Flint Hills Resources Alaska, LLC

Annual 2023 Onsite Groundwater Monitoring Report

North Pole Terminal
North Pole, Alaska
ADEC File Number: 100.38.090

January 16, 2024

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Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

2017 LTM Plan	Long-Term Monitoring Plan – 2017 Update
µg/L	microgram per liter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
Arcadis	Arcadis U.S., Inc.
BTEX	benzene, toluene, ethylbenzene, and xylenes
COC	constituent of concern
DRO	diesel-range organics
FHRA	Flint Hills Resources Alaska, LLC
GRO	gasoline-range organics
GRTS	groundwater remediation and treatment system
ITRC	Interstate Technology & Regulatory Council
LNAPL	light nonaqueous phase liquid
LTM	Long Term Monitoring Plan
NSZD	natural source zone depletion
Onsite RSAP	Revised Onsite Sampling and Analysis Plan
Onsite SCR – 2013	Onsite Site Characterization Report – 2013 Addendum
POC	point of compliance
report	Annual 2023 Onsite Groundwater Monitoring Report
ROCP	Revised Onsite Cleanup Plan
site	North Pole Terminal, located on H and H Lane in North Pole, Alaska
VPT	vertical profile transect

1 Introduction

Arcadis U.S., Inc. (Arcadis) prepared this Annual 2023 Onsite Groundwater Monitoring Report (report) for the North Pole Terminal, located on H and H Lane in North Pole, Alaska (site). This report summarizes onsite field activities completed during the annual 2023 reporting period as described in Section 3 and presented in Table 1-1.

The data, analyses, and conclusions presented in this report are the product of a collaborative effort by a consulting team engaged by Flint Hills Resources Alaska, LLC (FHRA) to undertake the work discussed in this report. The team includes qualified professionals in a variety of technical disciplines from three environmental consulting firms: Arcadis, Shannon & Wilson, Inc., and Barr Engineering Co. FHRA engaged these consulting firms to perform various tasks for the project. Pursuant to 18 Alaska Administrative Code (AAC) 75.335(c)(1), this report was prepared and submitted by Qualified Environmental Professionals. Samples were collected and analyzed in accordance with 18 AAC 75.355(a). Sample locations are defined in the Long-Term Monitoring (LTM) Plan – 2017 Update (2017 LTM Plan), provided as Appendix A to the Revised Onsite Cleanup Plan (ROCP; Arcadis 2017b) and the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis 2023). The sampling and analyses for this reporting period were completed in accordance with the following documents, which were also prepared by Qualified Environmental Professionals and approved by the Alaska Department of Environmental Conservation (ADEC):

- ROCP (Arcadis 2017b)
- 2017 LTM Plan (Arcadis 2017b)
- Revised Onsite Sampling and Analysis Plan (Onsite RSAP; provided as Appendix A to the Second Semiannual 2016 Onsite Groundwater Monitoring Report [Arcadis 2017a])
- 2023 updates to the 2017 LTM Plan (Arcadis 2023).

The site, offsite area, and the site's physical setting are described in the conceptual site model, which was provided in Appendix A of the Onsite Site Characterization Report – 2013 Addendum (Onsite SCR – 2013; Arcadis 2013). The site location, current site features, and an onsite site plan are shown on Figures 1-1, 1-2, and 1-3, respectively. The former treatment systems, GAC West and GAC East, are shown on Figure 1-2. The GAC West system was shut down in third quarter 2016. The GAC East system is also referred to in this report as the groundwater remediation and treatment system (GRTS). Shutdown of the GRTS occurred in third quarter 2017 (see Section 2). Responses to shutdown of the treatment system are discussed in Section 3. The former recovery well locations associated with the GRTS are shown on Figure 1-3.

2 Current Groundwater Monitoring Program and Methods

Monitoring conducted during the reporting period was based on the following activities included in the 2017 LTM Plan (Arcadis 2017b), and the 2023 updates to the 2017 LTM Plan (Arcadis 2023):

- Groundwater elevation measurements

- Light nonaqueous phase liquid (LNAPL) migration monitoring
- Groundwater sampling and analysis of sulfolane
- Groundwater sampling and analysis for other constituents of concern (COCs), including benzene, toluene, ethylbenzene, and xylenes (BTEX); gasoline-range organics (GRO); and diesel-range organics (DRO)
- Groundwater sampling and analysis for natural attenuation parameters (iron, manganese, sulfate, methane, and dissolved oxygen).

The ROCP (Arcadis 2017b) was submitted to and approved by ADEC in February 2017. In accordance with the ROCP, in third quarter 2017 the GRTS was shut down, and the updated sampling program defined under the ROCP was implemented.

Table 1-1 presents the field activities completed during the reporting period. Monitoring methods and well construction details are summarized in the Onsite RSAP (Arcadis 2017a). The following deviations from the 2017 LTM Plan (Arcadis 2017b) and the 2023 updates to the 2017 LTM Plan (Arcadis 2023) were noted during the reporting period:

- Monitoring well MW-303-CMT-59 had an unidentified obstruction in the well; therefore, the well depth measurement could not be completed.

3 Groundwater Monitoring Results

Groundwater impacts have been characterized and continue to be monitored through the analysis of water-level gauging data and groundwater samples collected from onsite monitoring wells. This section presents the results of water-level gauging and groundwater analyses of onsite well samples. Data are presented in Tables 3-1 through 3-7.

Historical groundwater elevation and LNAPL thickness measurements, and BTEX, GRO, DRO, and sulfolane analytical results are provided in Appendix A. Analytical laboratory reports are provided in Appendix B. A data quality evaluation, including ADEC quality assurance/quality control checklists, is provided in Appendix C. Field data sheets are provided in Appendix D.

3.1 Groundwater Elevation

Depth to water measurements were collected from monitoring wells on August 15, 2023. Measurements were also recorded from gauging points located at the North Gravel Pit during the same time periods. Potentiometric maps are included for each monitoring zone: water table, 10 to 55, 55 to 90, and 90 to 160 feet below the water table for each monitoring event (Figures 3-1 through 3-4). During the reporting period, the general direction of the horizontal hydraulic gradient was interpreted to be to the north-northwest, which is consistent with historical groundwater data. Groundwater elevations and horizontal hydraulic gradients were within the range of historical groundwater data.

Groundwater monitoring well field parameters for the reporting period are presented in Table 3-1. Groundwater elevations measured during the reporting period, as well as surface water elevations and depth to LNAPL, are presented in Table 3-2. Historical gauging data are provided in Appendix A.

3.2 Light Nonaqueous Phase Liquid Monitoring Results

LNAPL migration observations were collected from a network of monitoring, observation, and recovery wells screened across the water table according to the 2017 LTM Plan and the 2023 updates to the 2017 LTM Plan (Arcadis 2017b, 2023). Additionally, LNAPL was gauged during the reporting period during monitoring events at wells outside of the LNAPL migration network. Comprehensive LNAPL gauging data are provided in Appendix E.

3.2.1 Light Nonaqueous Phase Liquid Extent

Per the 2017 LTM Plan and the 2023 updates to the 2017 LTM Plan (Arcadis 2017b, 2023), LNAPL migration observations were made from wells along the perimeter of the LNAPL plume. During the annual LNAPL migration monitoring event, LNAPL was observed in LNAPL migration wells O-11, O-27, and O-31. Results are presented in Table 3-3. Figure 3-5 shows thickness data from the LNAPL migration monitoring event, as well as maximum thickness data measured during the reporting period in other gauging events. LNAPL was gauged during groundwater elevation monitoring and groundwater sampling and field parameter collection throughout the reporting period. Gauging data from each monitoring event conducted at the site during the reporting period are provided in Appendix E.

LNAPL thickness measurements were similar to historical results. LNAPL was not detected in any new wells during the reporting period (that is, in wells that have not previously had a detection).

3.2.2 Natural Source Zone Depletion Assessment Results

The potential efficacy of natural source zone depletion (NSZD) as a means of reducing LNAPL mass, which through time will further reduce LNAPL mobility, was evaluated following protocols outlined in the Interstate Technology & Regulatory Council (ITRC) guidance for LNAPL site characterization and management (ITRC 2009, 2018).

Fourteen monitoring wells were sampled for NSZD parameters to evaluate the occurrence of ongoing NSZD at the site. Sample locations are defined in the 2017 LTM Plan and the 2023 updates to the 2017 LTM Plan (Arcadis 2017b, 2023). Prior to sampling, LNAPL was present in NSZD monitoring well MW-348-15. In accordance with the 2017 LTM Plan and the 2023 updates to the 2017 LTM Plan, LNAPL was removed from the well prior to collection of the NSZD samples. Field parameters were collected from 14 monitoring wells and are presented in Table 3-1. Natural attenuation parameters (iron, manganese, sulfate, and methane), GRO, and DRO are presented in Table 3-4 and shown on Figure 3-6.

The occurrence of ongoing biodegradation and dissolution of the submerged portion of the LNAPL can be assessed by comparing the chemical composition of groundwater upgradient, within, and immediately downgradient of the source zone. Biodegradation of petroleum hydrocarbons results in a decrease in electron acceptor concentrations and a corresponding increase in biodegradation transformation products, observable in groundwater samples from upgradient wells to wells within and/or downgradient from the LNAPL plume. The NSZD process is further discussed in the Onsite SCR – 2013 (Arcadis 2013).

A comparison of the upgradient and source zone/downgradient data indicates the following:

- Sulfate concentrations generally decreased from upgradient monitoring locations to the source zone and downgradient monitoring locations, indicating sulfate reduction from anaerobic degradation.

- Dissolved iron concentrations increased from upgradient monitoring locations to the source zone monitoring locations, indicating iron production as a product of anaerobic degradation.
- Dissolved manganese concentrations increased from upgradient monitoring locations to the source zone monitoring locations, indicating manganese production as a product of anaerobic degradation.
- Methane concentrations generally increased from upgradient locations to the source zone monitoring locations, indicating carbon dioxide reduction or organic acid fermentation from anaerobic degradation.
- There was no significant change in dissolved oxygen concentrations across the LNAPL source zone. This observation is a result of the fact that the aquifer is naturally anoxic; therefore, oxygen is not a readily available electron acceptor at the site.

This spatial comparison of upgradient, source zone, and downgradient natural attenuation parameters shows a clear decreasing trend in electron acceptor concentrations and an increasing trend in biodegradation transformation products, which indicates that biodegradation of LNAPL is occurring in the submerged portion of the LNAPL body. Parameters at downgradient locations do not continue to exhibit the influence of ongoing NSZD, because concentrations are trending towards background conditions in the most downgradient wells due to distance from the source zone. Similarly, results from the addition of sampling at deep interval well MW-154B-95 indicates the limited presence of dissolved-phase petroleum constituents in groundwater and as a result, the absence of corresponding NSZD parameters used to qualitatively identify the occurrence of ongoing depletion processes.

3.3 Monitoring Well Sampling

Petroleum analyte sample locations are defined in the 2017 LTM Plan and the 2023 updates to the 2017 LTM Plan (Arcadis 2017b, 2023). Monitoring wells included in these plans were sampled for BTEX, GRO, and DRO. Results are presented in Table 3-5. Figure 3-7 shows analytical results for benzene.

Analyses for sulfolane were completed on groundwater samples collected from the wells identified in the 2017 LTM Plan (Arcadis 2017b). Sulfolane analytical results are presented in Tables 3-6 and shown on Figures 3-8, 3-9, and 3-10.

Groundwater samples were collected from the point of compliance (POC) wells to evaluate the vertical distribution of sulfolane concentrations. Sulfolane concentrations for the POC, which includes well nests MW-358, MW-359, MW-360, MW-362, and MW-364, and well MW-149A-15, are presented in Table 3-7. Groundwater samples were also collected from wells along the vertical profile transect (VPT), which is located between 250 and 950 feet upgradient of the POC wells. Figure 3-11 shows groundwater sulfolane concentrations at the VPT.

3.4 Statistical Analysis of Benzene and Sulfolane Data

A statistical evaluation of benzene and sulfolane concentration trends using a Mann-Kendall trend analysis is conducted annually using analytical data for samples collected through the third quarter to evaluate plume migration, stability, and remedial action effectiveness. A graphical analysis of analytical and gauging data is also completed to identify relationships between concentrations, groundwater elevations, and flow directions. Use of the Monitoring and Remediation Optimization System for Mann-Kendall trend analysis was applied to groundwater monitoring data collected since 2006 from monitoring and observation wells. Only wells that were sampled during the monitoring period were included in this analysis. Wells with LNAPL present were excluded

from evaluation of the benzene statistical trend, or results of samples collected since LNAPL was last detected were used for analysis.

The analysis trends are expressed as probably increasing, increasing, probably decreasing, decreasing, stable, or no trend. Results of the Mann-Kendall trend analysis for the reporting period are provided in Appendix F (Tables F-1 and F-2; Figures F-1, F-2, F-3, F-4, and F-5) and presented in the table below.

Parameter Trend	Third Quarter	
	Benzene	Sulfolane
Number of wells	28	55
All results nondetect[1]	6	0
Insufficient data points[1]	2	0
Probably decreasing	0	4
Decreasing	5	20
Probably increasing	0	1
Increasing	4	9
Stable	2	9
No trend	9	12

Note:
[1]Wells with insufficient data points for the statistical analysis (less than four points), but with all results less than detection limits, are listed under "all results nondetect."

3.4.1 Benzene Statistical Evaluation

The Mann-Kendall trend analysis indicated an increasing benzene concentration trend in wells MW-130-25, MW-154B-95, O-4, and O-24 during the reporting period. However, a review of the benzene time-series plots provided in Appendix F, Attachment F-1, provides more clarity on the current trends based on 2023 results.

Monitoring well MW-130-25 is within the detectable benzene plume at the site, near the downgradient extent. Although the Mann-Kendall analysis indicates a trend that is increasing in this well, concentrations consistently decreased from 2015 to 2018 with a partial rebound starting in 2019. Concentrations appear to have peaked in 2020 and continued to decrease in 2023 (100 micrograms per liter [µg/L]); 2023 concentrations are less than historical levels observed in this well. MW-154B-95 is also within the detectable benzene plume at the site. The analysis indicates an increasing trend in this well; however, recent concentrations have fluctuated between detectable and nondetectable. The results in 2023 indicated a low-level detection (3.29 µg/L), which is less than the maximum concentration observed in this well. The benzene detected at O-4 is low-level (0.494 µg/L) and continues a decline, with some fluctuations, from the maximum concentration observed in 2018. The benzene concentration at O-24 has fluctuated since shutdown of the GRTS, peaking in 2022, then decreasing an order of magnitude in 2023. The 2023 results were lower than the results from 2019 to 2022.

3.4.2 Sulfolane Statistical Evaluation

As noted in Section 3.3, the cleanup objective for sulfolane in groundwater is 400 µg/L at the POC. As discussed below, none of the POC wells or wells along the VPT had sulfolane concentrations exceeding 400 µg/L during the reporting period. The only wells with concentrations exceeding 400 µg/L (MW-372-15 and O-1) during this reporting period are water table wells near the former source areas, which are source area wells more than 1,500 feet upgradient of the POC. Current trends support the cleanup objective and do not suggest that sulfolane will exceed 400 µg/L at the POC.

Sulfolane time-series plots for all wells sampled during the reporting period are provided in Appendix F, Attachment F-1. These time-series plots are presented with both linear and logarithmic concentration scales to facilitate the evaluation of concentration trends since shutdown of the GRTS. The time since GRTS shutdown is relatively short compared to the periods of record for most of the monitoring wells; therefore, stabilization of sulfolane concentrations in many wells is apparent in charts with the logarithmic concentration scale, whereas stabilization may not be as apparent in the charts with linear concentration scales.

The Mann-Kendall trend analysis that has been used to analyze the site sample results indicates that the majority of onsite wells sampled during this reporting period exhibit decreasing or probably decreasing trends, supporting the goal of meeting the cleanup objective for sulfolane. Wells with current concentrations exceeding 400 µg/L are MW-372-15 and O-1, which are source area wells more than 1,500 feet upgradient of the POC. These wells have overall stable or decreasing concentration trends.

Most of the onsite wells exhibiting an increasing sulfolane concentration trend during their respective periods of record are located adjacent to or downgradient from the recovery wells associated with the former treatment systems (MW-345-15, MW-345-55, MW-345-75, MW-371-15, O-26-65, O-27, and O-27-65) that initially increased following shutdown of the GRTS but are now decreasing. Monitoring wells MW-148-80, MW-304-80, and MW-359-80 also exhibited increasing trends but are further downgradient from the former treatment systems. Sulfolane results in monitoring well MW-148-80 have been decreasing since an apparent peak in 2020. Sulfolane was non-detectable in groundwater samples collected from MW-304-80 in 2022 and 2023. The concentration detected in the sample collected from MW-359-80 (11.1 µg/L) decreased from the 2022 concentration and is significantly less than 400 µg/L. These results are as expected, as discussed below, and do not suggest that sulfolane will exceed 400 µg/L at the POC.

As described in Section 3.4.3 below, other wells located within and downgradient from the former recovery wells exhibited an initial increase in concentrations following GRTS shutdown, but not an overall increasing or probably increasing trend based on data from a given well. Concentrations at most of these locations exhibited a subsequent decrease or have stabilized. As with the Mann-Kendall results described above, these are expected outcomes that do not suggest that sulfolane will exceed 400 µg/L at the POC. The observed sulfolane trends that have developed in response to the GRTS shutdown are discussed in Section 3.4.3.

3.4.3 Sulfolane Trend Summary in Response to Groundwater Remediation and Treatment System Shutdown

As shown on Figures 3-8, 3-9, and 3-10, the plume axis is well-defined and the plume orientation downgradient of the former treatment systems is consistent with the north-northwest groundwater flow directions presented in Section 3.1. Maximum concentrations in the plume in this area decrease in the downgradient direction and do not

exceed 400 µg/L in POC wells or at the VPT. Sulfolane concentrations and trends within the plume in the area influenced by the GRTS shutdown do not suggest that sulfolane will exceed 400 µg/L at the POC.

Sulfolane concentrations during the reporting period, and concentration trends since GRTS shutdown for all wells sampled during the reporting period in areas where increases were observed following GRTS shutdown, are summarized below:

- *Wells adjacent to the former recovery wells.* The greatest sulfolane concentration in any well in this area during the reporting period was 125 µg/L (MW-345A-15; Table 3-6), which is less than the greatest concentration measured in 2022. All wells in this area stabilized and now exhibit decreasing concentrations since GRTS shutdown (MW-186A-15, MW-186B-60, MW-309-15, MW-334-15, MW-345-15, MW-345-55, MW-345-75, and O-2).[1]
- *Wells between the former recovery wells and the VPT.* The greatest sulfolane concentration in any well in this area during the reporting period was 102 µg/L (O-27; Table 3-6), which is less than the greatest concentration measured in 2022. All wells in this area that were sampled multiple times since GRTS shutdown exhibit decreasing or stabilizing concentrations following the shutdown (MW-127-25, MW-139-25, MW-142-20, MW-154B-95, MW-371-15, O-26, O-26-65, O-27, and O-27-65).
- *Wells in the VPT.* The greatest sulfolane concentration in any well in this area during the reporting period was 118 µg/L (MW-303-CMT-19; Table 3-6), which is less than the greatest concentration measured in 2022. All wells in this group that were sampled multiple times since GRTS shutdown exhibit decreasing, stabilized or stabilizing concentrations since GRTS shutdown (MW-302-CMT-20, MW-302-CMT-50, MW-302-CMT-80, MW-303-CMT-19, MW-303-CMT-29, MW-303-CMT-39, MW-303-CMT-49, MW-303-CMT-59, MW-303-80, MW-304-CMT-20, MW-304-CMT-40, MW-304-CMT-60, MW-304-80, and MW-305-CMT-48).
- *Wells in and downgradient of the POC.* The greatest sulfolane concentration in any well in this area during the reporting period was 130 µg/L (MW-359-35; Table 3-6), which is less than the greatest concentration measured in 2022. All wells in this group that were sampled multiple times since GRTS shutdown except MW148-15 exhibit decreasing or stabilized concentrations since GRTS shutdown (MW-148B-30, MW-148C-55, MW-148-80, MW-358-20, MW-358-40, MW-358-60, MW-359-15, MW-359-35, MW-359-60, MW-359-80, MW-360-15, MW-360-35, MW-360-50, MW-360-80, MW-364-15, MW-364-30, MW-364-65, and MW-364-90). The concentration at well MW-148-15 increased slightly to 14 µg/L, significantly below both its historical high concentration of 348 µg/L and the cleanup objective of 400 µg/L.

As summarized for the wells listed above, initial increases were observed in most wells following GRTS shutdown, and have been followed by stabilization and, in most cases, decreases in concentration.

As noted in Section 3.3, the cleanup objective for sulfolane is 400 µg/L at the POC. None of the samples collected from wells in any of the areas influenced by the GRTS shutdown had sulfolane concentrations exceeding 400 µg/L during the reporting period or since GRTS shutdown. In addition, the concentration trends do not suggest that sulfolane will exceed 400 µg/L at the POC.

[1] For the purposes of this evaluation, “stabilized” means that the concentration reached a maximum value and then remained at similar values or declined. “Stabilizing” means that the rate of increase appears to be slowing and a corresponding chart of data with a logarithmic concentration scale that is flattening out but still increasing with time based on the most current data.

3.5 Nonroutine Activities

During this reporting period, 62 site monitoring wells were decommissioned in accordance with the Onsite RSAP (Arcadis 2017a). Decommissioning of most of these wells was proposed in December 2021 and approved in an email from ADEC in March 2022 (ADEC 2022). In addition to the wells proposed for decommissioning in 2021, three additional wells were found to be destroyed and subsequently decommissioned, these wells were not part of the 2023 LTM plan updates:

- the monument for monitoring well O-21 was found to be destroyed
- the casing for MW-143-20 was broken/separated below ground surface likely as a result of frost heaving
- O-12-65 appeared to have been hit during snow removal operations, irreparably damaging the monument and casing.

A list of the wells that were decommissioned is included as Appendix G.

4 Conclusions

Groundwater monitoring and sampling events were conducted during the reporting period in accordance with the Onsite RSAP, 2017 LTM Plan, and the 2023 updates to the 2017 LTM Plan (Arcadis 2017a, 2017b, 2023).

The cleanup objectives for groundwater established in the ROCP (Arcadis 2017b) are that sulfolane concentrations will not exceed 400 µg/L at the POC and that cleanup objectives for other COCs listed in 18 AAC 75.345 Table C will be met at the POC.

Conclusions based on results of the onsite field activities conducted during the reporting period are summarized below:

- Qualitative assessment to identify ongoing naturally occurring degradation processes through groundwater analysis at existing wells indicates that conditions are consistent with the occurrence of NSZD in the saturated zone. NSZD results have remained consistent since shutdown of the GRTS in 2017. Changing the monitoring plan to biennial NSZD sampling (every two years) is recommended, with the next event to be conducted in 2025. Appendix H includes updated LTM tables.
- Groundwater monitoring data collected during the reporting period are within expected ranges and support the cleanup objective presented in the ROCP (Arcadis 2017b).
- Although there are four wells experiencing an increasing trend of benzene concentrations (MW-130-25, MW-154B-95, O-4, and O-24), their respective concentrations are supportive of cleanup objectives. All four wells are within location of former recovery wells, where increases are expected to be observed.
- The statistical analyses provided in Appendix F show that sulfolane concentrations in 24 wells and plume are decreasing or probably decreasing and sulfolane concentrations in 21 wells are stable or exhibit no trends. The Mann-Kendall analysis indicated 10 wells with increasing or probably increasing sulfolane trends; sulfolane concentrations in every one of the ten wells either decreased from prior concentrations or were non-detectable in 2023, further supporting the cleanup objective presented in the ROCP (Arcadis 2017b).
- As expected, and as described in previous reports, a sulfolane concentration rebound occurred in many wells near and downgradient from the former treatment systems; in most cases, concentrations have subsequently stabilized and are decreasing. The only wells with sulfolane concentrations greater than 400 µg/L are located

in the historical source areas, more than 1,500 feet upgradient of the POC, and concentrations in these wells are trending downward.

The current nature and extent of the COCs is supportive of the cleanup objectives. The 2017 LTM Plan was updated as part of the in Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis 2023). The 2023 groundwater results support that these updates are appropriate; the modified groundwater network will be continued for 2024 monitoring, with the additional change of reduced NSZD sampling as noted above.

5 References

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ATTACHMENT 1
REVIEW COMMENTS

PROJECT: Flint Hills Resources Alaska, LLC – North Pole Terminal (ADEC File 100.38.090)
DOCUMENT: Annual 2023 Onsite Groundwater Monitoring Report
Location: North Pole, Alaska

	DATE: March 14, 2024 **REVIEWER: Marty Brewer** **Ahtna Engineering Services, Inc.** **PHONE: 907-433-0702**	DATE: June 21, 2024 RESPONDER: Kristen Freiburger, Shannon & Wilson, Inc. PHONE: 907-479-0600

Item No.	Section, Page #, Checklist (SDG/WO)	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE (Revised Response's for #'s 6, 9, 10, and 11)	ADEC RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)
		Appendix C – Analytical QA/QC Summary			
1.	Data Tables	No cleanup level or project specific interim action levels are included in the data tables for comparison to sample results.		Project-specific cleanup objectives will be added to applicable tables moving forward.	A
2.	All DEC Checklists	5.0 d. was marked "Yes" indicating that all reported limits of quantitation (LOQ) or limits of detections (LOD), or reporting limits (RL) less than the Cleanup Level or the action level for the project, but no reference to applicable cleanup levels or project action levels is included.		Project-specific cleanup objectives will be added to applicable tables moving forward. These values are used to compare to the non-detect reporting limits.	A
3.	DEC Checklist 1233648	3.c. and d. state that there were sample receipt discrepancies noted by the laboratory including damaged sample container lids and incorrectly labeled sample containers, but these discrepancies were not discussed in the Analytical Quality Assurance and Quality Control report. Incorrect statement "Data quality and/or usability affected" made in 3.c. according to answer to 3.e.		The reviewer is correct that the statement "Data quality and/or usability affected" is incorrect and it should say "Data quality and/or usability is unaffected." Please note the Analytical Quality Assurance and Quality Control report only summarizes information in which sample results are impacted by QA/QC failures. The reader is referenced in this report to the LDRCs for additional details.	A
3.	DEC Checklist 1233648, 1233683	6.g. ii. is marked "Yes" indicating that all equipment blank results were less than LOQ or RL, but there is a comment "See above" which does not address the question. The preceding section notes that an equipment blank was analyzed at a frequency of 1 per 20 project samples for the totality of project samples. Equipment blank EB-358-40 was submitted with this work order. These statements do not address whether there was equipment blank contamination above the LOQ or RL. The more appropriate response would have been that there were no equipment blank detections.		This appears to be carry-over from the template used to complete the LDRC for these work orders. We agree that "see above" does not add useful information to answer the question. The response "Yes" is sufficient to answer the question and the comment section should have been left blank. We also agree that a statement added in the comments would be more appropriate if it noted there were no equipment blank detections.	A
4.	DEC Checklist 1233683	Improper correction on chain of custody – strike through was not initialed and dated.		We will emphasize the correct procedures to staff.	A

5.	DEC Checklist 1233796	6.a. Sulfolane detection greater than LOQ in MB 1724926 associated with prep batch XXX48294 was not discussed in the Analytical Quality Assurance and Quality Control report. Although samples were reextracted and reanalyzed with MB 1728260 associated with prep batch XXX48397, this level of detail was lacking in the report.		Results from the reextracted batch were used for reporting purposes. Please note the Analytical Quality Assurance and Quality Control report only summarizes information in which sample results are impacted (resulted in applied qualifiers) by QA/QC failures. The reader is referenced in this report to the LDRCs for additional details.	A
6.	DEC Checklist 1233796	6.e. section noted that one trip blank was reported per analysis, but no trip blank was submitted for RSK-175.		Following review of the laboratory SOP, it is our understanding a trip blank is not required for methane samples analyzed by method RSK-175. However, the sampling and analysis plan and ADEC Field Sampling Guidance notes trip blanks will be analyzed for the same volatile organic parameters as the groundwater samples. Trip blanks will be requested from the laboratory in the future for methane analysis.	
7.	DEC Checklist 1233796	Improper correction on chain of custody – strike through was not initialed and dated and text scribbled out.		See response to question 4 above.	A
8.	DEC Checklist 1233870	3.d. does not mention that on the sample chain of custody and laboratory sample receipt form there are notes to “run cleanup method” for 4 samples (MW-186A-15, MW-334-15, O-34, and O-2).		Due to known naphthalene interference with the sulfolane analytical method, the SPE clean up step is requested on the COCs when LNAPL/sheen is present in the sample. Use of the SPE clean up step is listed as a “Deviation from Reference Method” in 3.0 of the laboratory’s approved SOP. This is not viewed as a corrective action or discrepancy.	A

9.	DEC Checklist 1233932	6. QC Samples a. Method Blank Associated sample qualifications for blank contamination are not consistent with EPA's *National Functional Guidelines for Organic Superfund Methods Data Review* (EPA, 2020). iii. States: DRO were detected in samples MW-125-25 (2.36mg/L), MW-130-25 (3.32mg/L), and O-25 (0.768mg/L) at concentrations greater than the LOQ but less than five times the DRO concentration detected in MB 1727684 (0.817mg/L). DRO results for these samples are considered not detected at the reported sample concentration and have been flagged UB* in the analytical database. According to 2020 NFGs, the semivolatile results for MW-125-25 and MW-130-25 greater than/equal to the quantitation limit QL and greater than/equal to the blank concentration should not have been marked as non-detect at their reportable concentration but rather reported at the concentration detected and flagged as being associated with blank contamination. The validator also referred to sample concentrations of 5 or 10 times the blank concentration as criteria for qualification. However, the "10 times" professional judgement rule is typically applied to common laboratory contaminants of which are generally listed in the analytical method and in NFGs. GRO and DRO are not considered common laboratory contaminants.		We have re-validated the results for this work order based on the 2020 National Functional Guidelines (NFGs). Our review now aligns with the NFGs for qualifying a project sample result as non-detect due to a method blank concentration. These methods will be used moving forward. Please note that the NFGs outline areas where "professional judgement" should be applied to volatile and semi-volatile results, specifically when qualifying the sample as "biased high" (denoted as "JH" or J+). For consistency with historical qualification, we have defined our professional judgement to a limit of 10X the MB concentration. For example, where sample concentrations exceed the LOQ and/or MB concentration, results will be flagged as "biased high" (JH) where the sample result is within 10X the MB concentration. Several of the flags applied remained the same using the NFGs. However, the LDRC was updated to remove the reference to "5X" in these cases. Where changes to the qualifiers have been applied, they are defined below: • GRO result for *O-25* is considered biased high, flagged with a JH (was previously flagged UB [non-detect] at the detected concentration). • DRO results for *MW-125-25, MW-130-25,* and *O-25* are considered biased high, flagged with a JH (was previously flagged UB at the detected concentration). We have updated the associated analytical tables and LDRC to address the changes discussed above. Please note the tables were updated to address the values. Project-specific levels have not been added, but will be added to the tables moving forward with the 2024 reporting. We also note that work order 1233796 was assessed, as it contained MB detections. There were no changes to the qualifiers based on the application of the 2020 NFGs.	

10.	DEC Checklist 1233932	6.g.iii. notes that benzene was detected greater than the LOQ, but less than 5-times that detected in associated equipment blank EB-130-25 and therefore considered non-detect at the reported sample concentration and flagged UB. According to 2020 NFGs, the volatile result greater than/equal to the quantitation limit QL and greater than/equal to the blank concentration should not have been marked as non-detect reported at the sample concentration detected and flagged as being associated with blank contamination.		As noted above in our response to comment #9, we have aligned our data assessment with the NFGs for applying qualifiers due to blank contamination. Please see comment #9 with respect to our professional judgement for qualifying result as biased high (JH). We have updated the analytical tables and LDRC to address the following change: • The benzene result for sample *O-3* is considered biased high, flagged JH in the analytical database.	
11.	DEC Checklist 1233932	6.e. Section completed noting that one trip blank was reported per analysis, but no trip blank was submitted for RSK-175.		See response to question 6.	

Revised Table 3-4
Natural Source Zone Depletion Monitoring Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Sample Name	Dup	Date	Benzene	Toluene	Ethylbenzene	P&M-Xylene	o-Xylene	Total Xylenes	Gasoline Range Organics	Diesel Range Organics	Dissolved Iron	Dissolved Manganese	Sulfate	Methane
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-101A-25	10-55	MW-101A-25	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.420J	0.666	2.03	37.3	0.0395
MW-125-25	10-55	MW-125-25	—	7/27/2023	255	<5.00	204	2080	<5.00	2080	14.9	2.36JH*	34.9	16.7	<0.100	4.14
MW-130-25	10-55	MW-130-25	—	7/27/2023	100	12.0	109	512	139	651	3.86	3.32JH*	27.8	7.56	6.71	2.21
MW-139-25	10-55	MW-139-25	—	7/21/2023	26.3	<0.500	27.4	324	1.33	325	1.52JH*	2.90	20.5	5.08	8.54	5.90
MW-139-25	10-55	MW-239-25	DUP	7/21/2023	26.2	<0.500	28.4	331	1.32	332	1.60JH*	2.35	20.4	5.46	8.98	5.70
MW-142-20	WT	MW-142-20	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	1.03	13.1	8.31	3.05	1.68
MW-154B-95	55-90	MW-154B-95	—	7/21/2023	3.29	<0.500	0.703J	3.38	<0.500	3.38	<0.100B*	0.981	5.79	3.90	18.5	1.73
MW-192A-15	WT	MW-192A-15	—	7/25/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	0.156	<0.300J*	<0.125	0.0565	41.6	0.00520
MW-303-CMT-39	10-55	MW-303-CMT-39	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.847	1.14	2.41	34.2	0.228
MW-304-CMT-40	10-55	MW-304-CMT-40	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.337J	0.777	4.40	37.0	0.293
MW-336-20	WT	MW-336-20	—	7/27/2023	10600	<50.0	813	11100	<50.0	11100	52.3	12.6	29.4	4.20	<0.100	13.9
MW-336-20	WT	MW-436-20	DUP	7/27/2023	10800	<100	789	11000	<100	11000	48.4	11.1	29.6	4.29	<0.100	13.3
MW-348-15	WT	MW-348-15	—	7/26/2023	15.6	<0.500	1.06	2.91	1.15	4.06	0.137	1.55JL*	8.69	4.53	5.07	1.37
MW-359-35	10-55	MW-359-35	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.411J	1.07	6.48	20.5	0.102
MW-360-50	10-55	MW-360-50	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.491JL*	3.42	5.01	24.5	<0.000250
O-15	WT	O-15	—	7/27/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	<0.588B*	<0.125	0.197	46.3	0.0258

Notes:

[1] The ranges presented indicate fee below the water table.

1. Total xylenes are calculated by the laboratory as the sum of o-, p- and m-xylenes.
2. Only monitoring wells scheduled for sampling per Table 3-6 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here.
   Additional constituent of concern sampling data are presented in Table 3-5.
3. NSZD analytes include GRO, DRO, BTEX, sulfate, dissolved iron, dissolved manganese, and methane.
4. Revised result, per ADEC comments. Result previously considered not detected at the reported concentration. Following the National Functional Guidelines for data validation of semi-volatile analytes, the result is considered biased high.

Acronyms and Abbreviations:

— = not applicable
< = Not detected; presented as <LOD (limit of detection). Unless otherwise noted by quality control failures.
µg/L = micrograms per liter
mg/L = milligrams per liter
DUP = field-duplicate sample
NSZD = natural source zone depletion

Qualifiers:

B* = Result is considered not detected due to quality control failures; see data review checklist for details. Flag applied by Shannon & Wilson, Inc.
J = Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ). Flag applied by laboratory.
J* = Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon & Wilson, Inc.
JH* = Result is considered estimated, biased high. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.

Reference:

Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Revised Table 3-5
Annual 2023 Constituent of Concern Analytical Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Location	Zone[1]	Sample Name	Dup	Sample Date	Benzene	Toluene	Ethylbenzene	P & M -Xylene	o-Xylene	Total Xylenes	Gasoline Range Organics	Diesel Range Organics
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L
MW-101A-25	10-55	MW-101A-25	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.420J
MW-125-25	10-55	MW-125-25	—	7/27/2023	255	<5.00	204	2080	<5.00	2080	14.9	2.36JH*
MW-130-25	10-55	MW-130-25	—	7/27/2023	100	12.0	109	512	139	651	3.86	3.32JH*
MW-131-25	10-55	MW-131-25	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.594
MW-137-20	WT	MW-137-20	—	7/28/2023	767	8000	2010	8240	3730	12000	56.0	6.59JH*
MW-139-25	10-55	MW-139-25	—	7/21/2023	26.3	<0.500	27.4	324	1.33	325	1.52JH*	2.90
MW-139-25	10-55	MW-239-25	DUP	7/21/2023	26.2	<0.500	28.4	331	1.32	332	1.60JH*	2.35
MW-142-20	WT	MW-142-20	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	1.03
MW-144A-25	10-55	MW-144A-25	—	7/24/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.599
MW-145-20	WT	MW-145-20	—	7/28/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	<0.294
MW-149A-15	WT	MW-149A-15	—	7/17/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.239JL*
MW-154B-95	55-90	MW-154B-95	—	7/21/2023	3.29	<0.500	0.703J	3.38	<0.500	3.38	<0.100B*	0.981
MW-192A-15	WT	MW-192A-15	—	7/25/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	0.156	<0.300J*
MW-303-CMT-19	WT	MW-303-CMT-19	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.954
MW-303-CMT-39	10-55	MW-303-CMT-39	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.847
MW-304-CMT-40	10-55	MW-304-CMT-40	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.337J
MW-321-15	WT	MW-321-15	—	7/25/2023	77.5	<0.500	<0.500	<1.00	<0.500	<1.50	0.226	0.753JL*
MW-321-15	WT	MW-421-15	DUP	7/25/2023	80.9	<0.500	<0.500	<1.00	<0.500	<1.50	0.223	0.793JL*
MW-336-20	WT	MW-336-20	—	7/27/2023	10600	<50.0	813	11100	<50.0	11100	52.3	12.6
MW-336-20	WT	MW-436-20	DUP	7/27/2023	10800	<100	789	11000	<100	11000	48.4	11.1
MW-348-15	WT	MW-348-15	—	7/26/2023	15.6	<0.500	1.06	2.91	1.15	4.06	0.137	1.55JL*
MW-359-35	10-55	MW-359-35	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.411J
MW-360-15	WT	MW-360-15	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.514J
MW-360-50	10-55	MW-360-50	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.491JL*
MW-371-15	WT	MW-371-15	—	7/18/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.530J
O-15	WT	O-15	—	7/27/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	<0.588B*
O-24	WT	O-24	—	7/26/2023	19.4	<0.500	<0.500	<1.00	<0.500	<1.50	0.110	0.825JL*
O-25	WT	O-25	—	7/28/2023	28.9	<0.500	0.354J	14.2	<0.500	14.2	0.282JH*	0.768JH*
O-3	WT	O-3	—	7/27/2023	0.882JH*	<0.500	<0.500	<2000B*	<0.500	1.24J	<0.100B*	<0.288
O-4	WT	O-4	—	7/24/2023	0.494	<0.500	<0.500	1.26J	<0.500	1.26J	<0.100B*	1.52
S-9	WT	S-9	—	7/26/2023	0.274J	<0.500	<0.500	0.800J	<0.500	<1.50	<0.0500	0.470JL*

Notes:

[1] The ranges presented indicate fee below the water table.

1. Total xylenes are calculated by the laboratory as the sum of o-, p- and m-xylenes.
2. Only monitoring wells scheduled for sampling per Table 3-4 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here. Additional constituent of concern data collected as part of the natural source zoen depletion sampling are presented in Table 3-4.
3. Revised result, per ADEC comments. Result previously considered not detected at the reported concentration. Following the National Functional Guidelines for data validation of volatile analytes, the result is considered biased high.

Acronyms and Abbreviations:

— = not applicable
< = Not detected; presented as <LOD (limit of detection). Unless otherwise noted by quality control failures.
µg/L = micrograms per liter
mg/L = milligrams per liter
DUP = field-duplicate sample
WT = water table

Qualifiers:

B* = Result is considered not detected due to quality control failures; see data review checklist for details. Flag applied by Shannon & Wilson, Inc.
J = Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ). Flag applied by laboratory.
J* = Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon & Wilson, Inc.
JH* = Result is considered estimated, biased high. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.

Reference:

Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

ADEC Contaminated Sites Program Laboratory Data Review Checklist

Completed By:	Andrew Frick/Kristen Freiburger	**CS Site Name:**	Flint Hill Resources Refinery	**Lab Name:**	SGS North America, Inc.
Title:	Environmental Scientist/Senior Associate	**ADEC File No.:**	100.38.090	**Lab Report No.:**	1233932
Consulting Firm:	Shannon & Wilson, Inc.	**Hazard ID No.:**	539	**Lab Report Date:**	August 30, 2023

Note: *Any N/A or No box checked must have an explanation in the comments box.*

1. **Laboratory**

   a. Did an ADEC Contaminated Sites Laboratory Approval Program (CS-LAP) approved laboratory receive and perform all of the submitted sample analyses?
   Yes ☒ No ☐ N/A ☐
   Comments: Samples in this work order were submitted to SGS North America, Inc. in Anchorage. SGS Anchorage, Alaska analyzed samples associated with this work order except for Light Gases by RSK-175 samples, which were analyzed at SGS Orlando, Florida.

   b. If the samples were transferred to another "network" laboratory or sub-contracted to an alternate laboratory, was the laboratory performing the analyses CS-LAP approved?
   Yes ☒ No ☐ N/A ☐
   Comments: While the SGS Orlando, Florida laboratory maintains ADEC CS certification for several analyses, the ADEC CS laboratory certification program does not certify for Light Gases analysis by RSK-175. Sample results are not considered affected.

2. **Chain of Custody (CoC)**

   a. Is the CoC information completed, signed, and dated (including released/received by)?
   Yes ☒ No ☐ N/A ☐
   Comments:

b. Were the correct analyses requested?
Yes ☒ No ☐ N/A ☐
Analyses requested: GRO (AK 101), DRO (AK 102), BTEX (EPA 8260), methane (RSK-175), sulfate (EPA 300.0), dissolved iron and manganese (EPA 200.8), and PFAS (537M).
Comments: Analysis performed as requested.

3. Laboratory Sample Receipt Documentation

a. Is the sample/cooler temperature documented and within range at receipt (0° to 6° C)?
Yes ☒ No ☐ N/A ☐
Cooler temperature(s): The SGS Anchorage laboratory noted that the two submitted sample coolers were received at 4.5° C and 4.2° C. The SGS Orlando laboratory noted that one submitted sample cooler was received at a temperature of 3.8° C.
Sample temperature(s): Click or tap here to enter text.
Comments: None. The sample cooler temperatures were within acceptable temperatures.

b. Is the sample preservation acceptable – acidified waters, methanol preserved soil (GRO, BTEX, VOCs, etc.)?
Yes ☒ No ☐ N/A ☐
Comments:.

c. Is the sample condition documented – broken, leaking, zero headspace (VOA vials); canister vacuum/pressure checked and no open valves, etc.?
Yes ☒ No ☐ N/A ☐
Comments: The SGS sample receipt form notes the samples were received in good condition.

d. If there were any discrepancies, were they documented? For example, incorrect sample containers/preservation, sample temperature outside of acceptable range, insufficient or missing samples, canister not holding a vacuum, etc.?
Yes ☐ No ☐ N/A ☒
Comments: No discrepancies were noted on the sample receipt form.

e. Is the data quality or usability affected?
Yes ☐ No ☒ N/A ☐
Comments: Data quality and usability were not affected.

4. Case Narrative

a. Is the case narrative present and understandable?
Yes ☒ No ☐ N/A ☐
Comments:

b. Are there discrepancies, errors, or QC failures identified by the lab?
Yes ☒ No ☐ N/A ☐
Comments: The case narratives note the following:
- GRO results for sample *EB-130-25* may be biased high due to carryover. The sample was reanalyzed outside of hold-time and GRO was detected below the LOQ. The initial within hold-time sample results are reported. Refer to Section 6.g. for further assessment.
- Recovery of nitrite in MS 1727100 was outside of laboratory QC acceptance criteria. Nitrite analysis was not requested for samples in this work order. Sample results are not affected.
- Recovery of DRO in LCSD 1727559 was outside of laboratory QC acceptance criteria. Refer to Section 6.b. for further assessment.
- Recovery of DRO surrogate 5a-androstane in LCS 1727685 and LCSD 1727686 was outside of laboratory QC acceptance criteria. Refer to Sectoin 6.c. for further assessment.
- Recoveries of PFAS surrogates were outside of laboratory QC acceptance criteria for sample *FHRA TOTES*. Sample dilution was also required for the sample due to isotopic dilution recovery standards failures for the PFAS analysis. Refer to Section 6.d. for further assessment.
- The methane result for sample *EB-130-25* was confirmed by reanalysis. Sample results are not affected.

c. Were all the corrective actions documented?
Yes ☒ No ☐ N/A ☐
Comments: Sample dilution for the PFAS analysis of sample *FHRA TOTES* and reanalysis of methane for sample *EB-130-25* were noted in the case narrative.

d. What is the effect on data quality/usability according to the case narrative?
Comments: There are no comments regarding data quality/usability in the case narrative. Refer to the following sections for a discussion on the effect of data quality/usability.

5. Sample Results

a. Are the correct analyses performed/reported as requested on CoC?
Yes ☒ No ☐ N/A ☐
Comments:

b. Are all applicable holding times met?
Yes ☒ No ☐ N/A ☐
Comments:

c. Are all soils reported on a dry weight basis?
Yes ☐ No ☐ N/A ☒
Comments: Soil samples were not submitted for analysis.

d. Are the reported limits of quantitation (LOQ) or limits of detections (LOD), or reporting limits (RL) less than the Cleanup Level or the action level for the project?
Yes ☒ No ☐ N/A ☐
Comments:

e. Is the data quality or usability affected?
Yes ☐ No ☒ N/A ☐
Comments: Data quality/usability was not affected.

6. QC Samples

a. Method Blank

i. Was one method blank reported per matrix, analysis, and 20 samples?
Yes ☒ No ☐ N/A ☐
Comments:

ii. Are all method blank results less than LOQ (or RL)?
Yes ☐ No ☒
Comments: DRO were detected above the LOQ in MB 1727684 associated with prep batch XXX48377 containing project samples *EB-130-25*, *MW-125-25*, *MW-130-25*, *MW-137-20*, *MW-145-20*, *MW-336-20*, *MW-436-20*, *O-15*, *O-25*, and *O-3*.

Also, GRO were detected below the LOQ in MB 1728075 associated with prep batch VXX40250 containing project samples *MW-125-25*, *MW-137-20*, *MW-336-20*, *MW-436-20*, and *O-25*.

Perfluorohexanoic acid was detected in MB OP98557 for the PFAS analysis.

iii. If above LOQ or RL, what samples are affected?
Comments: DRO results were not-detected for samples *MW-145-20* and *O-3*. DRO results for these samples were not affected.

DRO were detected at estimated concentrations less than the LOQ in samples *EB-130-25* and *O-15*. DRO results for these samples are considered not detected at the LOQ and have been flagged UB* in the analytical database.

DRO were detected in samples *MW-125-25*, *MW-130-25*, and *O-25* at concentrations greater than the LOQ and the MB concentration but less than 10X the DRO concentration detected in MB 1727684. DRO results for these samples are considered biased high and have been flagged JH* in the analytical database.

DRO were detected in sample *MW-137-20* at a concentration greater than the LOQ and the MB concentration, but less than 10X the DRO concentration detected in MB 1727684. The DRO result for the sample is considered biased high due to the method blank detection and has been flagged JH* in the analytical database.

DRO were detected in samples *MW-336-20* and *MW-436-20* at concentrations greater than 10X the DRO concentration detected in MB 1727684. The DRO results for these samples are not considered affected by the method blank detection.

GRO were detected in sample *O-25* at concentrations greater than the LOQ but less than 10X the GRO concentration detected in MB 1728075. GRO results for these samples are considered biased high and have been flagged JH* in the analytical database.

GRO were detected in samples *MW-125-25*, *MW-137-20*, *MW-336-20*, and *MW-436-20* at concentrations greater than ten times the GRO concentration detected in MB 1728075. The GRO results for these samples are not considered affected by the method blank detection.

Perfluorohexanoic acid was detected in sample FHRA TOTES at a concentration greater than ten times that detected in MB OP98557. The perfluorohexanoic acid result for the sample is not considered affected by the method blank detection.

iv. Do the affected sample(s) have data flags? If so, are the data flags clearly defined?
Yes ☒ No ☐ N/A ☐
Comments: Yes; see 6.a.iii above.

v. Data quality or usability affected?
Yes ☒ No ☐ N/A ☐
Comments: Sample results have been flagged in the analytical database as discussed above. Data quality/usability is considered acceptable with the applied data qualifiers.

b. Laboratory Control Sample/Duplicate (LCS/LCSD)

i. Organics – Are one LCS/LCSD reported per matrix, analysis and 20 samples? (LCS/LCSD required per AK methods, LCS required per SW846)
Yes ☐ No ☒ N/A ☐
Comments: LCS/LCSD were reported for the BTEX, DRO, GRO, and methane analyses. LCS and a laboratory duplicate samples were reported for the PFAS analysis. Laboratory duplicate samples were also reported for the methane analysis.

ii. Metals/Inorganics – Are one LCS and one sample duplicate reported per matrix, analysis and 20 samples?
Yes ☐ No ☒ N/A ☐
Comments: LCS results were reported for the sulfate, dissolved iron, and dissolved manganese analyses. A sample duplicate was not reported for these analyses. Refer to the field-duplicate results discussed in Section 6.f. for an assessment of precision for these analyses.

iii. Accuracy – Are all percent recoveries (%R) reported and within method or laboratory limits and project specified objectives, if applicable? (AK Petroleum methods: AK101 60%-120%, AK102 75%-125%, AK103 60%-120%; all other analyses see the laboratory QC pages)
Yes ☐ No ☒ N/A ☐
Comments: Low DRO recovery was reported for LCSD 1727559 in prep batch XXX48370 containing project samples *MW-192A-15*, *MW-321-15*, *MW-348-15*, *MW-421-15*, *O-24*, and *S-9*.

iv. Precision – Are all relative percent differences (RPD) reported and less than method or laboratory limits and project specified objectives, if applicable? Was the RPD reported from LCS/LCSD, and or sample/sample duplicate? (AK Petroleum methods 20%; all other analyses see the laboratory QC pages)
Yes ☒ No ☐ N/A ☐
Comments:

v. If %R or RPD is outside of acceptable limits, what samples are affected?
Comments: DRO were not detected in sample *MW-192A-15*. The reporting limit (LOD) for this not-detected result is considered estimated due to the low DRO recovery in LCSD 1727559 and has been flagged UJ* in the analytical database.

Detected DRO results for samples *MW-321-15*, *MW-348-15*, *MW-421-15*, *O-24*, and *S-9* are considered estimated, biased low, due to the low DRO recovery in LCSD 1727559 and have been flagged JL* in the analytical database.

vi. Do the affected sample(s) have data flags? If so, are the data flags clearly defined?
Yes ☒ No ☐ N/A ☐
Comments: Yes; see above.

vii. Is the data quality or usability affected?
Yes ☐ No ☒ N/A ☐
Comments: Sample results have been flagged in the analytical database as discussed above. Data quality/usability is considered acceptable with the applied data qualifiers.

c. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

i. Organics – Are one MS/MSD reported per matrix, analysis and 20 samples?
Yes ☐ No ☒ N/A ☐
Comments: MS results were reported for the PFAS and methane analyses; MSD results were not reported. MS/MSD results were not reported for the other organic analyses.

ii. Metals/Inorganics – Are one MS/MSD reported per matrix, analysis and 20 samples?
Yes ☐ No ☒ N/A ☐
Comments: MS results were reported for the sulfate, dissolved iron, and dissolved manganese analyses; MSD results were not reported. Refer to the field-duplicate results discussed in Section 6.f. for an assessment of precision for these analyses.

iii. Accuracy – Are all percent recoveries (%R) reported and within method or laboratory limits and project specified objectives, if applicable?
Yes ☒ No ☐ N/A ☐
Comments:

iv. Precision – Are all relative percent differences (RPD) reported and less than method or laboratory limits and project specified objectives, if applicable? RPD reported from MS/MSD, and or sample/sample duplicate.
Yes ☐ No ☐ N/A ☒
Comments: MSD results were not reported.

v. If %R or RPD is outside of acceptable limits, what samples are affected?
Comments: N/A; there were no results outside of laboratory QC criteria.

vi. Do the affected sample(s) have data flags? If so, are the data flags clearly defined?
Yes ☐ No ☐ N/A ☒
No samples were affected.

vii. Is the data quality or usability affected?
Yes ☐ No ☒ N/A ☐
Comments: Data quality and usability were not affected.

d. Surrogates – Organics Only or Isotope Dilution Analytes (IDA) – Isotope Dilution Methods Only

i. Are surrogate/IDA recoveries reported for organic analyses – field, QC, and laboratory samples?
Yes ☐ No ☒ N/A ☐
Comments: Surrogate recoveries are not reported for the methane analysis. However, surrogates are not required for this analysis.

ii. Accuracy – Are all percent recoveries (%R) reported and within method or laboratory limits and project specified objectives, if applicable? (AK Petroleum methods 50-150 %R for field samples and 60-120 %R for QC samples; all other analyses see the laboratory report pages).
Yes ☐ No ☒ N/A ☐
Comments: High recovery of DRO surrogate 5a-androstane was reported for MB 1727684, LCS 1727685, and LCSD 1727686. Recoveries of DRO for the MB, LCS, LCSD were within laboratory QC criteria; project sample results are not affected.

Gross low IDA recovery failures were observed in sample *FHRA TOTES* for the PFAS IDAs 13C6-PFDA, 13C7-PFUnDA, 13C2-PFDoDA, 13C8-FOSA, d3-MeFOSAA, and d5-EtFOSAA. However, the associated samples were reanalyzed. The reanalysis samples were used for reporting.

Low IDA recovery failures were observed in sample *FHRA TOTES* for the PFAS IDAs 13C2-8:2 FTS and 13C4-PFBA. However, the associated samples were reanalyzed. The reanalysis samples were used for reporting.

Low IDA recovery failures were observed in the reanalysis for sample *FHRA TOTES* for the PFAS IDAs 13C2-PFDoDA and 13C2-PFTeDA.

iii. Do the sample results with failed surrogate/IDA recoveries have data flags? If so, are the data flags clearly defined?
Yes ☒ No ☐ N/A ☐
Comments: The analytes associated with the PFAS IDAs 13C2-PFDoDA and 13C2-PFTeDA are considered affected. The not-detected results for perfluorododecanoic acid (PFDoA), perfluorotridecanoic acid (PFTrDA), and perfluorotetradecanoic acid (PFTeDA) in sample *FHRA TOTES* are considered estimated due to the IDA recovery failures. The PFAS analysis was performed for waste characterization purposes and is not reported in the analytical database.

iv. Is the data quality or usability affected?
Yes ☒ No ☐ N/A ☐
Comments: Yes; see above.

e. Trip Blanks

i. Is one trip blank reported per matrix, analysis, and for each cooler containing volatile samples? Yes ☒ No ☐ N/A ☐
Comments: Click or tap here to enter text.

ii. Are all results less than LOQ or RL?
Yes ☒ No ☐ N/A ☐
Comments: Click or tap here to enter text.

iii. If above LOQ or RL, what samples are affected?
Comments: N/A; see above.

iv. Is the data quality or usability affected?
Yes ☐ No ☒ N/A ☐
Comments: Data quality and usability were not affected.

f. Field Duplicate

i. Are one field duplicate submitted per matrix, analysis, and 10 project samples?
Yes ☒ No ☐ N/A ☐
Comments: Field duplicates were analyzed at a frequency of 1 per 10 project samples for the totality of project samples. Field duplicate pair MW-321-15 / MW-421-15 was submitted for analysis of GRO, DRO, and BTEX. Field duplicate pair MW-336-20 and MW-436-20 was submitted for analysis of GRO, DRO, BTEX, methane, sulfate, dissolved iron, and dissolved manganese. PFAS analysis was performed for waste characterization purposes and does not require a field duplicate.

ii. Was the duplicate submitted blind to lab?
Yes ☒ No ☐ N/A ☐
Comments:

iii. Precision – All relative percent differences (RPD) less than specified project objectives? (Recommended: 30% water or air, 50% soil)

$$RPD\ (\%) = \left| \frac{R_1 - R_2}{\left(\frac{R_1 + R_2}{2}\right)} \right| X\ 100$$

Where R_1 = Sample Concentration

R_2 = Field Duplicate Concentration

Yes ☒ No ☐ N/A ☐
Comments: RPDs for all field duplicate results were less than the 30% data quality objective for water samples.

iv. Is the data quality or usability affected? (Explain)
Yes ☐ No ☒ N/A ☐
Comments: Data quality and usability were not affected.

g. Decontamination or Equipment Blanks

i. Were decontamination or equipment blanks collected?
Yes ☒ No ☐ N/A ☐
Comments: Equipment blanks were analyzed at a frequency of 1 per 20 project samples for the totality of project samples. Equipment blank EB-130-25 was submitted with this work order for sulfolane analysis. Sample FHRA TOTES submitted for PFAS analysis was collected using non-reusable equipment and did not require an associated equipment blank.

ii. Are all results less than LOQ or RL?
Yes ☐ No ☒ N/A ☐
Comments: GRO, DRO, manganese, benzene, p & m xylenes, toluene, and methane were detected in equipment blank sample. Project samples MW-125-25, MW-130-25, MW-336-20, MW-436-20, O-15, and O-3 were collected the same day as EB-130-25 using the same equipment.

iii. If above LOQ or RL, specify what samples are affected.
Comments: Benzene was detected at a concentration greater than 10 times that detected in EB-130-25 in samples MW-125-25, MW-130-25, MW-336-20, and MW-436-20 and was not detected in sample O-15. These results are unaffected by the equipment blank detection. Benzene was detected in sample O-3 at a concentration greater than the LOQ but less than 10X the benzene concentration detected in EB-130-25. The

benzene result for this sample is considered biased high and has been flagged JH* in the analytical database.

DRO detected in EB-130-25 has been attributed to artifacts in MB 1727684 as discussed in Section 6.a. DRO results reported for project samples are unaffected by the DRO equipment blank detection.

GRO were detected at a concentration greater than 10 times that detected in EB-130-25 in samples MW-125-25, MW-130-25, MW-336-20, and MW-436-20. These results are unaffected by the equipment blank detection. GRO were detected in samples O-15 and O-3 at estimated concentrations less than the LOQ. The GRO results for these samples are considered not-detected at the LOQ and have been flagged UB* in the analytical database.

Manganese was detected at a concentration greater than 10 times that detected in EB-130-25 in all associated project samples; manganese results are unaffected by the equipment blank detection.

p & m-xylenes were detected at a concentration greater than 10 times that detected in EB-130-25 in samples MW-125-25, MW-130-25, MW-336-20, and MW-436-20 and were not detected in sample O-15. These results are unaffected by the equipment blank detection. p & m-xylenes were detected in sample O-3 at an estimated concentration less than the LOQ. The p & m-xylenes result for this sample is considered not-detected at the LOQ and has been flagged UB* in the analytical database.

Toluene was detected at a concentration greater than 10 times that detected in EB-130-25 in sample MW-130-25 and was not detected in the remainder of the associated project samples; toluene results are unaffected by the equipment blank detection.

Methane was detected at a concentration greater than 10 times that detected in EB-130-25 in all associated project samples; methane results are unaffected by the equipment blank detection.

iv. Are data quality or usability affected?
Yes ☒ No ☐ N/A ☐
Comments: Sample results have been flagged in the analytical database as discussed above. Data quality/usability is considered acceptable with the applied data qualifiers.

7. Other Data Flags/Qualifiers (ACOE, AFCEE, Lab Specific, etc.)

a. Are they defined and appropriate?
Yes ☐ No ☐ N/A ☒
Comments: No additional data flags/qualifiers are necessary.

Tables

Table 1-1
Field Activities
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Activity	Frequency during 2023
Groundwater elevation monitoring	Annual (August)
LNAPL migration monitoring	Annual (October)
Sulfolane network sampling	Annual (July)
Constituent of concern (BTEX, GRO, and DRO) monitoring network sampling	Annual (July)
Natural source zone depletion monitoring network sampling	Annual (July)
Monitoring well repair and maintenance	August

Note:
1. Annual field activities associated with the sample results received July 1 through October 31, 2023.

Acronyms and Abbreviations:
BTEX = benzene, toluene, ethylbenzene, and xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
LNAPL = light nonaqueous phase liquid

Table 3-1
Groundwater Well Field Parameters
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Sample Name	Date	Analysis	Depth to Water (feet)	Depth to LNAPL (feet)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH	ORP (mV)	Water Clarity	Purge Criteria	Sample Collection Notes
MW-101A-25	MW-101A-25	7/20/2023	COC, NSZD	9.87	—	4.46	0.16	232	7.36	44.6	Clear	SP	
MW-125-25	MW-125-25	7/27/2023	NSZD	10.14	—	4.53	0.17	339	7.18	28.6	Clear	SP	
MW-127-25	MW-127-25	7/27/2023	S	7.20	—	4.04	0.18	256	7.20	51.5	Clear	SP	
MW-130-25	MW-130-25	7/27/2023	COC, NSZD	—	—	4.23	0.15	276	7.25	23.6	Clear	SP	Depth to water not recorded; water sounder malfunctioning.
MW-131-25	MW-131-25	7/21/2023	COC	10.61	—	4.43	0.25	284	7.20	74.9	Clear	SP	
MW-137-20	MW-137-20	7/28/2023	COC	11.24	—	4.71	0.42	543	6.18	58.2	Clear	3WV	
MW-139-25	MW-139-25	7/21/2023	S, COC, NSZD	11.65	—	3.42	0.22	260	7.26	-8.1	Clear	3WV	
MW-142-20	MW-142-20	7/21/2023	S, NSZD	10.50	—	4.87	0.46	287	7.46	-68.7	Clear	3WV	
MW-144A-25	MW-144-25	7/24/2023	COC	9.70	—	4.02	0.49	205	7.17	73.6	Clear	3WV	
MW-145-20	MW-145-20	7/28/2023	COC	9.81	—	5.37	0.21	370	7.13	76.7	Clear	SP	
MW-148-80	MW-148-80	7/17/2023	S	9.22	—	4.92	0.42	216	6.41	108.4	Slightly turbid	SP	
MW-148A-15	MW-148A-15	7/17/2023	S	8.92	—	5.26	3.15	153	6.27	89.6	Turbid	3WV	
MW-148B-30	MW-148B-30	7/17/2023	S	9.05	—	3.24	0.33	264	6.75	73.6	Clear	SP	
MW-148C-55	MW-148C-55	7/17/2023	S	9.00	—	5.79	0.41	262	6.71	75.8	Clear	SP	
MW-149A-15	MW-149A-15	7/17/2023	COC	9.08	—	3.50	1.03	266	6.97	73.2	Clear	3WV	
MW-154B-95	MW-154B-95	7/21/2023	S, COC, NSZD	12.10	—	6.28	0.58	261	7.34	22.7	Clear	SP	
MW-186A-15	MW-186A-15	7/26/2023	S	10.02	10.01	—	—	—	—	—	—	1WV	Product present; parameters not recorded.
MW-186B-60	MW-186B-60	7/26/2023	S	10.01	—	5.53	0.19	219	7.53	84.1	Clear	SP	
MW-192A-15	MW-192A-15	7/25/2023	NSZD	8.14	—	6.59	0.77	243	7.10	43.2	Clear	3WV	
MW-302-80	MW-302-80	7/20/2023	S	8.23	—	5.49	0.19	216	7.39	49.6	Clear	SP	
MW-302-CMT-20	MW-302-CMT-20	7/20/2023	S	8.89	—	4.87	0.40	234	7.35	63.3	Clear	3WV	
MW-302-CMT-50	MW-302-CMT-50	7/20/2023	S	8.89	—	5.57	0.31	223	7.38	49.2	Clear	3WV	
MW-303-80	MW-303-80	7/20/2023	S	6.46	—	5.22	0.34	212	7.44	44.9	Clear	SP	
MW-303-CMT-19	MW-303-CMT-19	7/20/2023	S, COC	10.42	—	4.92	0.40	278	7.32	19.6	Clear	3WV	
MW-303-CMT-29	MW-303-CMT-29	7/20/2023	S	10.69	—	5.11	0.21	258	7.39	5.8	Clear	3WV	
MW-303-CMT-39	MW-303-CMT-39	7/20/2023	S, COC, NSZD	10.65	—	5.87	0.43	247	7.31	1.4	Clear	3WV	
MW-303-CMT-49	MW-303-CMT-49	7/20/2023	S	10.39	—	5.99	1.6	242	7.32	-4.1	Clear	3WV	
MW-303-CMT-59	MW-303-CMT-59	7/20/2023	S	10.65	—	6.26	0.25	236	7.31	-10.6	Clear	3WV	
MW-304-CMT-20	MW-304-CMT-20	7/21/2023	S	12.30	—	5.40	0.22	286	7.09	-15.1	Clear	3WV	
MW-304-CMT-40	MW-304-CMT-40	7/21/2023	S, COC, NSZD	12.60	—	5.88	0.18	253	7.48	-28.8	Clear	SP	
MW-304-CMT-60	MW-304-CMT-60	7/21/2023	S	12.30	—	6.52	0.24	227	7.49	-23.6	Clear	3WV	
MW-304-80	MW-304-80	7/21/2023	S	11.40	—	5.28	0.22	219	7.45	-0.8	Clear	SP	
MW-305-CMT-48	MW-305-CMT-48	7/21/2023	S	11.16	—	5.55	0.30	231	7.44	53.0	Clear	SP	
MW-309-15	MW-309-15	7/24/2023	S	8.12	—	4.13	0.69	256	7.01	92.4	Clear	3WV	
MW-321-15	MW-321-15	7/25/2023	COC	8.68	—	5.77	0.31	311	6.87	59.3	Clear	3WV	
MW-330-20	MW-330-20	7/25/2023	S	13.36	—	5.79	0.20	279	6.90	73.7	Clear	SP	
MW-334-15	MW-334-15	7/26/2023	S	11.37	11.32	—	—	—	—	—	—	1WV	Product present; parameters not recorded.
MW-336-20	MW-336-20	7/27/2023	NSZD	—	—	8.33	0.16	363	6.82	51.6	Clear	SP	Depth to water not recorded; water sounder malfunctioning.
MW-345-15	MW-345-15	7/25/2023	S	9.85	—	5.13	0.16	344	7.18	35.1	Clear	SP	
MW-345-55	MW-345-55	7/25/2023	S	10.50	—	5.47	0.19	227	7.27	68.9	Clear	SP	
MW-345-75	MW-345-75	7/25/2023	S	9.70	—	5.42	0.25	225	7.03	83.6	Clear	SP	
MW-348-15	MW-348-15	7/26/2023	NSZD	6.66	6.65	7.76	0.15	250	7.27	67.9	Clear	SP	
MW-358-20	MW-358-20	7/19/2023	S	10.80	—	5.34	0.22	258	7.17	24.3	Clear	SP	
MW-358-40	MW-358-40	7/19/2023	S	10.67	—	4.25	0.20	246	7.30	31.8	Clear	SP	
MW-358-60	MW-358-60	7/19/2023	S	10.70	—	5.48	0.18	221	7.43	34.2	Clear	SP	
MW-359-15	MW-359-15	7/18/2023	S	10.32	—	6.07	2.3	310	6.5	69.9	Clear	3WV	
MW-359-35	MW-359-35	7/18/2023	S, COC, NSZD	10.20	—	4.08	0.26	272	6.98	76.2	Clear	SP	
MW-359-60	MW-359-60	7/18/2023	S	10.30	—	5.20	0.30	229	7.18	62.4	Clear	SP	
MW-359-80	MW-359-80	7/18/2023	S	10.30	—	5.23	0.41	215	7.30	84.7	Clear	SP	
MW-360-15	MW-360-15	7/19/2023	S, COC	10.00	—	5.17	0.14	340	6.93	51.1	Clear	SP	
MW-360-35	MW-360-35	7/19/2023	S	10.14	—	4.06	0.16	269	7.15	18	Clear	SP	

Table 3-1
Groundwater Well Field Parameters
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Sample Name	Date	Analysis	Depth to Water (feet)	Depth to LNAPL (feet)	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH	ORP (mV)	Water Clarity	Purge Criteria	Sample Collection Notes
MW-360-50	MW-360-50	7/19/2023	S, NSZD	10.16	—	4.23	0.20	270	7.12	10.3	Clear	SP	
MW-360-80	MW-360-80	7/19/2023	S	9.98	—	5.06	0.26	213	7.62	82	Clear	SP	
MW-364-15	MW-364-15	7/18/2023	S	9.93	—	4.69	0.26	194	6.55	108.1	Clear	3WV	
MW-364-30	MW-364-30	7/18/2023	S	9.89	—	4.10	0.25	223	6.99	99.9	Clear	3WV	
MW-364-65	MW-364-65	7/18/2023	S	9.34	—	5.19	0.27	221	7.06	105.3	Clear	SP	
MW-364-90	MW-364-90	7/18/2023	S	10.12	—	4.97	0.29	218	6.8	129.3	Clear	SP	
MW-371-15	MW-371-15	7/18/2023	S, COC	10.59	—	5.52	0.51	274	6.84	61.0	Clear	3WV	
MW-372-15	MW-372-15	7/25/2023	S	13.81	—	4.10	0.59	332	6.92	73.2	Clear	3WV	
O-1	O-1	7/26/2023	S	9.78	—	11.79	0.26	305	6.88	59.7	Clear	3WV	
O-2	O-2	7/27/2023	S	11.10	11.09	—	—	—	—	—	—	1WV	Product present; parameters not recorded.
O-3	O-3	7/27/2023	COC	11.80	—	7.09	0.36	585	7.07	74.8	Clear	3WV	
O-4	O-4	7/24/2023	COC	10.80	—	5.94	0.27	314	7.04	84.5	Clear	3WV	
O-15	O-15	7/27/2023	NSZD	10.56	—	5.99	0.34	246	6.47	76.1	Clear	SP	
O-24	O-24	7/26/2023	S, COC	11.56	—	4.99	0.20	452	6.86	55.9	Clear	3WV	
O-25	O-25	7/28/2023	COC	12.29	—	7.30	0.55	303	6.93	58.7	Clear	SP	
O-26	O-26	7/26/2023	S	11.45	—	4.74	0.25	417	7.43	25.6	Clear	SP	
O-26-65	O-26-65	7/26/2023	S	10.97	—	5.52	0.15	224	7.46	32.4	Clear	SP	
O-27	O-27	7/24/2023	S	11.25	11.24	—	—	—	—	—	—	1WV	Product present; parameters not recorded.
O-27-65	O-27-65	7/24/2023	S	11.69	—	5.44	0.22	223	7.02	88.0	Clear	SP	
O-34	O-34	7/26/2023	S	9.73	9.72	—	—	—	—	—	—	1WV	Product present; parameters not recorded.
S-9	S-9	7/26/2023	COC	9.56	—	4.69	0.17	271	7.64	18.1	Clear	3WV	

Notes:
1. The MW-148 nest is located offsite, near the property boundary, but is being monitored and reported as part of the onsite groundwater monitoring program.
2. COCs at the site include BTEX, GRO, and DRO.
3. NSZD analytes include BTEX, GRO, DRO, oxygen, sulfate, dissolved iron, dissolved manganese, and methane.

Acronyms and Abbreviations:
— = not applicable
°C = degree Celsius
µS/cm = microSiemen per centimeter
1WV = one well volume
3WV = three well volumes
COC = contaminant of concern
DRO = diesel-range organics
GRO = gasoline-range organics
LNAPL = light nonaqueous phase liquid
mg/L = milligram per liter
mV = millivolt
NSZD = natural source zone depletion
ORP = oxidation-reduction potential
S = sulfolane
SP = stable parameter

Table 3-2
Annual 2023 Groundwater Elevation, Surface Water Elevation, and Depth to LNAPL Monitoring Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Date	Riser Elevation (feet MSL)	Survey Date	Depth to LNAPL (feet)	Depth to Water (feet)	LNAPL Thickness (feet)	Corrected Water Table Elevation‡ (feet MSL)	Notes
MW-104-65	10 to 55	8/15/2023	496.03	9/13/2018	--	11.04	--	484.99	
MW-142-20	Water table	8/15/2023	495.83	9/13/2018	--	10.64	--	485.19	
MW-144BR-90	Water table	8/15/2023	495.03	9/13/2018	--	9.46	--	485.57	
MW-145-20	Water table	8/15/2023	495.63	9/14/2018	--	9.80	--	485.83	
MW-149A-15	Water table	8/15/2023	493.20	9/13/2018	--	9.07	--	484.13	
MW-173B-150	90 to 150	8/15/2023	496.33	9/13/2018	--	10.83	--	485.50	
MW-174-15	Water table	8/15/2023	494.43	9/13/2018	--	7.91	--	486.52	
MW-174A-50	10 to 55	8/15/2023	493.59	9/13/2018	--	7.62	--	485.97	
MW-174B-90	55 to 90	8/15/2023	493.49	9/13/2018	--	7.21	--	486.28	
MW-176A-15	Water table	8/15/2023	497.11	9/13/2018	9.93	9.94	0.01	487.18	
MW-176B-50	10 to 55	8/15/2023	496.93	9/13/2018	--	10.00	--	486.93	
MW-186A-15	Water table	8/15/2023	495.98	9/13/2018	Sheen	10.18	Sheen	485.80	
MW-186B-60	10 to 55	8/15/2023	495.97	9/13/2018	--	10.16	--	485.81	
MW-192A-15	Water table	8/15/2023	496.28	9/13/2018	--	8.25	--	488.03	
MW-192B-55	10 to 55	8/15/2023	495.59	9/13/2018	--	7.47	--	488.12	
MW-198-150	90 to 150	8/15/2023	493.16	9/14/2018	--	5.82	--	487.34	
MW-300-150	90 to 150	8/15/2023	495.94	9/13/2018	--	8.80	--	487.14	
MW-301-60	10 to 55	8/15/2023	492.70	9/13/2018	--	7.58	--	485.12	
MW-302-CMT-50	10 to 55	8/15/2023	493.41	9/13/2018	--	8.32	--	485.09	
MW-302-80	55 to 90	8/15/2023	494.21	9/13/2018	--	9.13	--	485.08	
MW-303-CMT-59	10 to 55	8/15/2023	491.56	9/13/2018	--	6.56	--	485.00	
MW-303-80	55 to 90	8/15/2023	495.73	9/13/2018	--	10.74	--	484.99	
MW-306-80	55 to 90	8/15/2023	496.47	9/13/2018	--	11.69	--	484.78	
MW-309-15	Water table	8/15/2023	494.77	9/13/2018	--	8.98	--	485.79	
MW-310-15	Water table	8/15/2023	493.85	9/13/2018	--	8.10	--	485.75	
MW-310-110	90 to 150	8/15/2023	494.26	9/13/2018	--	8.56	--	485.70	
MW-321-15	Water table	8/15/2023	495.59	9/13/2018	--	8.89	--	486.70	
MW-334-15	Water table	8/15/2023	497.06	9/13/2018	11.42	11.53	0.11	485.62	
MW-336-20	Water table	8/15/2023	493.26	9/20/2018	--	5.77	--	487.49	
MW-358-20	Water table	8/15/2023	495.53	9/13/2018	--	10.82	--	484.71	
MW-358-40	10 to 55	8/15/2023	495.19	9/13/2018	--	10.23	--	484.96	
MW-358-60	10 to 55	8/15/2023	495.46	9/13/2018	--	10.25	--	485.21	
MW-359-15	Water table	8/15/2023	495.16	9/13/2018	--	10.33	--	484.83	
MW-359-60	10 to 55	8/15/2023	495.02	9/13/2018	--	10.30	--	484.72	
MW-359-80	55 to 90	8/15/2023	495.02	9/13/2018	--	10.33	--	484.69	
MW-360-15	Water table	8/15/2023	494.96	9/13/2018	--	10.04	--	484.92	
MW-360-50	10 to 55	8/15/2023	494.57	9/13/2018	--	10.01	--	484.56	
MW-360-80	55 to 90	8/15/2023	494.86	9/13/2018	--	10.19	--	484.67	
MW-360-150	90 to 150	8/15/2023	494.46	9/13/2018	--	10.00	--	484.46	
MW-362-15	Water table	8/15/2023	495.09	9/13/2018	--	10.35	--	484.74	
MW-362-50	10 to 55	8/15/2023	495.27	9/13/2018	--	10.37	--	484.90	
MW-362-150	90 to 150	8/15/2023	494.99	9/13/2018	--	10.04	--	484.95	

Table 3-2
Annual 2023 Groundwater Elevation, Surface Water Elevation, and Depth to LNAPL Monitoring Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Date	Riser Elevation (feet MSL)	Survey Date	Depth to LNAPL (feet)	Depth to Water (feet)	LNAPL Thickness (feet)	Corrected Water Table Elevation‡ (feet MSL)	Notes
MW-364-15	Water table	8/15/2023	494.23	9/13/2018	--	9.90	--	484.33	
MW-364-65	10 to 55	8/15/2023	494.09	9/13/2018	--	9.33	--	484.76	
MW-364-90	55 to 90	8/15/2023	494.28	9/13/2018	--	10.11	--	484.17	
MW-366-15	Water table	8/15/2023	493.51	9/13/2018	No LNAPL	5.95	0.00	487.56	
O-34	Water table	8/15/2023	496.56	9/13/2018	No LNAPL	9.85	0.00	486.71	
North Gravel Pit	Surface water	8/15/2023	492.78	9/13/2018	--	7.11	--	485.67	

Notes:
[1] The ranges presented indicate feet below the water table.

1. If LNAPL is present, the water table elevation is corrected according to the following formula (riser elevation - depth to water) + (0.8 x LNAPL thickness).
2. Only monitoring wells scheduled for gauging per Table 3-2 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here.

Acronyms and Abbreviations:
-- = a water sounder was used; the well was not checked with an interface probe for the presence of LNAPL
‡ = at locations where the LNAPL specific gravity has not been determined, a specific gravity of 0.8 is used to calculate the corrected groundwater elevation
LNAPL = light nonaqueous phase liquid
MSL = mean sea level
No LNAPL = an air-oil-water interface probe was used; LNAPL was not detected
Sheen = LNAPL thickness was less than 0.01 foot and not detected with an interface probe; product was detected visually

Reference:
Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Table 3-3
LNAPL Migration Monitoring
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Location	Date	Frequency	Top of Riser Elevation (feet MSL)	Depth to LNAPL (feet)	Depth to Water (feet)	LNAPL Thickness (feet)	Water Table Elevation (feet MSL)	Notes
MW-139-25	7/21/2023	Annual	497.24	--	11.65	--	485.59	
MW-139-25	10/26/2023	Annual	497.24	No LNAPL	13.60	0.00	483.64	
MW-142-20	7/21/2023	Annual	495.83	--	10.50	--	485.33	
MW-142-20	8/15/2023	Annual	495.83	--	10.64	--	485.19	
MW-142-20	10/26/2023	Annual	495.83	No LNAPL	12.39	0.00	483.44	
MW-145-20	7/28/2023	Annual	495.63	--	9.81	--	485.82	
MW-145-20	8/15/2023	Annual	495.63	--	9.80	--	485.83	
MW-145-20	10/26/2023	Annual	495.63	No LNAPL	11.50	0.00	484.13	
O-4	7/24/2023	Annual	496.58	--	10.80	--	485.78	
O-4	10/26/2023	Annual	496.58	No LNAPL	12.77	0.00	483.81	
O-5	10/26/2023	Annual	495.83	No LNAPL	12.02	0.00	483.81	
O-7	10/26/2023	Annual	496.47	No LNAPL	12.28	0.00	484.19	
O-11	10/26/2023	Annual	497.91	14.07	14.09	0.02	483.84	
O-12	10/26/2023	Annual	496.44	No LNAPL	12.75	0.00	483.69	
O-24	7/26/2023	Annual	497.15	--	11.56	--	485.59	
O-24	10/26/2023	Annual	497.15	No LNAPL	13.47	0.00	483.68	
O-25	7/28/2023	Annual	497.86	--	12.29	--	485.57	
O-25	10/26/2023	Annual	497.86	No LNAPL	14.17	0.00	483.69	
O-26	7/26/2023	Annual	497.00	--	11.45	--	485.55	
O-26	10/26/2023	Annual	497.00	No LNAPL	13.40	0.00	483.60	
O-27	7/24/2023	Annual	496.91	11.24	11.25	0.01	485.67	
O-27	10/26/2023	Annual	496.91	13.05	13.57	0.52	483.77	
O-31	10/26/2023	Annual	496.14	12.21	12.45	0.24	483.88	

Notes:

1. If LNAPL is present, the water table elevation is corrected according to the following formula (riser elevation - depth to water) + (0.8 x LNAPL thickness).

2. Only monitoring wells scheduled for gauging per Table 3-2 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here. A comprehensive LNAPL gauging table is provided in Appendix E.

Acronyms and Abbreviations:

-- = a water sounder was used to measure the depth to water

—— = not measured

LNAPL = light nonaqueous phase liquid

MSL = mean sea level

No LNAPL = an interface probe was used to measure depth to water; LNAPL was not observed

Sheen = LNAPL thickness was less than 0.01 foot and not detected with an interface probe; product was detected visually

Reference:

Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Table 3-4
Natural Source Zone Depletion Monitoring Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Sample Name	DUP	Date	Benzene	Toluene	Ethylbenzene	P&M-Xylene	o-Xylene	Total Xylenes	Gasoline-Range Organics	Diesel-Range Organics	Dissolved Iron	Dissolved Manganese	Sulfate	Methane
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-101A-25	10 to 55	MW-101A-25	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.420J	0.666	2.03	37.3	0.0395
MW-125-25	10 to 55	MW-125-25	—	7/27/2023	255	<5.00	204	2080	<5.00	2080	14.9	<2.36B*	34.9	16.7	<0.100	4.14
MW-130-25	10 to 55	MW-130-25	—	7/27/2023	100	12.0	109	512	139	651	3.86	<3.32B*	27.8	7.56	6.71	2.21
MW-139-25	10 to 55	MW-139-25	—	7/21/2023	26.3	<0.500	27.4	324	1.33	325	1.52JH*	2.90	20.5	5.08	8.54	5.90
MW-139-25	10 to 55	MW-139-25	DUP	7/21/2023	26.2	<0.500	28.4	331	1.32	332	1.60JH*	2.35	20.4	5.46	8.98	5.70
MW-142-20	WT	MW-142-20	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	1.03	13.1	8.31	3.05	1.68
MW-154B-95	55 to 90	MW-154B-95	—	7/21/2023	3.29	<0.500	0.703J	3.38	<0.500	3.38	<0.100B*	0.981	5.79	3.90	18.5	1.73
MW-192A-15	WT	MW-192A-15	—	7/25/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	0.156	<0.300J*	<0.125	0.0565	41.6	0.00520
MW-303-CMT-39	10 to 55	MW-303-CMT-39	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.847	1.14	2.41	34.2	0.228
MW-304-CMT-40	10 to 55	MW-304-CMT-40	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.337J	0.777	4.40	37.0	0.293
MW-336-20	WT	MW-336-20	—	7/27/2023	10600	<50.0	813	11100	<50.0	11100	52.3	12.6	29.4	4.20	<0.100	13.9
MW-336-20	WT	MW-336-20	DUP	7/27/2023	10800	<100	789	11000	<100	11000	48.4	11.1	29.6	4.29	<0.100	13.3
MW-348-15	WT	MW-348-15	—	7/26/2023	15.6	<0.500	1.06	2.91	1.15	4.06	0.137	1.55JL*	8.69	4.53	5.07	1.37
MW-359-35	10 to 55	MW-359-35	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.411J	1.07	6.48	20.5	0.102
MW-360-50	10 to 55	MW-360-50	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.491JL*	3.42	5.01	24.5	<0.000250
O-15	WT	O-15	—	7/27/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	<0.588B*	<0.125	0.197	46.3	0.0258

Notes:

[1] The ranges presented indicate feet below the water table.

1. Total xylenes are calculated by Shannon & Wilson, Inc. as the sum of o-, p- and m-xylenes.
2. Only monitoring wells scheduled for sampling per Table 3-6 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here. Additional constituent of concern sampling data are presented in Table 3-5.
3. NSZD analytes include GRO, DRO, BTEX, sulfate, dissolved iron, dissolved manganese, and methane.

Acronyms and Abbreviations:
— = not applicable
< = not detected; presented as <LOD (less than the limit of detection) unless otherwise noted due to quality control failures
µg/L = microgram per liter
DUP = field duplicate sample
mg/L =milligram per liter
NSZD = natural source zone depletion
WT = water table

Qualifiers:
B* = Result is considered not detected due to quality control (QC) failures; see data review checklist for details. Flag applied by Shannon & Wilson, Inc.
J = Estimated concentration, detected above the detection limit and below the limit of quantitation. Flag applied by laboratory.
J* = Result is considered estimated (no direction of bias), due to QC failures or sample-handling anomalies. Flag applied by Shannon & Wilson, Inc.
JH* = Estimated concentration, biased high, due to quality control failures. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.

Reference:
Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Table 3-5
Annual 2023 Constituent of Concern Analytical Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Sample Name	DUP	Sample Date	Benzene	Toluene	Ethylbenzene	P&M -Xylene	o-Xylene	Total Xylenes	Gasoline-Range Organics	Diesel-Range Organics
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L
MW-101A-25	10 to 55	MW-101A-25	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.420J
MW-125-25	10 to 55	MW-125-25	—	7/27/2023	255	<5.00	204	2080	<5.00	2080	14.9	<2.36B*
MW-130-25	10 to 55	MW-130-25	—	7/27/2023	100	12.0	109	512	139	651	3.86	<3.32B*
MW-131-25	10 to 55	MW-131-25	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.594
MW-137-20	WT	MW-137-20	—	7/28/2023	767	8000	2010	8240	3730	12000	56.0	6.59JH*
MW-139-25	10 to 55	MW-139-25	—	7/21/2023	26.3	<0.500	27.4	324	1.33	325	1.52JH*	2.90
MW-139-25	10 to 55	MW-239-25	DUP	7/21/2023	26.2	<0.500	28.4	331	1.32	332	1.60JH*	2.35
MW-142-20	WT	MW-142-20	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	1.03
MW-144A-25	10 to 55	MW-144A-25	—	7/24/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.599
MW-145-20	WT	MW-145-20	—	7/28/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	<0.294
MW-149A-15	WT	MW-149A-15	—	7/17/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.239JL*
MW-154B-95	55 to 90	MW-154B-95	—	7/21/2023	3.29	<0.500	0.703J	3.38	<0.500	3.38	<0.100B*	0.981
MW-192A-15	WT	MW-192A-15	—	7/25/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	0.156	<0.300J*
MW-303-CMT-19	WT	MW-303-CMT-19	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.954
MW-303-CMT-39	10 to 55	MW-303-CMT-39	—	7/20/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.847
MW-304-CMT-40	10 to 55	MW-304-CMT-40	—	7/21/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.337J
MW-321-15	WT	MW-321-15	—	7/25/2023	77.5	<0.500	<0.500	<1.00	<0.500	<1.50	0.226	0.753JL*
MW-321-15	WT	MW-421-15	DUP	7/25/2023	80.9	<0.500	<0.500	<1.00	<0.500	<1.50	0.223	0.793JL*
MW-336-20	WT	MW-336-20	—	7/27/2023	10600	<50.0	813	11100	<50.0	11100	52.3	12.6
MW-336-20	WT	MW-436-20	DUP	7/27/2023	10800	<100	789	11000	<100	11000	48.4	11.1
MW-348-15	WT	MW-348-15	—	7/26/2023	15.6	<0.500	1.06	2.91	1.15	4.06	0.137	1.55JL*
MW-359-35	10 to 55	MW-359-35	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.411J
MW-360-15	WT	MW-360-15	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.514J
MW-360-50	10 to 55	MW-360-50	—	7/19/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.491JL*
MW-371-15	WT	MW-371-15	—	7/18/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.0500	0.530J
O-3	WT	O-3	—	7/27/2023	<0.882B*	<0.500	<0.500	<2000B*	<0.500	1.24J	<0.100B*	<0.288
O-4	WT	O-4	—	7/24/2023	0.494	<0.500	<0.500	1.26J	<0.500	1.26J	<0.100B*	1.52
O-15	WT	O-15	—	7/27/2023	<0.200	<0.500	<0.500	<1.00	<0.500	<1.50	<0.100B*	<0.588B*
O-24	WT	O-24	—	7/26/2023	19.4	<0.500	<0.500	<1.00	<0.500	<1.50	0.110	0.825JL*
O-25	WT	O-25	—	7/28/2023	28.9	<0.500	0.354J	14.2	<0.500	14.2	<0.282B*	<0.768B*
S-9	WT	S-9	—	7/26/2023	0.274J	<0.500	<0.500	0.800J	<0.500	<1.50	<0.0500	0.470JL*

Notes:
[1] The ranges presented indicate feet below the water table.

1. Total xylenes are calculated by Shannon & Wilson, Inc. as the sum of o-, p- and m-xylenes.
2. Only monitoring wells scheduled for sampling per Table 3-4 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here. Additional constituent of concern data collected as part of the natural source zone depletion sampling are presented in Table 3-4.

Acronyms and Abbreviations:

— = not applicable

< = not detected; presented as <LOD (less than the limit of detection) unless otherwise noted due to quality control failures
µg/L = microgram per liter
DUP = field duplicate sample
mg/L = milligram per liter
WT = water table

Qualifiers:
B* = Result is considered estimated (no direction of bias), due to method blank detection. Flag applied by Shannon & Wilson, Inc.
J = Estimated concentration, detected above the detection limit and below the limit of quantitation. Flag applied by laboratory.
J* = Result is considered estimated (no direction of bias), due to quality control (QC) failures. Flag applied by Shannon & Wilson, Inc.
JH* = Result is considered estimated, biased high, due to QC failures. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.

Reference:
Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Table 3-6
Annual 2023 Onsite Sulfolane Analytical Results
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Sample Name	Dup	Sample Date	Sulfolane
					µg/L
MW-127-25	10 to 55	MW-127-25	—	7/27/2023	15.5
MW-127-25	10 to 55	MW-227-25	DUP	7/27/2023	16.0
MW-139-25	10 to 55	MW-139-25	—	7/21/2023	73.1JL*
MW-142-20	WT	MW-142-20	—	7/21/2023	58.4JL*
MW-142-20	WT	MW-242-20	DUP	7/21/2023	62.5JL*
MW-148-80	10 to 55	MW-148-80	—	7/17/2023	13.7
MW-148A-15	WT	MW-148A-15	—	7/17/2023	14.0
MW-148B-30	10 to 55	MW-148B-30	—	7/17/2023	37.9
MW-148C-55	10 to 55	MW-148C-55	—	7/17/2023	42.0
MW-154B-95	55 to 90	MW-154B-95	—	7/21/2023	46.1JL*
MW-154B-95	55 to 90	MW-254B-95	DUP	7/21/2023	54.6JL*
MW-186A-15	WT	MW-186A-15	—	7/26/2023	95.5
MW-186B-60	10 to 55	MW-186B-60	—	7/26/2023	5.01J
MW-302-80	55 to 90	MW-302-80	—	7/20/2023	<5.15
MW-302-CMT-20	WT	MW-302-CMT-20	—	7/20/2023	7.65J
MW-302-CMT-50	10 to 55	MW-302-CMT-50	—	7/20/2023	3.72J
MW-303-80	55 to 90	MW-303-80	—	7/20/2023	<5.15
MW-303-CMT-19	WT	MW-303-CMT-19	—	7/20/2023	118
MW-303-CMT-29	10 to 55	MW-303-CMT-29	—	7/20/2023	97.8
MW-303-CMT-39	10 to 55	MW-303-CMT-39	—	7/20/2023	67.3
MW-303-CMT-49	10 to 55	MW-303-CMT-49	—	7/20/2023	47.2
MW-303-CMT-59	10 to 55	MW-303-CMT-59	—	7/20/2023	29.9
MW-304-CMT-20	WT	MW-304-CMT-20	—	7/21/2023	26.1JL*
MW-304-CMT-40	10 to 55	MW-304-CMT-40	—	7/21/2023	20.3JL*
MW-304-CMT-60	10 to 55	MW-304-CMT-60	—	7/21/2023	<5.20J*
MW-304-80	55 to 90	MW-304-80	—	7/21/2023	<5.20J*
MW-305-CMT-48	10 to 55	MW-305-CMT-48	—	7/21/2023	<5.20J*
MW-309-15	WT	MW-309-15	—	7/24/2023	13.4JL*
MW-309-15	WT	MW-409-15	DUP	7/24/2023	12.9JL*
MW-330-20	WT	MW-330-20	—	7/25/2023	35.5
MW-334-15	WT	MW-334-15	—	7/26/2023	16.3
MW-345-15	WT	MW-345-15	—	7/25/2023	125
MW-345-55	10 to 55	MW-345-55	—	7/25/2023	30.9
MW-345-75	55 to 90	MW-345-75	—	7/25/2023	22.7
MW-358-20	WT	MW-358-20	—	7/19/2023	42.6
MW-358-40	10 to 55	MW-358-40	—	7/19/2023	46.8
MW-358-60	10 to 55	MW-358-60	—	7/19/2023	<5.30
MW-359-15	WT	MW-359-15	—	7/18/2023	23.0
MW-359-35	10 to 55	MW-359-35	—	7/19/2023	130
MW-359-60	10 to 55	MW-359-60	—	7/18/2023	37.9
MW-359-80	55 to 90	MW-359-80	—	7/18/2023	11.1
MW-360-15	WT	MW-360-15	—	7/19/2023	5.05J
MW-360-35	10 to 55	MW-360-35	—	7/19/2023	27.8
MW-360-50	10 to 55	MW-360-50	—	7/19/2023	40.8
MW-360-80	55 to 90	MW-360-80	—	7/19/2023	7.31J
MW-364-15	WT	MW-364-15	—	7/18/2023	<5.15
MW-364-30	10 to 55	MW-364-30	—	7/18/2023	8.34J
MW-364-65	10 to 55	MW-364-65	—	7/18/2023	14.0
MW-364-90	55 to 90	MW-364-90	—	7/18/2023	14.8
MW-371-15	WT	MW-371-15	—	7/18/2023	84.0
MW-371-15	WT	MW-471-15	DUP	7/18/2023	84.7
MW-372-15	WT	MW-372-15	—	7/25/2023	647
O-1	WT	O-1	—	7/26/2023	555
O-2	WT	O-2	—	7/27/2023	82.0
O-24	WT	O-24	—	7/26/2023	<5.45
O-26	WT	O-126	DUP	7/26/2023	50.0
O-26	WT	O-26	—	7/26/2023	47.3
O-26-65	10 to 55	O-26-65	—	7/26/2023	6.72J
O-27	WT	O-27	—	7/24/2023	102JL*
O-27-65	10 to 55	O-27-65	—	7/24/2023	26.1JL*
O-34	WT	O-34	—	7/26/2023	152

Notes:
[1] The ranges presented indicate feet below the water table.

1. Only monitoring wells scheduled for sampling per Table 3-3 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here.

Acronyms and Abbreviations:
— = not applicable
< = not detected; presented as <LOD (less than the limit of detection) unless otherwise noted due to quality control failures
µg/L = microgram per liter
DUP = field duplicate sample
WT = water table

Qualifiers:
J = Estimated concentration, detected greater than the detection limit and less than the limit of quantitation. Flag applied by the laboratory.
J* = Result is considered estimated due to qualify control (QC) failures. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low, due to QC failures. Flag applied by Shannon & Wilson, Inc.

Reference:
Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Table 3-7
Annual 2023 Sulfolane Analytical Results – Point of Compliance
Annual 2023 Onsite Groundwater Monitoring Report
North Pole Terminal, North Pole, Alaska

Well ID	Zone[1]	Sample Name	DUP	Date	Sulfolane
					µg/L
MW-358-20	WT	MW-358-20	—	7/19/2023	42.6
MW-358-40	10 to 55	MW-358-40	—	7/19/2023	46.8
MW-358-60	10 to 55	MW-358-60	—	7/19/2023	<5.30
MW-359-15	WT	MW-359-15	—	7/18/2023	23.0
MW-359-35	10 to 55	MW-359-35	—	7/19/2023	130
MW-359-60	10 to 55	MW-359-60	—	7/18/2023	37.9
MW-359-80	55 to 90	MW-359-80	—	7/18/2023	11.1
MW-360-15	WT	MW-360-15	—	7/19/2023	5.05J
MW-360-35	10 to 55	MW-360-35	—	7/19/2023	27.8
MW-360-50	10 to 55	MW-360-50	—	7/19/2023	40.8
MW-360-80	55 to 90	MW-360-80	—	7/19/2023	7.31J
MW-364-15	WT	MW-364-15	—	7/18/2023	<5.15
MW-364-30	10 to 55	MW-364-30	—	7/18/2023	8.34J
MW-364-65	10 to 55	MW-364-65	—	7/18/2023	14.0
MW-364-90	55 to 90	MW-364-90	—	7/18/2023	14.8

Notes:

[1] The ranges presented indicate feet below the water table.

1. Only point of compliance monitoring wells scheduled for sampling per Table 3-3 of the 2023 updates to the 2017 LTM Plan, provided in Appendix I to the Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report (Arcadis U.S., Inc. 2023) are shown here.

Acronyms and Abbreviations:

— = not applicable

µg/L = microgram per liter

< = not detected; presented as <LOD (less than the limit of detection) unless otherwise noted due to quality control failures

DUP = field duplicate sample

WT = water table

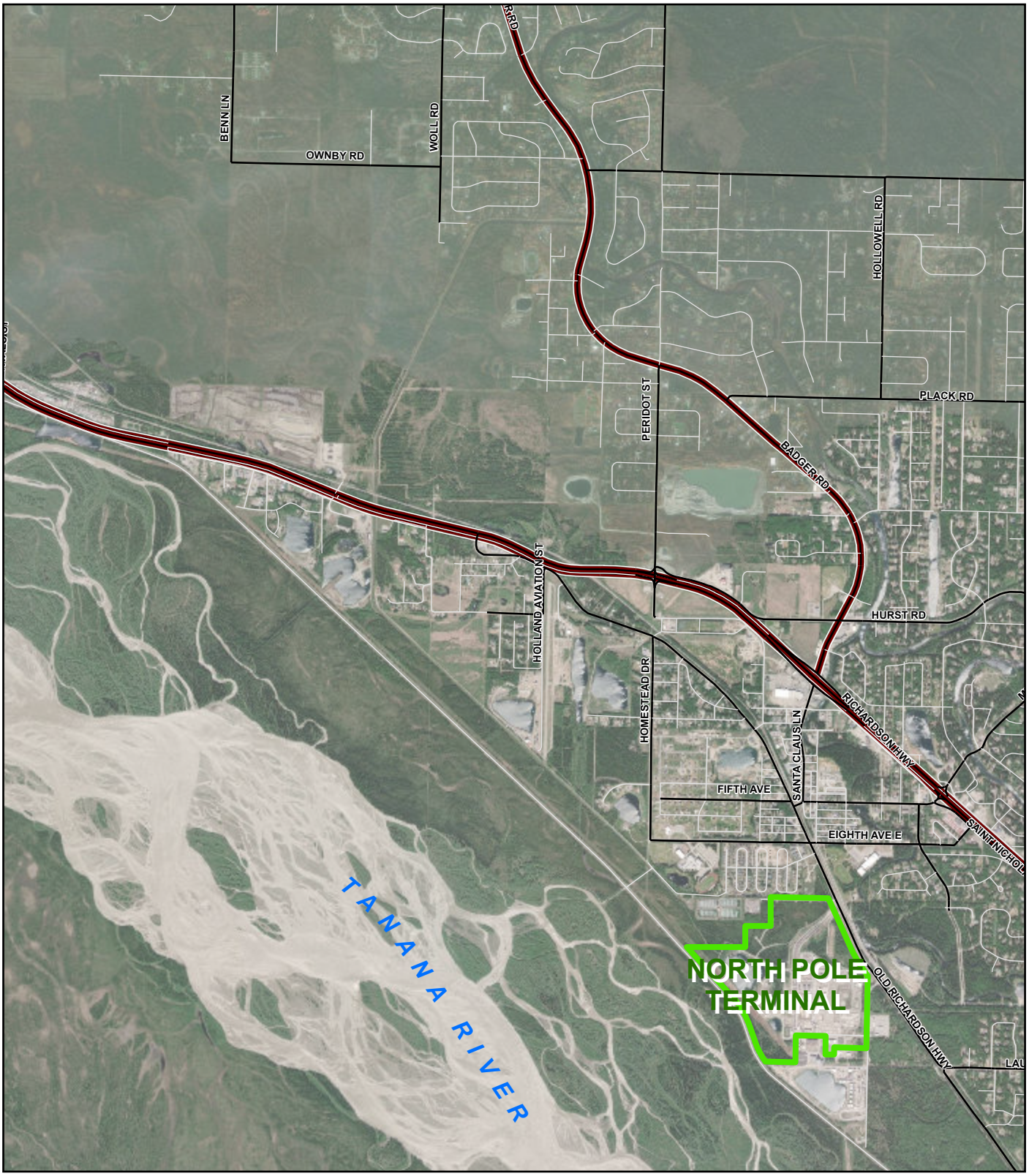
Qualifier:

J = Estimated concentration, detected greater than the detection limit and less than the limit of quantitation. Flag applied by the laboratory.

Reference:

Arcadis. 2023. Annual 2022 Onsite Groundwater Monitoring and Five-Year Periodic Review Report. North Pole Terminal, North Pole, Alaska. ADEC File No. 100.38.090. January 24.

Figures



LEGEND:

PROPERTY BOUNDARY

0 0.5 Miles

GRAPHIC SCALE

Note:
May 2015 ESRI Cloud Imagery

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

SITE LOCATION

ARCADIS

FIGURE 1-1

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 9/6/2023 Time: 11:42 AM

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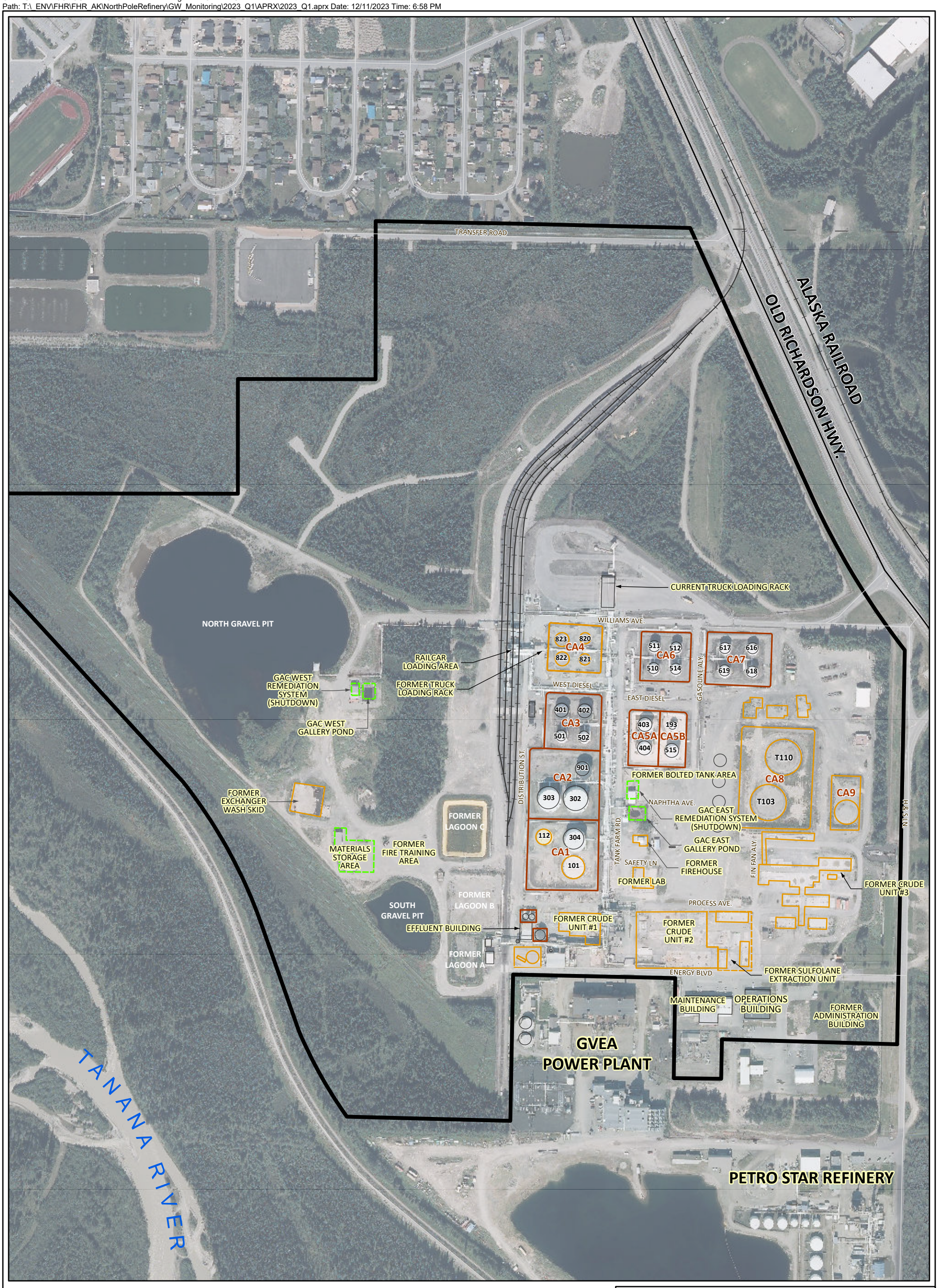


Legend
- Bermed Containment Areas (CA)
- Approximate Area
- Property Boundary
- Structure Demolished

Notes:
GAC: Granular Activated Carbon
GVEA: Golden Valley Electric Association
- July 21, 2018 Imagery provided by Quantum Spatial

0 400 800
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

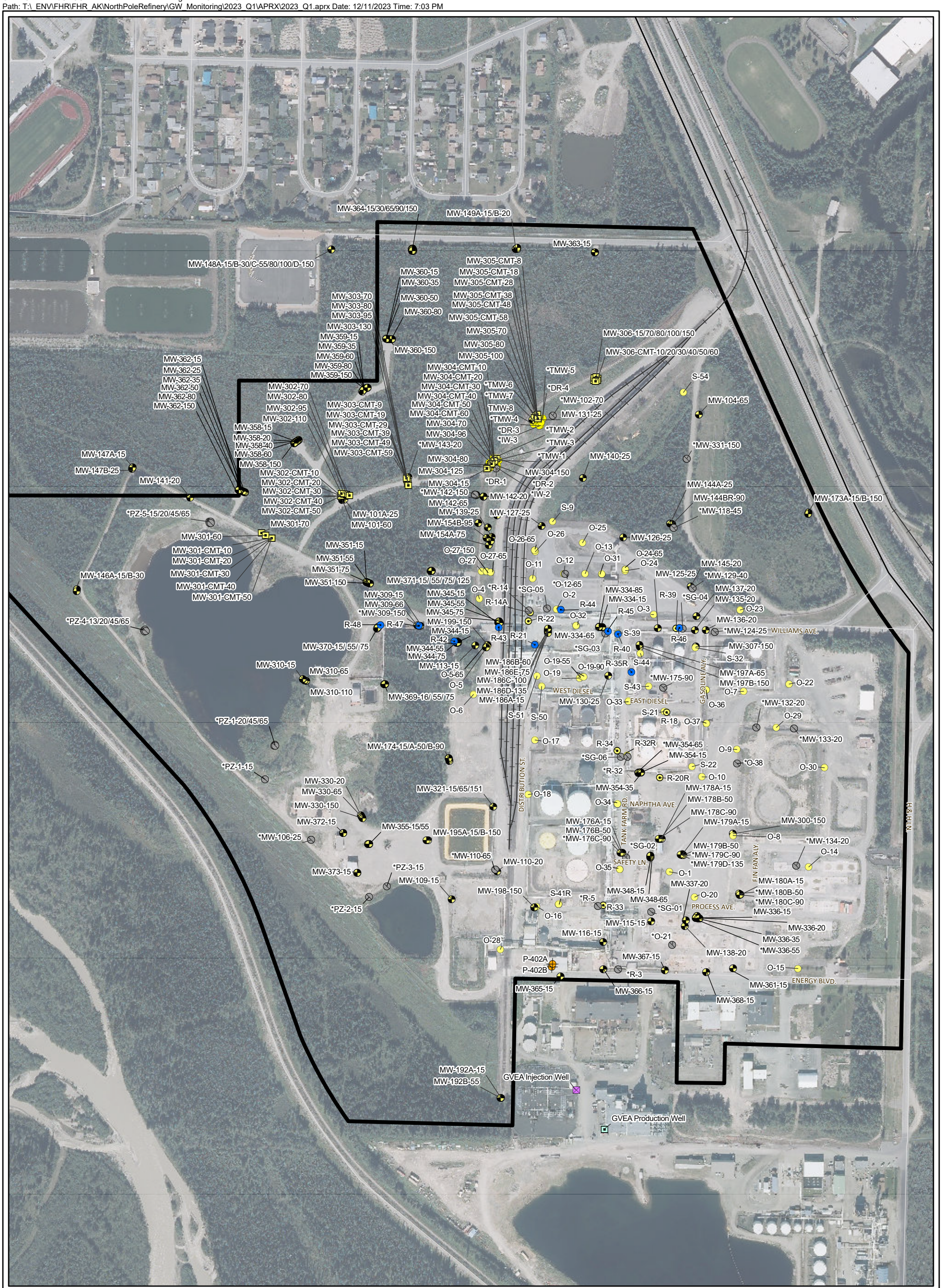
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

SITE FEATURES

ARCADIS

FIGURE
1-2

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 12/11/2023 Time: 7:03 PM



Legend

- Monitoring Well
- Observation Well
- Vertical Profile Transect Well
- Recovery Well (Former)
- Recovery Wells (Inactive)
- * Decommissioned Well
- GVEA Injection Well (Approximate)
- GVEA Production Well (Approximate)
- Production Wells (Approximate)
- Major Road
- Local Road
- Rail Line
- Property Boundary

0 400 800
SCALE IN FEET

Notes:
GVEA = Golden Valley Electric Association
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

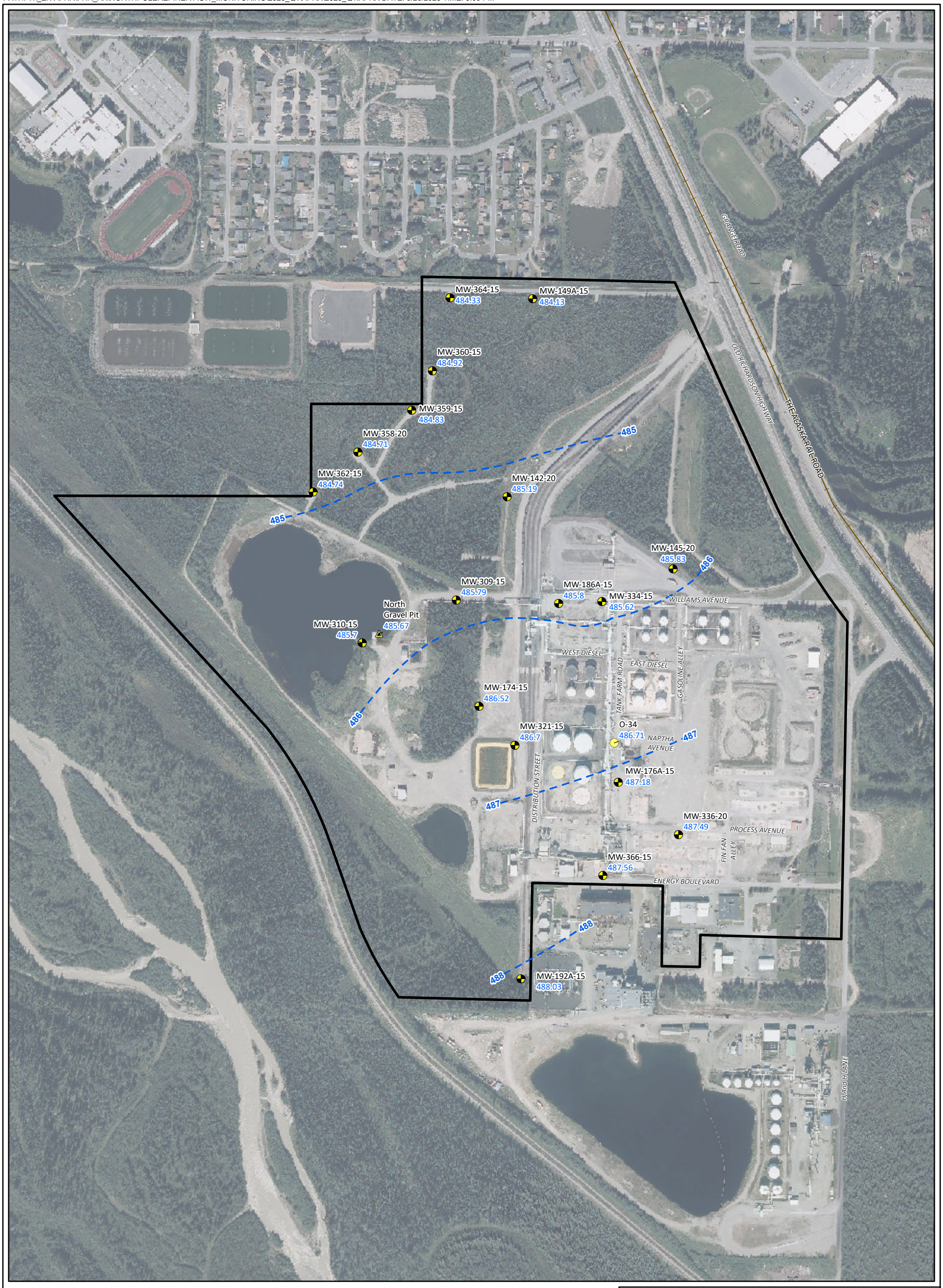
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

SITE PLAN - ONSITE

ARCADIS

FIGURE
1-3

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2023_Q1\APRX\2023_Q1.APRX DATE: 9/20/2023 TIME: 5:09 PM



Legend

- Monitoring Well
- Observation Well
- Surface Water
- Property Boundary
- 486 Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)

0 500 1,000

SCALE IN FEET

Notes:
- Wells were gauged in August 2023
- Only monitoring wells scheduled for gauging per Table 3-1 of the Long Term Monitoring Plan - 2017 Update are shown on the figure.
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

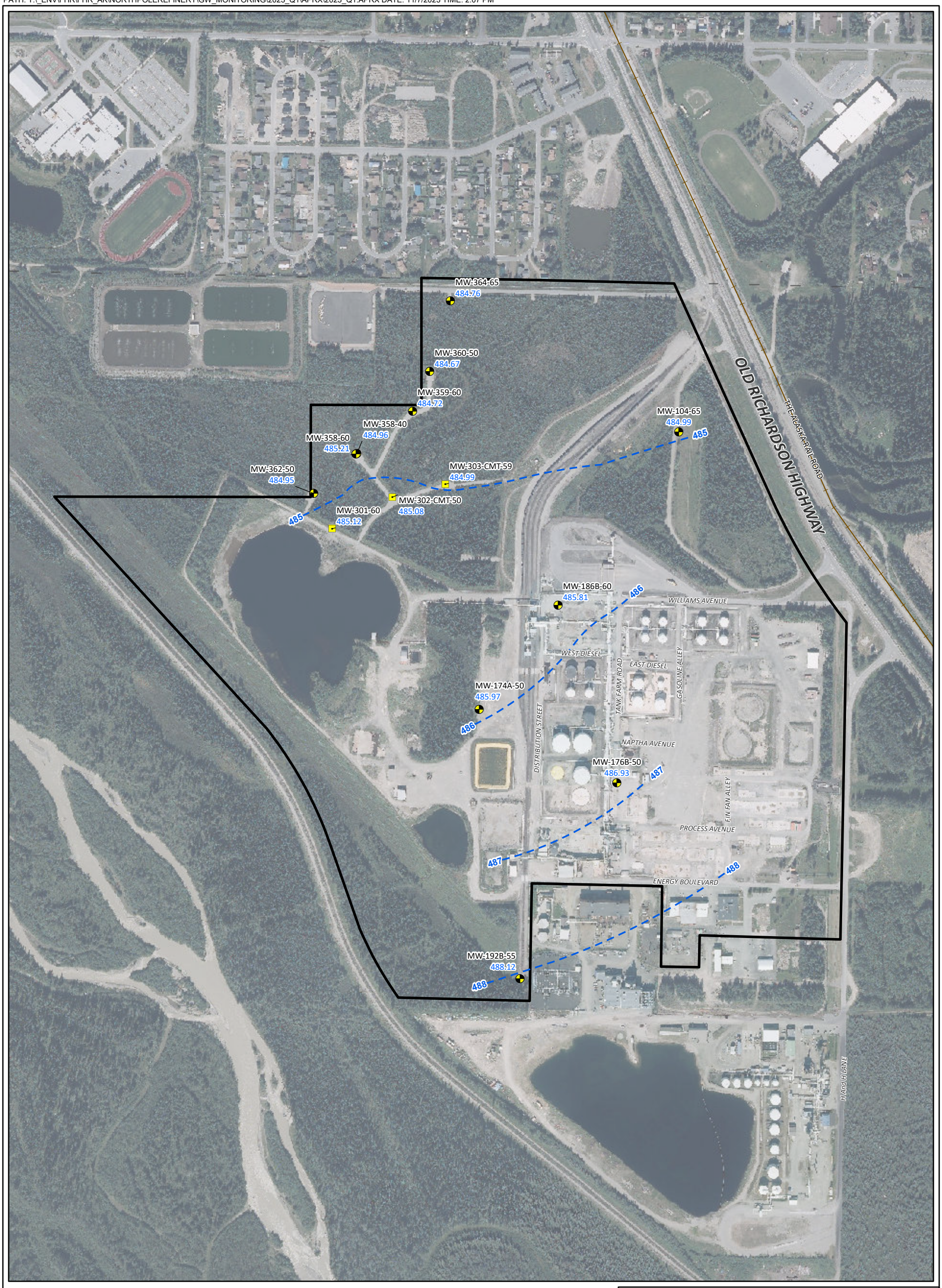
ANNUAL 2023 GROUNDWATER CONTOUR MAP – ONSITE WELLS AT WATER TABLE

ARCADIS

FIGURE

3-1

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2023_Q1\APRX\2023_Q1.APRX DATE: 11/7/2023 TIME: 2:07 PM



Legend

- Vertical Profile Transect Well
- Monitoring Well
- Property Boundary
- 485 — Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)

0 500 1,000
SCALE IN FEET

Notes:
- Wells were gauged in August 2023
- Only monitoring wells scheduled for gauging per Table 3-1 of the Long Term Monitoring Plan - 2017 Update are shown on the figure.
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

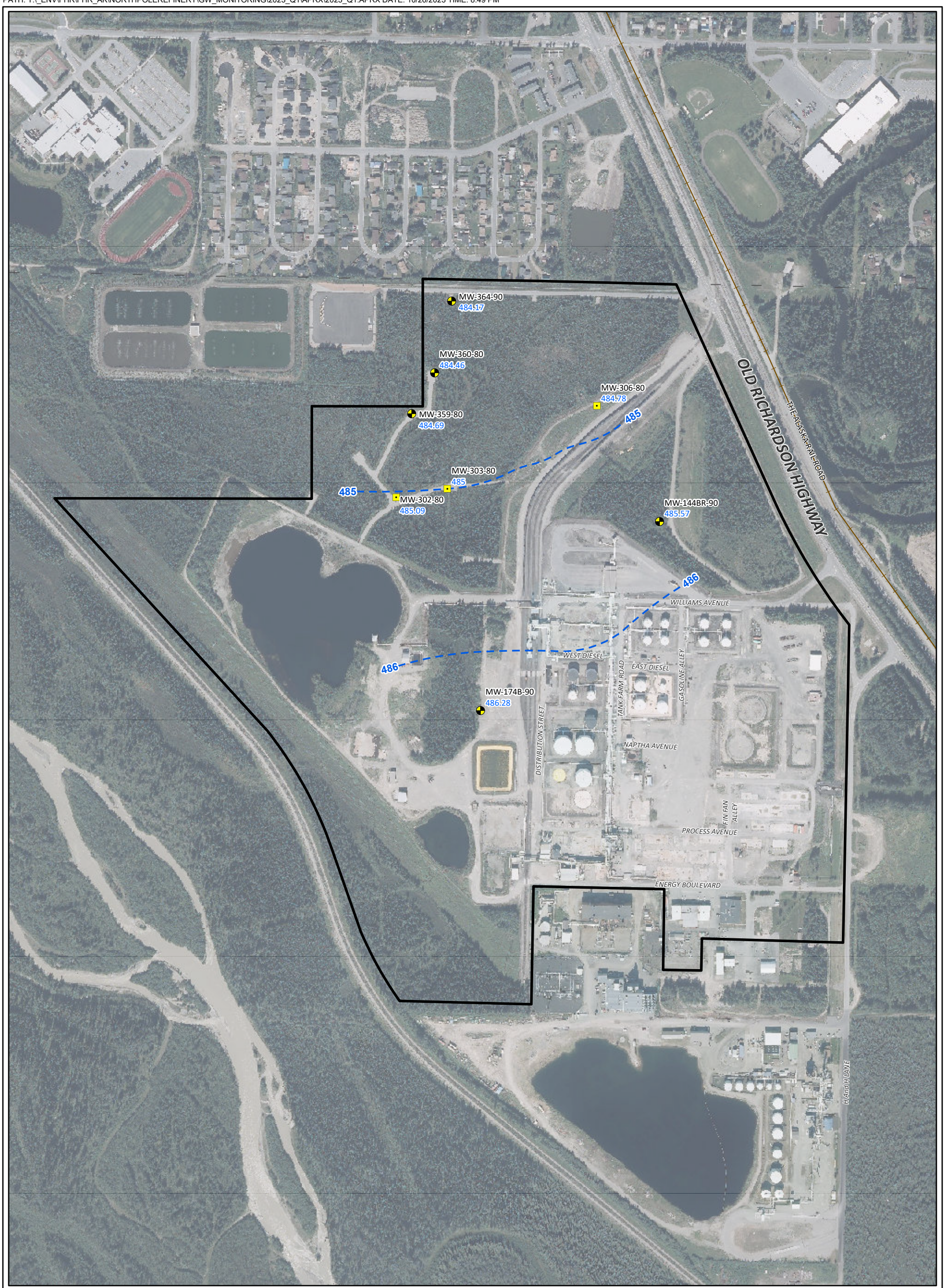
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 GROUNDWATER CONTOUR MAP – ONSITE WELLS 10 TO 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-2

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2023_Q1\APRX\2023_Q1.APRX DATE: 10/26/2023 TIME: 8:49 PM



Legend

- Vertical Profile Transect Well
- Monitoring Well
- Property Boundary
- 486 — Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)

0 500 1,000

SCALE IN FEET

Notes:
- Wells were gauged in August 2023
- Only monitoring wells scheduled for gauging per Table 3-1 of the Long Term Monitoring Plan - 2017 Update are shown on the figure.
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

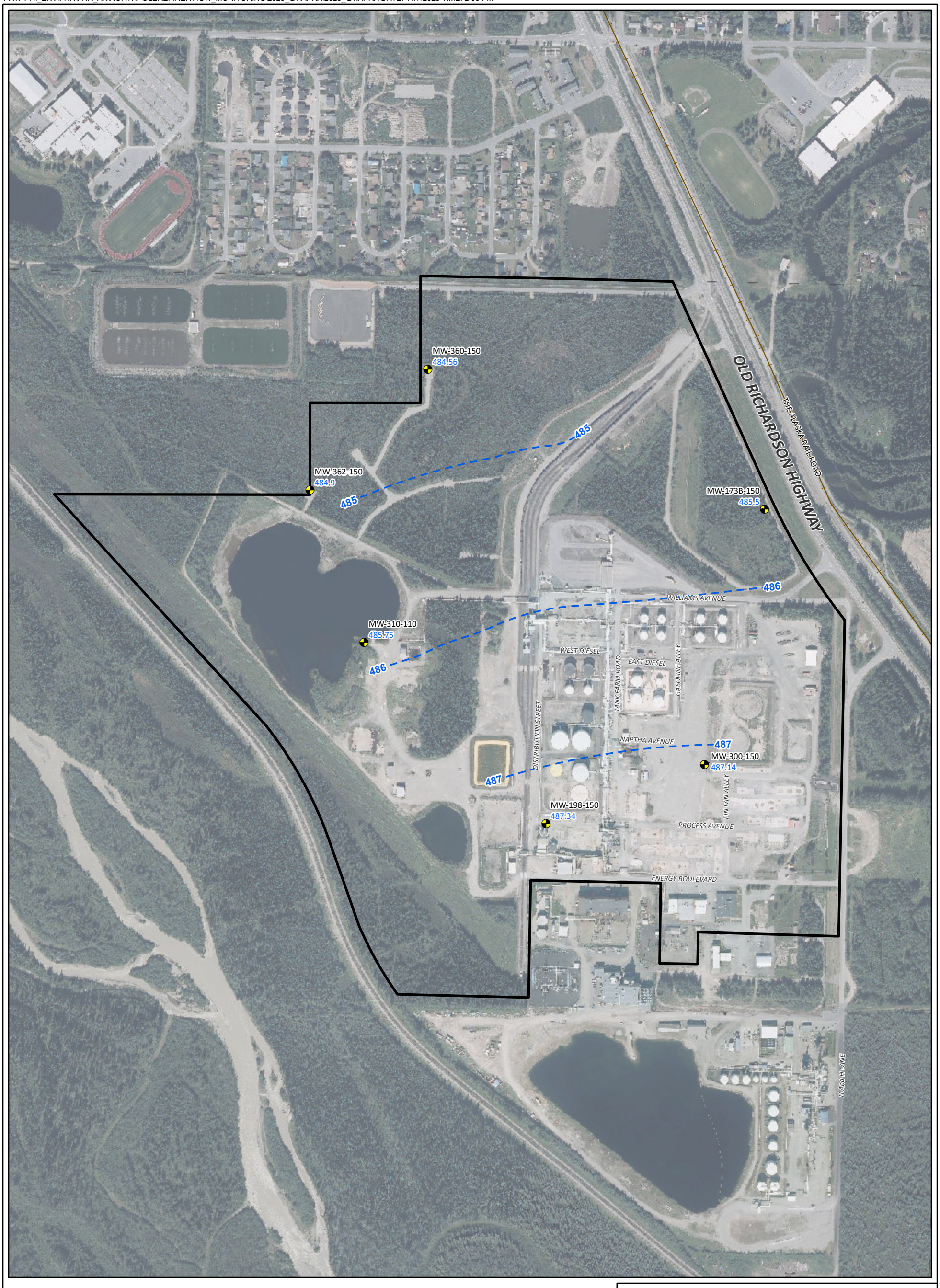
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 GROUNDWATER CONTOUR MAP – ONSITE WELLS 55 TO 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-3

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2023_Q1\APRX\2023_Q1.APRX DATE: 11/7/2023 TIME: 2:08 PM



Legend

Monitoring Well

Property Boundary

485 — Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)

0 500 1,000

SCALE IN FEET

Notes:
- Wells were gauged in August 2023
- Only monitoring wells scheduled for gauging per Table 3-1 of the Long Term Monitoring Plan - 2017 Update are shown on the figure.
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

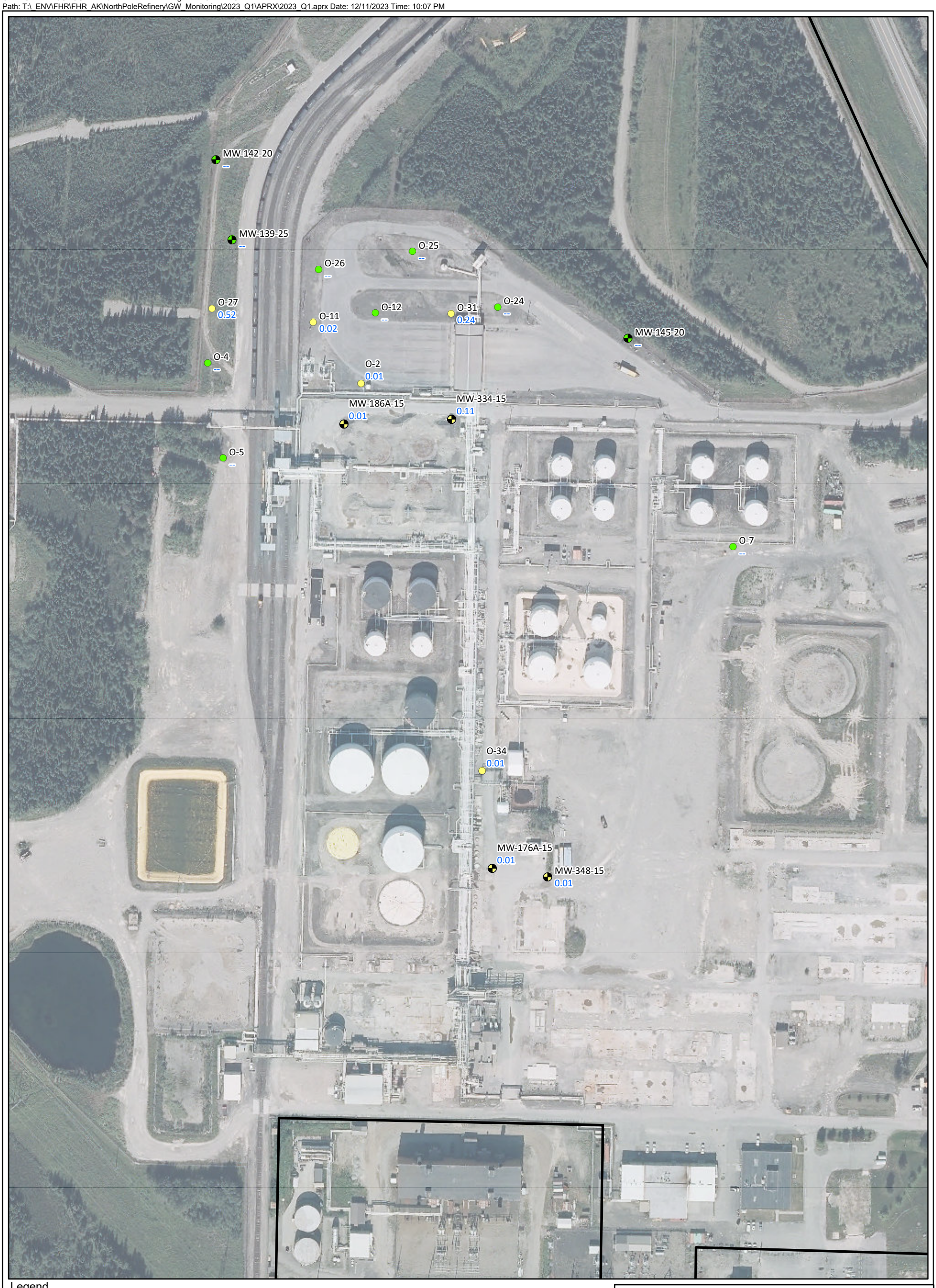
ANNUAL 2023 GROUNDWATER CONTOUR MAP – ONSITE WELLS 90 TO 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE

3-4

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 12/11/2023 Time: 10:07 PM



Legend

No LNAPL or Sheen Observed
- Monitoring Well
- Observation Well
- Recovery Well (Inactive)

LNAPL or Sheen Observed
- Monitoring Well
- Observation Well
- Recovery Well (Inactive)

- Property Boundary
- 0.52 LNAPL Thickness (feet)
- -- No LNAPL measured or sheen observed

0 200 400
SCALE IN FEET

Notes:
- LNAPL = Light Non-Aqueous Phase Liquid.
- LNAPL results posted on figure are in feet.
- The maximum LNAPL thickness for wells gauged as part of the Long Term Monitoring Plan - 2023 Update are shown on the figure.
- Wells with LNAPL or sheen observed during the reporting period are also shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- Annual gauging was conducted in October 2023.

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 LNAPL MONITORING DATA

ARCADIS

FIGURE
3-5

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 10/26/2023 Time: 8:47 PM

MW-360-50	
GRO	<0.0500
DRO	0.491JL*
Dissolved Iron	3.42
Dissolved Manganese	5.01
Sulfate	24.5
Methane	<0.000250

MW-359-35	
GRO	<0.0500
DRO	0.411J
Dissolved Iron	1.07
Dissolved Manganese	6.48
Sulfate	20.5
Methane	0.102

MW-304-CMT-40	
GRO	<0.0500
DRO	0.337J
Dissolved Iron	0.777
Dissolved Manganese	4.40
Sulfate	37.0
Methane	0.293

MW-142-20	
GRO	<0.100B*
DRO	1.03
Dissolved Iron	13.1
Dissolved Manganese	8.31
Sulfate	3.05
Methane	1.68

MW-139-25	
GRO	1.60JH*
DRO	2.90
Dissolved Iron	20.5
Dissolved Manganese	5.46
Sulfate	8.98
Methane	5.90

MW-101A-25	
GRO	<0.0500
DRO	0.420J
Dissolved Iron	0.666
Dissolved Manganese	2.03
Sulfate	37.3
Methane	0.0395

MW-154B-95	
GRO	<0.100B*
DRO	0.981
Dissolved Iron	5.79
Dissolved Manganese	3.90
Sulfate	18.5
Methane	1.73

MW-125-25	
GRO	14.9
DRO	<2.36B*
Dissolved Iron	34.9
Dissolved Manganese	16.7
Sulfate	<0.100
Methane	4.14

MW-303-CMT-39	
GRO	<0.0500
DRO	0.847
Dissolved Iron	1.14
Dissolved Manganese	2.41
Sulfate	34.2
Methane	0.228

MW-130-25	
GRO	3.86
DRO	<3.32B*
Dissolved Iron	27.8
Dissolved Manganese	7.56
Sulfate	6.71
Methane	2.21

MW-348-15	
GRO	0.137
DRO	1.55JL*
Dissolved Iron	8.69
Dissolved Manganese	4.53
Sulfate	5.07
Methane	1.37

MW-336-20	
GRO	52.3
DRO	12.6
Dissolved Iron	29.6
Dissolved Manganese	4.29
Sulfate	<0.100
Methane	13.9

O-15	
GRO	<0.100B*
DRO	<0.588B*
Dissolved Iron	<0.125
Dissolved Manganese	0.197
Sulfate	46.3
Methane	0.0258

MW-192A-15	
GRO	0.156
DRO	<0.300J*
Dissolved Iron	<0.125
Dissolved Manganese	0.0565
Sulfate	41.6
Methane	0.00520

Notes:
- < = Not detected; presented as <LOD (limit of detection). Unless otherwise noted by quality control failures.
- J* = Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon & Wilson, Inc.
- JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.
- J = Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ). Flag applied by laboratory.
- JH* = Estimated concentration, biased high, due to quality control failures. Flag applied by Shannon & Wilson, Inc.
- B* = Result is considered not detected due to quality control failures; see data review checklist for details. Flag applied by Shannon & Wilson, Inc.
- GRO = Gasoline Range Organics.
- DRO = Diesel Range Organics.
- Results in milligrams per liter.
- Only monitoring wells scheduled for sampling per Table 3-6 of the Long Term Monitoring Plan - 2023 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- For locations with duplicate sample results, the highest result is shown.

Legend
- Cluster Well
- Monitoring Well
- Observation Well
- Property Boundary

0 240 480
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

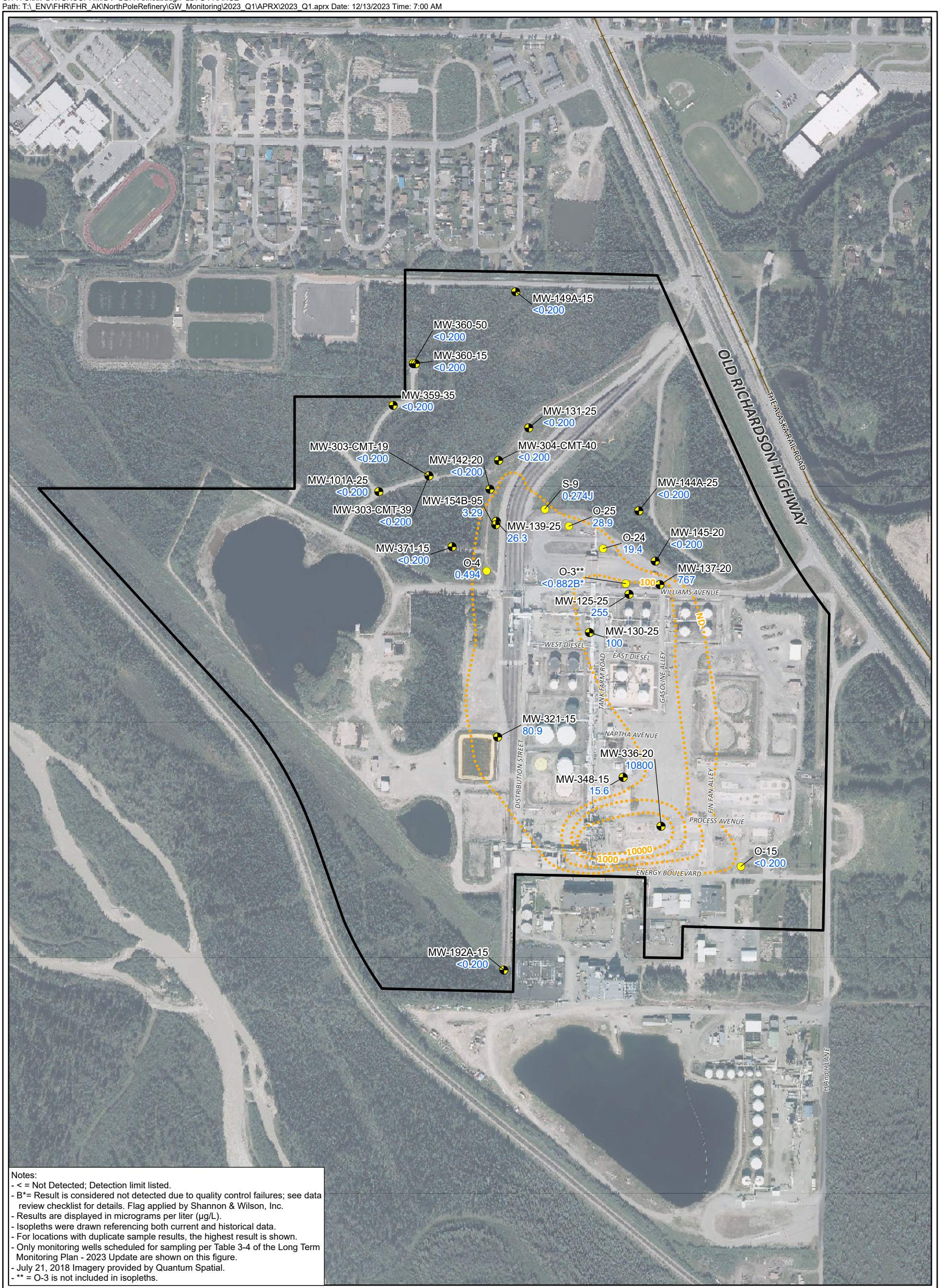
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 NATURAL SOURCE ZONE DEPLETION MONITORING RESULTS

ARCADIS

FIGURE
3-6

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 12/13/2023 Time: 7:00 AM



Notes:
- < = Not Detected; Detection limit listed.
- B*= Result is considered not detected due to quality control failures; see data review checklist for details. Flag applied by Shannon & Wilson, Inc.
- Results are displayed in micrograms per liter (µg/L).
- Isopleths were drawn referencing both current and historical data.
- For locations with duplicate sample results, the highest result is shown.
- Only monitoring wells scheduled for sampling per Table 3-4 of the Long Term Monitoring Plan - 2023 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- ** = O-3 is not included in isopleths.

Legend:

- Monitoring Well
- Observation Well
- Property Boundary

0 500 1,000
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

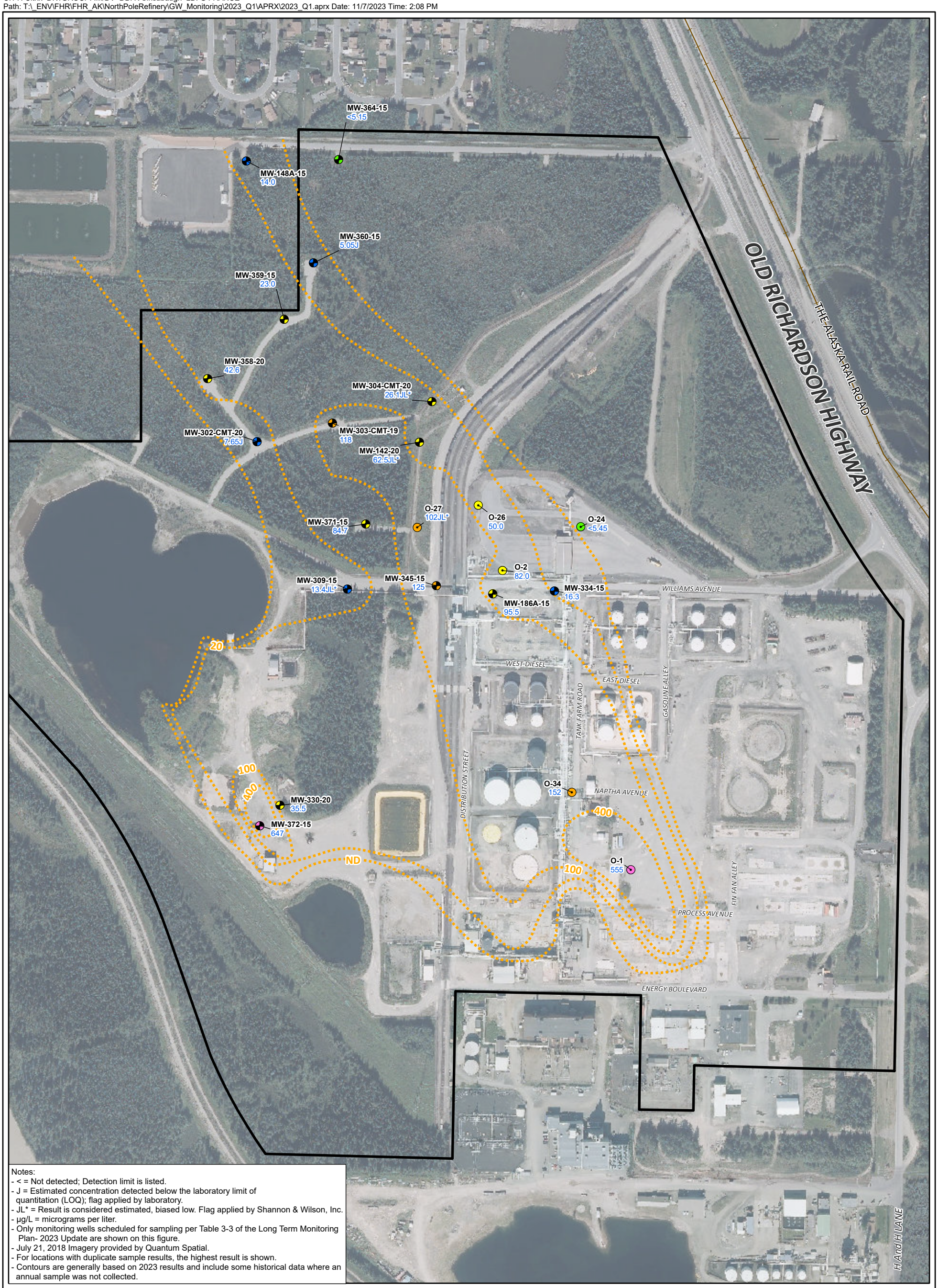
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 ONSITE BENZENE GROUNDWATER ANALYTICAL RESULTS

ARCADIS

FIGURE
3-7

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 11/7/2023 Time: 2:08 PM



Notes:
- < = Not detected; Detection limit is listed.
- J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
- JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.
- µg/L = micrograms per liter.
- Only monitoring wells scheduled for sampling per Table 3-3 of the Long Term Monitoring Plan- 2023 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- For locations with duplicate sample results, the highest result is shown.
- Contours are generally based on 2023 results and include some historical data where an annual sample was not collected.

Legend
- Monitoring Well
- Observation Well
- Property Boundary
- Approximate Sulfolane Isopleth in µg/L

Sulfolane Results
- Not Detected
- 3.14 - < 20 µg/L
- 20 - < 100 µg/L
- 100 - < 400 µg/L
- >400 µg/L

0 350 700
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

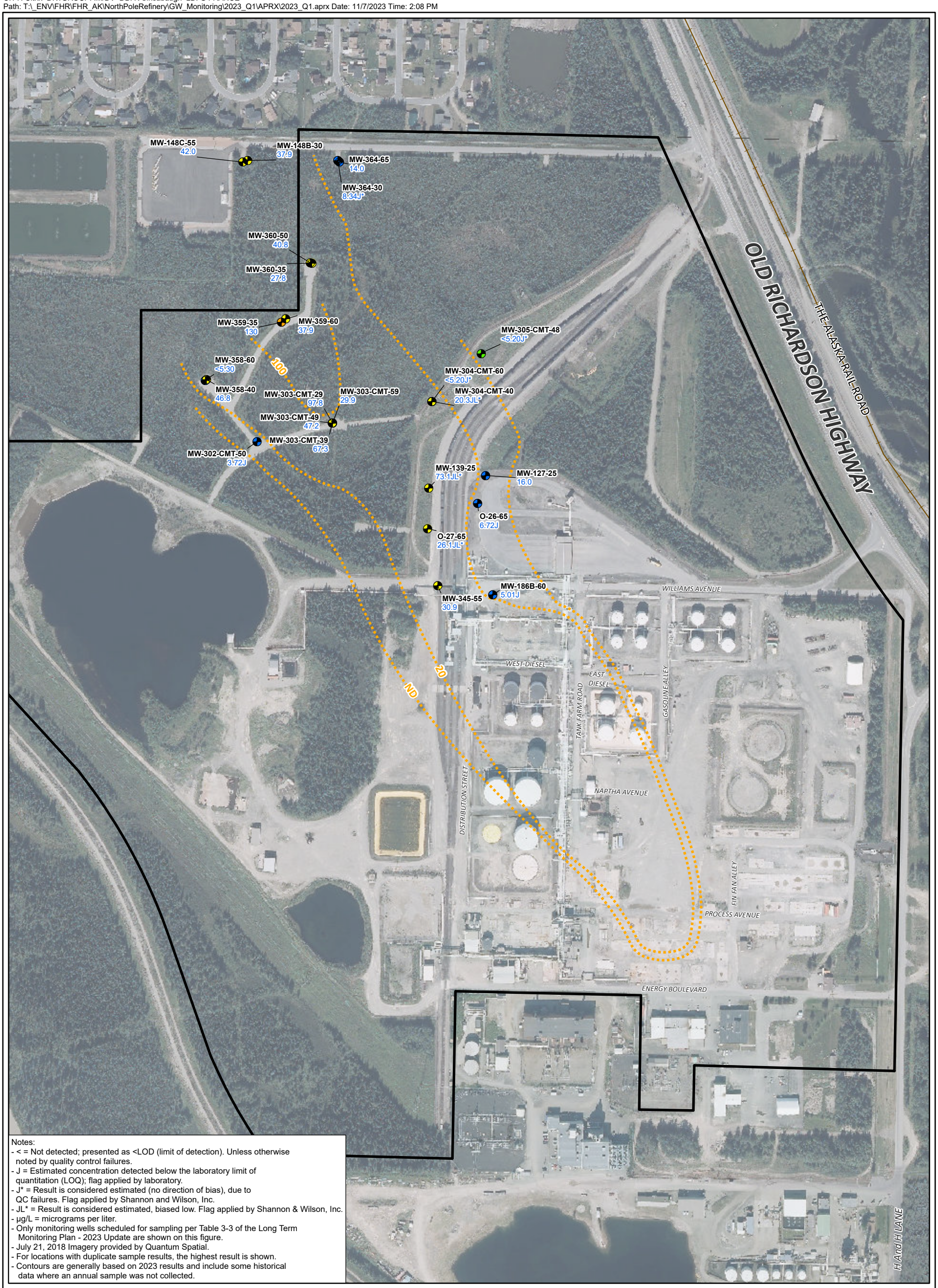
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

2023 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS WATER TABLE

ARCADIS

FIGURE
3-8

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 11/7/2023 Time: 2:08 PM



Notes:
- < = Not detected; presented as <LOD (limit of detection). Unless otherwise noted by quality control failures.
- J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
- J* = Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon and Wilson, Inc.
- JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.
- µg/L = micrograms per liter.
- Only monitoring wells scheduled for sampling per Table 3-3 of the Long Term Monitoring Plan - 2023 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- For locations with duplicate sample results, the highest result is shown.
- Contours are generally based on 2023 results and include some historical data where an annual sample was not collected.

Legend
- Monitoring Well
- Observation Well
- Property Boundary
- Approximate Sulfolane Isopleth in µg/L

Sulfolane Results
- Not Detected
- 3.14 - < 20 µg/L
- 20 - < 100 µg/L
- 100 - < 400 µg/L
- >400 µg/L

0 350 700
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 10 TO 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-9

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2023_Q1\APRX\2023_Q1.aprx Date: 11/7/2023 Time: 2:07 PM

Notes:
- < = Not detected; presented as <LOD (limit of detection). Unless otherwise noted by quality control failures.
- J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
- J*= Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon & Wilson, Inc.
- µg/L = micrograms per liter.
- JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.
- Only monitoring wells scheduled for sampling per Table 3-3 of the Long Term Monitoring Plan - 2023 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial.
- For locations with duplicate sample results, the highest result is shown.
- Contours are generally based on 2023 results and include some historical data where an annual sample was not collected.

Legend
- Monitoring Well
- Approximate Sulfolane Isopleth in µg/L
- Property Boundary

Sulfolane Results
- Not Detected
- 3.14 - < 20 µg/L
- 20 - < 100 µg/L
- 100 - < 400 µg/L
- >400 µg/L

0 350 700
SCALE IN FEET

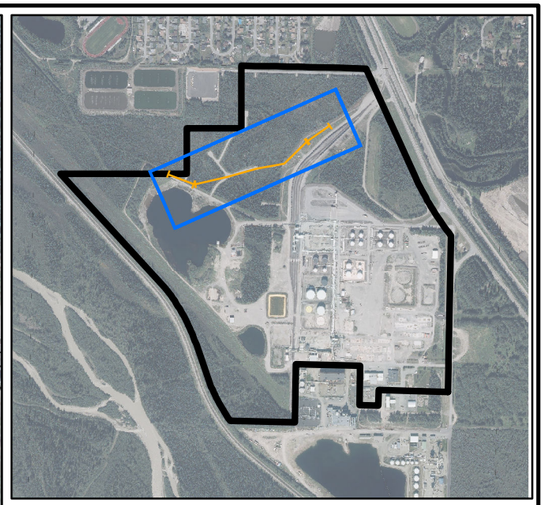
NORTH POLE TERMINAL, NORTH POLE, ALASKA

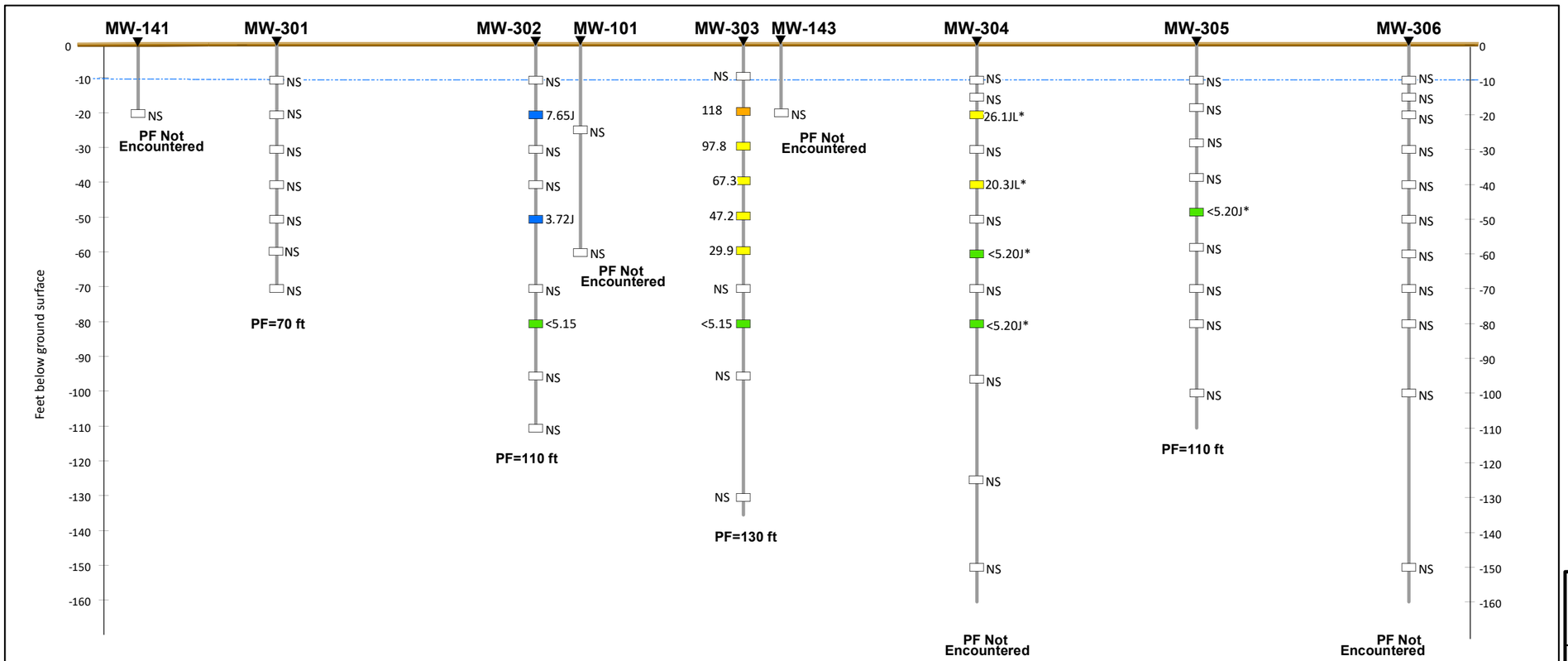
ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 55 TO 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-10





Legend:

Sulfolane Results

- Not Detected
- 3.72 - < 20 µg/L
- 20 - < 100 µg/L
- 100 - < 400 µg/L
- Ground Surface
- Approximate Groundwater Surface
- Well Profile

NOTES:
J* = Result is considered estimated (no direction of bias), due to QC failures. Flag applied by Shannon & Wilson, Inc.
JL* = Result is considered estimated, biased low. Flag applied by Shannon & Wilson, Inc.
J = Estimated concentration detected below the laboratory limit of quantitation (LOQ). Flag applied by laboratory.
NS = Not sampled per Long-Term Monitoring Plan (LTM)
PF= Permafrost encountered at bottom of boring.
ft = feet
µg/L = micrograms per liter
< = Not detected; limit of detection (LOD) listed.
- For locations with duplicate sample results, the highest value is shown
- July 21, 2018 Imagery provided by Quantum Spatial
- Profile has a vertical exaggeration of 5x

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2023 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2023 SULFOLANE AT THE VERTICAL PROFILING TRANSECT

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FIGURE 3-11