

MEMO

ТО	Katie Daugherty, ODEQ
FROM	Brendan Robinson, PE, ERM; Todd Slater, LSS
DATE	19 June 2025
REFERENCE	0732445.204
SUBJECT	Groundwater Source Control Measure Monthly Performance Monitoring Report

1. INTRODUCTION

The Oregon Department of Environmental Quality (ODEQ), in its letter dated 31 May 2019 and in the subsequent meeting with Legacy Site Services LLC (LSS) and Environmental Resources Management, Inc. (ERM) on 2 July 2019, requested that LSS initiate monthly status reports associated with the onsite groundwater source control measure (GW SCM) at the Arkema site (Site) consistent with the Performance Monitoring Plan (PMP; ERM 2014¹) beginning July 2019. The Site is located at 6400 NW Front Avenue in Portland, Oregon, and the Site location is shown on Figure 1. 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 Monthly Performance Monitoring Report (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.

On 6 June 2024, ODEQ requested that LSS and ERM reduce the scope of future MPRs to facilitate faster review. On 11 September 2024, ODEQ agreed for the first amended MPR to be the August 2024 MPR submitted in October 2024.

¹ ERM-West, Inc. 2014. Revised Final Performance Monitoring Plan – Groundwater Source Control Measure, Arkema Inc. Facility, Portland, Oregon. July 2014.



GWET SYSTEM PERFORMANCE

The average influent flow rate was 42.05 gallons per minute (gpm) for the entire month of March 2025, and the average operational influent flow during operational periods was 44.95 gpm.

Extraction wells, pumps, and conveyance lines become fouled with accumulated solids over time. A proactive pump removal and maintenance program is in place to address pump fouling. Regularly scheduled redevelopment is anticipated to maintain the productivity of the groundwater extraction trenches and recovery wells. Conveyance line cleaning will be conducted as needed based on analysis of backpressure.

Compared to February 2025, the March 2025 average system influent flow rate was 5.49 gpm higher. During this same time period, the average Shallow Zone groundwater elevation decreased by 1.63 feet, and the average Intermediate Zone groundwater elevation increased by 0.74 feet, as shown on Attachments A-1 and A-2.

River elevations are shown over time on Attachments A-1 and A-2, and in an inset on the potentiometric surface maps (Figures 2 through 4). The river elevation has generally been trending upward since a seasonal low was observed in October 2024. The river elevation in March 2025 had an average elevation of 11.25 feet North American Vertical Datum of 1988 (NAVD88) with a minimum elevation of 7.32 feet NAVD88 and a maximum elevation of 15.90 feet NAVD88. The average river elevation had an increase of 1.67 feet NAVD88 compared to February 2025.

LSS is continuing to optimize extraction rates within the system to increase flow rates at each operational well until either the extraction rates specified in the *Groundwater Extraction Enhancement Final Design Report* (ERM 2022²) are achieved, the wells are producing the maximum quantity of water possible, or until the Capture Zone Objectives are met.

Actions taken in March 2025 to optimize flow rates included the following:

- Redevelopment of the horizontal screen section at underperforming trenches 1, 4, 5, and 6 began in February, and continued through March 2025.
- Cleaning of the conveyance line was performed.

2.1 GWFT PLANT OPERATIONS

The GWET plant operated within permit conditions during the reporting period. There was one shutdown during March 2025:

• 2 March 2025: The wellfield was shut down for 2 days due to conveyance line cleaning and GWET plant maintenance.

² ERM-West, Inc. 2022. Final Design Report, Arkema Inc. Facility, Portland, Oregon. May 2022.



CAPTURE ZONE EVALUATION

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 groundwater barrier wall (GWBW) and to evaluate the effective hydraulic capture produced by the GW SCM.

3.1 GROUNDWATER ELEVATION MONITORING

Groundwater elevation monitoring was completed on 14 March 2025. The Serfes (1991)³ method was used to account for tidal variations of groundwater and river elevations as described in the PMP. Horizontal and vertical gradients were calculated and plotted over time as shown in Attachments B-1 and B-2. Groundwater elevations, horizontal gradients, and vertical gradients from 14 March 2025 are tabulated in Attachment B-3 and Attachment B-4.

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

Groundwater elevation data collected on 14 March 2025 was used to prepare potentiometric surface maps based on manual measurements and averaged transducer groundwater elevations (Figures 2 through 4) and vertical gradient difference maps (Figures 5 and 6).

The generalized flow direction indicated by the potentiometric surface maps shows groundwater flow from upgradient toward the GWBW. Potentiometric surface maps (Figures 2, 3, and 4) show generalized groundwater movement to the extraction trenches in the Shallow, Intermediate, and Deep Zones due to GW SCM pumping, and cones of depression are apparent around the groundwater extraction trenches in the Shallow and Intermediate Zones. Horizontal gradient in the Shallow Zone at gradient control cluster 2 (GCC 2) was inward in March 2025, nearly zero at GCC 1 and outward at GCC 3, GCC 4, GCC 5, and GCC 6, as shown in Attachments B-1 and B-3.

Vertical gradients were calculated for each vertical well pair and are plotted on Figures 5 and 6. Vertical groundwater gradients and trend lines are shown in Attachments B-2 and B-4. Vertical groundwater gradients exterior to the GWBW were neutral to slightly downward between the Shallow and Intermediate Zones and between the Intermediate and Deep Zones.

Vertical gradients interior to the GWBW between the Shallow Zone and Intermediate Zone were upward at GCC 2, nearly neutral at GCC 3, and downward at GCC 6, GCC 5, GCC 4, and GCC 1. Note that the vertical gradient for GCC 1 is exaggerated as a result of the localized pressure zone where soils are tight, and water is relatively immobile. Vertical gradients interior to the GWBW between the Intermediate Zone and Deep Zone were upward at GCC 6 and GCC 2, nearly neutral at GCC 5 and GCC 3, and downward at GCC 4 and GCC 1.

³ Serfes, Michael. 1991. "Determining the Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations." *Groundwater* 29(4): July–August.



4. CONCLUSIONS

Analysis of horizontal gradients over time indicate that the extraction wells are performing better than the historical recovery wells, and horizontal gradients are periodically inward, and the magnitude of outward gradients are decreasing over time, as shown on Attachment B-1. The extraction rates throughout the GWET system will continue to be optimized to meet Target Capture Objectives. Conveyance line cleaning took place in March 2025. Redevelopment of underperforming trenches 1, 4, 5, and 6 began in February 2025 and continued in March 2025 to mitigate accumulation of silt in the filter pack in both the vertical and horizontal sections using impulse redevelopment techniques, and resonant technology. These efforts will be continued through April 2025 to maximize flow rates. LSS will continue to optimize new extraction wells, including pump maintenance and upgrades. Additional modifications to the system, if needed to progress toward capture objectives, will be included in subsequent MPRs. The project schedule provided as Attachment C summarizes planned activities.

Attachment D shows the average influent groundwater flow rate from April 2019 through March 2025. As shown on this figure, the extraction trenches are removing approximately three times more water than the legacy system and achieving lower horizontal gradients over time.

Regards,

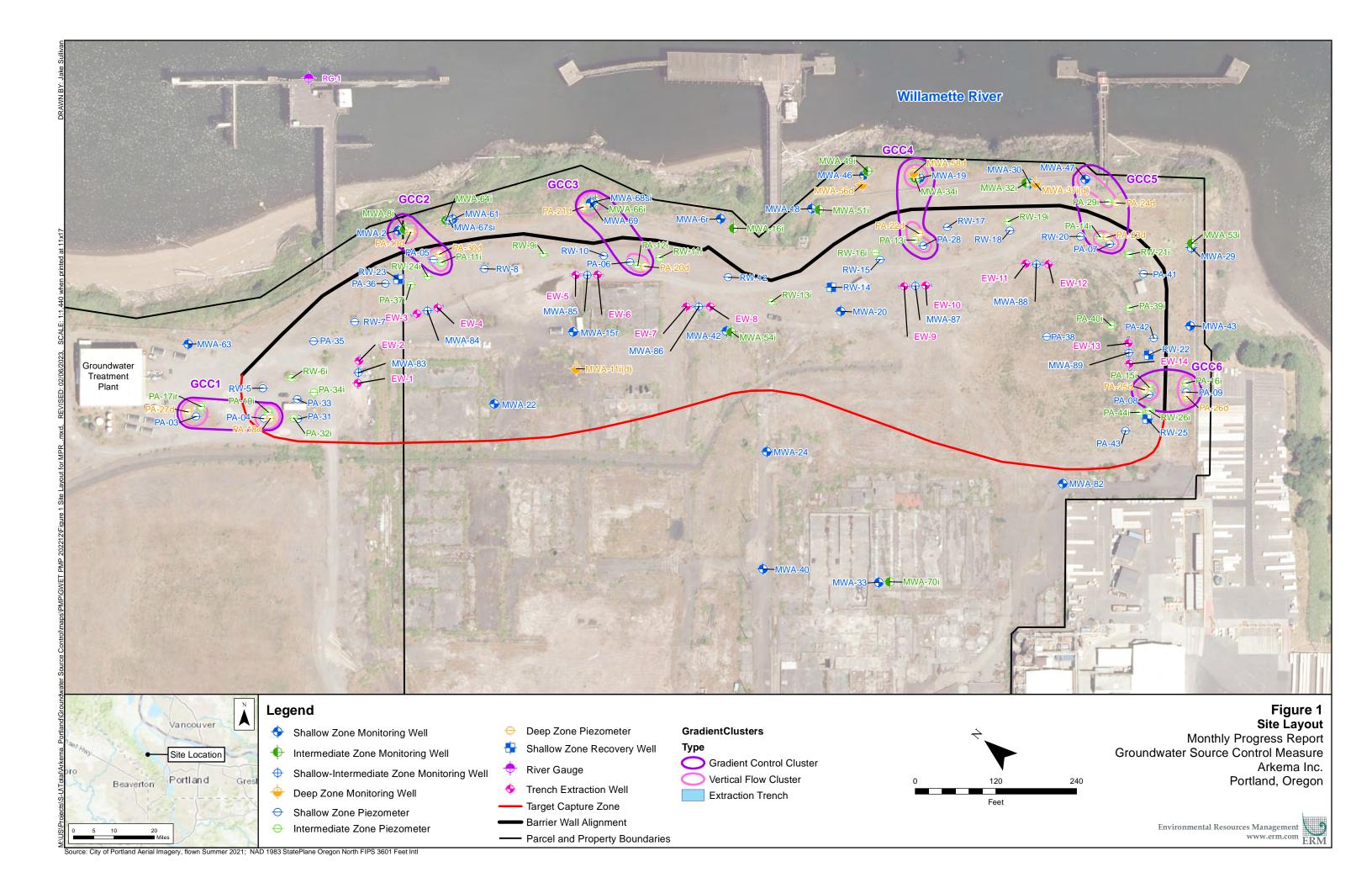
Brendan Robinson, PE

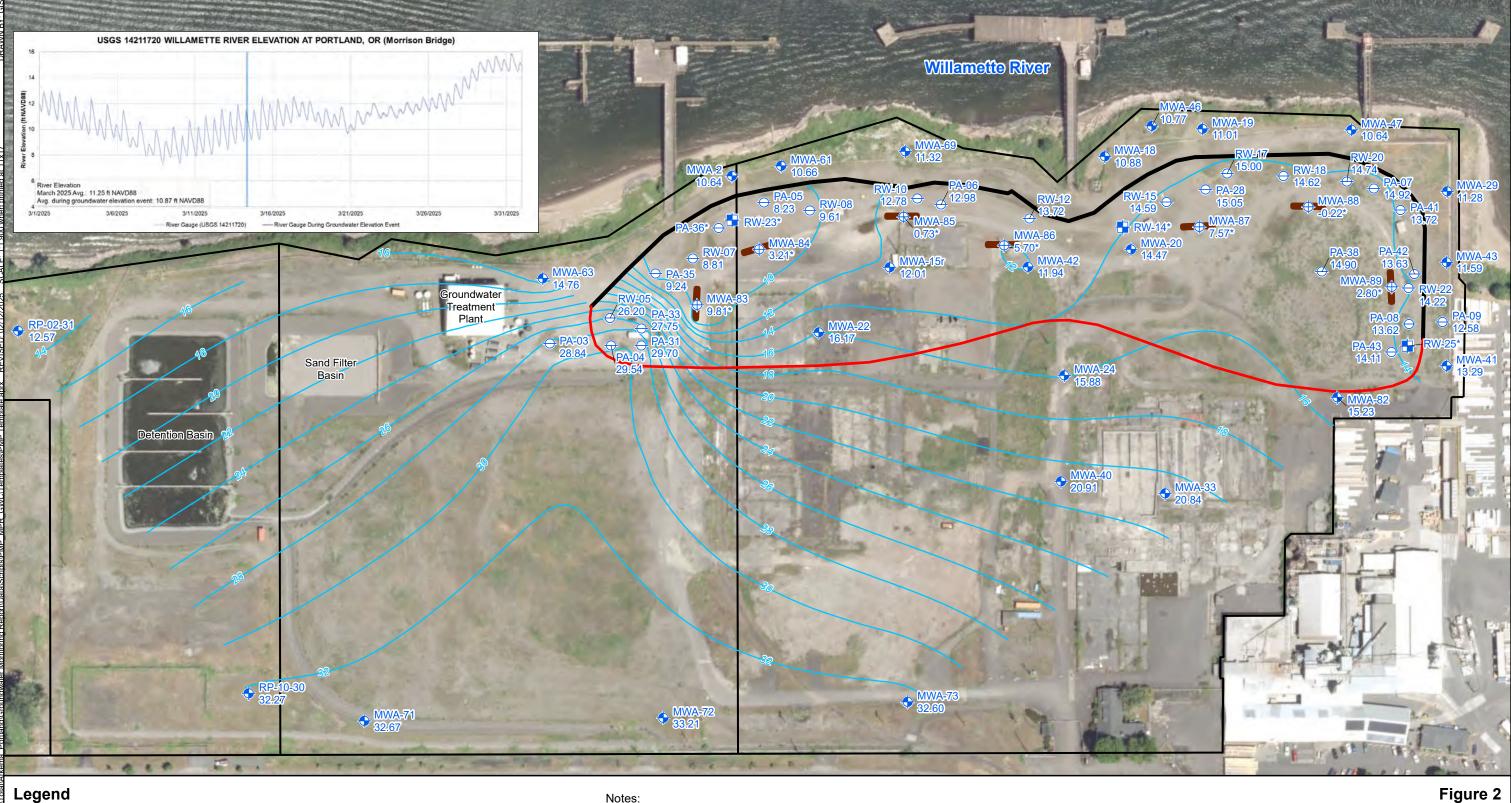
Partner



ATTACHMENTS

- FIGURE 1 SITE LAYOUT
- FIGURE 2 SHALLOW ZONE GROUNDWATER CONTOURS
- FIGURE 3 INTERMEDIATE ZONE GROUNDWATER CONTOURS
- FIGURE 4 DEEP ZONE GROUNDWATER CONTOURS
- FIGURE 5 SHALLOW TO INTERMEDIATE ZONE VERTICAL HEAD DIFFERENCE MAPS
- FIGURE 6 INTERMEDIATE TO DEEP ZONE VERTICAL HEAD DIFFERENCE MAPS
- ATTACHMENT A-1 OPERATIONAL PUMPING RATE GRAPH
- ATTACHMENT A-2 AVERAGE MONTHLY PUMPING RATE GRAPH
- ATTACHMENT A-3 GWET SYSTEM GROUNDWATER EXTRACTION RATES TABLE
- ATTACHMENT B-1 HORIZONTAL GRADIENTS SUMMARY GRAPH
- ATTACHMENT B-2 VERTICAL GRADIENTS SUMMARY GRAPH
- ATTACHMENT B-3 WATER LEVELS AND HORIZONTAL GRADIENTS TABLE
- ATTACHMENT B-4 WATER LEVELS AND VERTICAL GRADIENTS TABLE
- ATTACHMENT C PROJECT SCHEDULE
- ATTACHMENT D AVERAGE GROUNDWATER EXTRACTION RATE GRAPH





Legend

→ Shallow Zone Piezometer

Shallow Zone Monitoring Well

Active Recovery Well; Not Used During Contouring

◆ Shallow-Intermediate Zone Monitoring Well Extraction Trench (Not To Scale)

27.70 Groundwater Elevation (ft NAVD88)

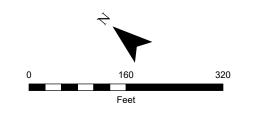
Notes:

Shallow Zone Groundwater Contours (ft NAVD88) Dashed where Inferred

Target Capture Zone

Barrier Wall Alignment

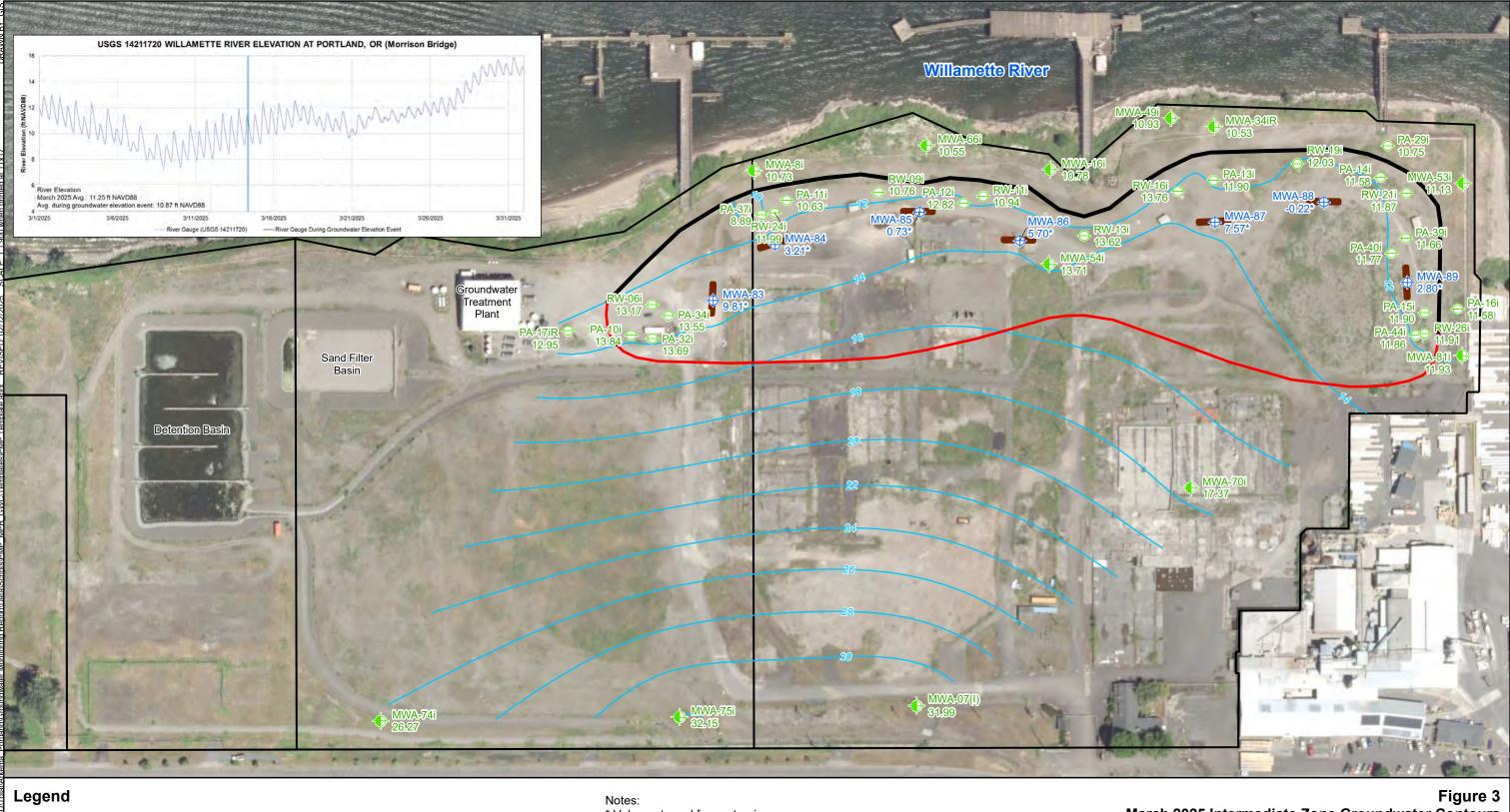
* Value not used for contouring. Water levels collected March, 2025. ft NAVD88: feet North American Vertical Datum of 1988. Aerial Photo: City of Portland, Summer 2017.



March 2025 Shallow Zone Groundwater Contours

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Intermediate Zone Piezometer

Intermediate Zone Monitoring Well

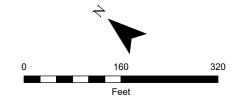
Shallow-Intermediate Zone Monitoring Well

27.70 Groundwater Elevation (ft NAVD88)

Intermediate Zone Groundwater Contours (ft NAVD88) Dashed where Inferred

Target Capture Zone

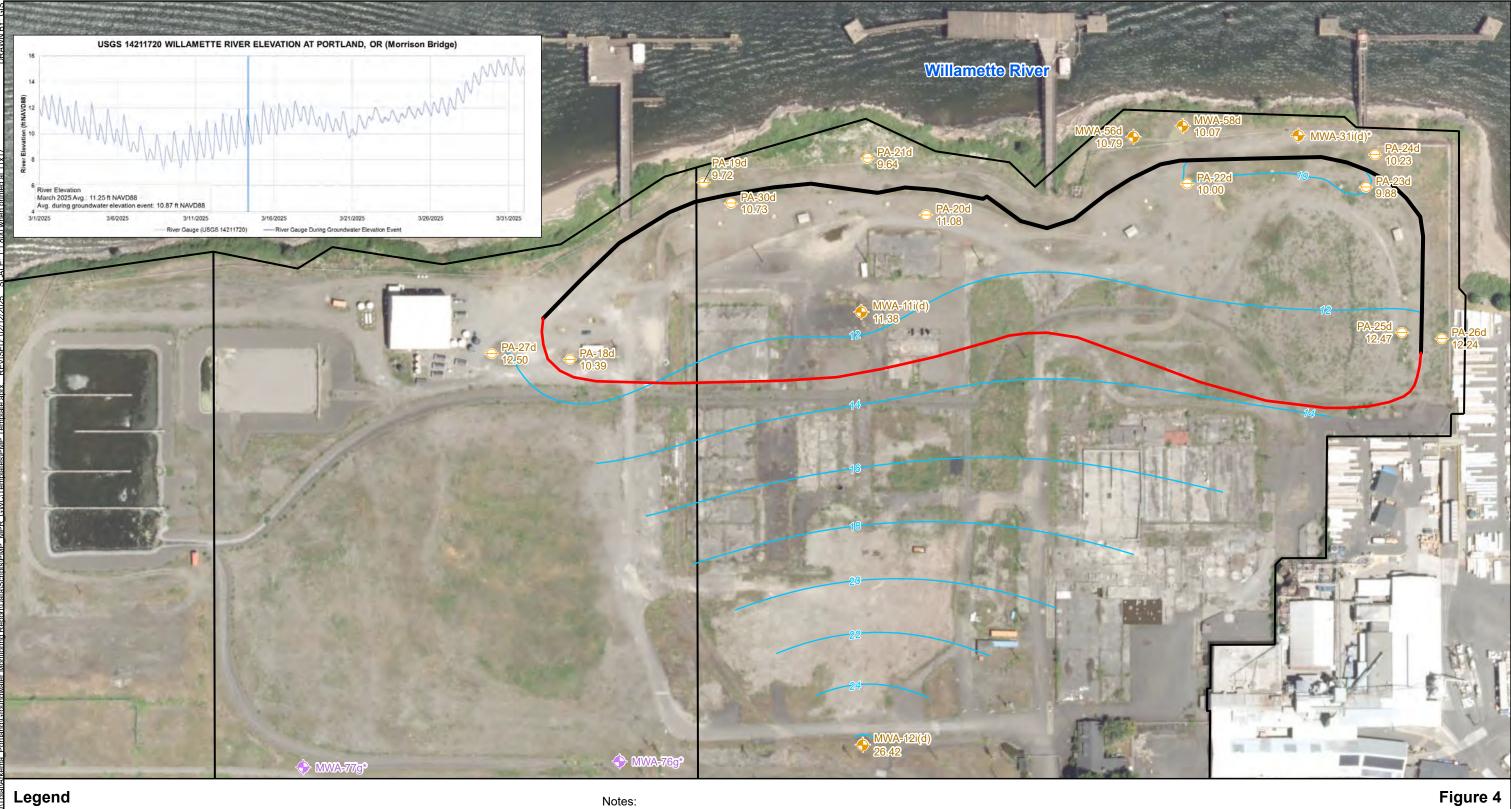
 Barrier Wall Alignment Extraction Trench (Not To Scale) * Value not used for contouring. Water levels collected March, 2025. ft NAVD88: feet North American Vertical Datum of 1988. Aerial Photo: City of Portland, Summer 2017.



March 2025 Intermediate Zone Groundwater Contours

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Oeep Zone Piezometer

Deep Zone Monitoring Well

Gravel Zone Monitoring Well

27.70 Groundwater Elevation (ft NAVD88)

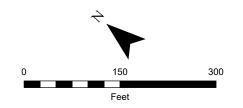
Deep Zone Groundwater Contours (ft NAVD88)

Dashed where Inferred

Target Capture Zone

Barrier Wall Alignment

* Value not used for contouring.
Gravel zone wells not used in contouring.
Water levels collected March, 2025.
ft NAVD88: feet North American Vertical Datum of 1988.
Aerial Photo: City of Portland, Summer 2017.



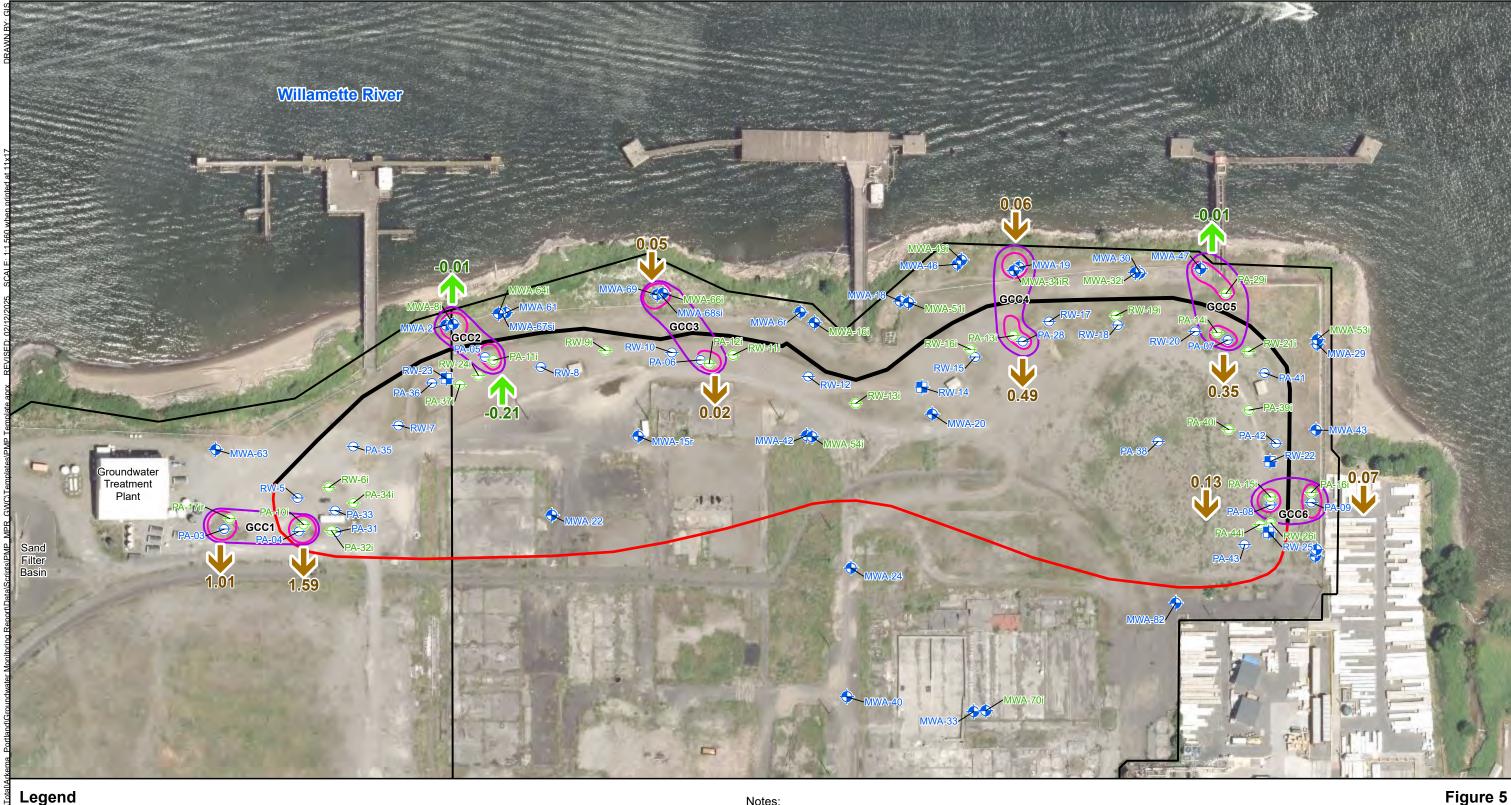
March 2025 Deep Zone Groundwater Contours

Monthly Performance Report

Groundwater Source Control Measures

roundwater Source Control Measures Arkema Inc. Portland, Oregon





Legend

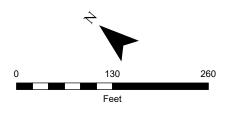
- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Shallow Zone Piezometer
- Intermediate Zone Piezometer
- Shallow Zone Recovery Well
- Trench Extraction Well

- Active Recovery Well
- Trench Extraction Well
- Target Capture Zone Barrier Wall Alignment
- Extraction Trench
- Gradient Control Cluster Vertical Flow Cluster

Downward Gradient

Upward Gradient

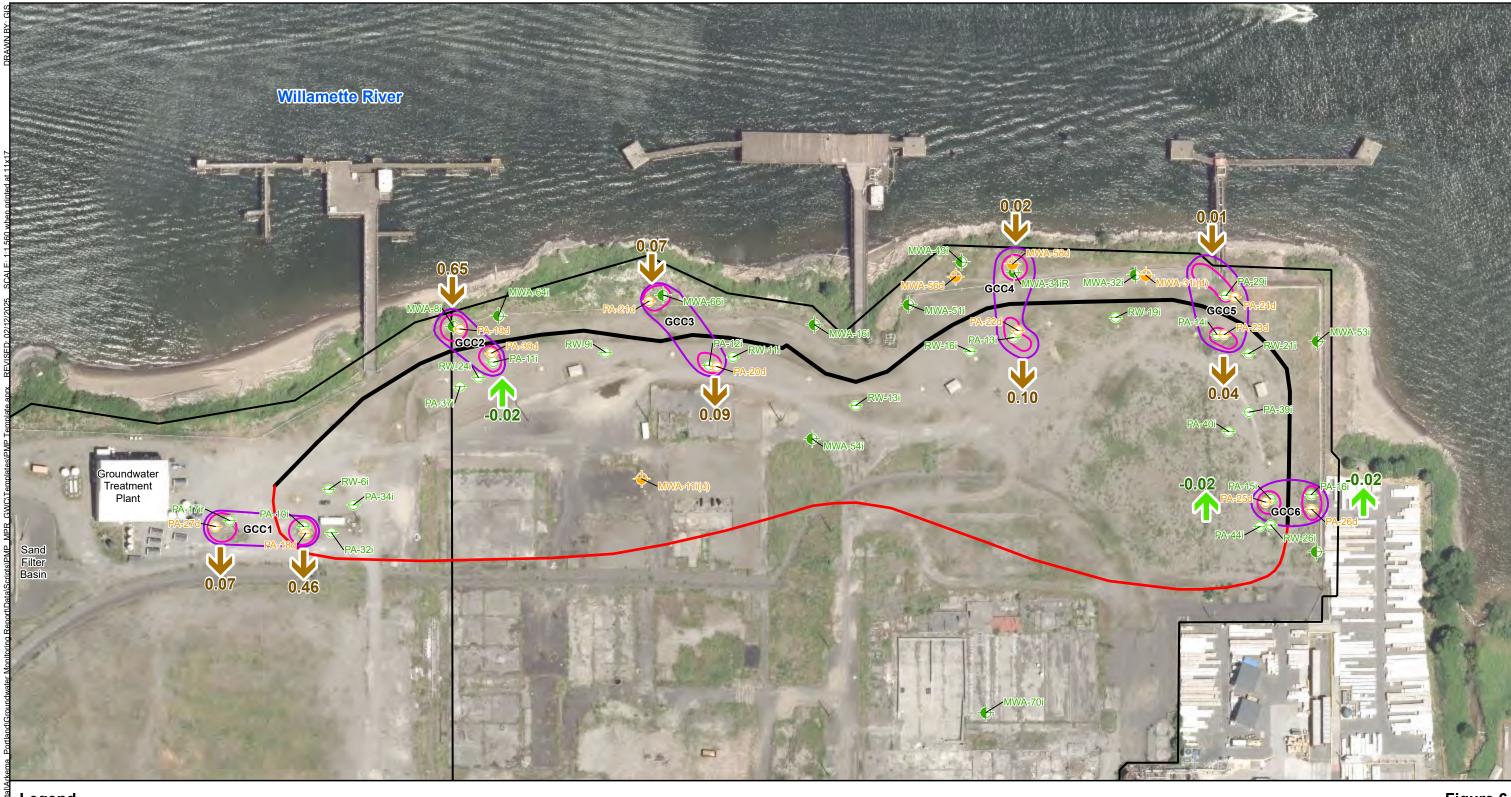
Brown gradient: Downward gradient.
Green gradient: Upward gradient.
Vertical gradient calculated as shallow zone minus intermediate zone potentiometric surfaces. Water levels collected March, 2025. Aerial Photo: City of Portland, Summer 2017.



March 2025 Shallow to Intermediate Zone **Vertical Head Difference**

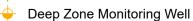
Monthly Progress Report Groundwater Source Control Measures Arkema Inc. Portland, Oregon





Legend

• Intermediate Zone Monitoring Well



→ Intermediate Zone Piezometer

Deep Zone Piezometer

Shallow-Intermediate Zone Monitoring Well Trench Extraction Well

Active Recovery WellTarget Capture Zone

Target Capture ZoneBarrier Wall Alignment

Extraction Trench

Downward Gradient

Upward Gradient

Note

Brown gradient: Downward gradient.
Green gradient: Upward gradient.
Vertical gradient calculated as
intermediate zone minus deep zone
potentiometric surfaces.
Water levels collected March, 2025.
Aerial Photo: City of Portland, Summer
2017.

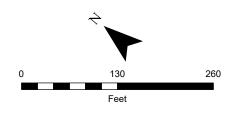


Figure 6 March 2025 Intermediate to Deep Zone Vertical Head Difference

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NAD 1983 StatePlane Oregon North FIPS 3601 Feet Intl

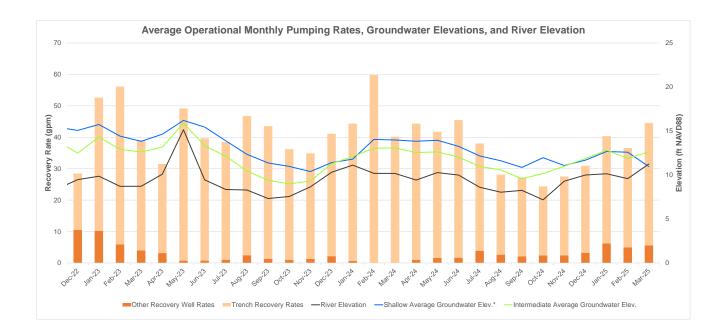


ATTACHMENT A-1

OPERATIONAL PUMPING RATE GRAPH

Attachment A-1

Operational Pumping Rate Graph Arkema Inc. Facility Portland, Oregon



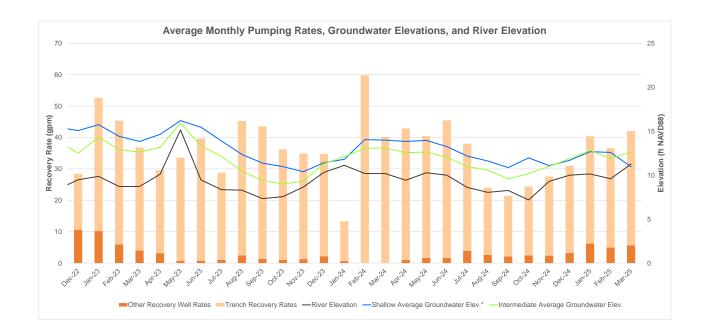


ATTACHMENT A-2

AVERAGE MONTHLY PUMPING RATE GRAPH

Attachment A-2

Average Pumping Rate Graph Arkema Inc. Facility Portland, Oregon





ATTACHMENT A-3

GWET SYSTEM GROUNDWATER EXTRACTION RATES TABLE

Attachment A-3

GWET System Groundwater Extraction Rates Table Arkema Inc. Facility Portland, Oregon

Recovery Well	March 2025 Average Operational Pumping Rate (gpm)	March 2025 Average Monthly Pumping Rate (gpm)	
RW-14	1.99	1.86	
RW-22	0.54	0.51	
RW-23	1.90	1.78	
RW-25	1.55	1.45	
EW-01	2.55	2.39	
EW-02*	0.00	0.00	
EW-03	12.58	11.77	
EW-04	0.52	0.48	
EW-05	5.06	4.74	
EW-06*	0.00	0.00	
EW-07	0.12	0.11	
EW-08	4.21	3.94	
EW-09	1.56	1.46	
EW-10	0.58	0.54	
EW-11	3.89	3.64	
EW-12*	0.00	0.00	
EW-13	6.89	6.45	
EW-14	1.01	0.94	
Total	44.95	42.05	

^{* =} Recovery well not in service during reporting period gpm = gallon per minute



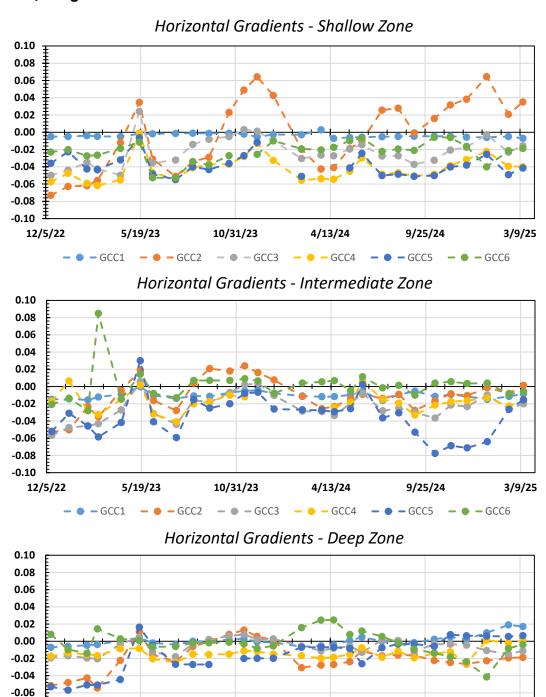
ATTACHMENT B-1

HORIZONTAL GRADIENTS SUMMARY GRAPH

Attachment B-1

-0.08 -0.10

Horizontal Gradients Summary: March 2025 Arkema Inc. Facility Portland, Oregon



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

10/31/23

4/13/24

- ● - GCC1 - ● - GCC2 - ● - GCC3 - ● - GCC4 - ● - GCC5 - ● - GCC6

9/25/24

3/9/25

5/19/23



ATTACHMENT B-2

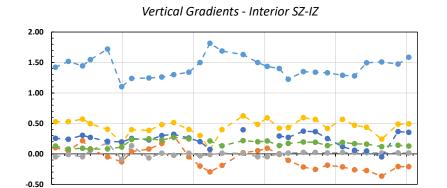
VERTICAL GRADIENTS SUMMARY GRAPH

Attachment B-2

12/5/22

5/19/23

Vertical Gradients Summary: March 2025 Arkema Inc. Facility Portland, Oregon

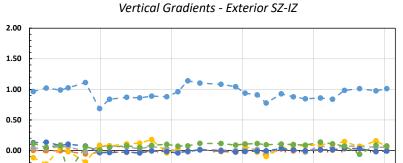


- • - GCC1 - • - GCC2 - • - GCC3 - • - GCC4 - • - GCC5 - • - GCC6

4/13/24

9/25/24

10/31/23



- • - GCC1 - • - GCC2 - • - GCC3 - • - GCC4 - • - GCC5 - • - GCC6

4/13/24

9/25/24

3/9/25

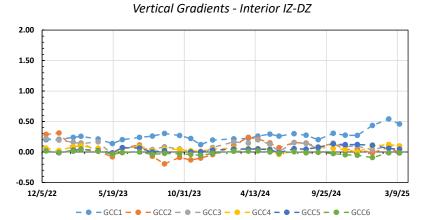
10/31/23

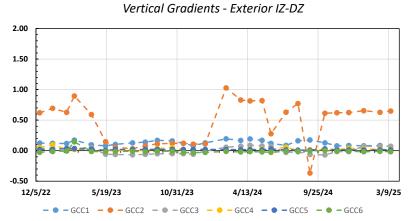
-0.50

12/5/22

5/19/23

3/9/25







ATTACHMENT B-3

WATER LEVELS AND HORIZONTAL GRADIENTS TABLE

Attachment B-3

Water Levels and Horizontal Gradients Table Arkema Inc. Facility Portland, Oregon

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	27.30	PA-04	27.80	-0.007
	Intermediate	PA-17iR	12.00	PA-10i	13.20	-0.009
	Deep	PA-27d	11.45	PA-18d	9.12	0.017
GCC2	Shallow	MWA-2	9.20	PA-05	7.77	0.035
	Intermediate	MWA-8i	9.50	PA-11i	10.09	0.001
	Deep	PA-19d	8.52	PA-30d	9.56	-0.019
GCC3	Shallow	MWA-69	10.03	PA-06	12.48	-0.016
	Intermediate	MWA-66i	9.33	PA-12i	12.30	-0.020
	Deep	PA-21d	8.44	PA-20d	10.36	-0.011
GCC4	Shallow	MWA-19	10.51	PA-28	14.48	-0.040
	Intermediate	MWA-34iR	9.36	PA-13i	11.37	-0.016
	Deep	MWA-58d	8.85	PA-22d	9.03	0.001
GCC5	Shallow	MWA-47	9.41	PA-07	14.48	-0.041
	Intermediate	PA-29i	9.58	PA-14i	11.02	-0.015
	Deep	PA-24d	9.10	PA-23d	8.81	0.007
GCC6	Shallow	PA-09	11.92	PA-08	13.11	-0.019
	Intermediate	PA-16i	10.78	PA-15i	11.27	-0.006
	Deep	PA-26d	11.24	PA-25d	11.76	-0.004

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

Horizontal gradient calculated as (Exterior Elevation – Interior Elevation) / Horizontal distance.

ft NAVD88 = feet North American Vertical Datum of 1988

^{* =} anonalous groundwater elevation

^{** =} horizontal gradient cannot be calculated due to anomalous elevation reading

^M = manual groundwater elevation measurement



ATTACHMENT B-4

WATER LEVELS AND VERTICAL GRADIENTS TABLE

Attachment B-4

Water Levels and Vertical Gradients Table Arkema Inc. Facility Portland, Oregon

Region	Pair	Gradient Cluster	Upper Well	Water Elevation (ft NAVD88)	Lower Well	Water Elevation (ft NAVD88)	Vertical Gradient (ft/ft)
	ZI-ZS	GCC1	PA-04	27.80	PA-10i	13.20	1.59
		GCC2	PA-05	7.77	PA-11i	10.09	-0.21
		GCC3	PA-06	12.48	PA-12i	12.30	0.02
		GCC4	PA-28	14.48	PA-13i	11.37	0.49
_		GCC5	PA-07	14.48	PA-14i	11.02	0.35
Interior		GCC6	PA-08	13.11	PA-15i	11.27	0.13
nte		GCC1	PA-10i	13.20	PA-18d	9.12	0.46
		GCC2	PA-11i	10.09	PA-30d	9.56	-0.02
	ZO-ZI	GCC3	PA-12i	12.30	PA-20d	10.36	0.09
		GCC4	PA-13i	11.37	PA-22d	9.03	0.10
		GCC5	PA-14i	11.02	PA-23d	8.81	0.04
		GCC6	PA-15i	11.27	PA-25d	11.76	-0.02
	ZI-ZS	GCC1	PA-03	27.30	PA-17iR ^M	12.00	1.01
		GCC2	MWA-2	9.20	MWA-8i	9.50	-0.01
		GCC3	MWA-69	10.03	MWA-66i	9.33	0.05
		GCC4	MWA-19	10.51	MWA-34iR	9.36	0.06
_		GCC5	MWA-47	9.41	PA-29i	9.58	-0.01
rio		GCC6	PA-09	11.92	PA-16i	10.78	0.07
Exterior	ZG-ZI	GCC1	PA-17iR ^M	12.00	PA-27d	11.45	0.07
ш		GCC2	MWA-8i	9.50	PA-19d	8.52	0.65
		GCC3	MWA-66i	9.33	PA-21d	8.44	0.07
		GCC4	MWA-34iR	9.36	MWA-58d	8.85	0.02
		GCC5	PA-29i	9.58	PA-24d	9.10	0.01
		GCC6	PA-16i	10.78	PA-26d	11.24	-0.02

Positive vertical gradient indicates an donward hydraulic gradient.

Vertical gradient calculated as (Upper Elevation – Lower Elevation) / Screen Midpoint distance.

DZ = Deep Zone

ft NAVD88 = feet North American Vertical Datum of 1988

IZ = Intermediate Zone

SZ = Shallow Zone

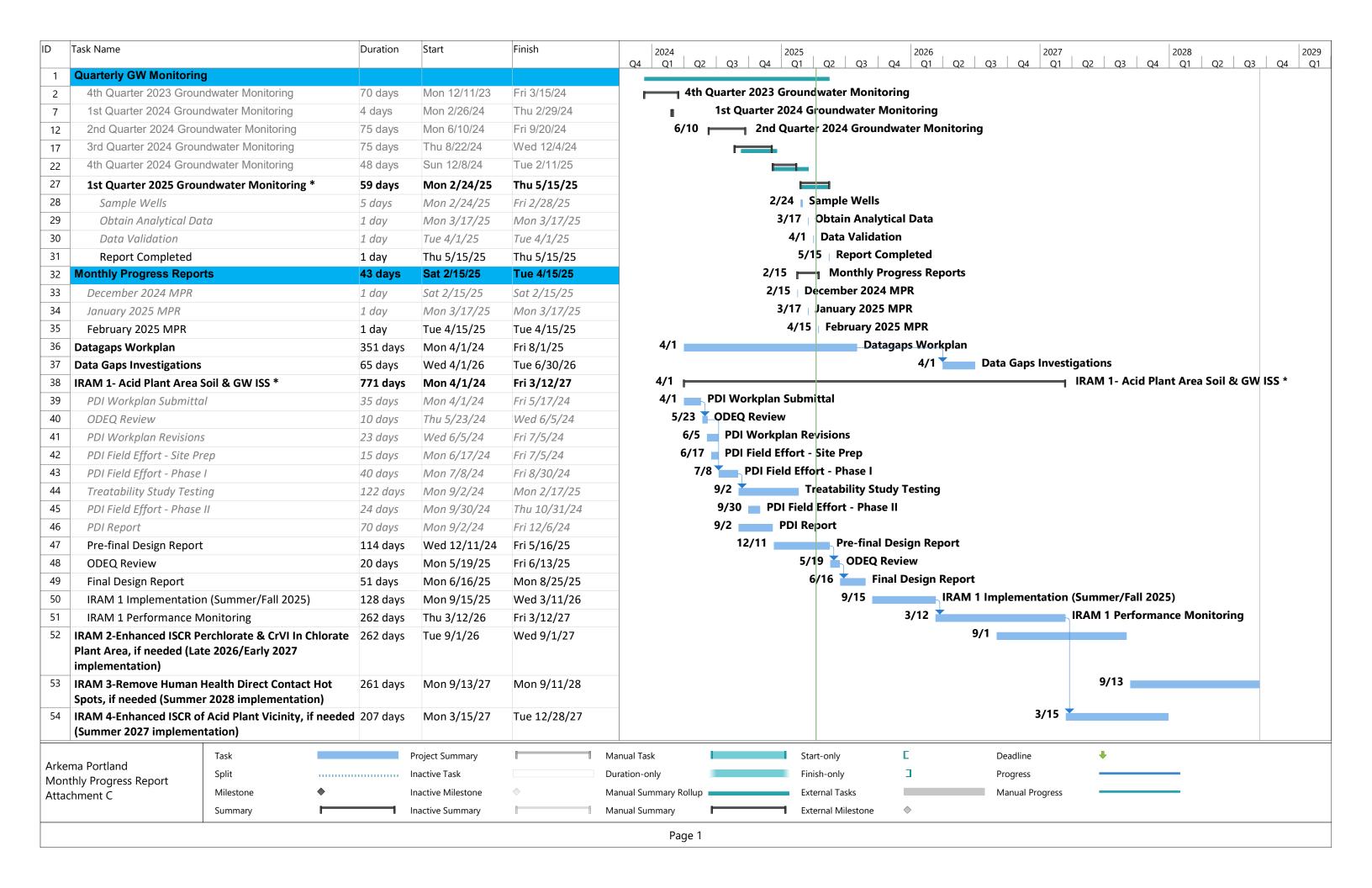
^{* =} anonalous groundwater elevation

^{** =} vertical gradient cannot be calculated due to anomalous elevation reading

^M = manual groundwater elevation measurement



ATTACHMENT C PROJECT SCHEDULE





ATTACHMENT D

AVERAGE GROUNDWATER EXTRACTION RATE GRAPH

Attachment D

Average Groundwater Extraction Rate Graph Arkema Inc. Facility Portland, Oregon

Average Groundwater Extraction Rate

