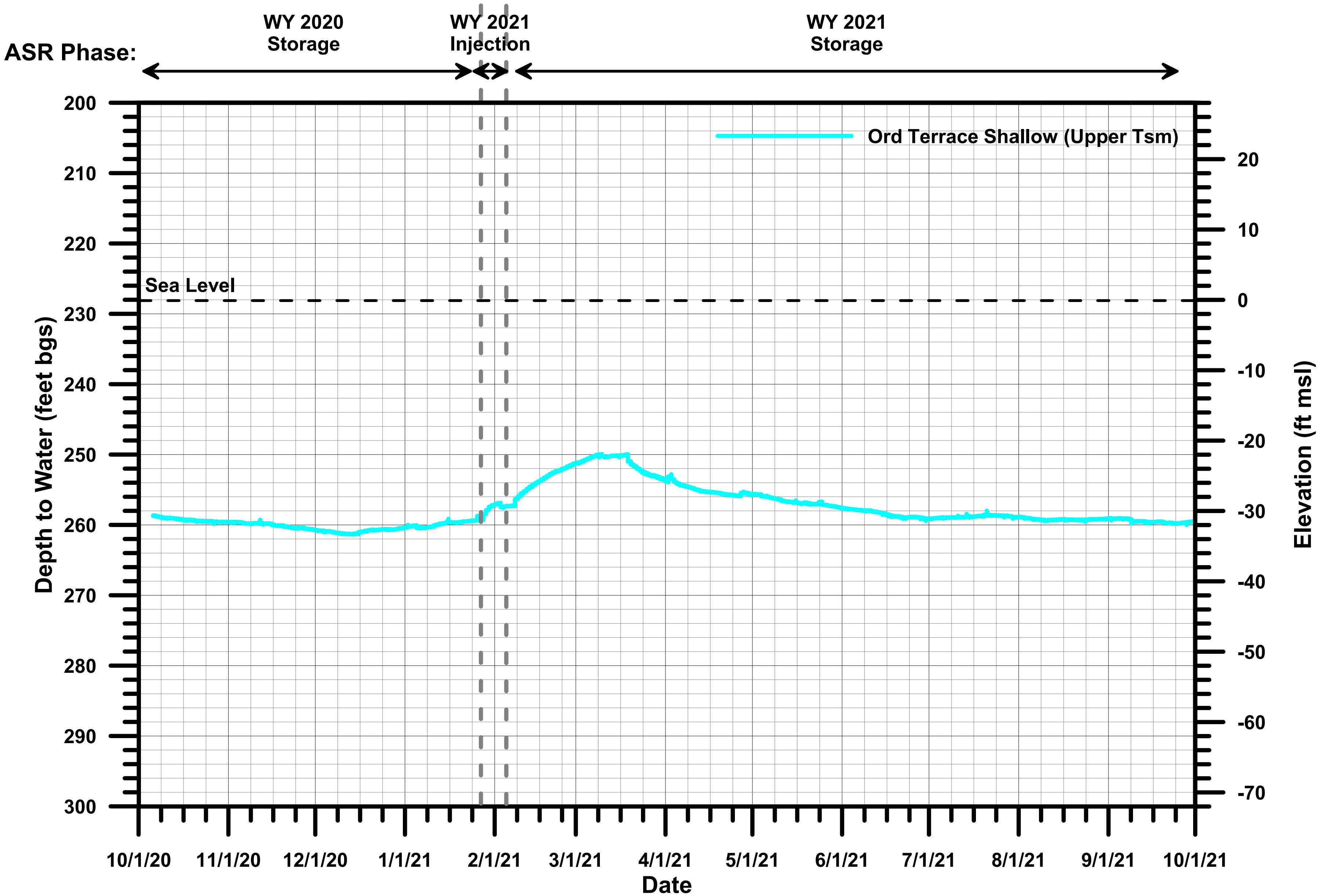
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 13. PARALTA TEST WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

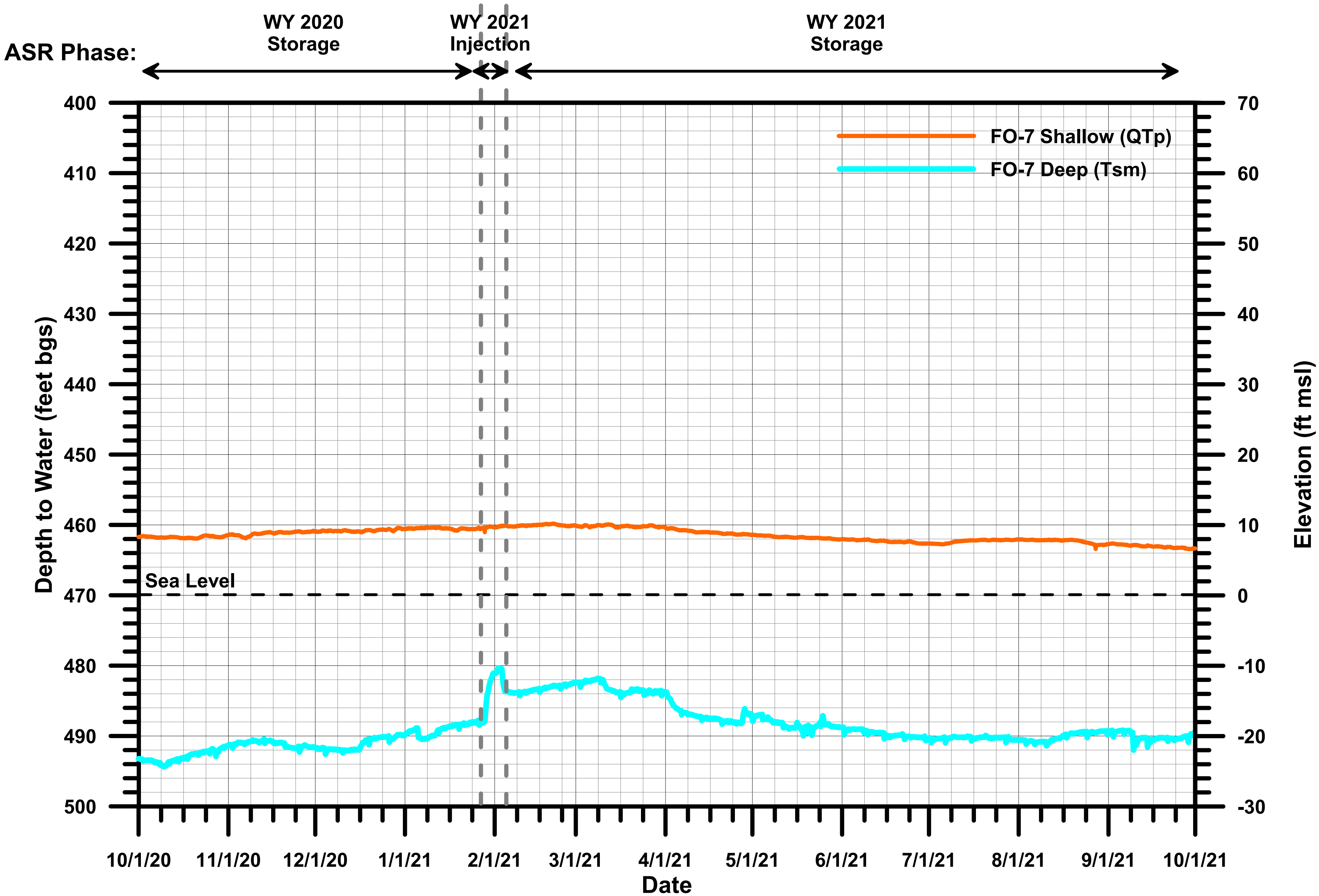
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 14. ORD TERRACE WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

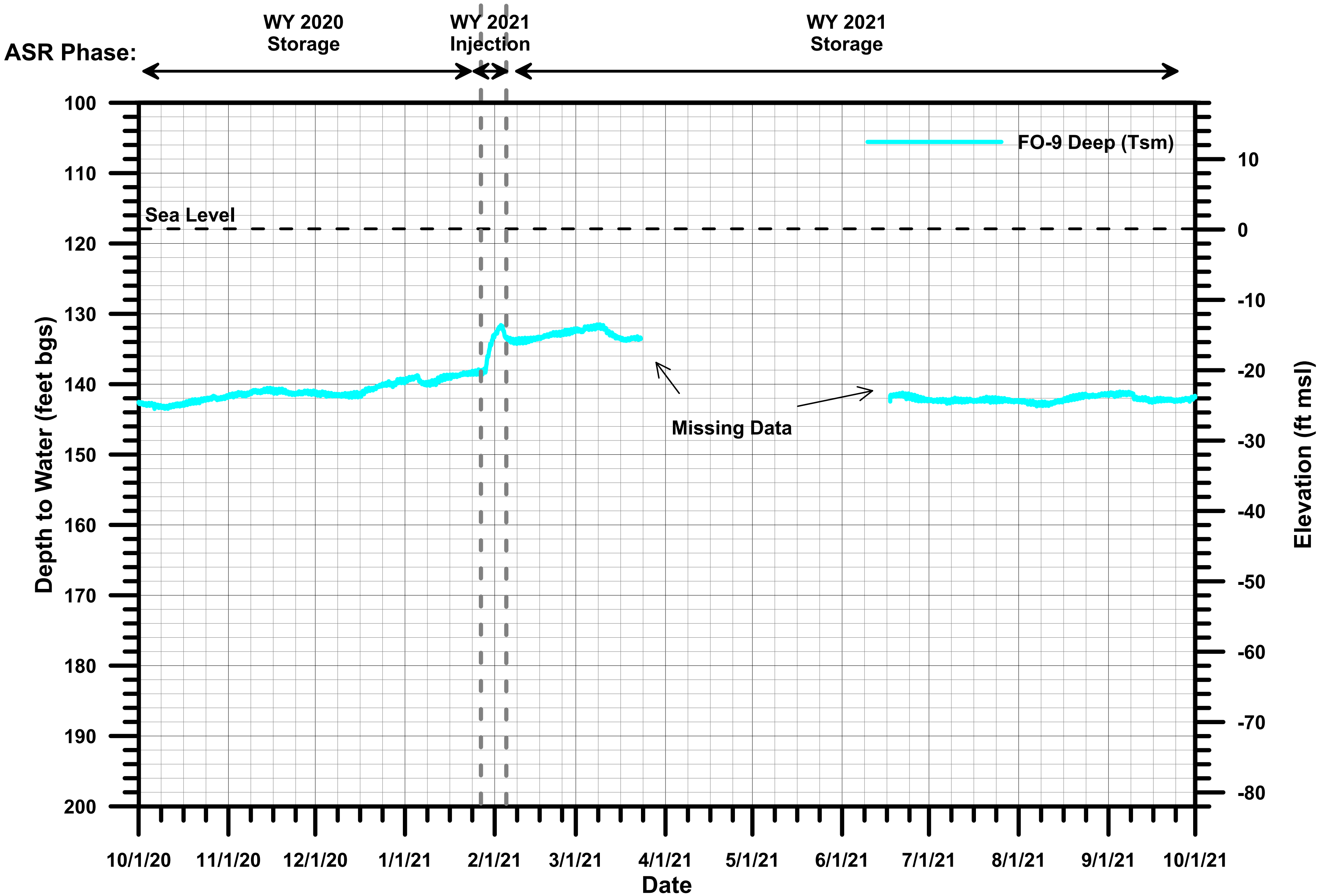
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 15. FO-7 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

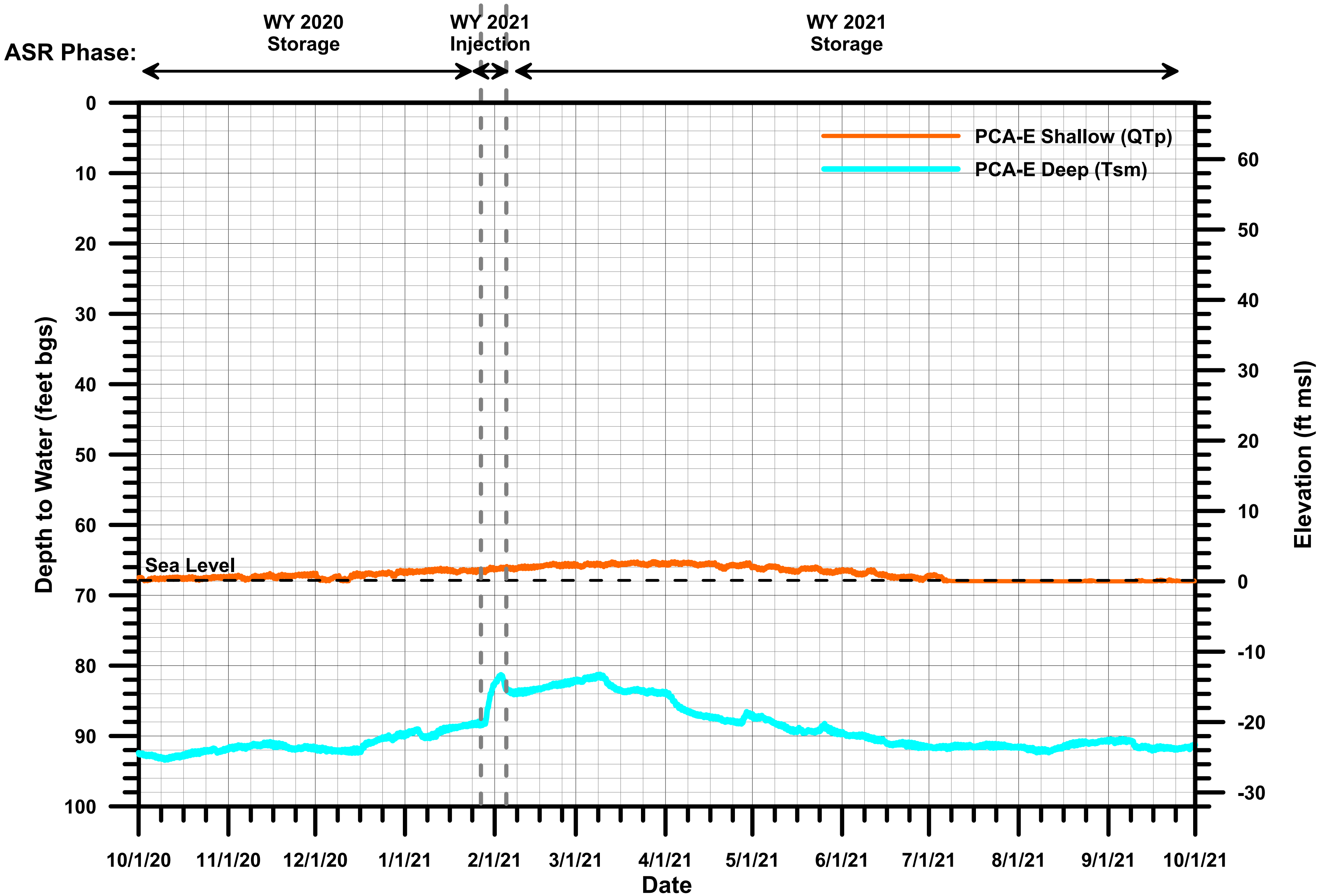
June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 16. FO-9 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098



PUEBLO water resources

FIGURE 17. PCA-EAST WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District

June 2022
Project No. 18-0098

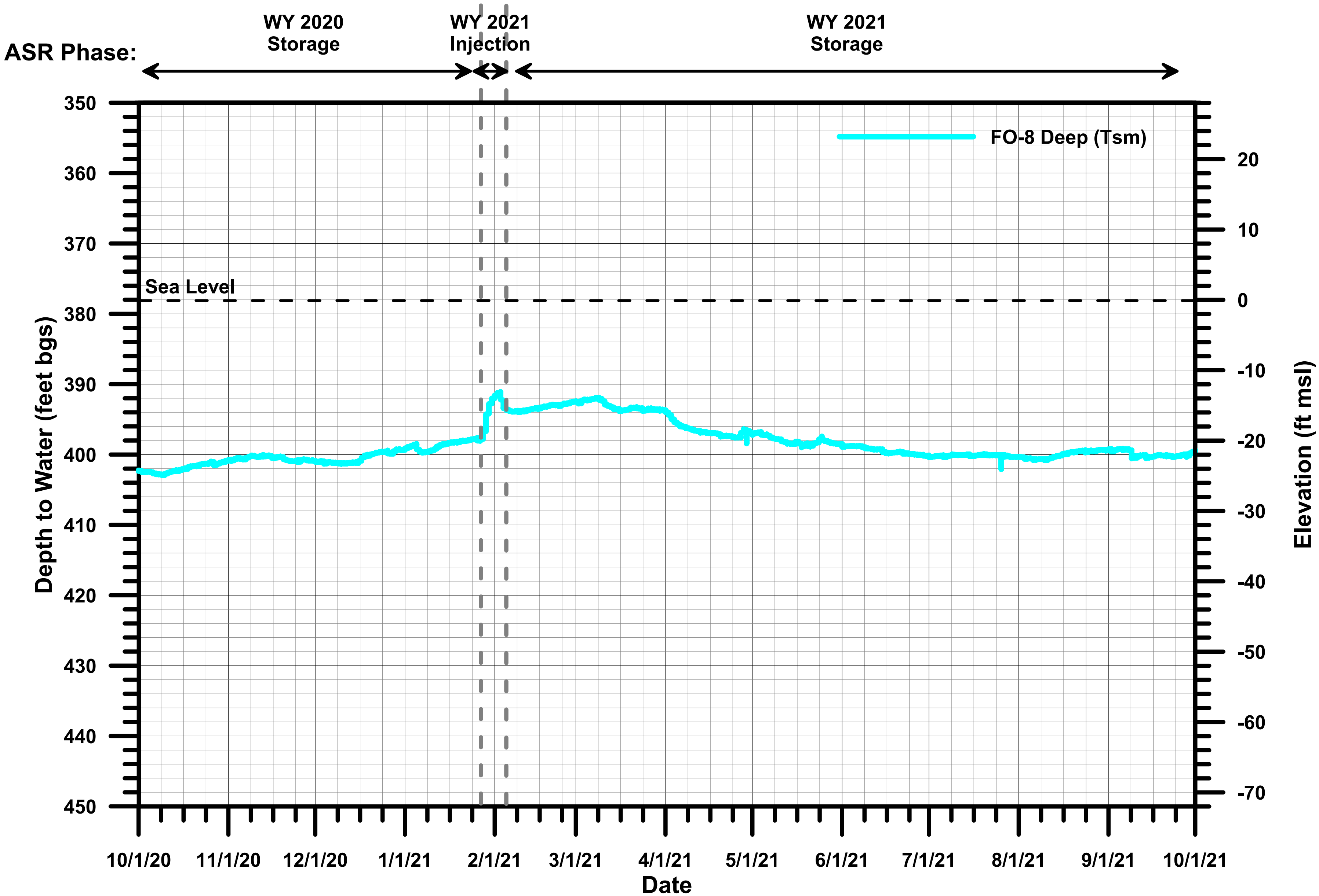


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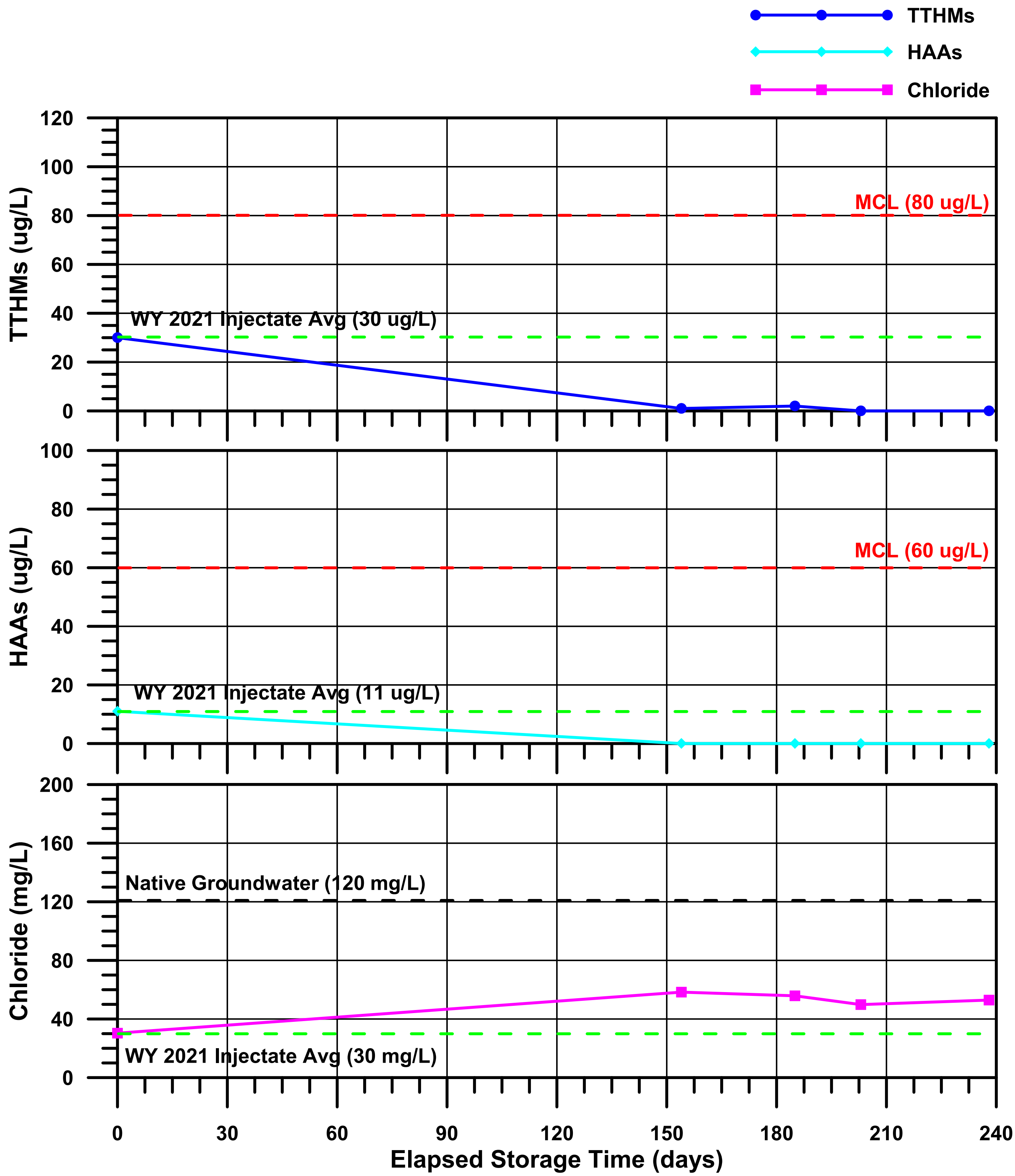
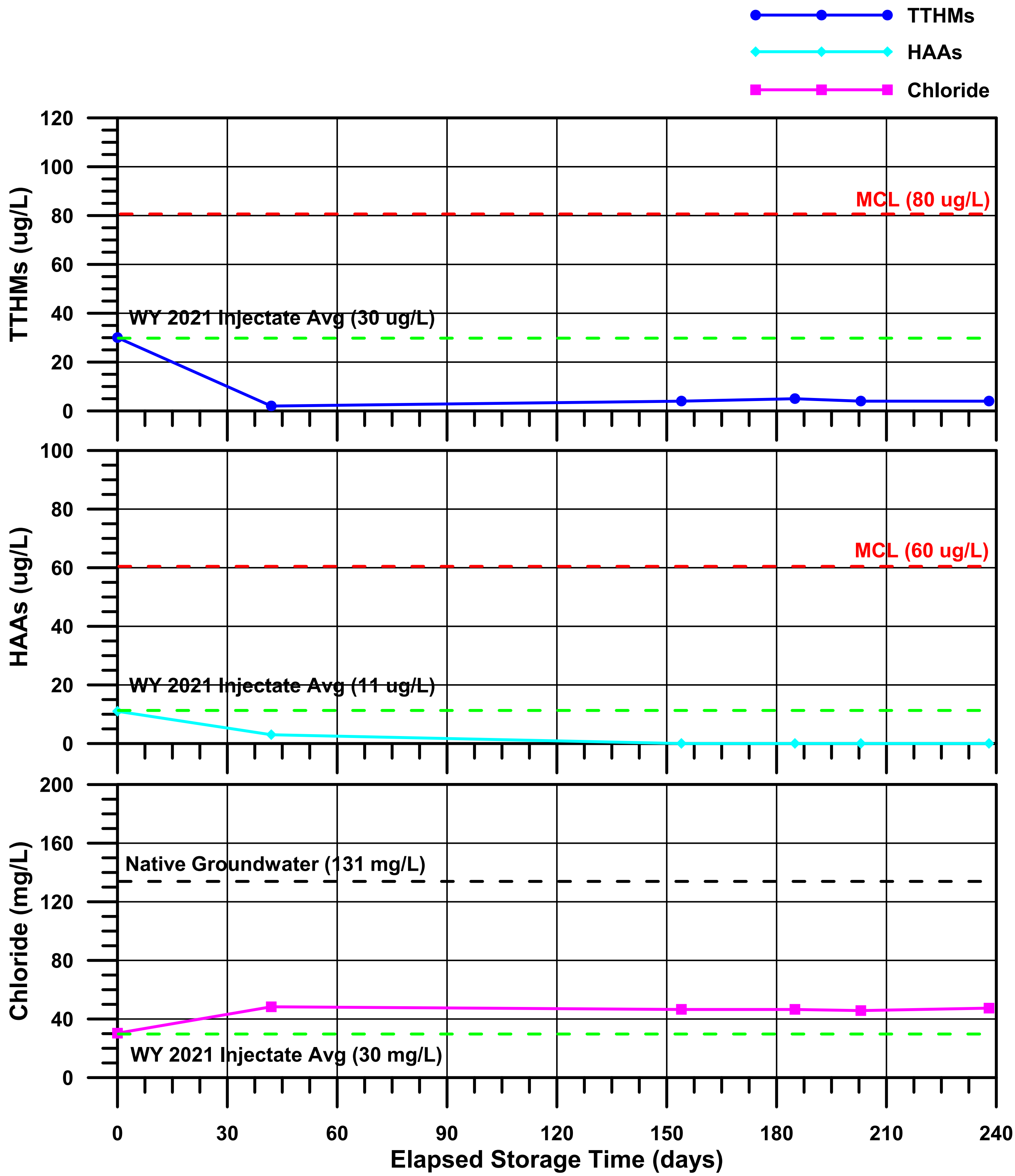
FIGURE 18. FO-8 WATER-LEVEL DATA
WY 2021 ASR Program
Monterey Peninsula Water Management District



PUEBLO water resources

FIGURE 19. ASR-1 DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District



PUEBLO water resources

FIGURE 20. ASR-2 DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District

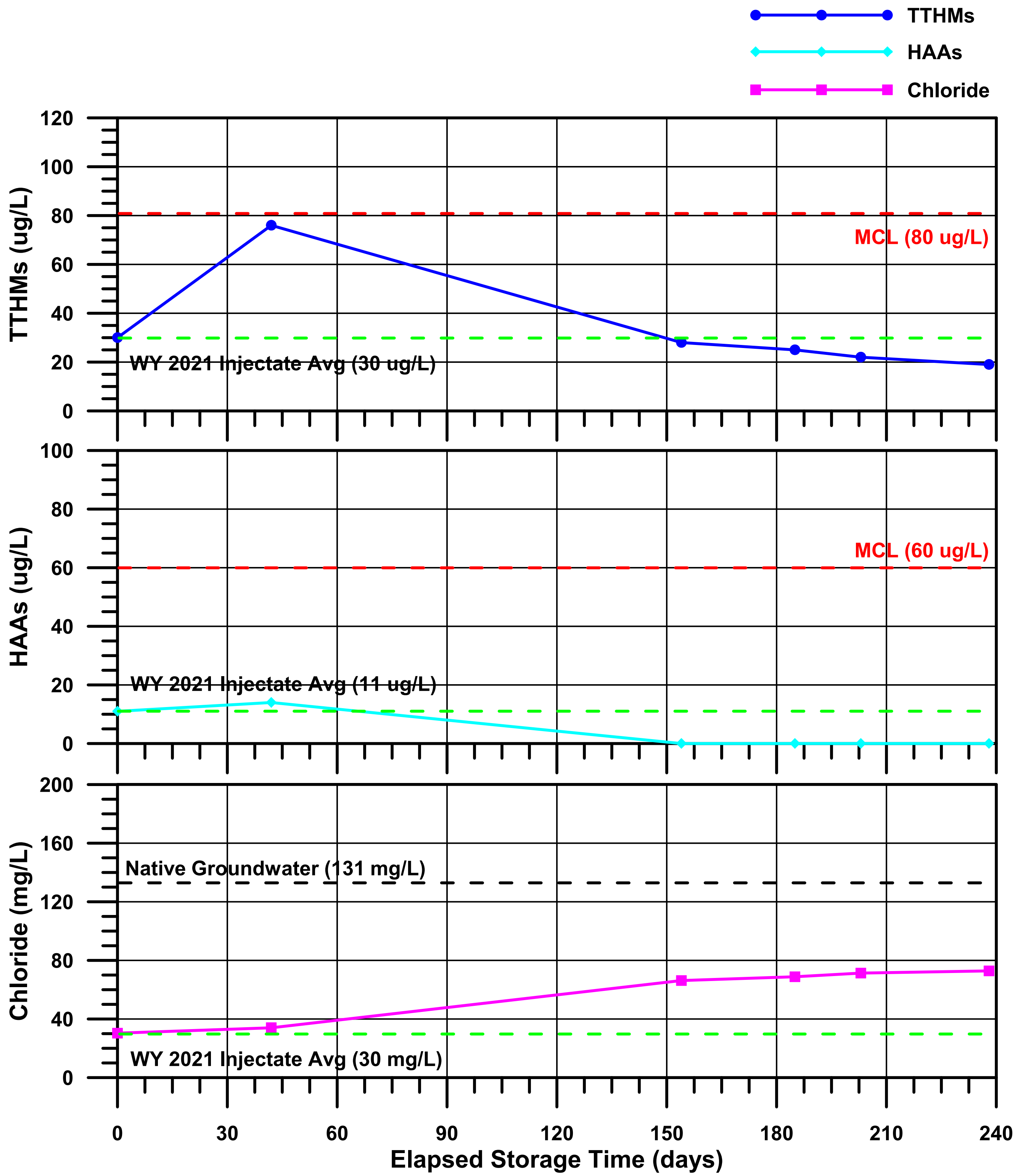
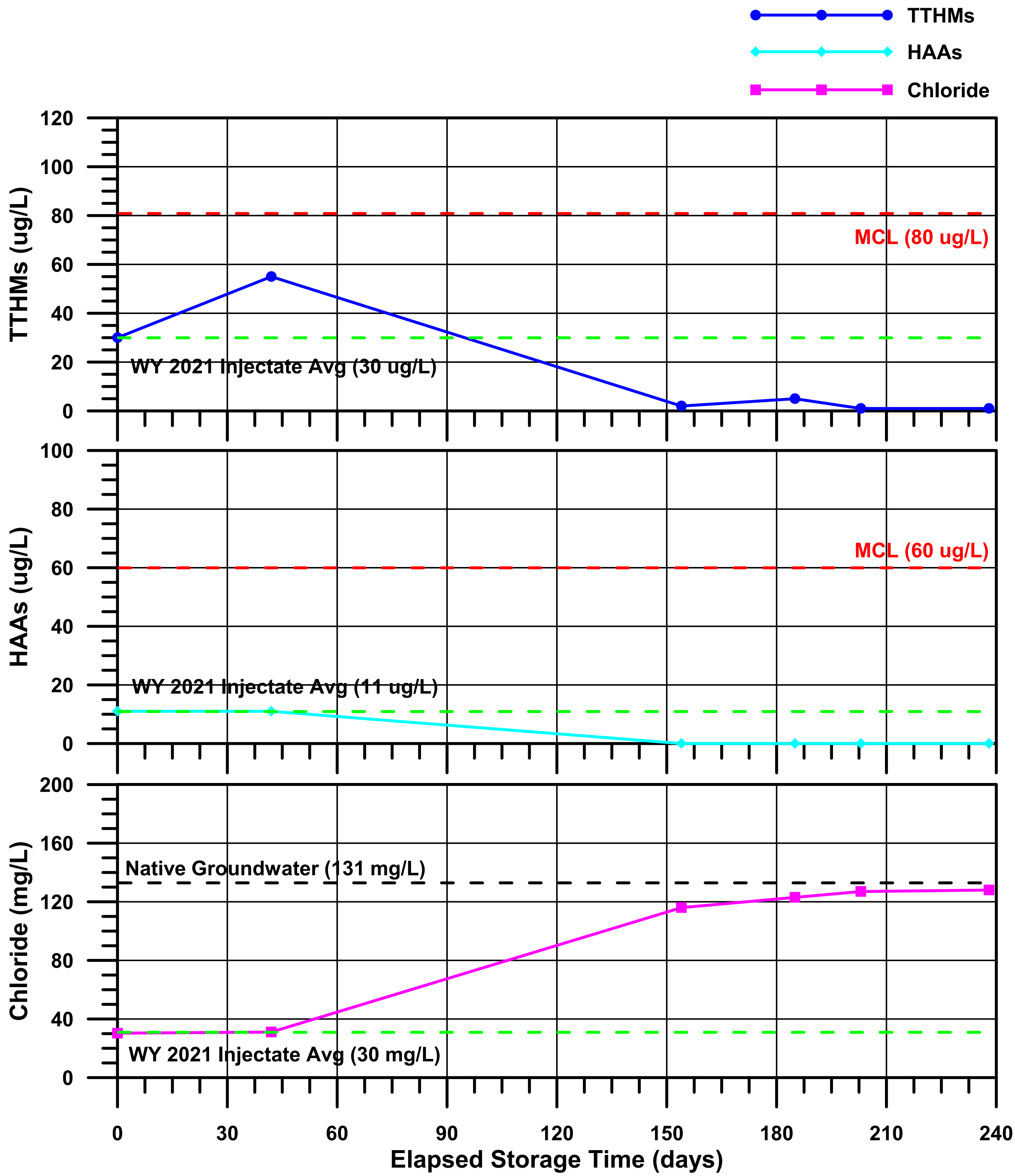
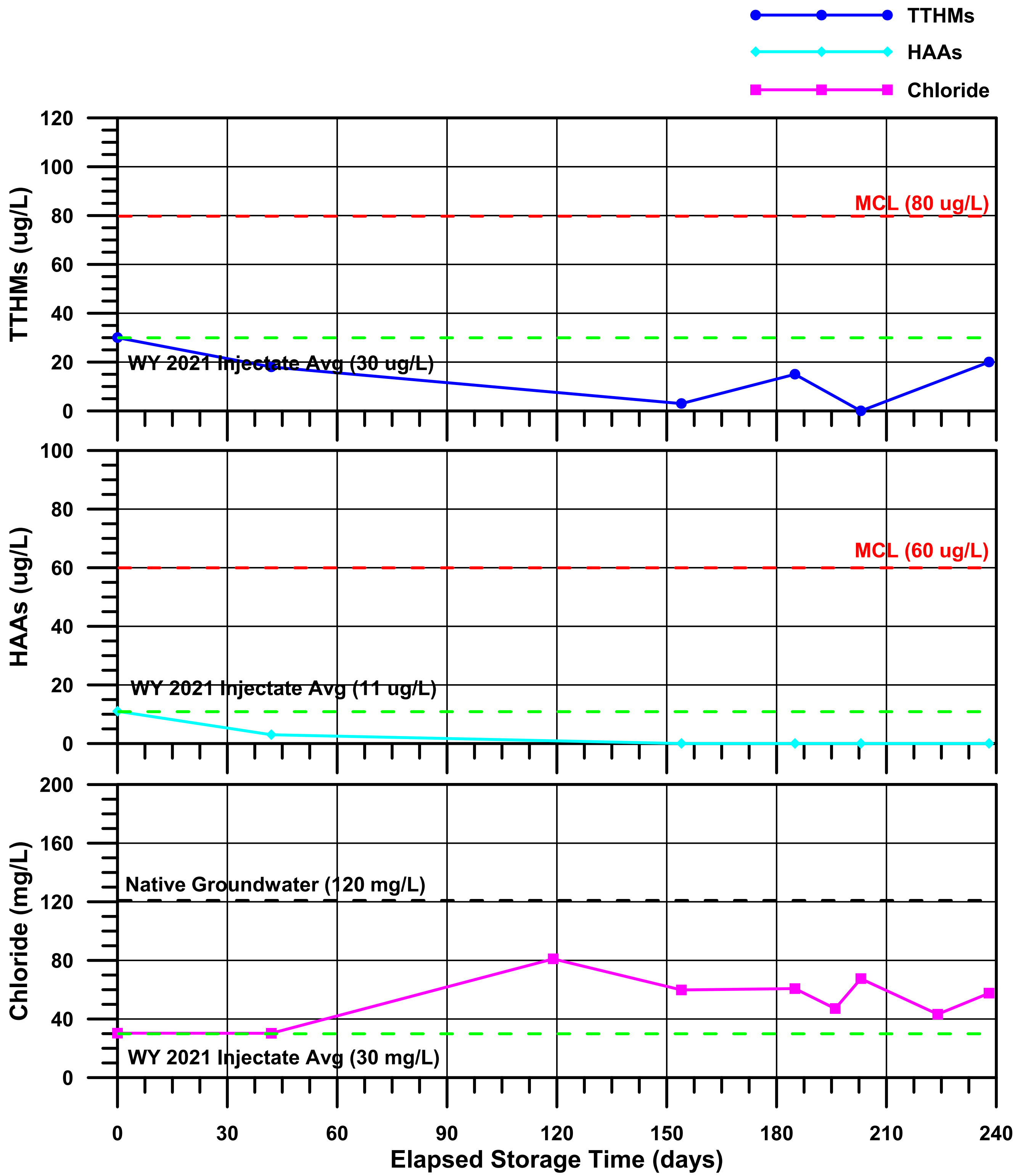


FIGURE 21. ASR-3 DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District



PUEBLO water resources

FIGURE 22. ASR-4 DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District



PUEBLO water resources

FIGURE 23. SM MW-1 DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District

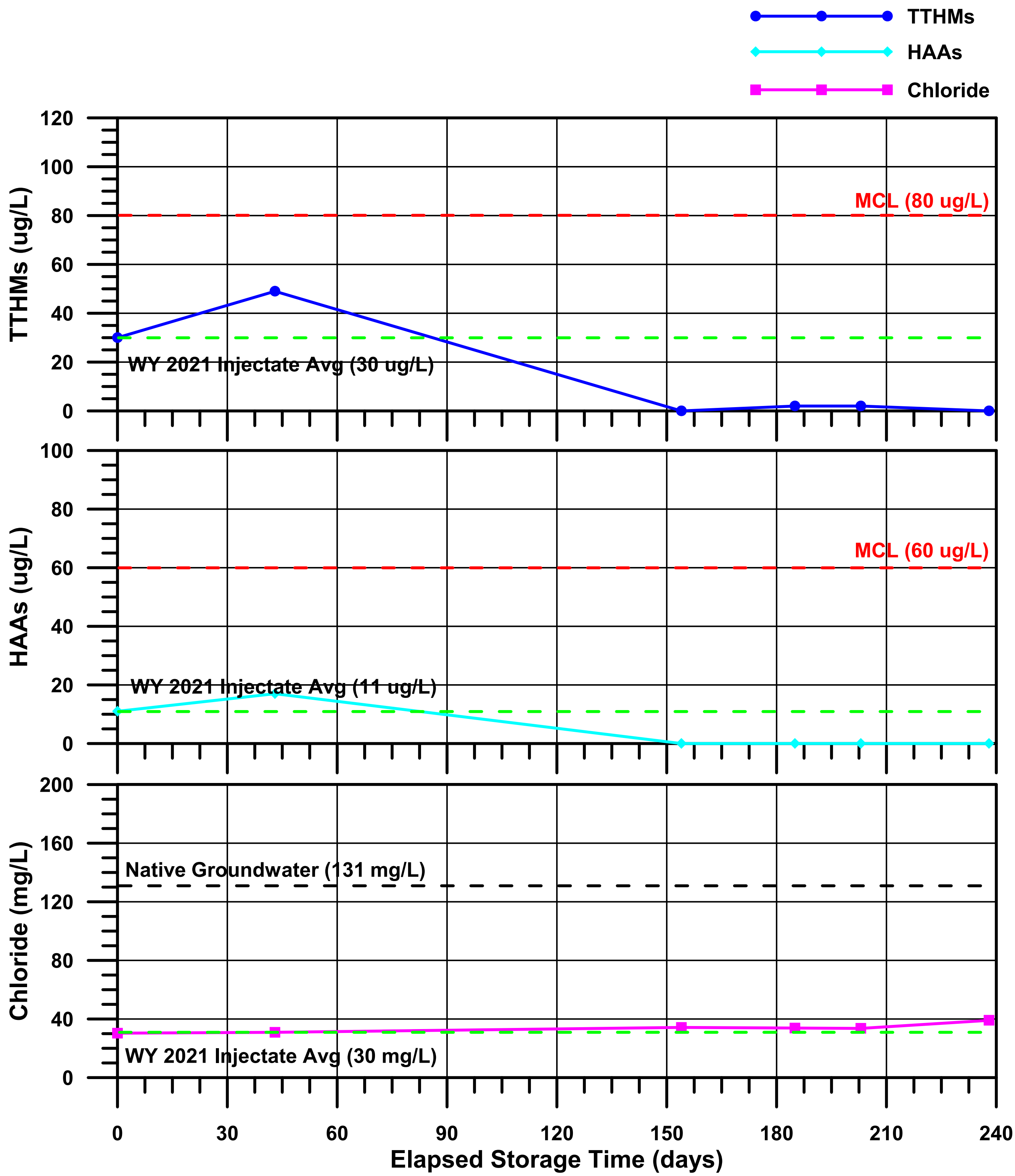


FIGURE 24. SMS DEEP DISINFECTION BYPRODUCTS PARAMETERS
WY 2021 ASR Program
Monterey Peninsula Water Management District

APPENDIX A - FIELD DATA
(not included in draft)

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