ERM

1050 SW 6th Avenue
Suite 1650
Portland, OR 97204

T +1 503 488 5282
F +1 503 488 5142

erm.com

MEMO

TO	Katie Daugherty, Oregon Department of Environmental Quality
FROM	Brendan Robinson, PE, Environmental Resources Management, Inc.
DATE	15 March 2024
REFERENCE	0719595 Phase 106
SUBJECT	January 2024 GW SCM Monthly Performance Monitoring Report

1. INTRODUCTION

Environmental Resources Management, Inc. (ERM) prepared this Monthly Performance Monitoring Report (MPR) on behalf of Legacy Site Services LLC (LSS), agent for Arkema Inc. (Arkema), for the former Arkema Portland Plant (the Site) at 6400 NW Front Avenue in Portland, Oregon. The Oregon Department of Environmental Quality (ODEQ), in its letter dated 31 May 2019 and in the subsequent meeting with LSS and ERM on 2 July 2019, requested that LSS initiate monthly status reports associated with the onsite groundwater source control measure (GW SCM) consistent with the Performance Monitoring Plan (PMP; ERM 2014) beginning July 2019. The 2014 PMP was prepared pursuant to the Order on Consent issued by ODEQ, signed on 31 October 2008 (ODEQ No. LQVC-NWR-08-04; Consent Order). The purpose of the PMP was to present the monitoring, reporting, and adaptive management processes used during implementation of the GW SCM. On 30 November 2021, ODEQ directed LSS that following the October 2021 MPR, subsequent MPRs would be suspended pending the implementation of the Groundwater Extraction Enhancement (GEE) project in 2022. During that time, ODEQ requested monthly schedule updates in lieu of MPRs. The trench wells installed as part of the GEE project were started on 27 November 2022, and MPR writing restarted in December 2022. The purpose of the GEE project was to install new extraction capacity to achieve the Capture Zone Objectives.

This January 2024 MPR summarizes the GW SCM performance monitoring data collected in January 2024. This report assesses the current gradient status and proposes system improvements to meet the Capture Zone Objectives set in the PMP.

2. GROUNDWATER SOURCE CONTROL IMPLEMENTATION

A detailed description of the design and implementation of the GW SCM is provided in the Revised Upland Feasibility Study Work Plan (ERM 2017); however, a brief description of the GW SCM is provided here. In February 2009, ODEQ and the U.S.

Environmental Protection Agency (USEPA) approved the general approach for the GW SCM. This approach included installation of a groundwater barrier wall (GWBW), groundwater recovery wells, and a Groundwater Extraction and Treatment (GWET) system, with treated water discharged to the Willamette River. ODEQ and USEPA approved the Groundwater Barrier Wall Final Design (ERM 2012) on 7 August 2012. Construction of the GWBW began in May 2012 and was completed in December 2012. ODEQ approved the Groundwater Extraction and Treatment System Final Design (ERM 2013) on 2 April 2013. Construction of the GWET system began in December 2012 and was completed in December 2013.

GWET startup and optimization commenced in May 2014. The GW SCM at the Site consists of the following primary components (Figure 1):

1. A GWBW to physically separate the affected upland portions and in-water portions of the Site.
2. Hydraulic control to minimize flow of groundwater containing unacceptable concentrations of constituents of potential concern (COPCs) around, over, and under the GWBW.
3. Management of extracted groundwater through the GWET system, with treated effluent discharged to the Willamette River under a National Pollutant Discharge Elimination System (NPDES) Permit.

On 1 September 2018, ERM submitted the Draft GWET System Effectiveness Evaluation (Draft SEE Report; ERM 2018). The Draft SEE Report provided an update on the corrective actions implemented to improve the performance of the GWET system, evaluate the extent of capture, and propose actions to improve hydraulic capture. Additional data requested by ODEQ were submitted on 26 October 2018.

The key objective of the GW SCM is to achieve hydraulic containment of the alluvial sequence within the Target Capture Zone at the Site to prevent the flow of COPCs to the Willamette River. The Site alluvial aquifer sequence within the Target Capture Zone consists of the Shallow Zone, Intermediate Zone, and the Deep Zone. Site hydraulic conditions are variable and subject to both seasonal and daily tidal fluctuations.

The hydraulic control component formerly consisted of 22 recovery wells (RWs) prior to the implementation of the GEE. Of the 22 pre-existing RWs, four were retained for active pumping. The remaining 18 former RWs had pumps removed but retained their pressure transducers so that they can continuously collect high-resolution groundwater elevation data. The hydraulic control system now consists of the four-remaining active RWs, as well as seven groundwater extraction trenches that each contain two extraction wells (EWs). Each trench is 50 feet deep, 50 feet long, and 3 feet wide and is filled with an engineered backfill. More information about the groundwater extraction trenches is provided in the Final Design Report (ERM 2022). The gradient control-monitoring network consists of six gradient control clusters (GCCs) with each cluster containing six monitoring points. Within each RW, EW, and GCC location, pressure transducers are continuously collecting high-resolution groundwater elevation data. Each GCC contains three transducers interior to the wall and three transducers exterior to the wall screened in the Shallow, Intermediate, and Deep Aquifers at the Site.

3. HYDRAULIC CONTAINMENT MONITORING PROGRAM

As described in the PMP, the purpose of hydraulic monitoring (i.e., groundwater elevation data) is to provide sufficient data to demonstrate an inward hydraulic gradient across the GWBW and to evaluate the effective hydraulic capture produced by the GW SCM.

Monitoring requirements were established in the PMP to demonstrate GWET effectiveness. The Site monitoring program includes groundwater elevation data (manual and transducer measurements) collected from the 36 monitoring points located within six GCCs spaced across the GWBW, with piezometers interior and exterior to the wall, throughout the alluvial sequence; and groundwater elevation and flow rate data from the four-remaining active RWs and 14 EWs. High-resolution groundwater elevation data is also collected from the 18 inactive RWs. Additionally, one new monitoring well was installed in each of the seven extraction trenches for manual water level measurement. These data were used to prepare horizontal and vertical potentiometric surface maps representing potentiometric differences between the alluvial sequences, and to generate spatial and temporal hydrographs to evaluate hydraulic capture.

3.1 GROUNDWATER ELEVATION MONITORING

Groundwater elevation monitoring was completed on 5 January 2024. Manual groundwater elevations were measured at wells that were experiencing transducer mechanical issues or that were offline during the groundwater elevation measurement event. All inactive RWs were manually measured in the month of June to affirm proper calibration. Manual water levels for those RWs are reported. Additionally, all transducers in inactive RWs were down until upgrades were completed and transducers were sequentially turned on. Specific issues are addressed in Attachment A-1.

As detailed in Attachments A-1 and A-2, during January 2024, the following transducers were:

<u>Fully out of service pending repairs:</u>

- PA-07
- PA-26d

<u>Out of service for a period but returned to full operation:</u>

- N/A

PA-07 and PA-26d both had faulted transducers, and replacements were ordered on 29 January 2024.

Some transducers onsite had the water elevations adjusted based on the recalibration event completed 20 February 2024. The January 2024 hydrographs shown in Attachment B-1 are the water elevations prior to adjusting for recalibration, but hydraulic gradients (Attachment B-2 and B-3) and groundwater elevation maps (Figures 2 through 4) account for the adjusted water table elevations. The revisions in water table elevations are noted in Attachment B.

3.2 HORIZONTAL AND VERTICAL GRADIENTS AT GRADIENT CONTROL POINTS

As described above, GCC locations collect high-resolution groundwater elevation data using transducers. Transducer data are filtered to remove anomalous data from monitoring points due to potential equipment failures, such as transducer malfunctions, power outages, or updates to the GWET programmable logic controller (PLC) system, which controls and houses all the operational data. These specific issues and time periods are summarized in Table A-1 in Attachment A. The following flags are applied to filter anomalous data:

- Groundwater elevations had a change greater than 1.5 feet within 1 hour
- Water column depth measurements that were found to be greater than 50 feet, or less than 1 foot
- Calculated groundwater elevation slope indicates no change between consecutive measurements indicating a transducer malfunction
- Manually flagging data that are inconsistent with the typical nature of the well
- Periods where transducer power supply was deactivated for work on interconnected electrical systems

After January 2024 flagged data were removed, the Serfes (1991) method was used to account for tidal variations as described in the PMP. Using Serfes corrected data, both horizontal and vertical gradients were calculated and plotted over time (Attachment B). Groundwater elevations, horizontal gradients, and vertical gradients from 5 January 2024 are shown below at each GCC (Table 1-1 and Table 1-2).

TABLE 1-1 JANUARY HORIZONTAL GRADIENTS

Gradient Cluster	Well Pair Zone	Exterior Well	Water Elevation (ft NAVD88)	Interior Well	Water Elevation (ft NAVD88)	Horizontal Gradient (ft/ft)
GCC1	Shallow	PA-03	29.01	PA-04	29.27	-0.003
	Intermediate	PA-17iR	11.73	PA-10i	12.55	-0.008

Gradient Cluster	Well Pair Zone	Exterior Well	Water Elevation (ft NAVD88)	Interior Well	Water Elevation (ft NAVD88)	Horizontal Gradient (ft/ft)
	Deep	PA-27d	10.90	PA-18d	11.07	-0.001
GCC2	Shallow	MWA-2	9.61	PA-05	6.69	0.043
	Intermediate	MWA-8i	9.40	PA-11i	8.84	0.008
	Deep	PA-19d	9.22	PA-30d	9.15	0.001
GCC3	Shallow	MWA-69	9.13	PA-06	10.18	-0.010
	Intermediate	MWA-66i	8.87	PA-12i	10.06	-0.010
	Deep	PA-21d	9.00	PA-20d	8.62	0.003
GCC4	Shallow	MWA-19	10.15	PA-28	13.43	-0.033
	Intermediate	MWA-34i	*	PA-13i	10.88	**
	Deep	MWA-58d	8.55	PA-22d	9.90	-0.015
GCC5	Shallow	MWA-47	9.51	PA-07	*	**
	Intermediate	PA-29i	9.42	PA-14i	10.83	-0.026
	Deep	PA-24d	8.60	PA-23d	9.65	-0.020
GCC6	Shallow	PA-09	11.84	PA-08	12.39	-0.010
	Intermediate	PA-16i	10.20	PA-15i	10.62	-0.008
	Deep	PA-26d	11.21	PA-25d	11.55	-0.005

Notes:
Positive horizontal gradient indicates an inward hydraulic gradient across the GWBW.
Horizontal gradient calculated as (Exterior Elevation – Interior Elevation) / Horizontal distance.
* = anomalous groundwater elevation; ** = horizontal gradient cannot be calculated due to anomalous elevation reading; ft NAVD88 = feet North American Vertical Datum of 1988;
M = manual groundwater elevation measurement

TABLE 1-2 JANUARY VERTICAL GRADIENTS

Region	Pair	Gradient Cluster	Upper Well	Water Elevation (ft NAVD88)	Lower Well	Water Elevation (ft NAVD88)	Vertical Gradient (ft/ft)
Interior	SZ-IZ	GCC1	PA-04	29.27	PA-10i	12.55	1.69
		GCC2	PA-05	6.69	PA-11i	8.84	-0.19
		GCC3	PA-06	10.18	PA-12i	10.06	0.01
		GCC4	PA-28	13.43	PA-13i	10.88	0.40
		GCC5	PA-07	*	PA-14i	10.83	**

Region	Pair	Gradient Cluster	Upper Well	Water Elevation (ft NAVD88)	Lower Well	Water Elevation (ft NAVD88)	Vertical Gradient (ft/ft)
		GCC6	PA-08	12.39	PA-15i	10.62	0.132
	IZ-DZ	GCC1	PA-10i	12.55	PA-18d	11.07	0.20
		GCC2	PA-11i	8.84	PA-30d	9.15	-0.04
		GCC3	PA-12i	10.06	PA-20d	8.62	0.07
		GCC4	PA-13i	10.88	PA-22d	9.90	0.05
		GCC5	PA-14i	10.83	PA-23d	9.65	0.03
		GCC6	PA-15i	10.62	PA-25d	11.55	-0.02
Exterior	SZ-IZ	GCC1	PA-03	29.01	PA-17iR	11.73	1.10
		GCC2	MWA-2	9.61	MWA-8i	9.40	0.01
		GCC3	MWA-69	9.13	MWA-66i	8.87	0.02
		GCC4	MWA-19	10.15	MWA-34i	*	**
		GCC5	MWA-47	9.51	PA-29i	9.42	0.01
		GCC6	PA-09	11.84	PA-16i	10.20	0.12
	IZ-DZ	GCC1	PA-17iR	11.73	PA-27d	10.90	0.13
		GCC2	MWA-8i	9.40	PA-19d	9.22	0.11
		GCC3	MWA-66i	8.87	PA-21d	9.00	-0.01
		GCC4	MWA-34i	*	MWA-58d	8.55	**
		GCC5	PA-29i	9.42	PA-24d	8.60	0.02
		GCC6	PA-16i	10.20	PA-26d	11.21	-0.03

Notes:
Positive vertical gradient indicates a downward hydraulic gradient.
Vertical gradient calculated as (Upper Elevation – Lower Elevation) / Screen Midpoint distance.
* = anomalous groundwater elevation; ** = vertical gradient cannot be calculated due to anomalous elevation reading; DZ = Deep Zone; ft NAVD88 = feet North American Vertical Datum of 1988; IZ = Intermediate Zone; M = manual groundwater elevation measurement; SZ = Shallow Zone

3.3 POTENTIOMETRIC SURFACE, GROUNDWATER ELEVATION DIFFERENCE MAPS, AND GROUNDWATER FLOW DIRECTIONS

As described in the PMP, potentiometric surface maps are used to evaluate flow paths. Vertical gradients are also used as an additional line of evidence to evaluate hydraulic containment. Groundwater elevation data collected on 5 January 2024 were used to prepare potentiometric surface maps based on manual measurements and averaged transducer groundwater elevations (Figures 2 through 4) and vertical difference maps (Figures 5 and 6).

The GWET system was shut down for 23 days to reconfigure the trunk line to connect to Trenches 5, 6, and 7 to the previously unused Intermediate Zone conveyance line to mitigate back pressure effects on pumping rates. However, the upgrades to the GWET system impacted pumping operations.

The generalized flow direction indicated by the potentiometric surface maps shows overall groundwater flow from upgradient toward the GWBW. Potentiometric maps (Figures 2, 3, and 4) indicate localized groundwater movement to the extraction trenches due to GW SCM pumping, and cones of depression are apparent around each groundwater extraction trench. As shown in Attachment B-2, Shallow Zone horizontal gradient trends historically have been trending toward inward at GCC5 and GCC6. During the month of January, however, horizontal gradients are only trending toward inward at GCC1 and GCC6. Despite this month’s changes, overall gradients are still substantially closer to inward than observed in January 2024.

In January 2024, horizontal gradients in the Shallow and Intermediate Zone were inward at GCC2. The horizontal gradients in the Deep Zone were inward at GCC2 and GCC3.

River elevations are shown over time on Figure 1-1 and 1-2 below, and in an inset on the potentiometric surface maps i(Figures 2 through 4). The river elevation in January 2024 varied with an average of 11.12 feet NAVD88 with a minimum elevation of 6.99 feet NAVD88 and a maximum elevation of 15.23 feet NAVD88 observed toward the end of the month, a higher maximum than in January 2024 (12.69 feet NAVD88). Historically, the river elevation is at its highest in May and decreases until its lowest in October, making it more challenging during late summer and fall months to achieve inward gradients. As the wet season continues, the river is expected to rise, increasing the elevation of groundwater downgradient of the GWBW. Depending on how much groundwater elevations upgradient of the GWBW rise with exterior groundwater elevations, there may be increasing trends toward inward horizontal gradients at all GCCs throughout the wet season.

The difference between average interior Shallow Zone groundwater elevations and river level elevation were 5.88 ft and 0.68 ft in January 2023 and January 2024, respectively. A potentiometric separation is still noticeable exterior to the GWBW, indicating that it is functioning by impeding groundwater flow.

Vertical gradients were calculated for each vertical well pair and are plotted on Figures 5 and 6. Vertical groundwater gradients interior to the GWBW between the Shallow and Intermediate Zones were generally downward, except for GCC2 being upward (Figure 5). Vertical groundwater gradients are also depicted in Attachment B-3. The magnitude of the gradient is much greater at GCC1 than other monitoring locations due to the influence from a localized high-pressure zone near GCC1 where vertical groundwater flow is impeded by a localized confining unit (Figure 2). Exterior of the GWBW, vertical gradients between the Shallow and Intermediate Zones were downward as shown on Figure 5 and in Attachment B-2.

The vertical groundwater gradient at GCC4 was unable to be calculated due to an anomalous groundwater elevation reading at MWA-34i. Compared to other wells in the Intermediate Zone, the rate of change of the water level elevation at MWA-34i during large rainfall events is much higher and will be investigated. The vertical gradient at GCC5 was unable to be calculated due to an anomalous groundwater elevation reading at PA-07 from a faulted transducer. A replacement transducer was ordered on 29 January 2024.

Interior of the GWBW vertical gradients between the Intermediate and Deep Zones were mixed with GCC2 and GCC6 being upward and the remaining downward. The direction of vertical gradients exterior to the GWBW were mixed with GCC3 and GCC6 being upward and the remaining downward, as shown on Figure 6 and Attachment B. The vertical groundwater gradient at GCC4 exterior of the wall was unable to be calculated due to an anomalous groundwater elevation reading at and MWA-34i as previously discussed.

3.3.1 GWET SYSTEM PERFORMANCE

The GWET system operated within permit conditions during the reporting period. There was one shutdown:

- 6 January 2024: ERM, on behalf of LSS, shut down the GWET system due to GWET system upgrades, which included reconfiguring the trunk line to connect to Trenches 5, 6, and 7 to the Intermediate Zone conveyance line. The ODEQ was notified of the shutdown, and discharge was restarted on 29 January 2024.

3.3.2 RECOVERY WELL AND EXTRACTION WELL PERFORMANCE

The average system influent flow rate was 13.30 gallons per minute (gpm) for the entire month of January 2024, including non-operational periods. The average influent flow during operational periods was 67.51 gpm. Reconfiguring the trunk line to connect to Trenches 5, 6, and 7 to the Intermediate Zone conveyance line was completed on 29 January 2024. Prior to reconfiguring the trunk line the operational average flow rate was 45.04 gpm. After reconfiguring the trunk line the operational average flow rate was 66.02 gpm with flows as high as 87.56 gpm observed immediately after startup. The trunk line was reconfigured to mitigate back pressure effects on pumping rates. However, to reconfigure the trunk line, the GWET system was shut down for 23 days, reducing the total flow rate for January 2024. LSS is currently in the process of optimizing extraction rates within the system to increase flow rates at each operational well until either the extraction rates specified in the *Final Design Report* (ERM 2022) are achieved, the wells are producing the maximum quantity of water possible, or until the Capture Zone Objectives are met.

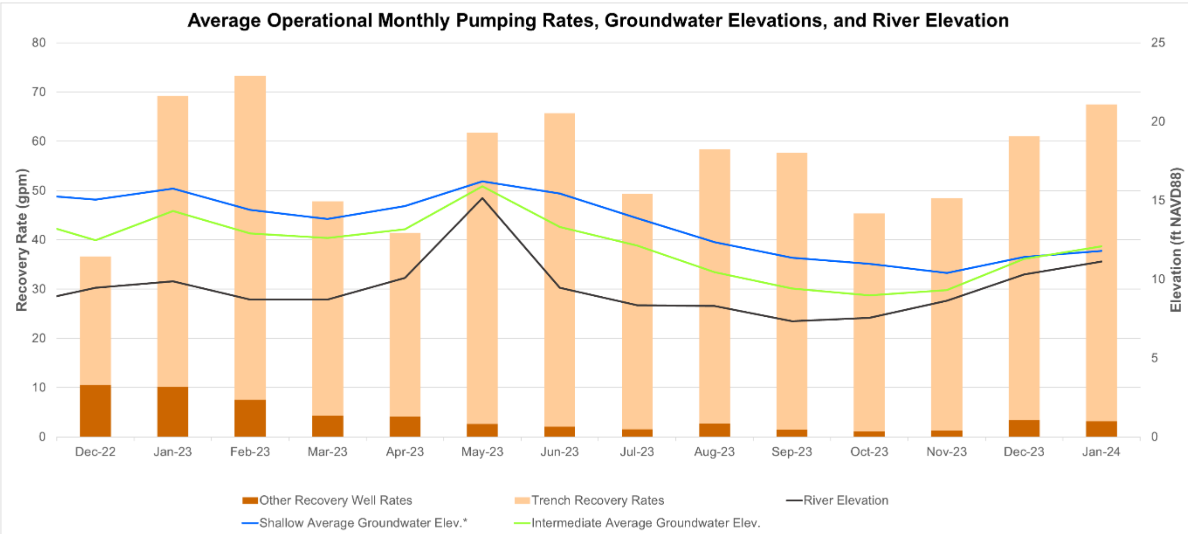
Site-wide redevelopment of the EW in the extraction trenches is planned for Q1 2024 to mitigate the biofouling and turbidity within the EWs that is affecting flow rates.

TABLE 1-3 RECOVERY WELL PUMPING RATES

Recovery Well	January 2024 Average Operational Pumping Rate (gpm)	January 2024 Average Monthly Pumping Rate (gpm)
RW-14	1.05	0.20
RW-22*	0.00	0.00
RW-23*	0.00	0.00
RW-25	2.11	0.41
EW-01	1.08	0.21
EW-02	2.97	0.38
EW-03	6.88	1.33
EW-04	5.48	1.41
EW-05	12.16	3.53
EW-06	3.82	0.37
EW-07*	0.00	0.00
EW-08	2.38	0.61
EW-09	1.84	0.41
EW-10	10.42	0.67
EW-11	2.38	0.61
EW-12	3.50	0.23
EW-13	1.47	0.33
EW-14	9.98	2.58
Total	67.51	13.30

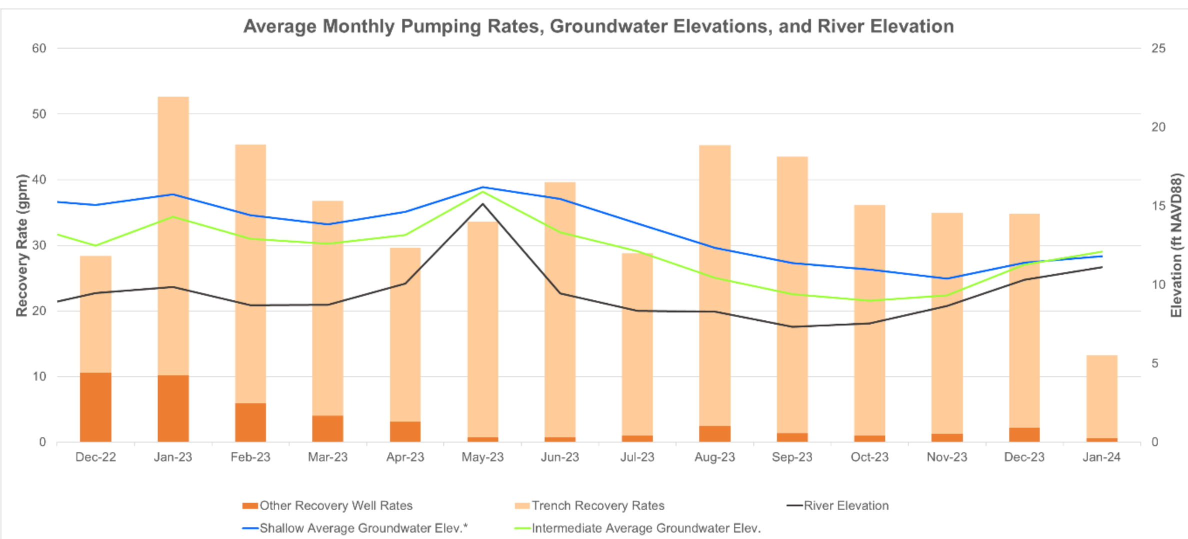
Notes:
* = Recovery well not in service during reporting period.
gpm = gallon per minute

FIGURE 1-1 OPERATIONAL MONTHLY PUMPING RATE



* = The shallow average groundwater elevation is calculated without PA-04 due to its groundwater elevations being unrepresentative of the whole aquifer.
ft NAVD88 = feet North American Vertical Datum of 1988

FIGURE 1-2 AVERAGE MONTHLY PUMPING RATE



* = The shallow average groundwater elevation is calculated without PA-04 due to its groundwater elevations being unrepresentative of the whole aquifer.
ft NAVD88 = feet North American Vertical Datum of 1988

3.3.3 RECOMMENDATIONS FOR EXTRACTION SYSTEM OPTIMIZATION

Recovery rates from the start of the system indicate that the active RWs and EWs are operating as designed except for the troubleshooting discussed above. The RWs and EWs that are not operating as designed due to possible biofouling and sediment accumulation in the Trenches filter pack will be redeveloped in February 2024. The extraction rates throughout the GWET system will continue to be optimized to meet Target Capture Objectives.

4. ANALYTICAL PROGRAM

Quarterly groundwater monitoring was implemented in accordance with the ODEQ-approved Arkema Quarterly Groundwater Monitoring Work Plan dated October 2019 and the ODEQ-approved reduced scope described in the 2021 monitoring program modification request memorandum dated 9 September 2021. The table below outlines sampling dates and submittal dates related to groundwater monitoring since the implementation of the reduced scope. The Quarterly Monitoring Reports present results from these sampling events.

Report	Sampling Dates	Report Submittal Date
2021 Quarter 3	9/21/2021–9/24/2021	1/14/2022
2021 Quarter 4	12/13/2021–12/16/2021	4/20/2022
2022 Quarter 1	3/14/2022–3/17/2022	6/15/2022
2022 Quarter 2	6/6/2022–6/9/2022	9/12/2022
2022 Quarter 4	11/7/2022–11/10/2022	2/17/2023
2023 Quarter 1	3/6/2023–3/10/2023	6/12/2023
2023 Quarter 2	6/12/2023–6/16/2023	9/22/2023
2023 Quarter 3	8/21/2023–8/24/2023	12/1/2023
2023 Quarter 4	12/11/2023–12/14/2023	3/15/2024
2024 Quarter 1	2/26/2024–2/29/2024	5/29/2024 *

* Dates are tentative.

5. SUMMARY AND CONCLUSIONS

This report presents a summary of the GW SCM operation, maintenance, and monitoring activities conducted at the Site in January 2024 and documents results from system monitoring. The following summarizes ERM's observations and conclusions drawn from collected data.

5.1 GROUNDWATER FLOW

- Horizontal groundwater gradients provided in Attachment B-2 for the Shallow, Intermediate, and Deep Zones were inward at GCC2 and trending toward inward at GCC5 and GCC6 in the Shallow Zone and GCC3 in the Deep Zone. Additionally, groundwater elevations show a noticeable difference in elevation across the GWBW, indicating the GWBW is functioning via impeding groundwater flow.

- Vertical groundwater gradients interior of the GWBW between the Shallow and Intermediate Zones were generally downward, except for GCC2 being inward (Figure 5). Exterior of the GWBW, vertical gradients between the Shallow and Intermediate Zones were downward.
- Interior of the GWBW vertical gradients between the Intermediate and Deep Zones were mixed with GCC2 and GCC6 being upward and the remaining downward. The direction of vertical gradients exterior to the GWBW were mixed with GCC3 and GCC6 being upward and the remaining downward, as shown on Figure 6.
- The average river elevation in January 2024 was 11.12 feet NAVD88 with a minimum elevation of 6.99 feet NAVD88 and a maximum elevation of 15.23 feet NAVD88. The seasonal river level elevation trends indicate a seasonal high in May and a seasonal low in October.

5.2 GROUNDWATER EXTRACTION

Based on January 2024 extraction and relevant hydrograph analysis, the trenches are achieving increased groundwater extraction rates compared to the legacy system. The groundwater mound around Trenches 1, 2, and 3 has diminished. The realignment on the south end of the wellfield discussed previously is anticipated to substantially improve extraction rates at Trenches 5, 6, and 7. Within the Site alluvial sequence, potentiometric maps indicate the GW SCM is producing localized areas of hydraulic capture throughout the Target Capture Zone. More time at elevated extraction rates will be required to evaluate whether GWET objectives are being met system wide.

The groundwater extraction flow rate is currently limited by a combination of groundwater elevation, fouling of the EWs within the trenches, and back pressure in the conveyance line. In November and December 2023, water from Trench 7 was routed via overland hoses to the Intermediate Zone trunk line to reduce the effects of back pressure in the Shallow Zone trunk line on pumping rates. In January, the wellfield was reconfigured to connect three of the trenches to the Intermediate Zone trunk line and this is anticipated to mitigate the impact of back pressure in the conveyance lines.

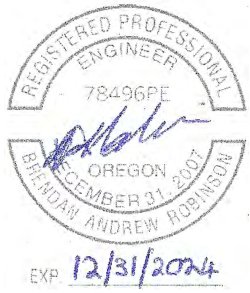
Additionally, the trenches will be redeveloped in February 2024 to mitigate the impact of silt on pumping rates.

5.3 RECOMMENDATIONS AND FUTURE WORK

LSS will continue to optimize new EWs, including pump maintenance/upgrades, redevelopment of the wells. Additional modifications to the system, if needed to meet capture objectives, will be included in subsequent MPRs. The project schedule provided as Attachment C summarizes planned activities.

Regards,

Brendan Robinson, PE
Partner



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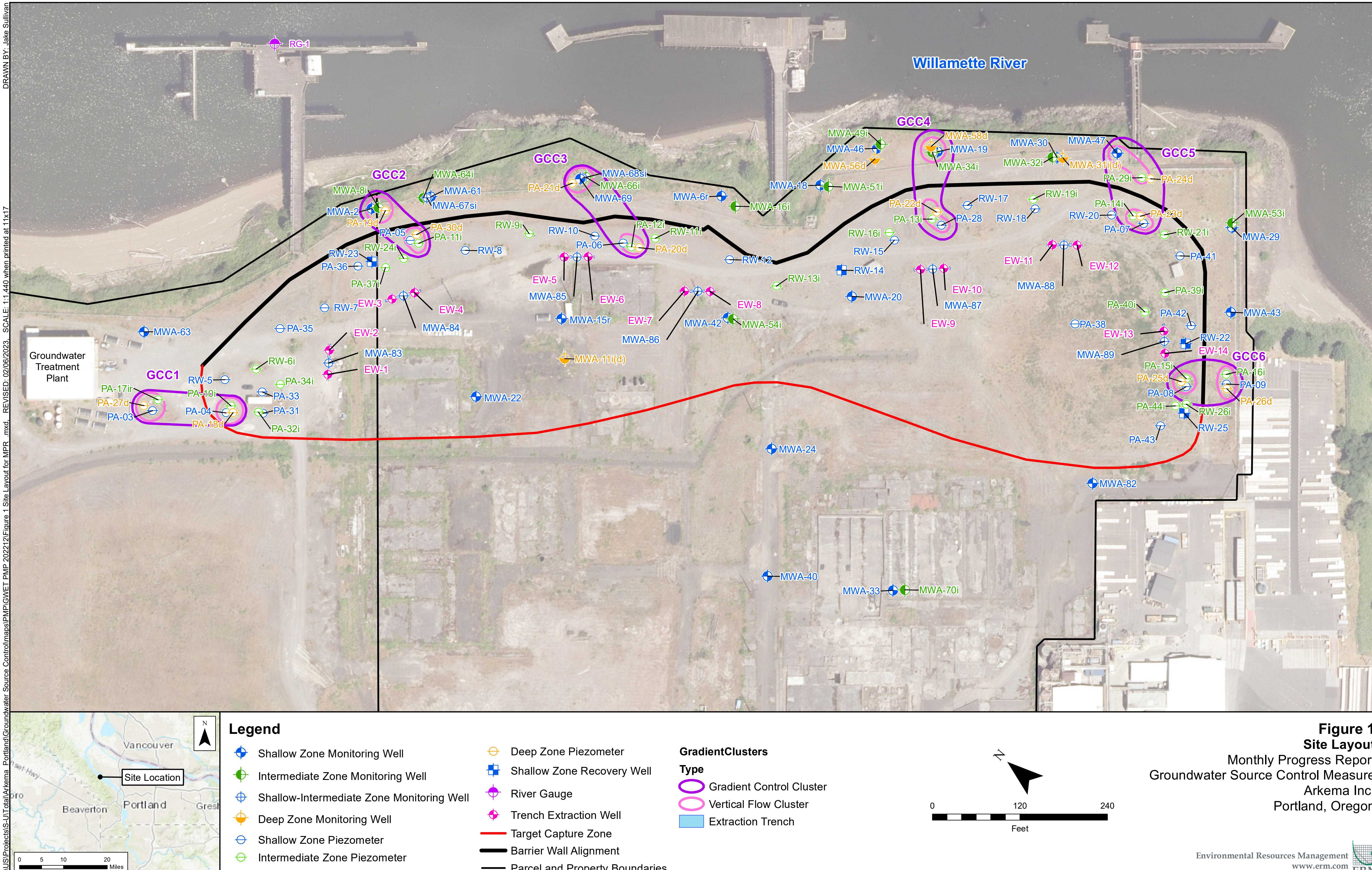
FIGURES



DRAWN BY: Jake Sullivan

M:\US\Projects\S-U\Total\Arkema_Portland\Groundwater Source Control\maps\PMP\GWET PMP 202212\Figure 1 Site Layout for MPR .mxd REVISED: 02/06/2023 SCALE: 1:1,440 when printed at 11x17

Legend

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Shallow Zone Piezometer
- Intermediate Zone Piezometer
- Deep Zone Piezometer
- Shallow Zone Recovery Well
- River Gauge
- Trench Extraction Well
- Target Capture Zone
- Barrier Wall Alignment
- Parcel and Property Boundaries

GradientClusters

Type

- Gradient Control Cluster
- Vertical Flow Cluster
- Extraction Trench

N

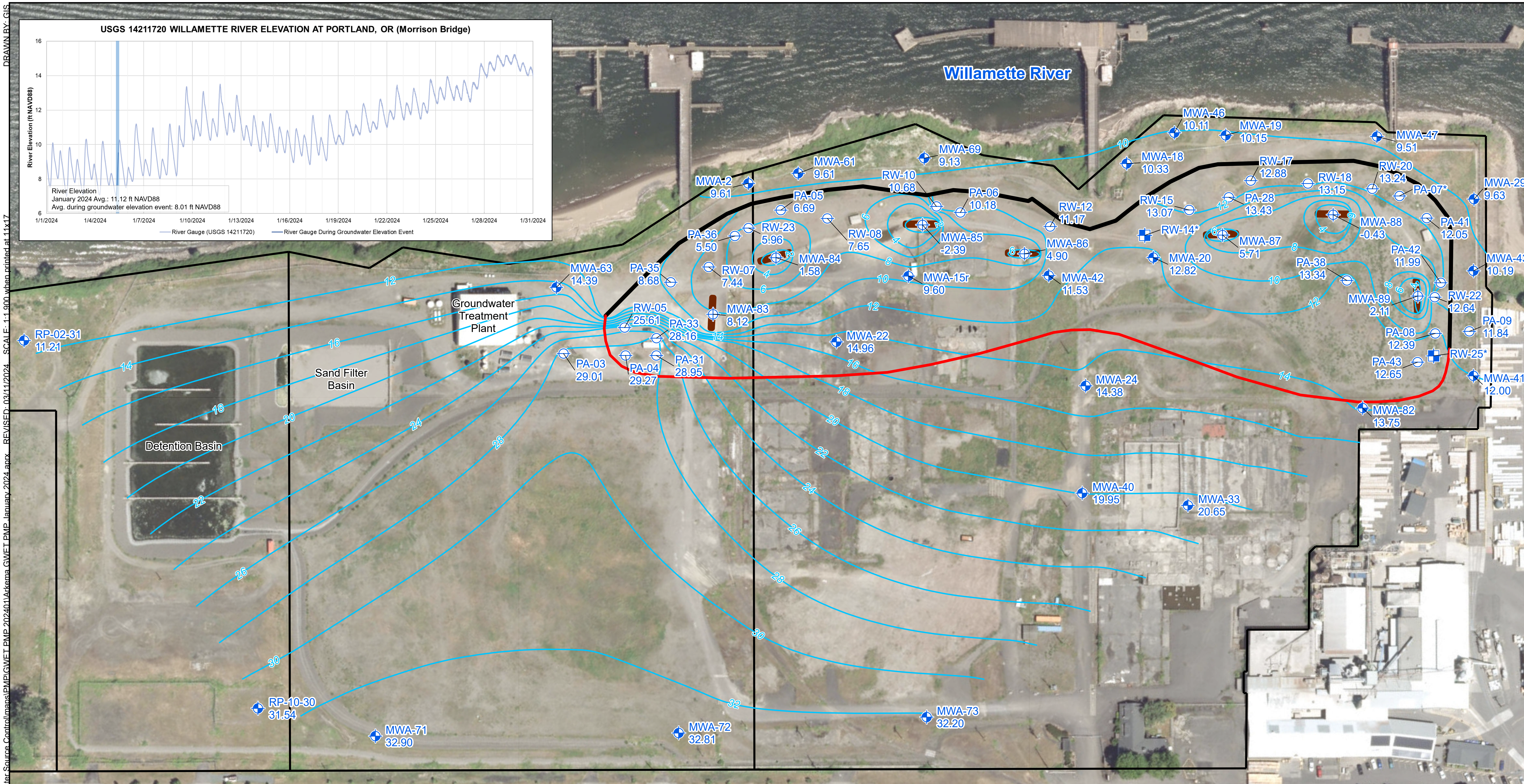
0 120 240

Feet

Figure 1
Site Layout
Monthly Progress Report
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

Environmental Resources Management
www.erm.com
ERM

Source: City of Portland Aerial Imagery, flown Summer 2021; NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl



Legend

- Shallow Zone Piezometer
- Shallow Zone Monitoring Well
- Active Recovery Well; Not Used During Contouring
- Shallow-Intermediate Zone Monitoring Well
- 27.70 Groundwater Elevation (ft NAVD88)
- Shallow Zone Groundwater Contours (ft NAVD88) Dashed where Inferred
- Target Capture Zone
- Barrier Wall Alignment
- Extraction Trench (Not To Scale)

Notes:
* Value not used for contouring.
Water levels collected January 5, 2024.
ft NAVD88: feet North American Vertical Datum of 1988.
Aerial Photo: City of Portland, Summer 2017.

N

0 160 320
Feet

Figure 2
January 2024 Shallow Zone Groundwater Contours
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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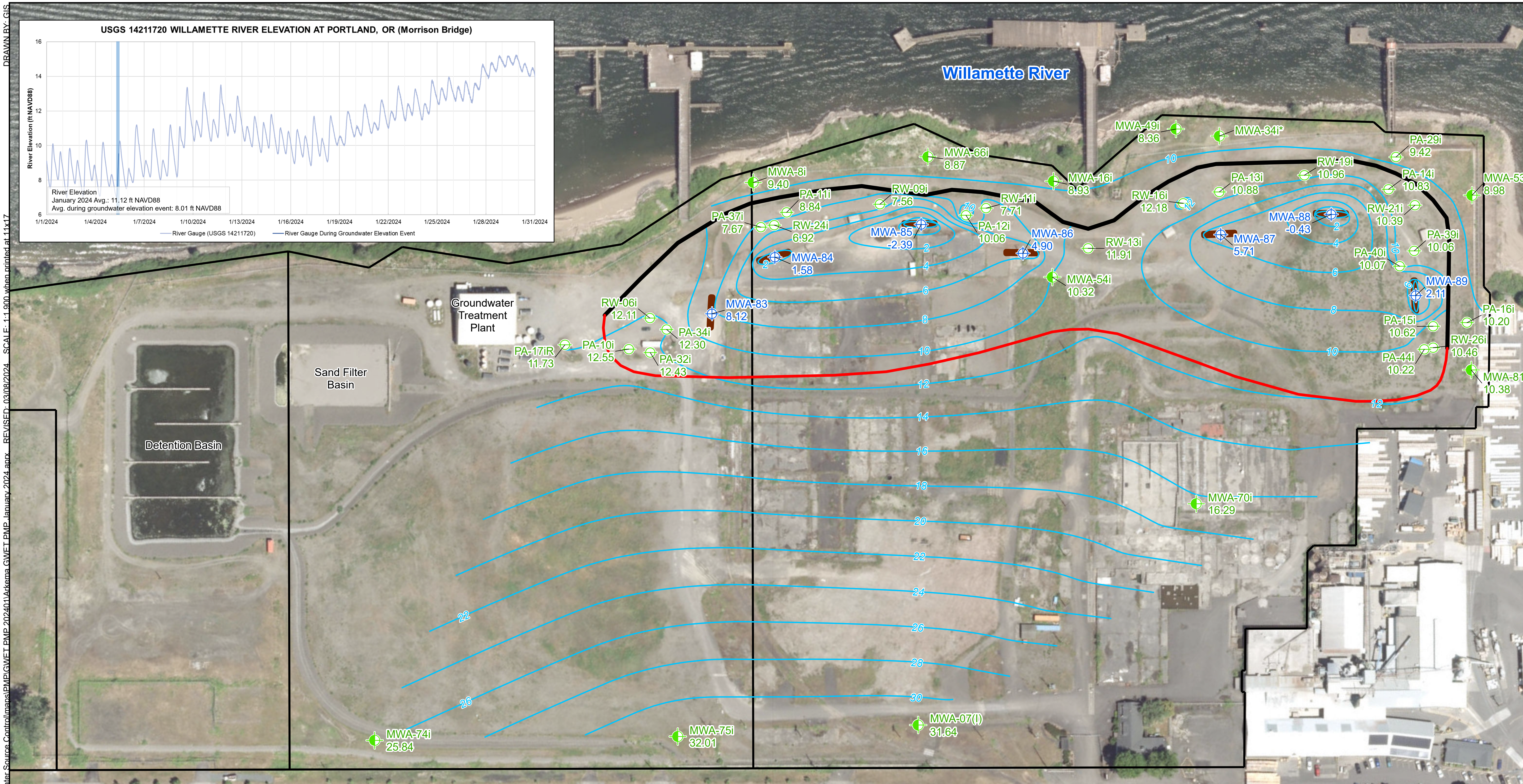
M:\US\Projects\S-U\Total\Arkema_Portland\Groundwater Source Control\maps\PMP\GWET PMP 2024\01\Arkema GWET PMP January 2024.aprx REVISED: 03/11/2024 SCALE: 1:1,900 when printed at 11x17 DRAWN BY: GIS

NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl



Legend

- Intermediate Zone Piezometer
- Intermediate Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well
- 27.70 Groundwater Elevation (ft NAVD88)
- Intermediate Zone Groundwater Contours (ft NAVD88) Dashed where Inferred
- Target Capture Zone
- Barrier Wall Alignment
- Extraction Trench (Not To Scale)

Notes:
* Value not used for contouring.
Water levels collected January 5, 2024.
ft NAVD88: feet North American Vertical Datum of 1988.
Aerial Photo: City of Portland, Summer 2017.

N

0 160 320
Feet

Figure 3
January 2024 Intermediate Zone Groundwater Contours
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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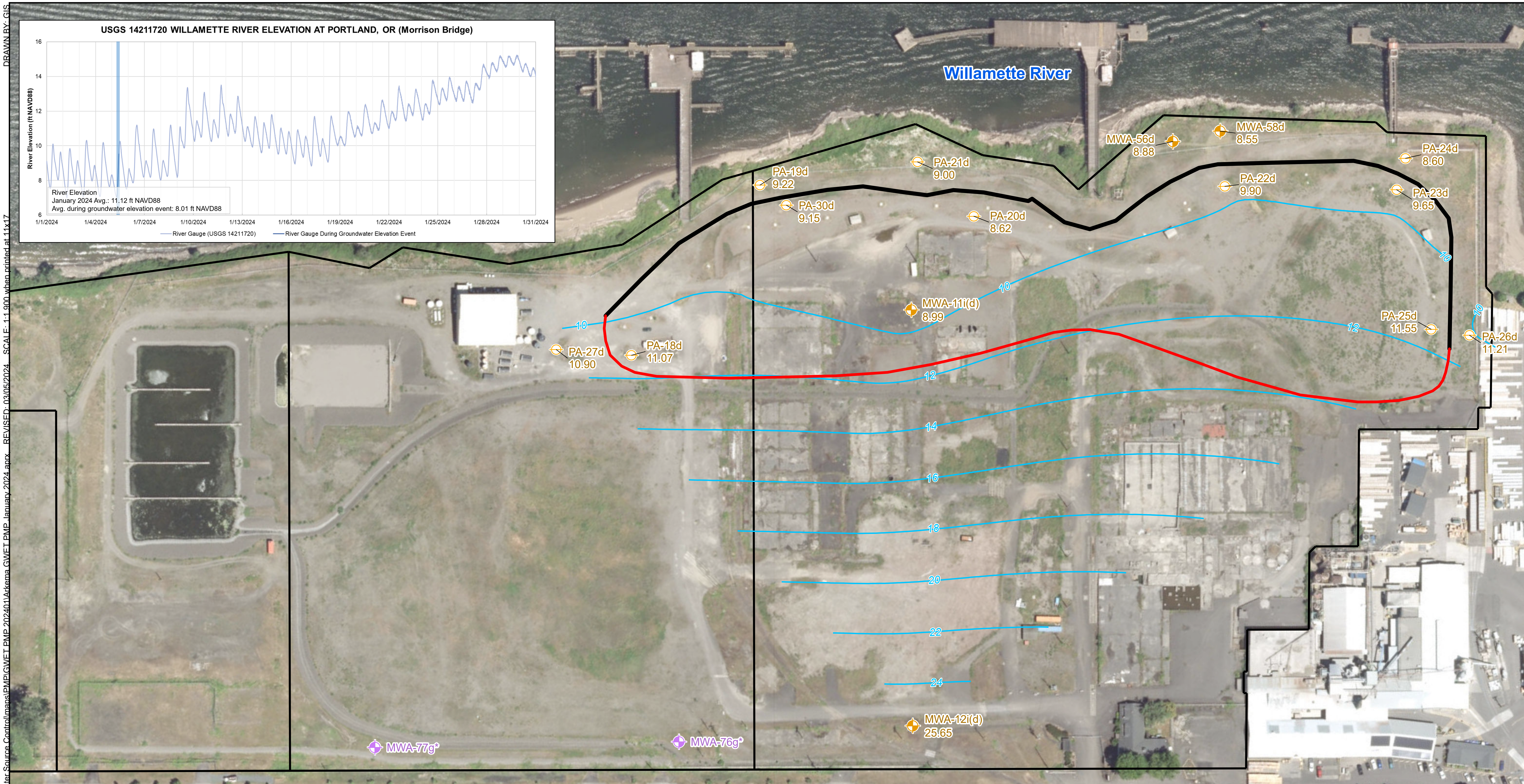
NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl



Legend

- Deep Zone Piezometer
- Deep Zone Monitoring Well
- Gravel Zone Monitoring Well
- 27.70 Groundwater Elevation (ft NAVD88)
- Deep Zone Groundwater Contours (ft NAVD88) Dashed where Inferred
- Target Capture Zone
- Barrier Wall Alignment

Notes:
* Value not used for contouring.
Gravel zone wells not used in contouring.
Water levels collected January 5, 2024.
ft NAVD88: feet North American Vertical Datum of 1988.
Aerial Photo: City of Portland, Summer 2017.

N

0 160 320
Feet

Figure 4
January 2024 Deep Zone Groundwater Contours
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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M:\US\Projects\S-U\Total\Arkema_Portland\Groundwater Source Control\maps\PMP\GWET PMP 2024\01\Arkema GWET PMP January 2024.aprx REVISED: 03/05/2024 SCALE: 1:1,900 when printed at 11x17 DRAWN BY: GIS

NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl

Legend

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Shallow Zone Piezometer
- Intermediate Zone Piezometer
- Shallow Zone Recovery Well
- Target Capture Zone
- Barrier Wall Alignment
- Gradient Control Cluster
- Vertical Flow Cluster
- Downward Flow
- Upward Flow
- Vertical Gradient not calculated due to anomalous groundwater elevation reading

Notes:
Brown gradient: Downward flow.
Green gradient: Upward flow.
Vertical gradient calculated as shallow zone minus intermediate zone potentiometric surfaces.
Water levels collected January 5, 2024.
Aerial Photo: City of Portland, Summer 2017.

N

0 130 260
Feet

Figure 5
January 2024 Shallow to Intermediate Zone Vertical Head Difference
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl

Legend

- Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Intermediate Zone Piezometer
- Deep Zone Piezometer
- Target Capture Zone
- Barrier Wall Alignment
- Gradient Control Cluster
- Vertical Flow Cluster
- Downward Flow
- Upward Flow
- Vertical Gradient not calculated due to anomalous groundwater elevation reading

Notes:
Brown gradient: Downward flow.
Green gradient: Upward flow.
Vertical gradient calculated as intermediate zone minus deep zone potentiometric surfaces.
Water levels collected January 5, 2024.
Aerial Photo: City of Portland, Summer 2017.

N

0 130 260
Feet

Figure 6
January 2024 Intermediate to Deep Zone Vertical Head Difference
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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DRAWN BY: GIS SCALE: 1:1,560 when printed at 11x17 REVISED: 03/05/2024 M:\US\Projects\S-U\Total\Arkema_Portland\Groundwater Source Control\maps\PMP\GWET PMP 2024\01\Arkema GWET PMP January 2024.aprx

NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl

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ATTACHMENT A-1 TRANSDUCER FLAGS

Attachment A-1. Transducer Fla

Table A-1
Transducer Malfunction Log: January 2024
Arkema Inc. Facility
Portland, Oregon

Gradient Cluster	Transducer	Interval	Date Range		Issue and Repairs Performed
GCC3	PA-26d	Deep	1/29/2024	Present	Transducer faulted, replacement ordered.
N/A	RW-13	Intermediate	1/29/2024	Present	Transducer faulted, replacement ordered.
N/A	RW-25	Shallow	1/29/2024	Present	Transducer faulted, replacement ordered.
GCC5	PA-07	Shallow	1/29/2024	Present	Transducer faulted, replacement ordered.

Notes:

I/O = input/output

LOTO = lockout/tagout

VFD = variable frequency drive

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ATTACHMENT A-2 RECOVERY WELL STATUS

Attachment A-2. Recovery Well Status

Table A-2
Recovery Well Status: January 2024
Arkema Inc. Facility
Portland, Oregon

Recovery Well ID	Status as of 12/31/2023 (active or inactive)	Issue	Actions to get online	Expected date back online	Transducer Status	Totalizer Status	Average Operational Flow Rate (gpm)	Overall Extraction Rate	Notes
RW-14	Active	None	N/A	N/A	Good	Good	1.05	M	
RW-22	Inactive	None	N/A	N/A	Good	Good	0.00	OFF*	Off due to ground fault
RW-23	Inactive	None	N/A	N/A	Good	Good	0.00	OFF*	Off due to low water levels
RW-25	Active	None	N/A	N/A	Good	Good	2.11	M	
EW-01	Active	None	N/A	N/A	Good	Good	1.08	M	Off for part of the month due to plumbing repairs
EW-02	Active	None	N/A	N/A	Good	Good	2.97	M	
EW-03	Active	None	N/A	N/A	Good	Good	6.88	G	
EW-04	Active	None	N/A	N/A	Good	Good	5.48	G	
EW-05	Active	None	N/A	N/A	Good	Good	12.16	G	
EW-06	Active	None	N/A	N/A	Good	Good	3.82	G	Off for part of the month due to plumbing repairs
EW-07	Inactive	None	N/A	N/A	Good	Good	0.00	OFF*	Off due to low water levels in trench
EW-08	Active	None	N/A	N/A	Good	Good	2.38	M	
EW-09	Active	None	N/A	N/A	Good	Good	1.84	M	
EW-10	Active	None	N/A	N/A	Good	Good	10.42	G	
EW-11	Active	None	N/A	N/A	Good	Good	2.38	M	
EW-12	Active	None	N/A	N/A	Good	Good	3.50	G	
EW-13	Active	None	N/A	N/A	Good	Good	1.47	M	
EW-14	Active	None	N/A	N/A	Good	Good	9.98	G	

Notes:
* Recovery wells not in service
** Recovery wells in service part of the month
G = good pumping, greater than 3.0 gpm
gpm = gallons per minute
M = moderate pumping, greater than 1.0 gpm and less than 3.0
P = poor pumping, less than 1.0 gpm
VFD = variable frequency drive
PA = piezometer

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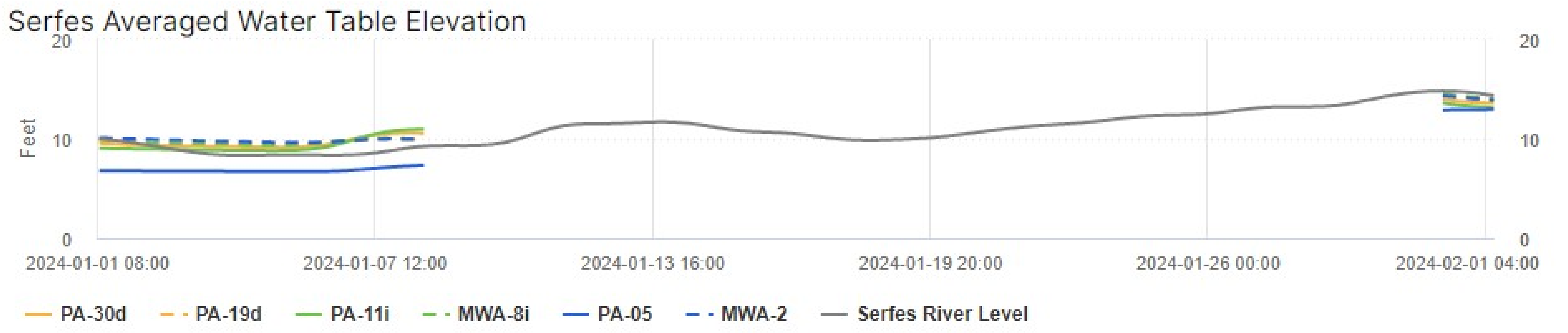
ATTACHMENT B-1 GRADIENT HYDROGRAPHS

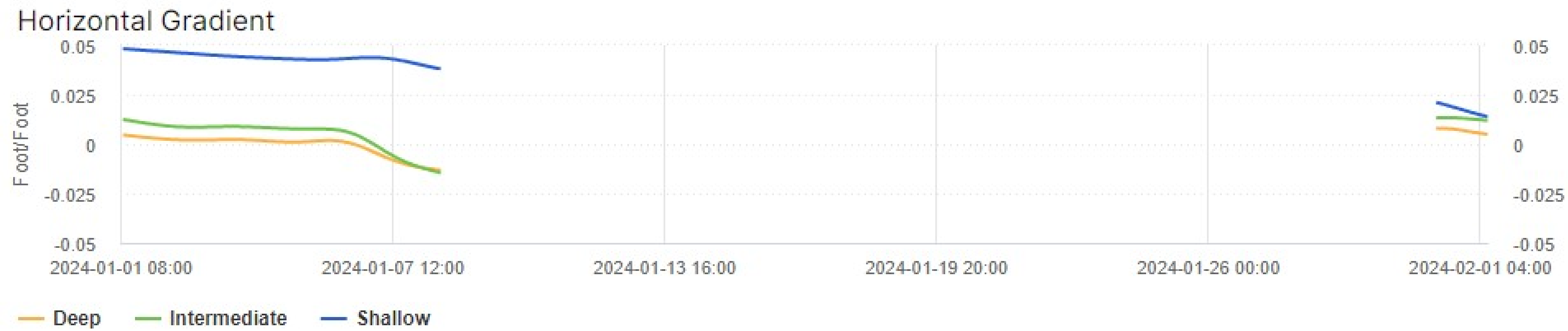
Gradient Control Cluster 1

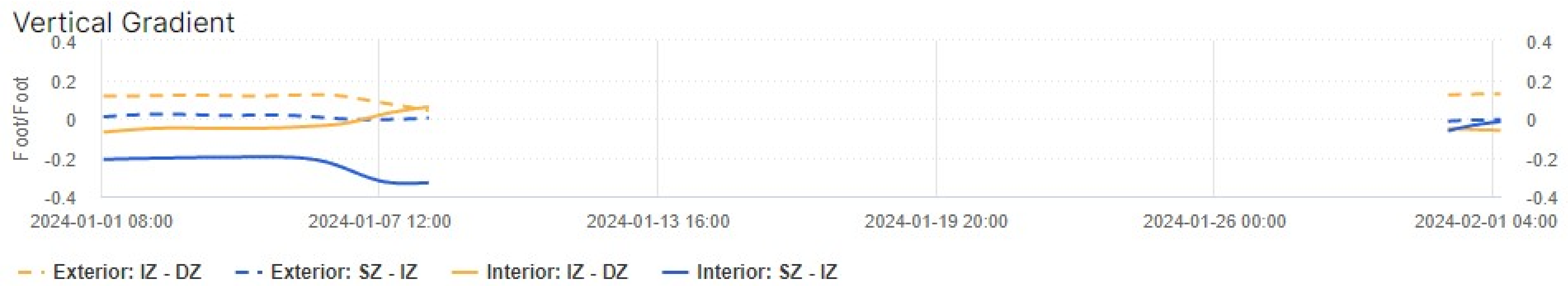
Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW

SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

Gradient Control Cluster 2

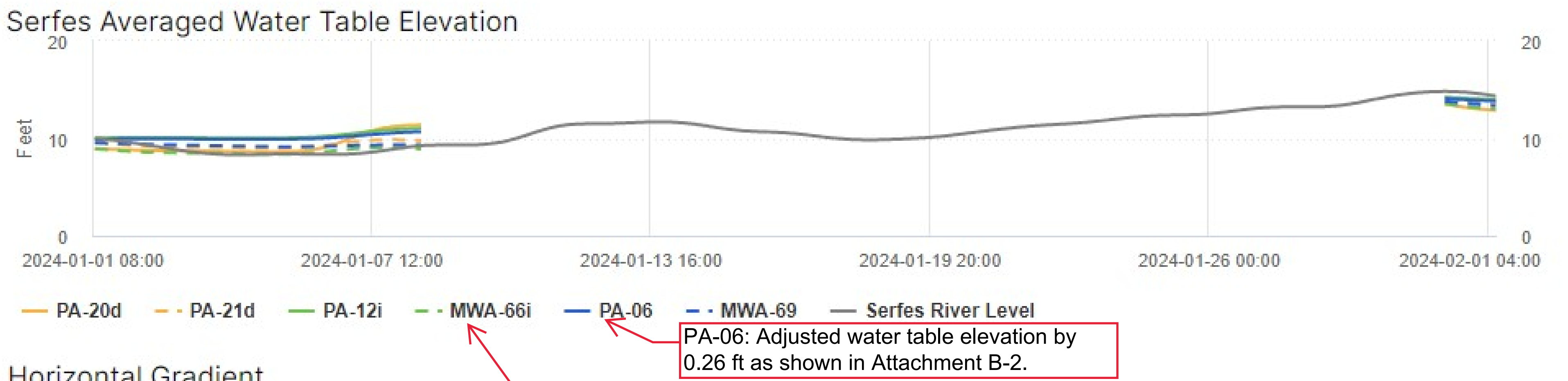


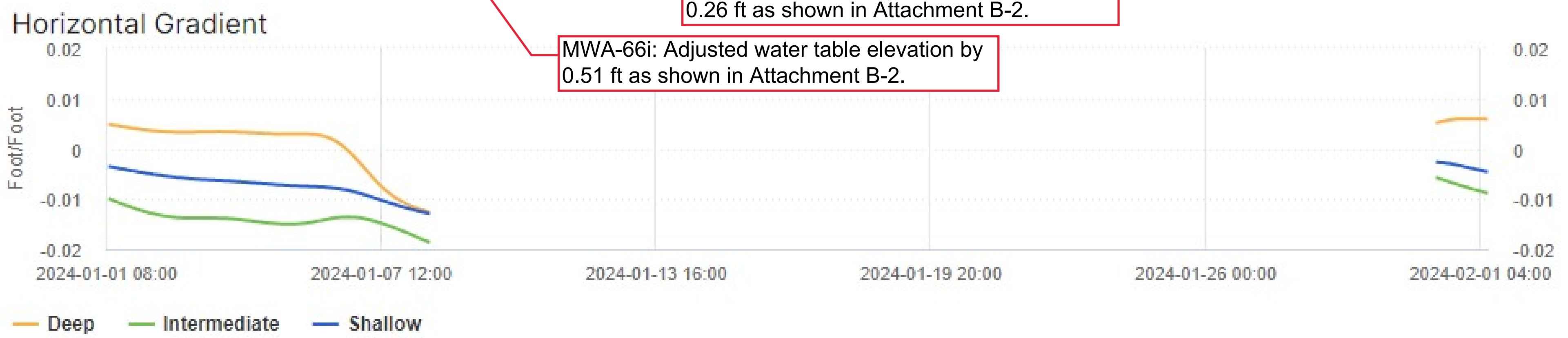


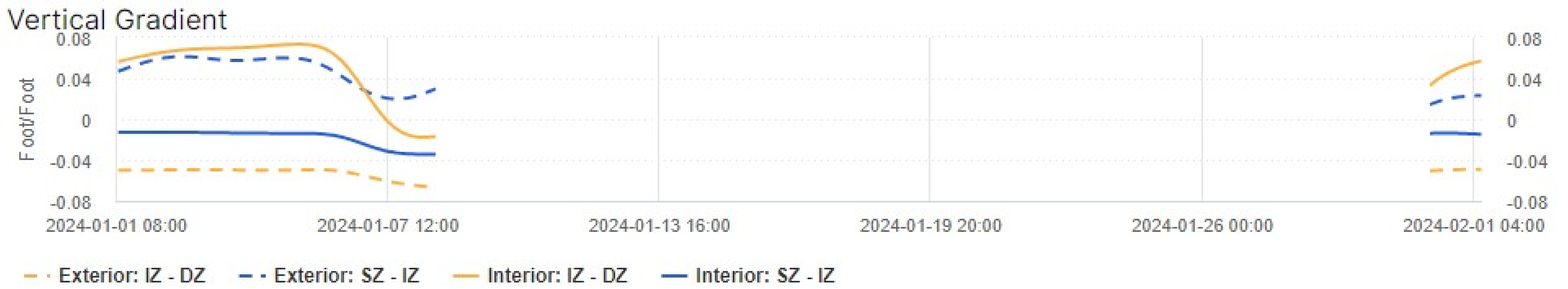


Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW
SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

Gradient Control Cluster 3



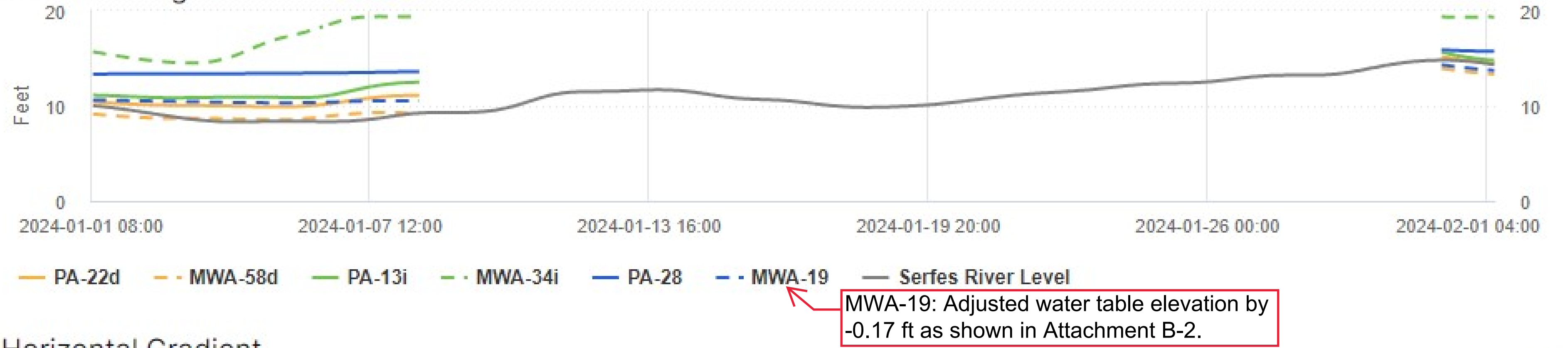




Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW
SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

Gradient Control Cluster 4

Serfes Averaged Water Table Elevation

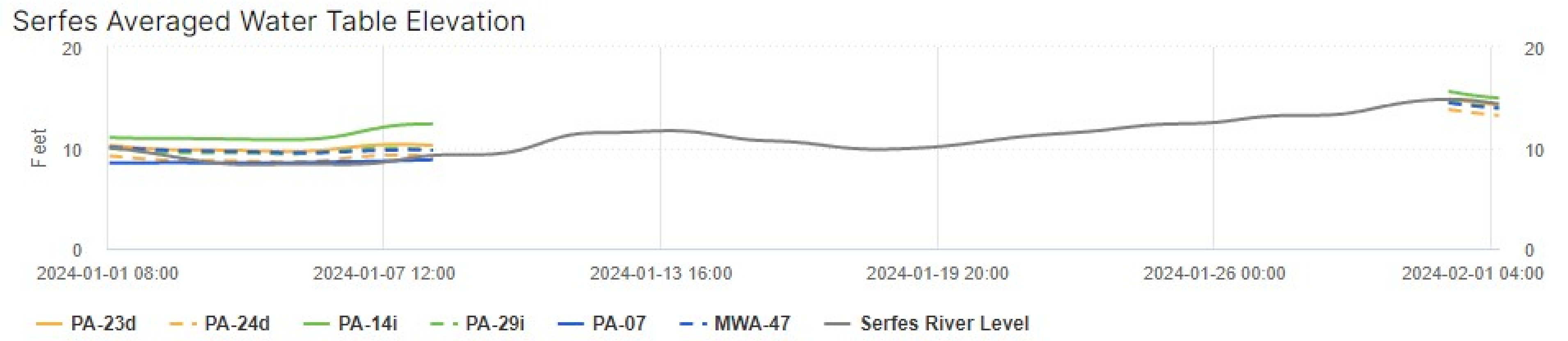


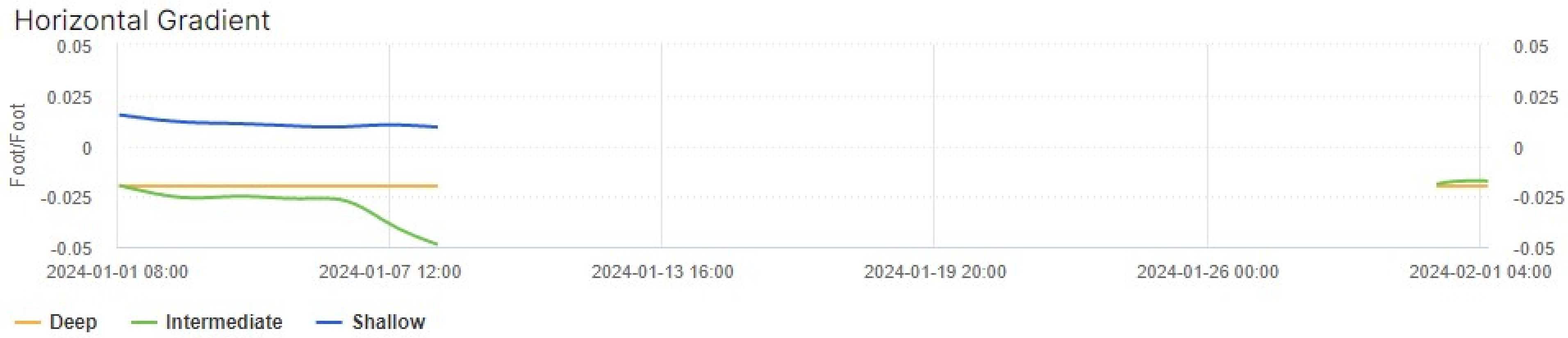
Horizontal Gradient

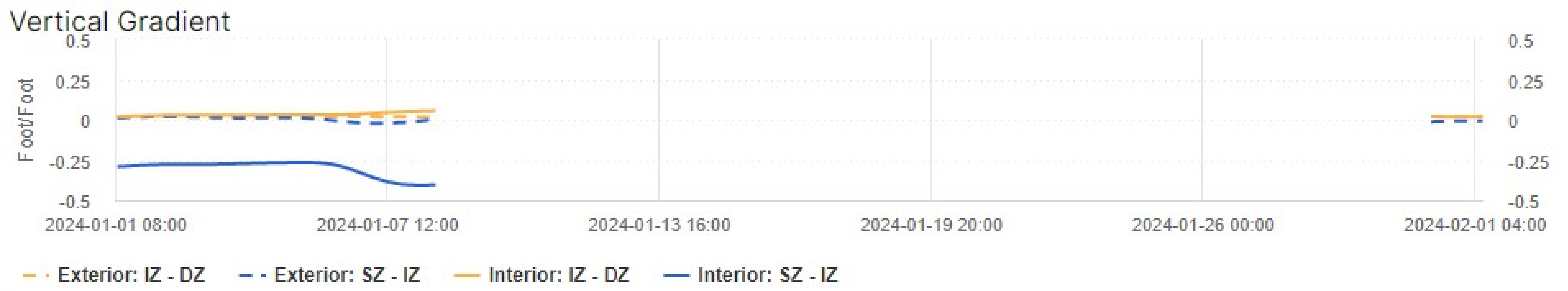
Vertical Gradient

Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW
SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

Gradient Control Cluster 5



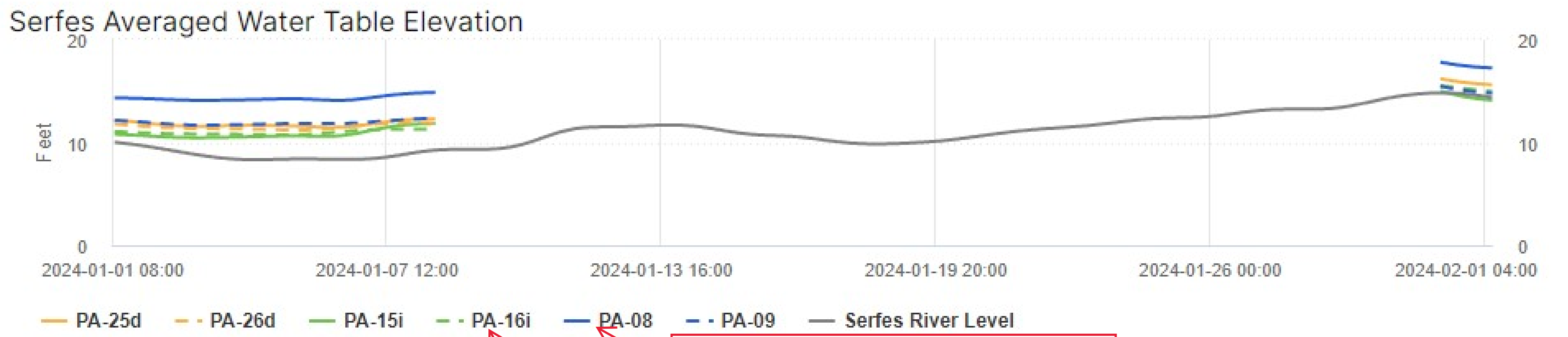


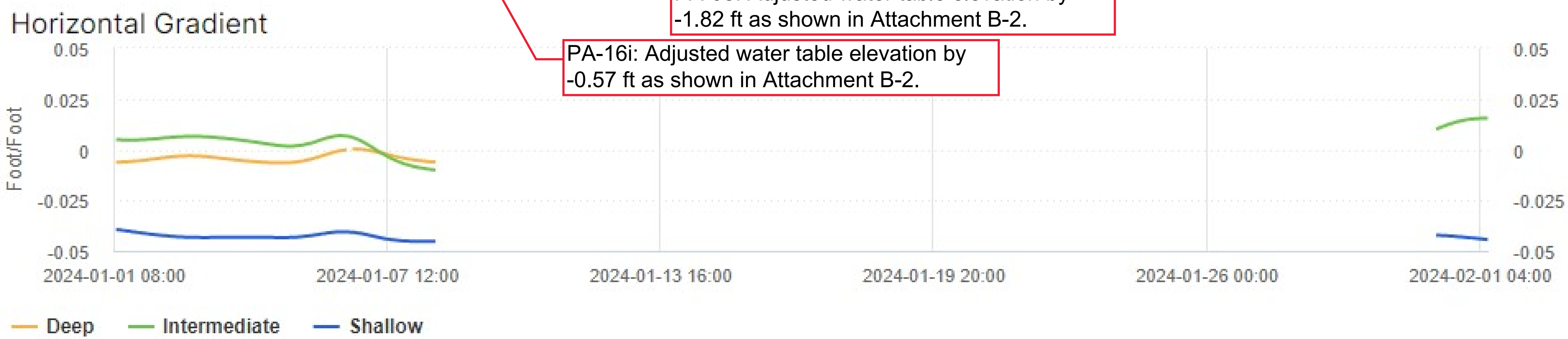


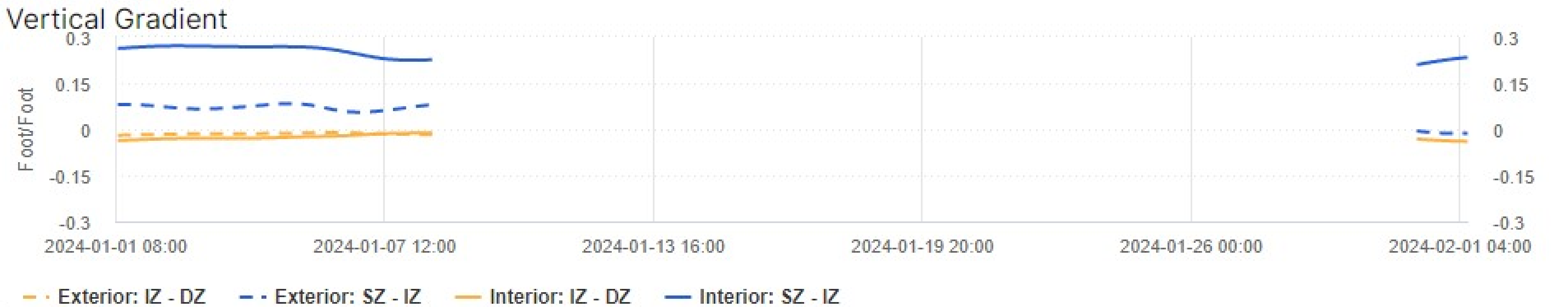
Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW

SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

Gradient Control Cluster 6







Notes:
Positive gradient indicates inward horizontal gradient and downward vertical gradient
Vertical Gradient calculated using (WTE_upper - WTE_lower)/(Bottom of Screen_upper - Top of Screen_lower)
Horizontal gradient calculated as Exterior – Interior. Interior: Upland of the GWBW, Exterior: Riverside of the GWBW
SZ = Shallow Zone
IZ = Intermediate Zone
DZ = Deep Zone

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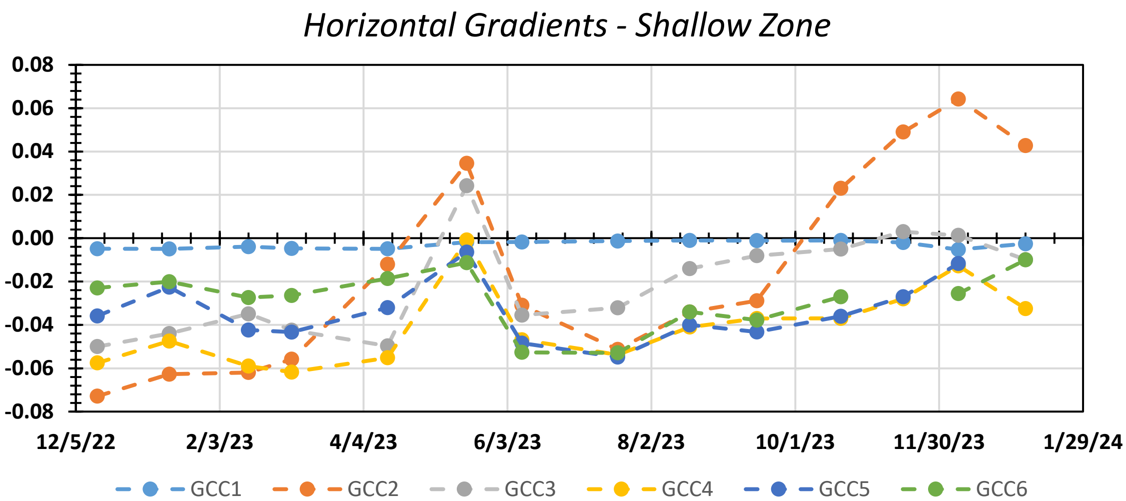
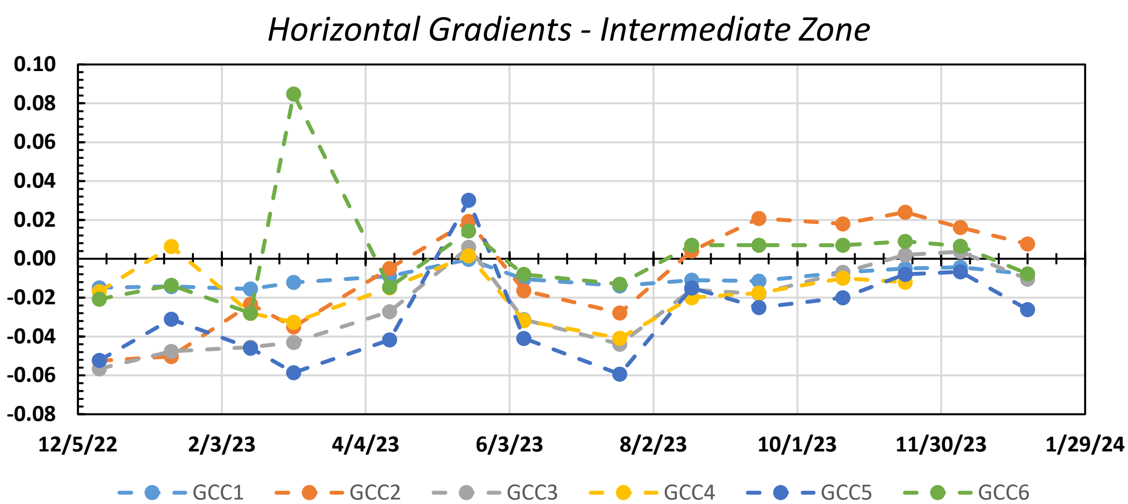
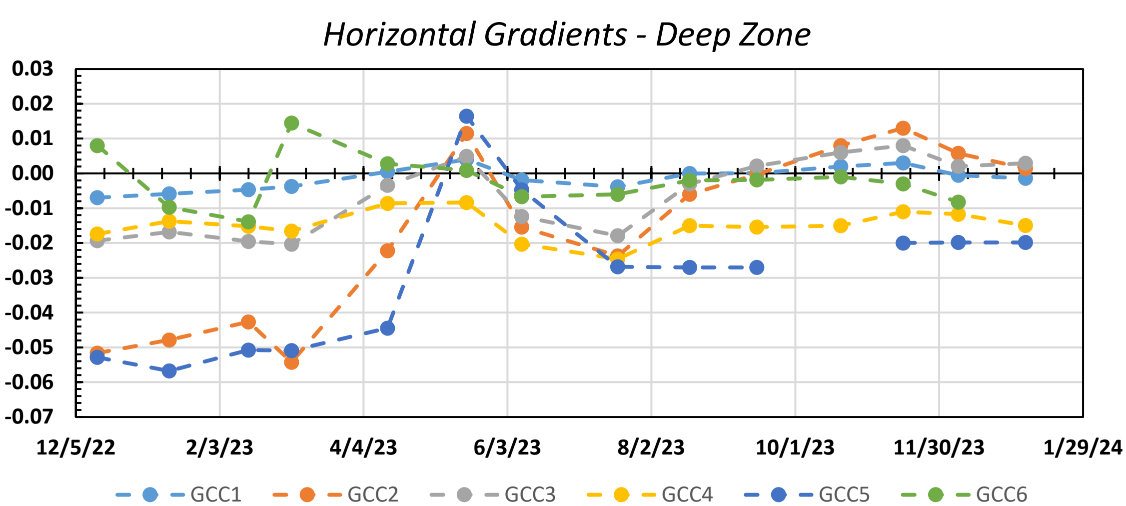
ATTACHMENT B-2 HORIZONTAL GRADIENTS

Attachment B-2

Horizontal Gradients Summary: January 2024
Arkema Inc. Facility
Portland, Oregon







Positive horizontal gradient indicates an inward hydraulic gradient across the GWBW.

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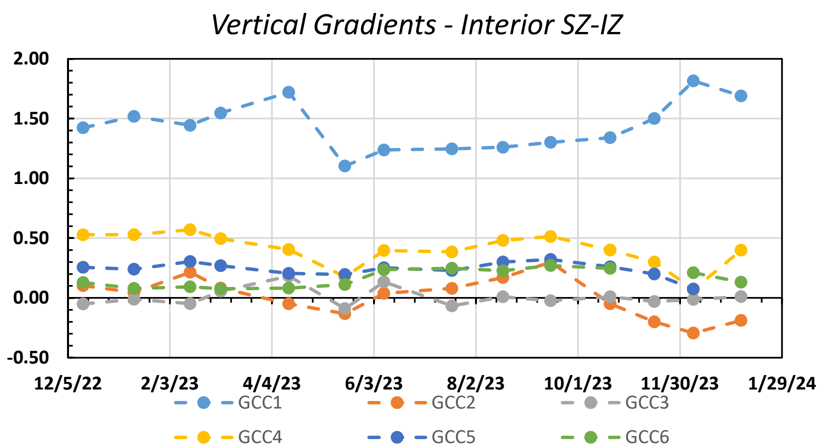
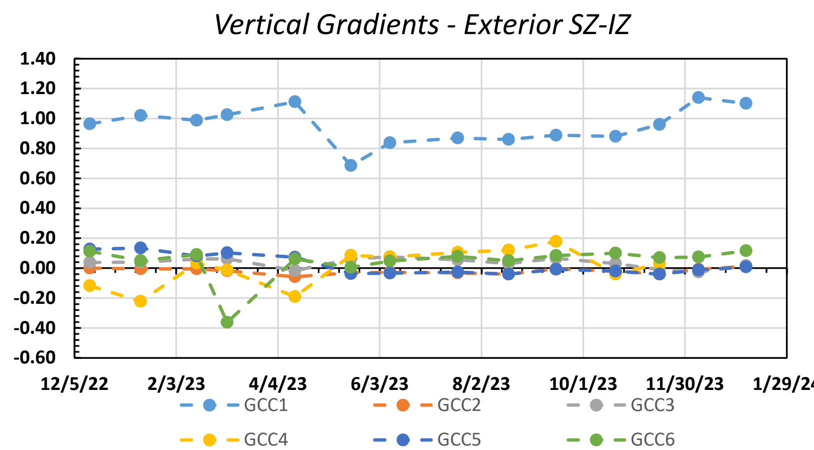
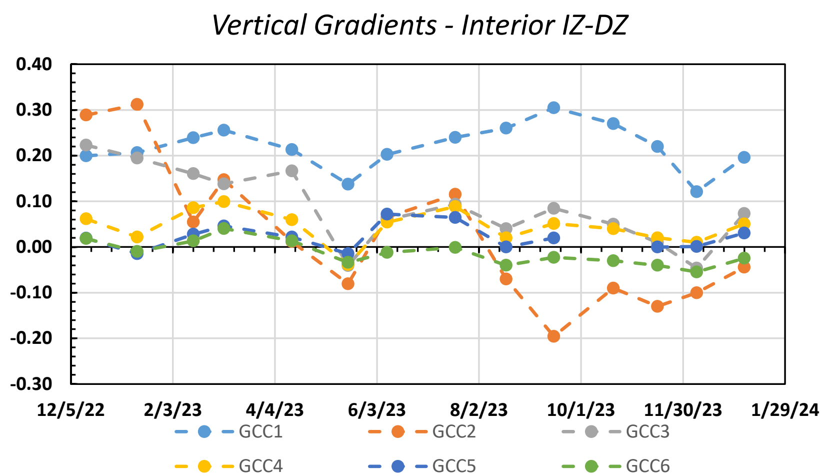
ATTACHMENT B-3 VERTICAL GRADIENTS

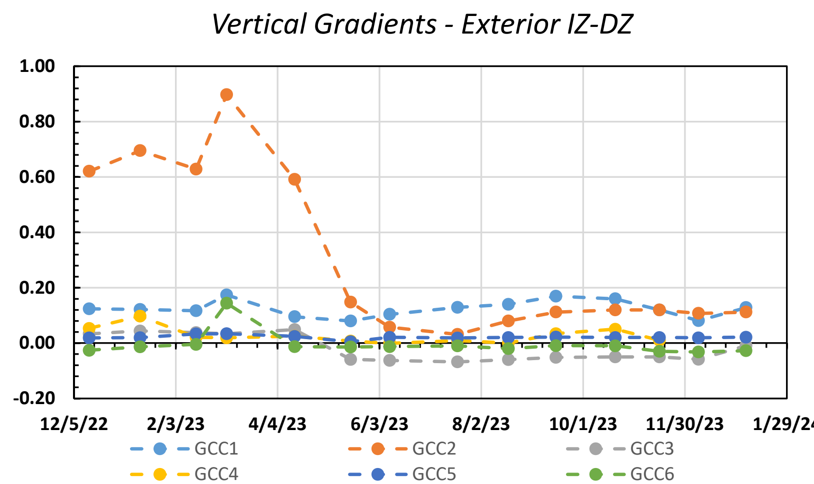
Attachment B-3

Vertical Gradients Summary: January 2024
Arkema Inc. Facility
Portland, Oregon









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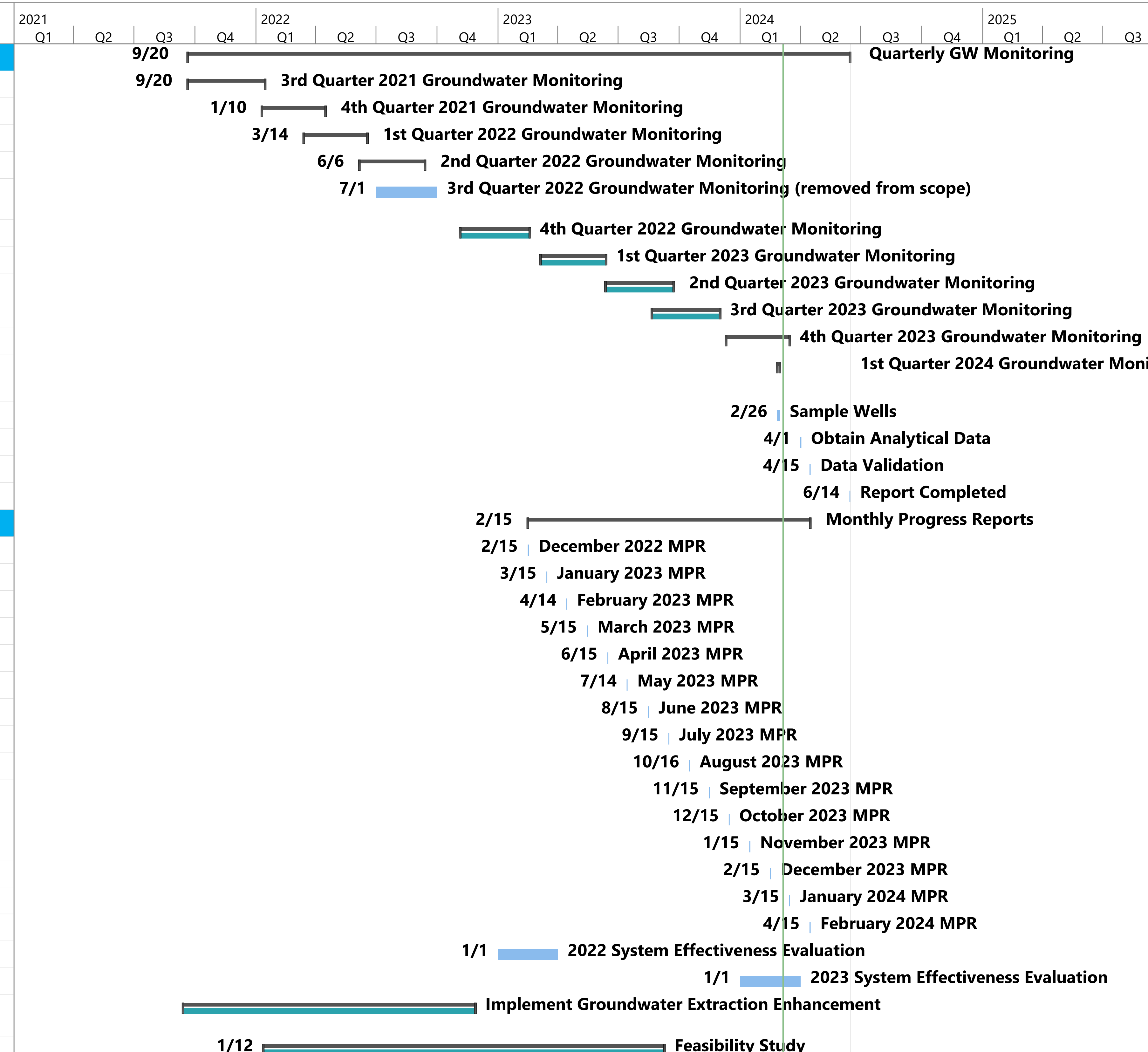
ATTACHMENT C PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Quarterly GW Monitoring**	**719 days**	**Mon 9/20/21**	**Fri 6/14/24**
2	*3rd Quarter 2021 Groundwater Monitoring*	*85 days*	*Mon 9/20/21*	*Fri 1/14/22*
7	*4th Quarter 2021 Groundwater Monitoring*	*70 days*	*Mon 1/10/22*	*Fri 4/15/22*
11	*1st Quarter 2022 Groundwater Monitoring*	*70 days*	*Mon 3/14/22*	*Fri 6/17/22*
16	*2nd Quarter 2022 Groundwater Monitoring*	*71 days*	*Mon 6/6/22*	*Mon 9/12/22*
21	*3rd Quarter 2022 Groundwater Monitoring (removed from scope)*	*66 days*	*Fri 7/1/22*	*Fri 9/30/22*
22	*4th Quarter 2022 Groundwater Monitoring*	*78 days*	*Sat 11/5/22*	*Fri 2/17/23*
27	*1st Quarter 2023 Groundwater Monitoring*	*71 days*	*Mon 3/6/23*	*Mon 6/12/23*
32	*2nd Quarter 2023 Groundwater Monitoring*	*75 days*	*Mon 6/12/23*	*Fri 9/22/23*
37	*3rd Quarter 2023 Groundwater Monitoring*	*75 days*	*Mon 8/21/23*	*Fri 12/1/23*
42	4th Quarter 2023 Groundwater Monitoring	70 days	Mon 12/11/23	Fri 3/15/24
47	**1st Quarter 2024 Groundwater Monitoring ***	**4 days**	**Mon 2/26/24**	**Thu 2/29/24**
48	*Sample Wells*	*4 days*	*Mon 2/26/24*	*Thu 2/29/24*
49	Obtain Analytical Data	1 day	Mon 4/1/24	Mon 4/1/24
50	Data Validation	1 day	Mon 4/15/24	Mon 4/15/24
51	Report Completed	1 day	Fri 6/14/24	Fri 6/14/24
52	**Monthly Progress Reports**	**305 days**	**Wed 2/15/23**	**Mon 4/15/24**
53	*December 2022 MPR*	*1 day*	*Wed 2/15/23*	*Wed 2/15/23*
54	*January 2023 MPR*	*1 day*	*Wed 3/15/23*	*Wed 3/15/23*
55	*February 2023 MPR*	*1 day*	*Fri 4/14/23*	*Fri 4/14/23*
56	*March 2023 MPR*	*1 day*	*Mon 5/15/23*	*Mon 5/15/23*
57	*April 2023 MPR*	*1 day*	*Thu 6/15/23*	*Thu 6/15/23*
58	*May 2023 MPR*	*1 day*	*Fri 7/14/23*	*Fri 7/14/23*
59	*June 2023 MPR*	*1 day*	*Tue 8/15/23*	*Tue 8/15/23*
60	*July 2023 MPR*	*1 day*	*Fri 9/15/23*	*Fri 9/15/23*
61	*August 2023 MPR*	*1 day*	*Mon 10/16/23*	*Mon 10/16/23*
62	*September 2023 MPR*	*1 day*	*Wed 11/15/23*	*Wed 11/15/23*
63	*October 2023 MPR*	*1 day*	*Fri 12/15/23*	*Fri 12/15/23*
64	*November 2023 MPR*	*1 day*	*Mon 1/15/24*	*Mon 1/15/24*
65	*December 2023 MPR*	*1 day*	*Thu 2/15/24*	*Thu 2/15/24*
66	January 2024 MPR	1 day	Fri 3/15/24	Fri 3/15/24
67	February 2024 MPR	1 day	Mon 4/15/24	Mon 4/15/24
68	***2022 System Effectiveness Evaluation***	***66 days***	***Sun 1/1/23***	***Fri 3/31/23***
69	2023 System Effectiveness Evaluation	66 days	Mon 1/1/24	Sun 3/31/24
70	***Implement Groundwater Extraction Enhancement***	***317 days***	***Mon 9/13/21***	***Sun 11/27/22***
78	***Feasibility Study***	***436 days***	***Wed 1/12/22***	***Fri 9/8/23***



Arkema Portland
Monthly Progress Report
Attachment C

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	