Mr. James Fish
Alaska Department of Environmental Conservation
610 University Avenue
Fairbanks, Alaska 99709

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December 13, 2021

RE: Annual 2021 Onsite Groundwater Monitoring Report
North Pole Terminal
North Pole, Alaska
ADEC File Number: 100.38.090

Dear Mr. Fish,

On behalf of Flint Hills Resources Alaska, LLC, attached please find the Annual 2021 Onsite Groundwater Monitoring Report. In accordance with the revised corrective action plan, wells were evaluated for potential decommissioning. Wells included in the table on the following page are not included in the Long-Term Monitoring Plan and are intended to be decommissioned in 2022.

If you have any questions, please contact David Smith at (316) 828-8496 or at david.smith8@gapac.com.

Sincerely,
Arcadis U.S., Inc.

Rebecca K. Andresen
Sr. Vice President

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Direct Line: 206.724.2363
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CC. David Smith - FHRA

Wells to be Decommissioned		
DR-1	MW-354-65	SG-04
DR-2	O-14	SG-05
DR-3	O-16	SG-06
DR-4	O-35	TMW-1
IW-2	O-36	TMW-2
IW-3	O-37	TMW-3
MW-102-70	O-38	TMW-4
MW-106-25	PZ-1-15	TMW-5
MW-109-15	PZ-1-20	TMW-6
MW-110-65	PZ-1-45	TMW-7
MW-118-45	PZ-1-65	TMW-8
MW-124-25	PZ-2-15	
MW-129-40	PZ-3-15	
MW-132-20	PZ-4-13	
MW-133-20	PZ-4-20	
MW-134-20	PZ-4-45	
MW-142-150	PZ-4-65	
MW-146A-15	PZ-5-15	
MW-146B-30	PZ-5-20	
MW-175-90	PZ-5-45	
MW-176C-90	PZ-5-65	
MW-179C-90	R-3	
MW-179D-135	R-5	
MW-180B-50	R-14	
MW-180C-90	R-32	
MW-309-150	SG-01	
MW-331-150	SG-02	
MW-336-55	SG-03	

Flint Hill Resources Alaska, LLC

Annual 2021 Onsite Groundwater Monitoring Report

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Prepared By:
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Prepared For:
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30066004.00001

James K. O'Connell
Environmental Engineer

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Senior Vice President

Contents

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Appendices

Acronyms and Abbreviations

2017 LTM Plan	Long-Term Monitoring Plan – 2017 Update
2020 LTM Plan	Long-Term Monitoring Plan – 2020 Update
2021 LTM Plan	Long-Term Monitoring Plan – 2021 Update
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
LNAPL	light nonaqueous phase liquid
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 2021 Onsite Groundwater Monitoring Report
reporting period	first and third quarters of 2021
ROCP	Revised Onsite Cleanup Plan
site	North Pole Terminal, located on H and H Lane in North Pole, Alaska
VPT	vertical profile transect
µg/L	microgram per liter

1 Introduction

Arcadis U.S., Inc. (Arcadis) prepared this Annual 2021 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 first and third quarters of 2021 (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 Plan – 2017 Update (2017 LTM Plan), provided as Appendix A to the Revised Onsite Cleanup Plan (ROCP; Arcadis 2017b), the Long-Term Monitoring Plan – 2020 Update (2020 LTM Plan; Arcadis 2020a, 2020b) and the one-time additions in the Long-Term Monitoring Plan – 2021 Update (2021 LTM Plan [Arcadis, 2021]). 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]).
- 2020 LTM Plan (provided as emails dated March 2 and July 9, 2020 [Arcadis 2020a, 2020b]).
- 2021 LTM Plan (approved in an email from ADEC dated July 19, 2021 [Arcadis 2021]).

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 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), the 2020 LTM Plan (Arcadis 2020a, 2020b), and the 2021 LTM Plan (Arcadis 2021):

- Groundwater elevation measurements
- Light nonaqueous phase liquid (LNAPL) migration monitoring
- Groundwater sampling and analysis of sulfolane
- Groundwater sampling and analysis of 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 of 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), the 2020 LTM Plan (Arcadis 2020a, 2020b) and the 2021 LTM Plan (Arcadis 2021) were noted during the reporting period:

- Monitoring wells MW-198-150 and MW-336-20 were frozen during the first planned groundwater elevation monitoring event; therefore, a depth to water measurement was not collected from these wells during the first semiannual monitoring event.

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 during the reporting period on March 4 and 5, and September 13, 2021. 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 3-8). 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 well field parameters for the reporting period are presented in Table 3-1. Groundwater elevations for the reporting period, as well as surface water elevations and depth to LNAPL, are presented in Tables 3-2a and 3-2b. 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 2020 LTM Plan (Arcadis 2017b, 2020a, 2020b). Additionally, LNAPL was gauged throughout the reporting period during monitoring events at wells outside of the LNAPL migration networks. Comprehensive LNAPL gauging data are provided in Appendix E.

3.2.1 Light Nonaqueous Phase Liquid Extent

Per the 2017 LTM Plan (Arcadis 2017b), 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 and O-27. Results are presented in Table 3-3. Figure 3-9 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 the following monitoring events throughout the reporting period: groundwater elevation monitoring, and groundwater sampling and field parameter collection. 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

Considering the 2019 and 2020 sampling results, ADEC requested and FHRA agreed to a one-time expanded network of 19 monitoring wells to further evaluate the occurrence of ongoing natural source zone depletion (NSZD) at the site. The expanded sampling network, which includes wells MW-139-25, MW-142-65, MW-154B-95, MW-186-60, MW-303-19, MW-303-39, MW-336-55, MW-359-15, and MW-359-35, includes wells designed to capture groundwater samples from deeper intervals and more downgradient locations. The additions were included to address concerns following the shutdown of the GRTS and perceived migration of dissolved-phase petroleum-related COCs. Sample locations are defined in the 2017 LTM Plan (Arcadis 2017b), and the one-time additions agreed to in the July 19, 2021, email from ADEC (2021 LTM Plan, Arcadis 2021). Additionally, some wells were removed from the sampling program (MW-116-15, MW-135-20, MW-145-20, MW-180A-15, MW-321-15, and MW-369-16) because results from prior events were deemed stable and removal from the program would present minimal disruption to the conceptual site model or NSZD findings overall. LNAPL was not present in any of the NSZD monitoring wells at the time of sampling. Field parameters, including dissolved oxygen, from the 19 monitoring wells where samples were collected are presented in Table 3-1. Natural attenuation parameters (including iron, manganese, sulfate, and methane), GRO, and DRO are presented in Table 3-4 and shown on Figure 3-10.

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 appear to have reached background conditions in the most downgradient wells due to distance from the source zone. Similarly, results from the addition of sampling at the deep interval wells indicate 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. The NSZD process continue to be effective in mitigating off-site migration risk of hydrocarbons and are effectively remediating the residual hydrocarbons remaining in the study area as predicted.

3.3 Monitoring Well Sampling

Petroleum analyte sample locations are defined in the 2017 LTM Plan (Arcadis 2017b), the 2020 LTM Plan (2020a, 2020b), and the 2021 LTM Plan (Arcadis 2021). Monitoring wells included in these plans were sampled for BTEX, GRO, and DRO. Results are presented in Tables 3-5a and 3-5b. Figures 3-11 and 3-12 show analytical results for benzene.

Analyses for sulfolane were completed on groundwater samples collected from the wells identified in the 2017 LTM Plan (Arcadis 2017b), 2020 LTM Plan (Arcadis 2020a, 2020b), and 2021 LTM Plan (Arcadis 2021). Sulfolane analytical results are presented in Tables 3-6a and 3-6b and shown on Figures 3-13 through 3-19.

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.

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, and Figures F-1, F-2, and F-3, F-4, F-5, and F-6) and presented in the table below.

Parameter Trend	Third Quarter	
	Benzene	Sulfolane
Number of wells	34	73
All results nondetect[1]	11	6
Insufficient data points[1]	2	0
Probably decreasing	0	2
Decreasing	4	27
Probably increasing	2	3
Increasing	3	9
Stable	2	9
No trend	10	17

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 or probably increasing benzene concentration trend in wells MW-130-25, MW-154B-95, MW-321-15, O-4, and O-24 during the reporting period, as seen on the benzene time series plots provided in Appendix F, Attachment F-1.

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 probably increasing in this well, concentrations consistently decreased from 2015 to 2018 with a partial rebound starting in 2019, and current concentrations are less than historical levels observed in this well. MW-154B-95 is within the detectable benzene plume at the site. The analysis indicates a trend that is probably increasing in this well; however, recent concentrations have fluctuated between detectable and non-detectable. The results in 2021 indicated a low-level detection (2.09 µg/L), which is less than the maximum concentration observed in this well. MW-321-15 is located within the detectable benzene plume at the site at the western extent and has exhibited seasonal variation since 2016. The analysis indicates a trend that is probably increasing in this well; however, the concentration measured in 2021 is within the fluctuation range observed from 2016 through 2019. The trend graphs show that concentrations in this well have been generally decreasing since 2016. Wells O-4 and O-24 are within the detectable benzene plume at the site, near the downgradient extent. The results at O-4 appear to have stabilized and are less than the maximum detected concentration of 86.0 µg/L in July 2018. The results at O-24 have indicated seasonal variation and are less than historical maximums; concentrations in this well have been generally stable since 2019.

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 during this reporting period are water table wells near the former source areas. 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 sampling results indicates that the majority of onsite wells exhibit decreasing or probably decreasing trends. In particular, concentrations in well S-51, located along the main plume axis upgradient of the former recovery wells, has dropped to less than 400 µg/L, supporting the goal of meeting the cleanup objective for sulfolane. Wells with current concentrations exceeding 400 µg/L are MW-176A-15, MW-336-20, MW-372-15, and O-1, which are source area wells more than 1,500 feet upgradient of the POC. These wells have overall decreasing or probably decreasing concentration trends.

Most of the onsite wells exhibiting an increasing sulfolane concentration trend during the reporting period are located adjacent to or downgradient from the recovery wells associated with the former treatment systems (MW-186A-15, MW-345-15, MW-345-55, MW-345-75, MW-371-15, O-2, O-26-65, O-27, and O-27-65). Monitoring wells MW-304-80, MW-304-96, and MW-359-80 also exhibited increasing trends but are further downgradient from the former treatment systems. The concentrations detected in MW-304-80 and MW-304-96 were both less than the concentrations detected in these wells in 2020. The concentration detected in the sample collected from MW-359-80 (80.8 µg/L) increased from the 2020 concentration, but 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. There are no probably increasing or increasing trends in the 90- to 160-foot zone wells.

In addition to these Mann-Kendall trend analysis results, other wells located within and downgradient from the former recovery wells exhibit increases in concentration following GRTS shutdown, but not an overall increasing or probably increasing trend based on all data from a given well. 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 3-16, 3-17, and 3-18, 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 highest sulfolane concentration in any well in this area during the reporting period was 249 µg/L (MW-186A-15; Table 3-6a), which is less than the highest concentration measured in 2020. All wells now exhibit stabilized 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 highest sulfolane concentration in any well in this area during the reporting period was 291 µg/L (O-27; Table 3-6b), which is less than the highest concentration measured in 2020. All wells in this area that were sampled multiple times since GRTS shutdown exhibit stabilized concentrations following the shutdown (MW-127-25, MW-139-25, MW-142-20, MW-154B-95, MW-371-15, MW-371-55, O-26, O-26-65, O-27, O-27-65).
- *Wells in the VPT.* The highest sulfolane concentration in any well in this area during the reporting period was 226 µg/L (MW-303-CMT-19; Table 3-6b), which is less than the highest concentration measured in 2020. All wells in this group that were sampled multiple times since GRTS shutdown exhibit 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-304-CMT-20, MW-304-CMT-40, MW-304-CMT-60, MW-304-96, MW-305-CMT-28, and MW-305-CMT-48).
- *Wells in and downgradient of the POC.* The highest sulfolane concentration in any well in this area during the reporting period was 231 µg/L (MW-359-35; Table 3-6b), which is less than the highest concentration measured in 2020. Of the wells in this group sampled during the reporting period, all but three wells exhibited stabilized or stabilizing concentrations since GRTS shutdown. Of these three wells, one of these wells exhibits an increasing trend with possible signs of stabilization (MW-359-15). Wells MW-359-80 and MW-359-150 show increasing trends with sulfolane concentrations significantly below 400 µg/L (80.8 and 10.8 µg/L, respectively).

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

[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.

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.

3.5 Nonroutine Activities

No nonroutine activities were conducted during the reporting period.

4 Conclusions

Groundwater monitoring and sampling events were conducted during the reporting period in accordance with the Onsite RSAP (Arcadis 2017a), 2017 LTM Plan (Arcadis 2017b), the 2020 LTM Plan (Arcadis 2020a, 2020b) and the 2021 LTM Plan (Arcadis 2021).

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:

- Groundwater monitoring data collected during the reporting period are within expected ranges and support the cleanup objective presented in the ROCP (Arcadis 2017b).
- Sulfolane concentrations in the source areas are decreasing in most cases. Increases in sulfolane and benzene concentrations were noted in only a limited number of wells downgradient of the former treatment systems. These concentration increases were expected, and the results of trend analysis support the cleanup objectives presented in the ROCP (Arcadis 2017b).
- The statistical analyses included in Appendix F show that sulfolane concentrations in 23 wells and benzene concentrations in three wells across the plume are decreasing or probably decreasing, while sulfolane concentrations in 12 wells and benzene concentrations in five wells across the plume are increasing or probably increasing. Sulfolane concentrations in nine wells and benzene concentrations in two wells across the plume are stable.
- 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 current nature and extent of the COCs is supportive of the cleanup objectives. Short-term modifications were made to the monitoring networks in 2020 and 2021. Based on the results of the groundwater samples collected in 2020 and 2021, continuation of these modifications is not warranted. The 2022 sampling network will revert to the network identified in the ROCP, minus wells that have previously been identified as no longer required.

5 References

Arcadis. 2013. Onsite Site Characterization Report – 2013 Addendum. North Pole Terminal, North Pole, Alaska. DEC File No. 100.38.090. December 20.

Arcadis. 2017a. Second Semiannual 2016 Onsite Groundwater Monitoring Report. North Pole Terminal, North Pole, Alaska. DEC File No. 100.38.090. January.

Arcadis. 2017b. Revised Onsite Cleanup Plan. North Pole Terminal, North Pole, Alaska. DEC File No. 100.38.090. February.

Arcadis. 2020a. Email from David A. Smith (Global Remediation & Environmental Services, LLC) to James T. Fish (Alaska Department of Environmental Conservation) re: 2020 onsite monitoring recommendations for FHR. March 2.

Arcadis. 2020b. Email from David A. Smith (Global Remediation & Environmental Services, LLC) to James T. Fish (Alaska Department of Environmental Conservation) re: Onsite well updates. July 9.

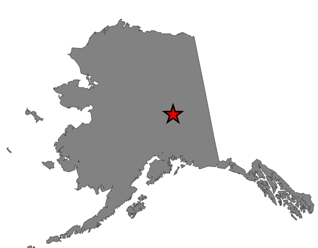
Arcadis. 2021. Email from James T. Fish (Alaska Department of Environmental Conservation) to David A. Smith (Koch) Re: Onsite wells follow-up. July 19.

Figures

LEGEND:

PROPERTY BOUNDARY

GRAPHIC SCALE: 0 – 0.5 Miles



Note:
May 2015 ESRI Cloud Imagery

NORTH POLE TERMINAL, NORTH POLE, ALASKA

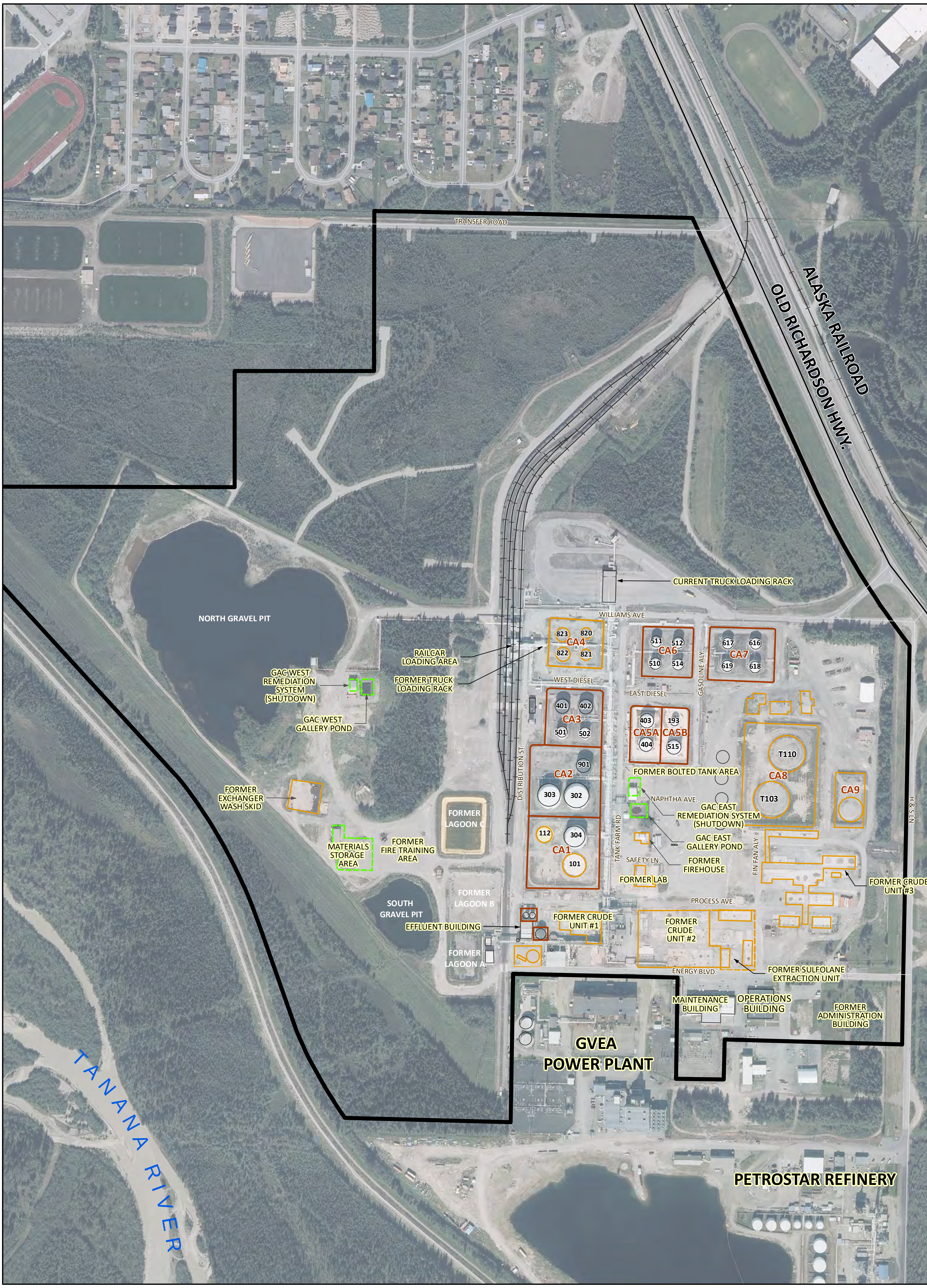
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

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\2021_Q1\MXD\Second_Semiannual_Onsite\Fig 1-1 SiteLocation.mxd Date: 6/8/2021 Time: 1:22:34 PM



Legend

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

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

0 400 800
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

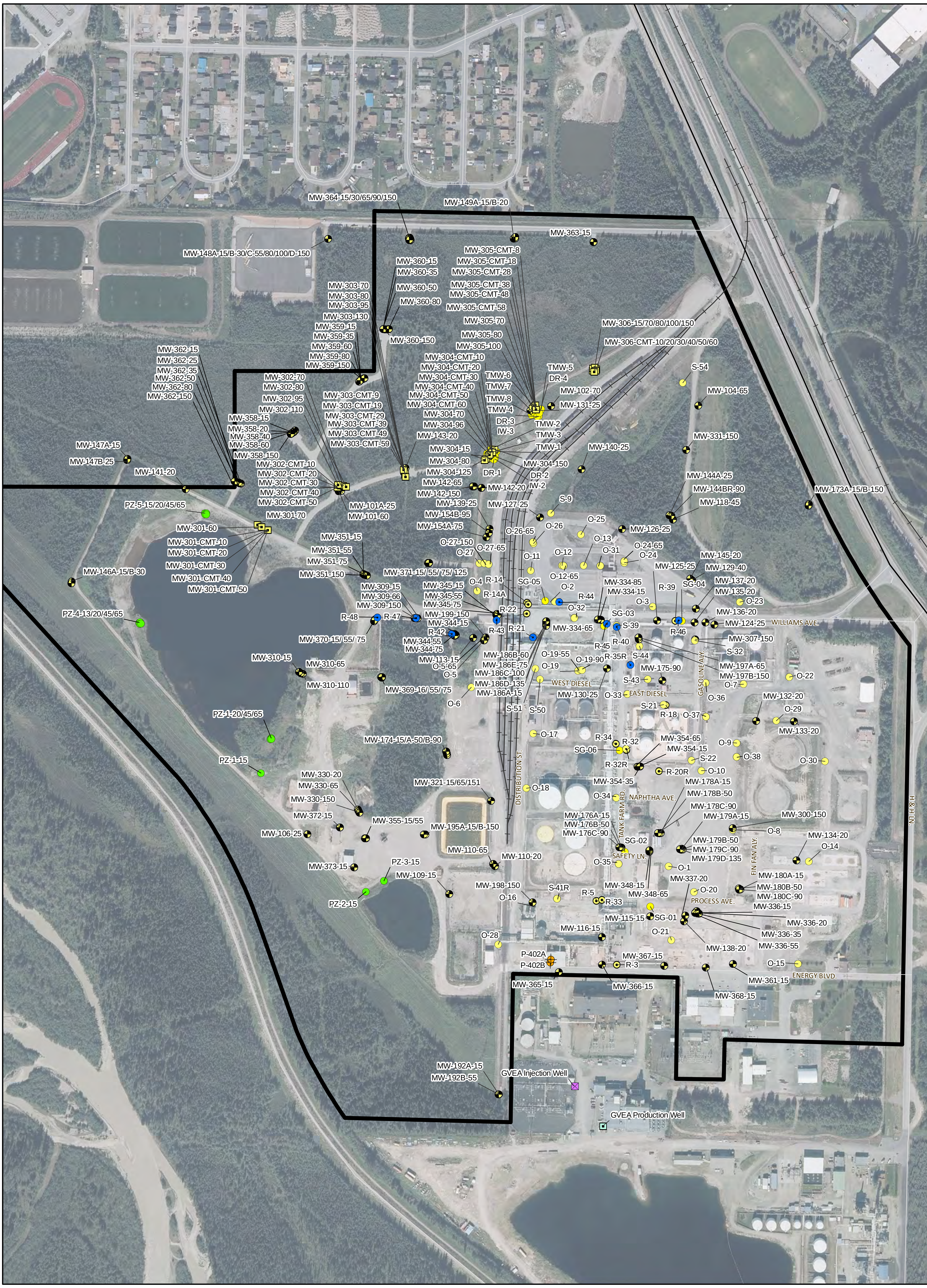
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

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\2021_Q1\MXD\Second_Semiannual_Onsite\Fig 1-3 SitePlan_Onsite.mxd Date: 6/8/2021 Time: 1:30:53 PM



Legend

- Monitoring Well
- Observation Well
- Vertical Profile Transect Well
- Recovery Well (Former)
- Recovery Wells (Inactive)
- Piezometer
- 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 Electrical Authority
- July 21, 2018 Imagery provided by Quantum Spatial

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SITE PLAN - ONSITE

ARCADIS

FIGURE

1-3

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-1 1Q20 GW_Contours-OnSite_WaterTable.mxd Date: 11/18/2021 Time: 9:28:00 AM

Legend

- Monitoring Well
- Observation Well
- Surface Water
- Property Boundary
- 486 Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)
- -- Not gauged due to well obstruction

0 500 1,000
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

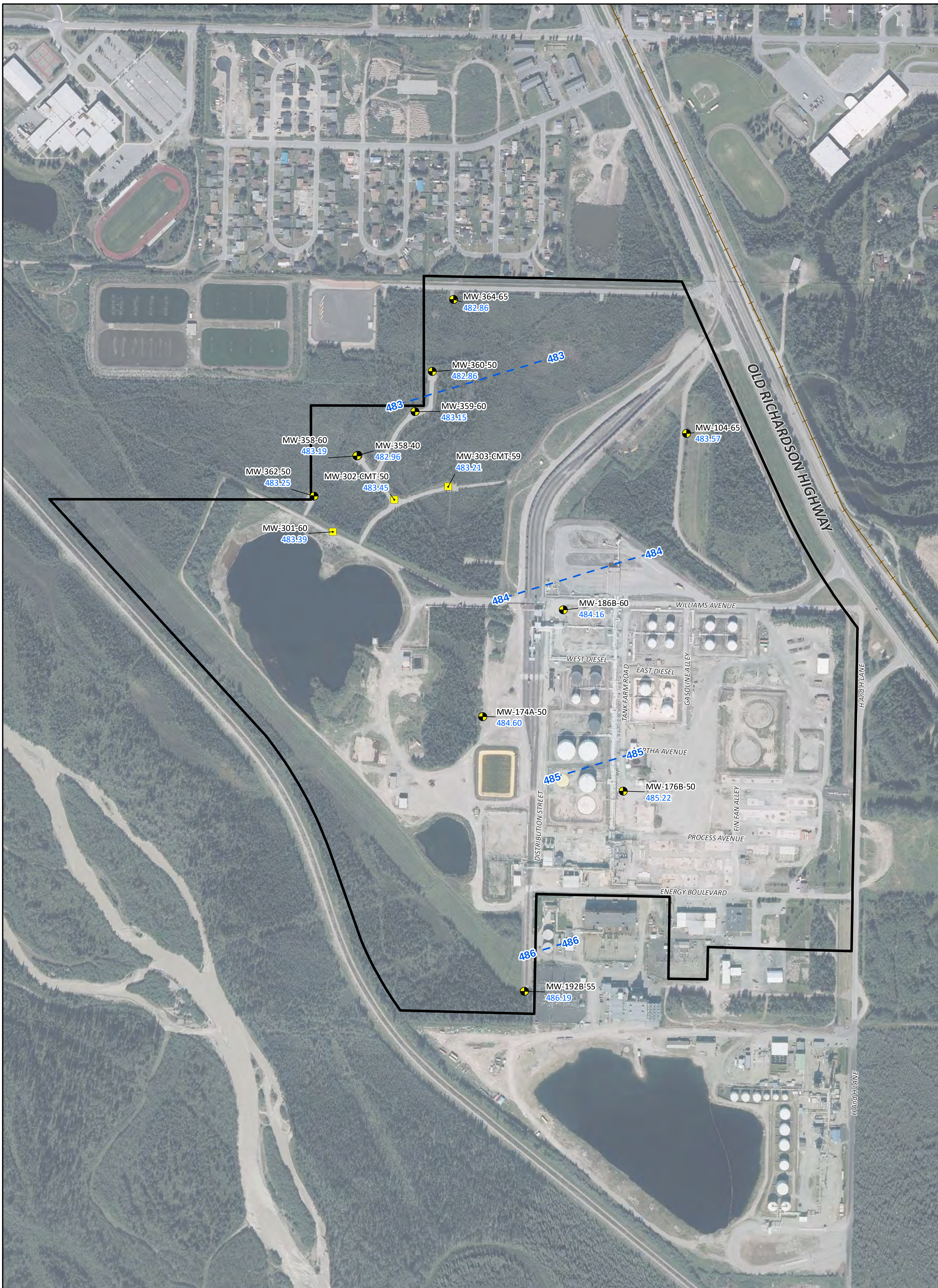
FIRST SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS AT WATER TABLE

ARCADIS

FIGURE
3-1

Notes:
- Wells were gauged in April 2021
- 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

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-2 1Q20 GW_Contours-OnSite_10-55ft.mxd Date: 11/18/2021 Time: 9:44:11 AM



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 April 2021
- 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 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 10 TO 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE

3-2

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-3 1Q20 GW_Contours-55-90ft.mxd Date: 11/18/2021 Time: 9:55:56 AM

Legend

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

0 500 1,000
SCALE IN FEET

Notes:
- Wells were gauged in April 2021
- 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 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 55 TO 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-3

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-4 1Q20 GW_Contours-90-160ft.mxd Date: 11/18/2021 Time: 9:58:28 AM

Legend

- Monitoring Well
- Property Boundary
- 484 Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)
- - - Not gauged due to well obstruction

0 500 1,000
SCALE IN FEET

Notes:
- Wells were gauged in April 2021
- 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 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 90 TO 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-4

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2021_Q3\MXD\FIG 3-5 3Q20 GW_CONTOURS-ONSITE_WATERTABLE.MXD DATE: 11/18/2021 TIME: 10:00:10 AM

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 September 2021
-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 2021 ONSITE GROUNDWATER MONITORING REPORT

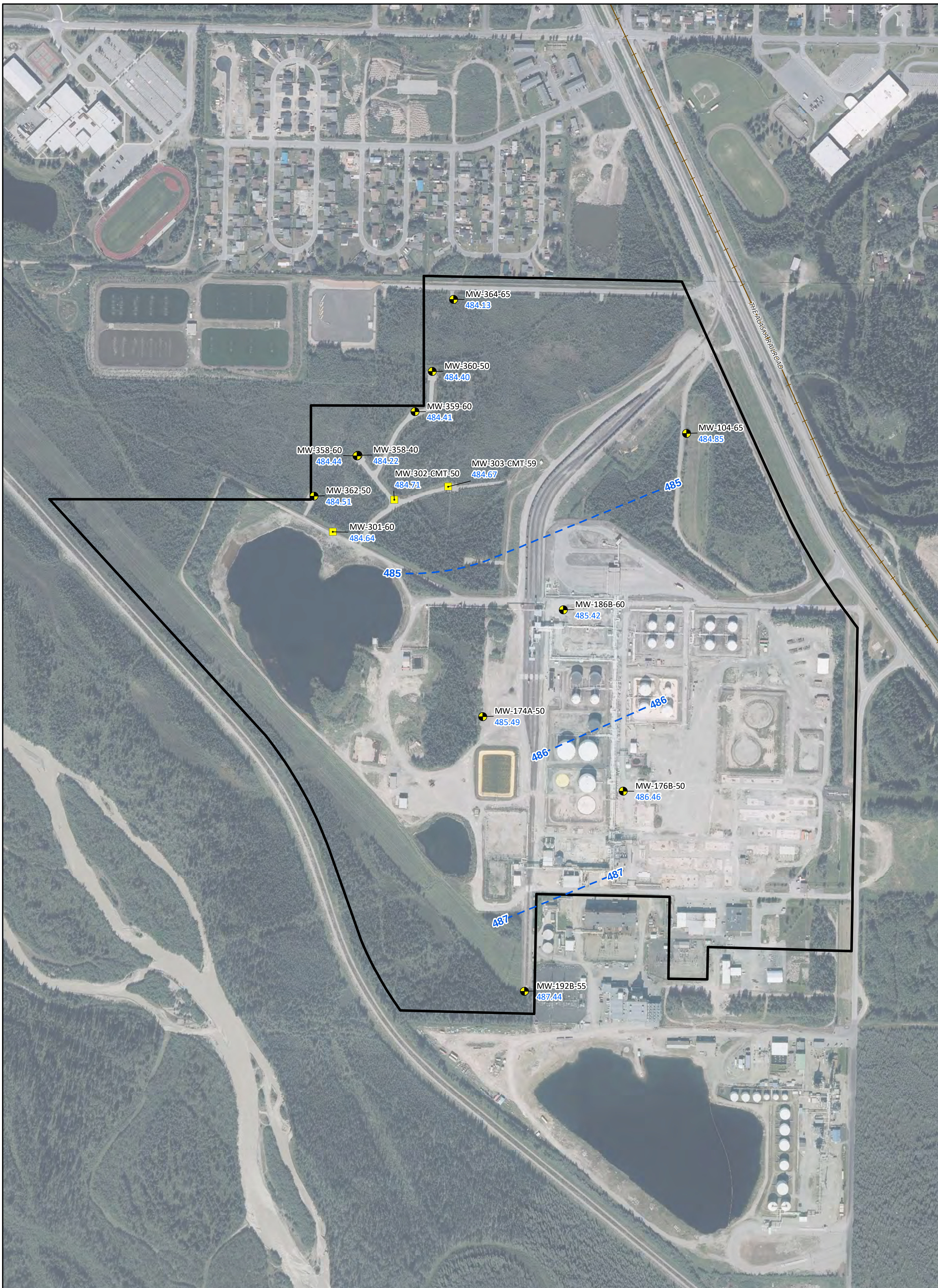
SECOND SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS AT WATER TABLE

ARCADIS

FIGURE

3-5

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2021_Q3\MXD\FIG 3-6 3Q20 GW_CONTOURS-ONSITE_10-55FT.MXD DATE: 11/18/2021 TIME: 10:01:48 AM



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

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 10 TO 55 FEET BELOW WATER TABLE

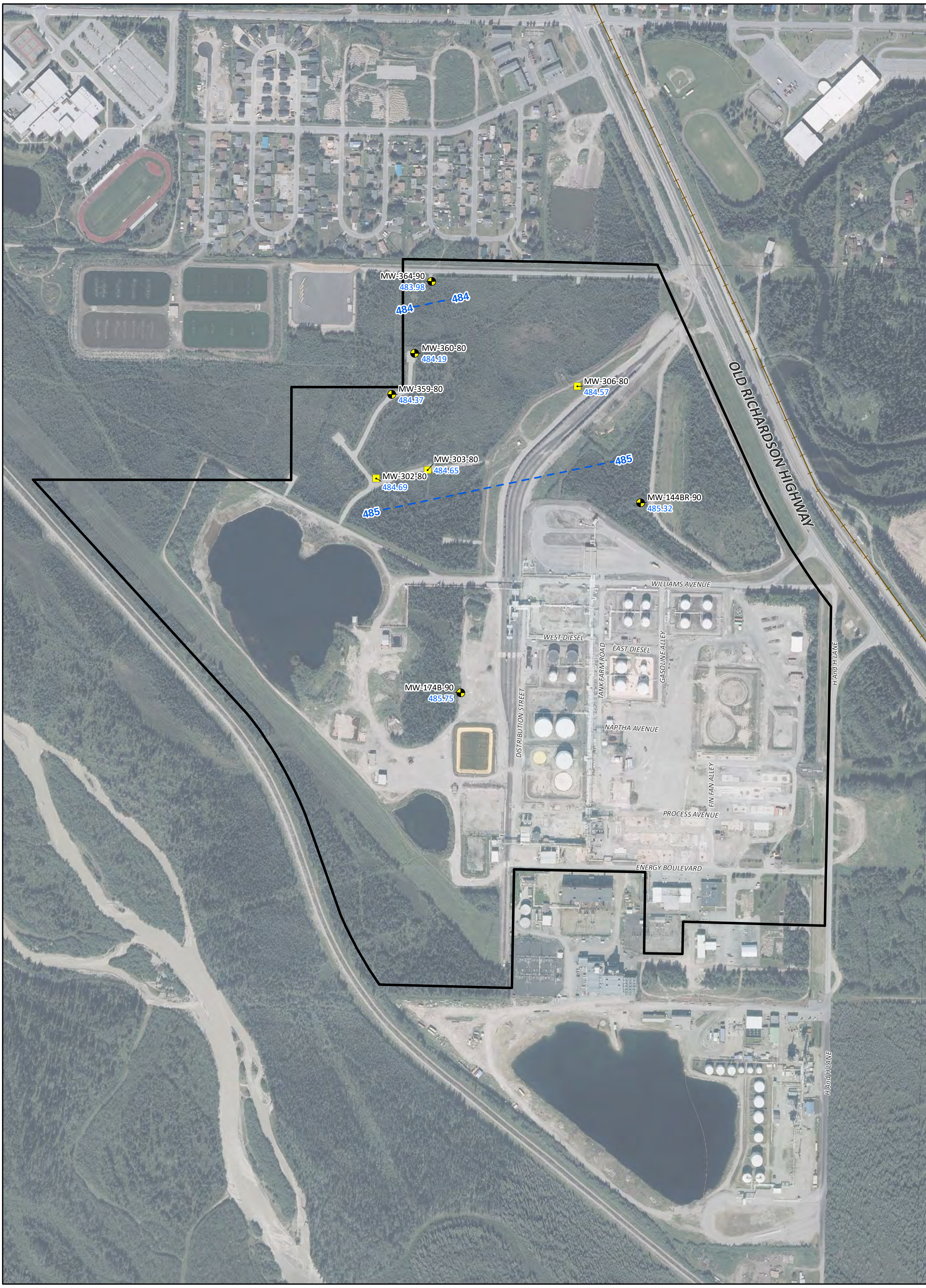
ARCADIS

FIGURE

3-6

Notes:
-Wells were gauged in September 2021
-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

CITY: CITRIX DIV/GROUP: IM/DV DB: K SINSABAUGH LD: G FRANCE
PATH: T:_ENV\FHR\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2021_Q3\MXD\FIG 3-7 3Q20 GW_CONTOURS-55-90FT.MXD DATE: 11/18/2021 TIME: 10:03:58 AM



Legend

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

0 500 1,000
SCALE IN FEET

Notes:
-Wells were gauged in September 2021
-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

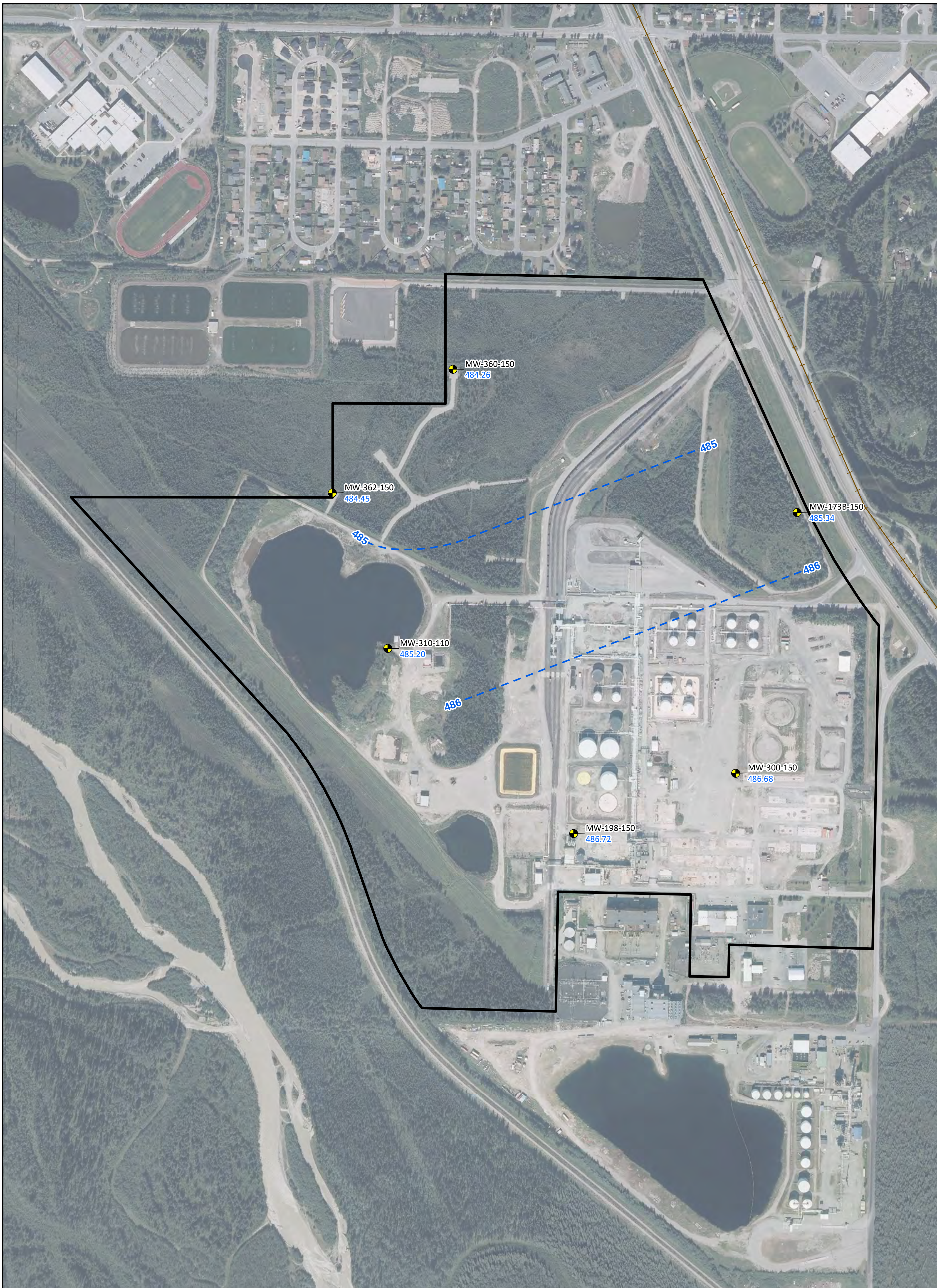
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 55 TO 90 FEET BELOW WATER TABLE

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\2021_Q3\MXD\FIG 3-8 3Q20 GW_CONTOURS-90-160FT.MXD DATE: 11/18/2021 TIME: 10:06:05 AM



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 September 2021
-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 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 GROUNDWATER CONTOUR MAP - ONSITE WELLS 90 TO 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE

3-8

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-9 Annual 2020 LNAPL_MonitoringData.mxd Date: 11/12/2021 Time: 1:06:45 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
0.72 LNAPL Thickness (feet)
Sheen An interface probe was used. No measurable LNAPL was present, but LNAPL sheen was observed visually.
- - No LNAPL measured or sheen observed

0 200 400
SCALE IN FEET

Notes:
LNAPL = Light Nonaqueous 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 - 2020 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 September and October 2021.

NORTH POLE TERMINAL, NORTH POLE, ALASKA

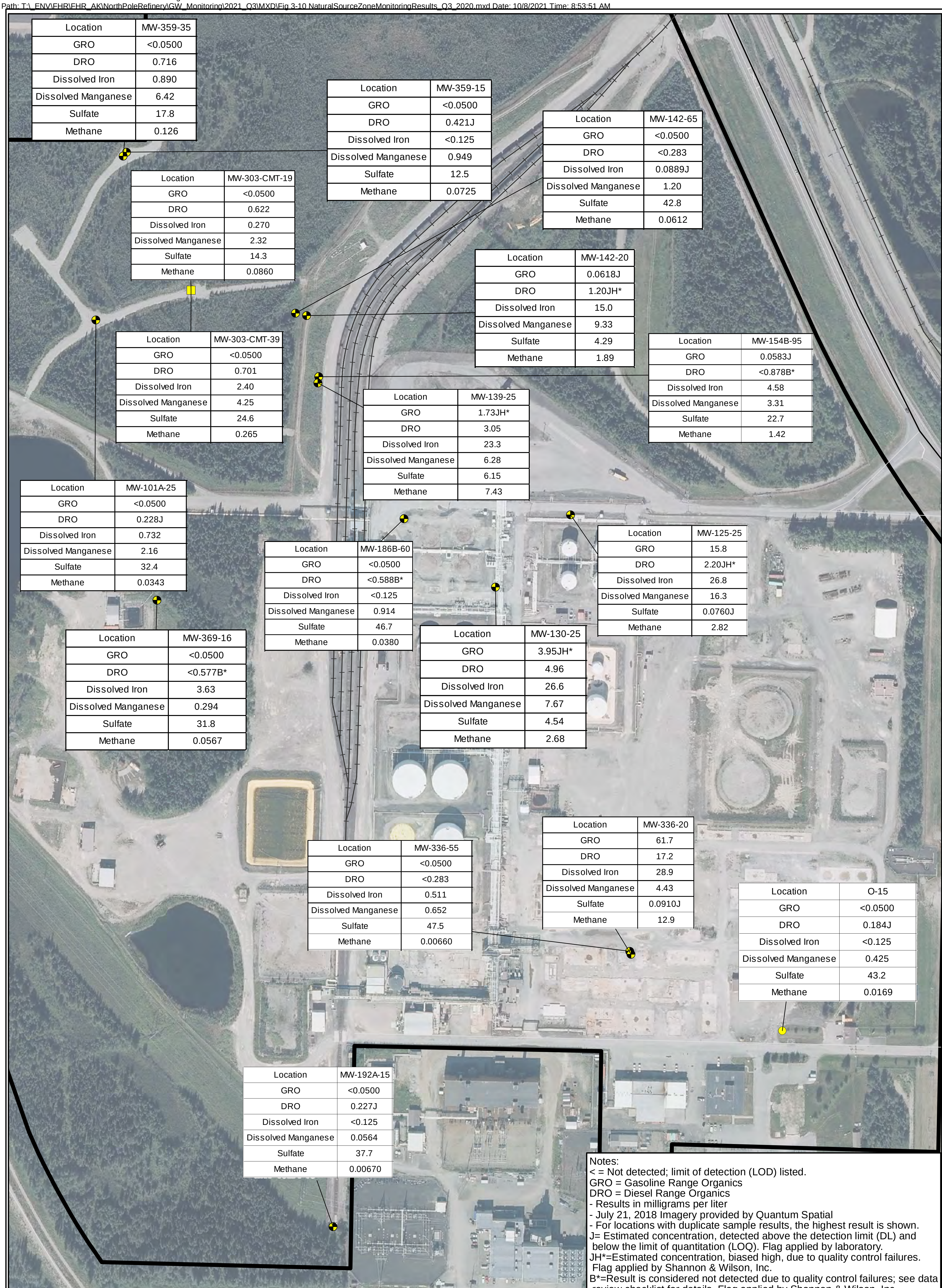
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2021 LNAPL MONITORING DATA

ARCADIS

FIGURE
3-9

CITY: Citrix DIV/GROUP: ENV/IM DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\EHR\EHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-10 NaturalSourceZoneMonitoringResults_Q3_2020.mxd Date: 10/8/2021 Time: 8:53:51 AM



Location	MW-359-35
GRO	<0.0500
DRO	0.716
Dissolved Iron	0.890
Dissolved Manganese	6.42
Sulfate	17.8
Methane	0.126

Location	MW-359-15
GRO	<0.0500
DRO	0.421J
Dissolved Iron	<0.125
Dissolved Manganese	0.949
Sulfate	12.5
Methane	0.0725

Location	MW-142-65
GRO	<0.0500
DRO	<0.283
Dissolved Iron	0.0889J
Dissolved Manganese	1.20
Sulfate	42.8
Methane	0.0612

Location	MW-303-CMT-19
GRO	<0.0500
DRO	0.622
Dissolved Iron	0.270
Dissolved Manganese	2.32
Sulfate	14.3
Methane	0.0860

Location	MW-142-20
GRO	0.0618J
DRO	1.20JH*
Dissolved Iron	15.0
Dissolved Manganese	9.33
Sulfate	4.29
Methane	1.89

Location	MW-303-CMT-39
GRO	<0.0500
DRO	0.701
Dissolved Iron	2.40
Dissolved Manganese	4.25
Sulfate	24.6
Methane	0.265

Location	MW-154B-95
GRO	0.0583J
DRO	<0.878B*
Dissolved Iron	4.58
Dissolved Manganese	3.31
Sulfate	22.7
Methane	1.42

Location	MW-139-25
GRO	1.73JH*
DRO	3.05
Dissolved Iron	23.3
Dissolved Manganese	6.28
Sulfate	6.15
Methane	7.43

Location	MW-101A-25
GRO	<0.0500
DRO	0.228J
Dissolved Iron	0.732
Dissolved Manganese	2.16
Sulfate	32.4
Methane	0.0343

Location	MW-186B-60
GRO	<0.0500
DRO	<0.588B*
Dissolved Iron	<0.125
Dissolved Manganese	0.914
Sulfate	46.7
Methane	0.0380

Location	MW-125-25
GRO	15.8
DRO	2.20JH*
Dissolved Iron	26.8
Dissolved Manganese	16.3
Sulfate	0.0760J
Methane	2.82

Location	MW-369-16
GRO	<0.0500
DRO	<0.577B*
Dissolved Iron	3.63
Dissolved Manganese	0.294
Sulfate	31.8
Methane	0.0567

Location	MW-130-25
GRO	3.95JH*
DRO	4.96
Dissolved Iron	26.6
Dissolved Manganese	7.67
Sulfate	4.54
Methane	2.68

Location	MW-336-20
GRO	61.7
DRO	17.2
Dissolved Iron	28.9
Dissolved Manganese	4.43
Sulfate	0.0910J
Methane	12.9

Location	MW-336-55
GRO	<0.0500
DRO	<0.283
Dissolved Iron	0.511
Dissolved Manganese	0.652
Sulfate	47.5
Methane	0.00660

Location	O-15
GRO	<0.0500
DRO	0.184J
Dissolved Iron	<0.125
Dissolved Manganese	0.425
Sulfate	43.2
Methane	0.0169

Location	MW-192A-15
GRO	<0.0500
DRO	0.227J
Dissolved Iron	<0.125
Dissolved Manganese	0.0564
Sulfate	37.7
Methane	0.00670

Notes:
< = Not detected; limit of detection (LOD) listed.
GRO = Gasoline Range Organics
DRO = Diesel Range Organics
- Results in milligrams per liter
- July 21, 2018 Imagery provided by Quantum Spatial
- For locations with duplicate sample results, the highest result is shown.
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.

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

0 240 480
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

ANNUAL 2021 NATURAL SOURCE ZONE DEPLETION MONITORING RESULTS

ARCADIS

FIGURE
3-10

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-11_Q1_20_AnalyticalBenzene.mxd Date: 11/18/2021 Time: 10:10:32 AM

Notes:
< = Not Detected; Detection limit listed. Flag applied by laboratory.
- Results are displayed in micrograms per liter (µg/L)
- 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 - 2020 Update are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial
- Refer to Figure 3-12 for estimated contours

Legend:
- Monitoring Well
- Property Boundary

0 500
SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

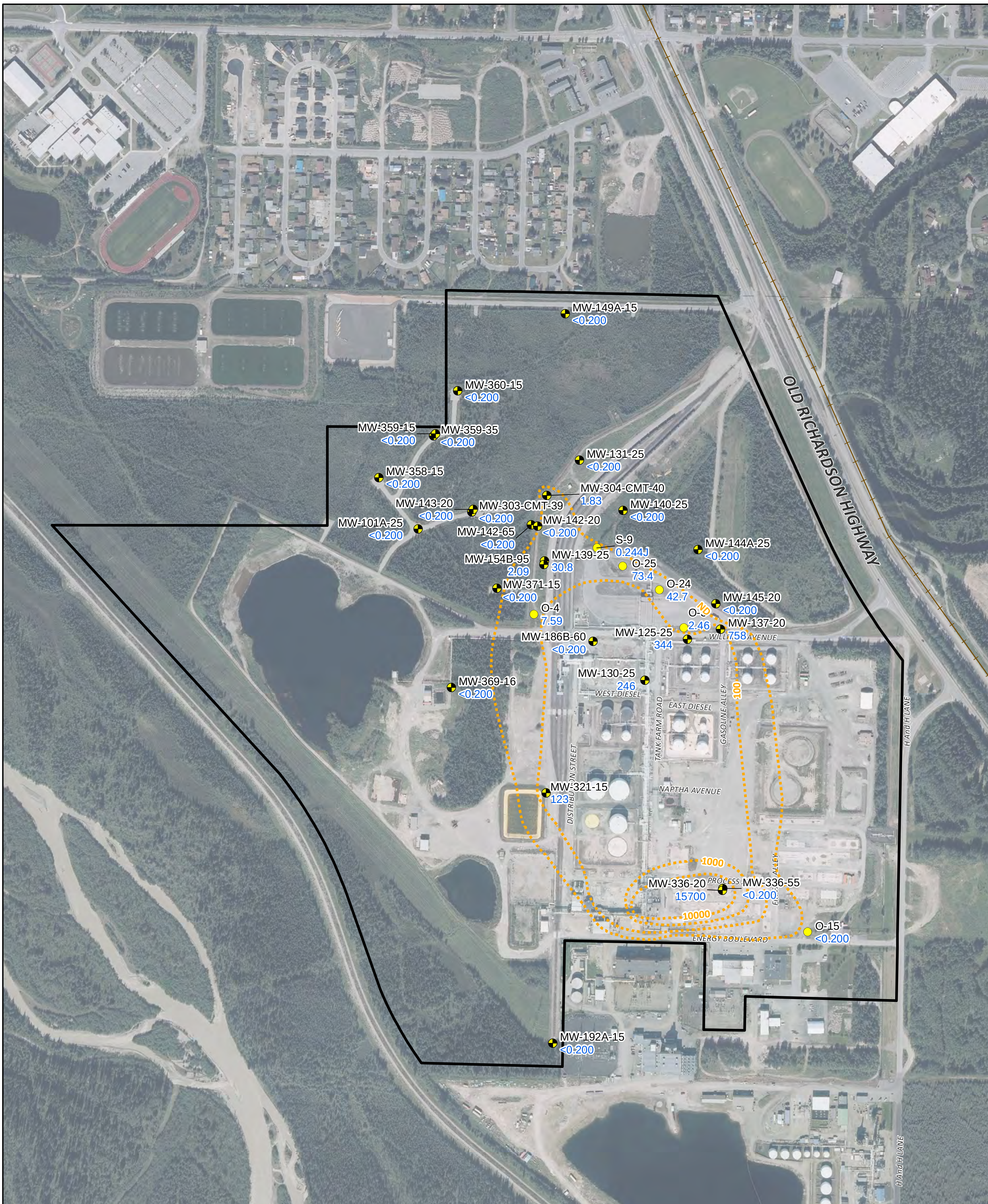
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 ONSITE BENZENE GROUNDWATER ANALYTICAL RESULTS

ARCADIS

FIGURE
3-11

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-12 3Q20 AnalyticalBenzene.mxd Date: 11/18/2021 Time: 10:17:55 AM



Notes:
< = Not Detected; Detection limit listed.
*= MW-135-20 is not included in isopleths
J = Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ). Flag applied by laboratory.
J*= Estimated result; no direction of bias, due to quality control failures; flag applied by Shannon and Wilson, Inc.
ND = Not Detected
-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 - 2020 Update, and one-time 2021 additions are shown on this figure.
- July 21, 2018 Imagery provided by Quantum Spatial

Legend:

- Monitoring Well
- Observation Well
- Benzene Isopleth in µg/L
- Property Boundary

0 500 1,000

SCALE IN FEET

NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 ONSITE BENZENE GROUNDWATER ANALYTICAL RESULTS

ARCADIS

FIGURE

3-12

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-13 1Q20 OnsiteGWSulfolaneResults_WT.mxd Date: 11/10/2021 Time: 1:29:17 PM

Notes:
ND = Not Detected
µg/L = micrograms per liter
- Refer to Figure 3-16 for estimated contours
- Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2017 Update are shown on the figure.
- July 21, 2018 Imagery provided by Quantum Spatial
- For locations with duplicate sample results, the highest result is shown.

Legend

- Monitoring Well
- Observation Well
- 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 2021 ONSITE GROUNDWATER MONITORING REPORT

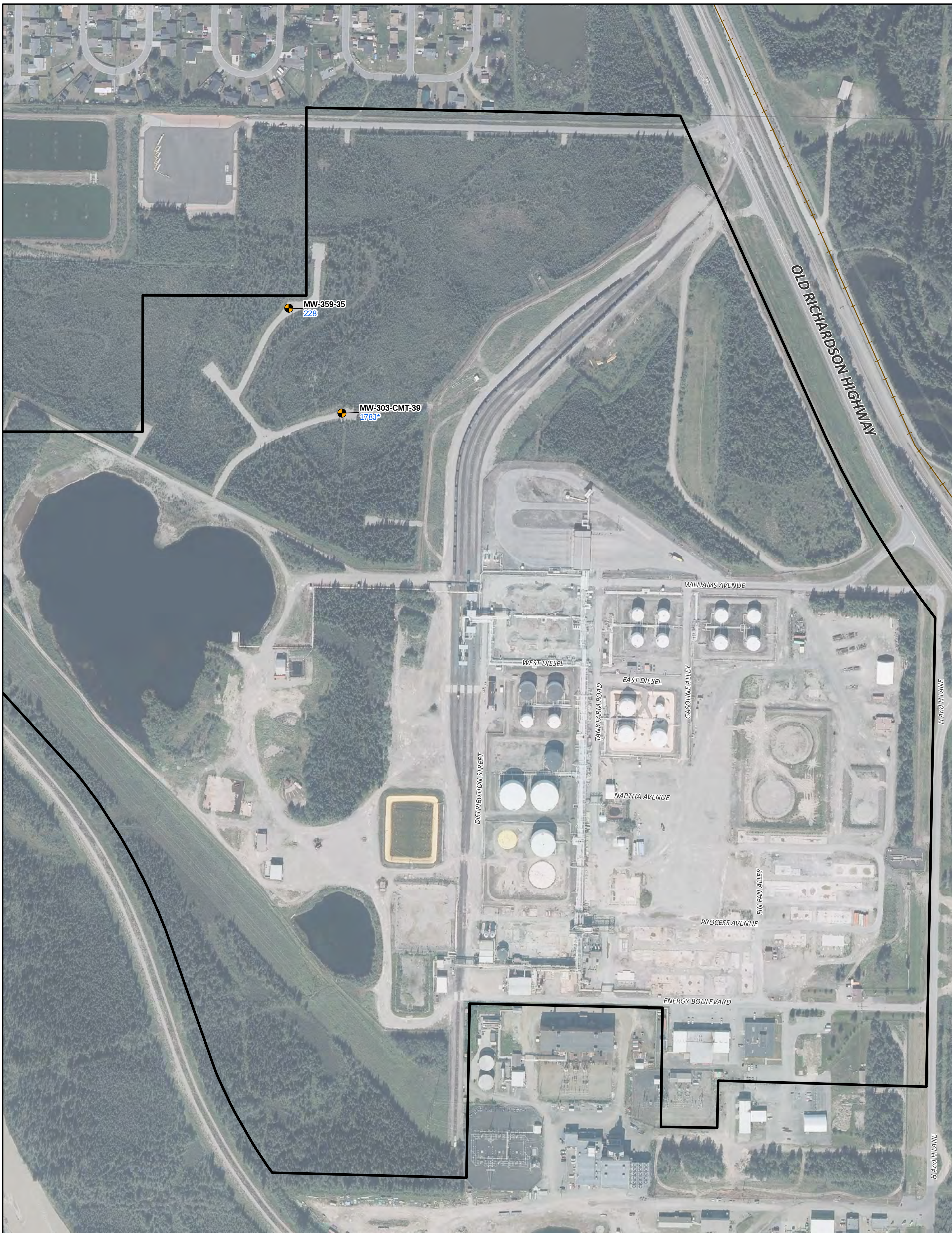
FIRST SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - WATER TABLE

ARCADIS

FIGURE

3-13

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-14 1Q20 OnsiteGWSulfolaneResults_10to55.mxd Date: 11/18/2021 Time: 10:22:36 AM



Notes:
µg/L = micrograms per liter
-Refer to Figure 3-16 for estimated contours
- Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 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

- Monitoring Well
- 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 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 10 TO 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-14

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-15 1Q20 OnsiteGWSulfolaneResults_55to90.mxd Date: 11/18/2021 Time: 10:24:51 AM

Notes:
µg/L = micrograms per liter
-Refer to Figure 3-16 for estimated contours
- Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 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

- Monitoring Well
- 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

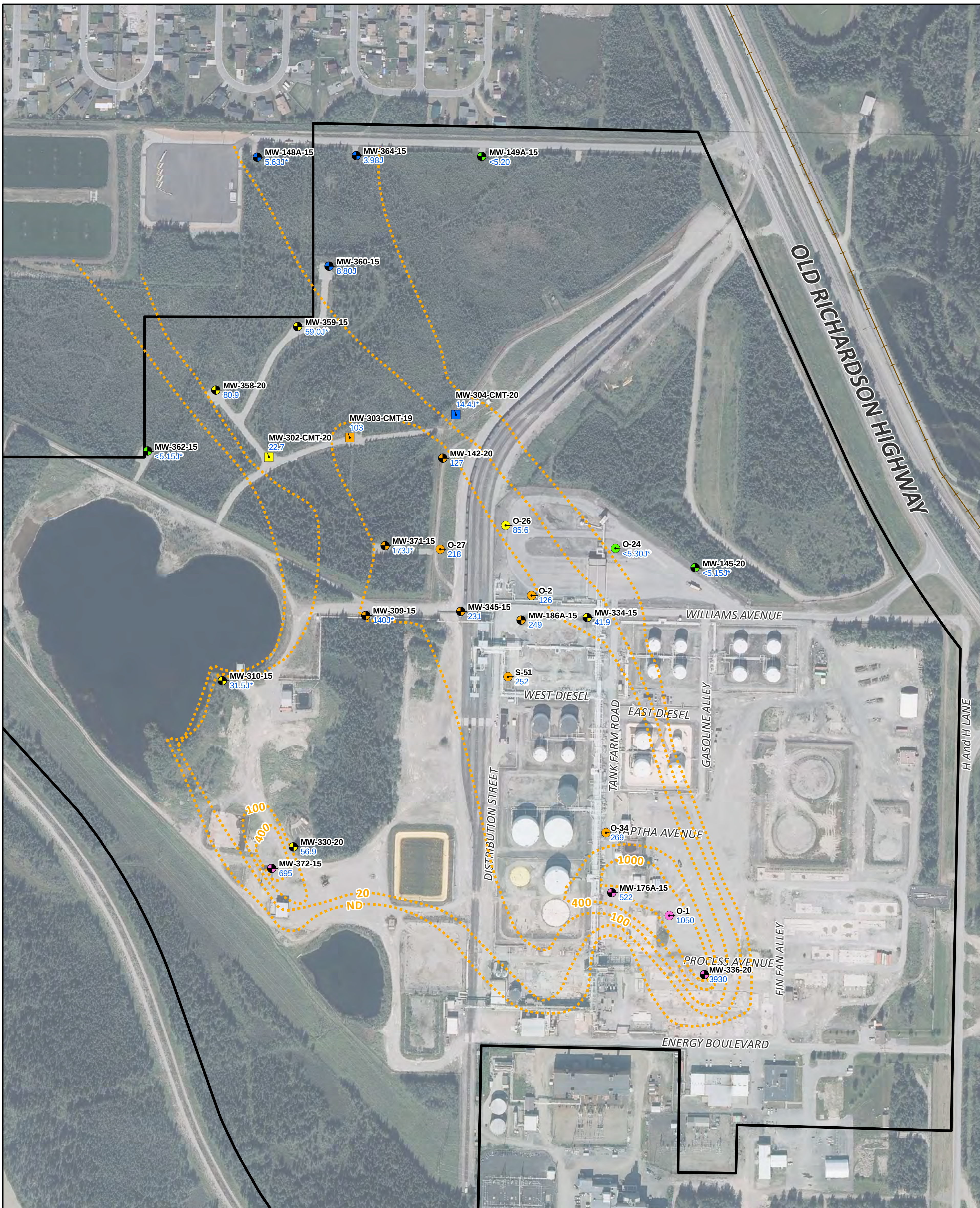
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

FIRST SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 55 TO 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-15

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-16 3Q20 OnsiteGWSulfolaneResults_WT.mxd Date: 11/18/2021 Time: 10:31:43 AM



Notes:
< = Not detected; Detection limit is listed
J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
J* = Estimated concentration, biased low, due to QC failures; flag applied by Shannon & Wilson, Inc.
µg/L = micrograms per liter
-Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 Update, and one-time 2021 additions are shown on the 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 second semiannual 2021 results and include some historical data where a second semiannual sample was not collected.

Legend

- Monitoring Well
- Observation Well
- Vertical Profile Transect 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

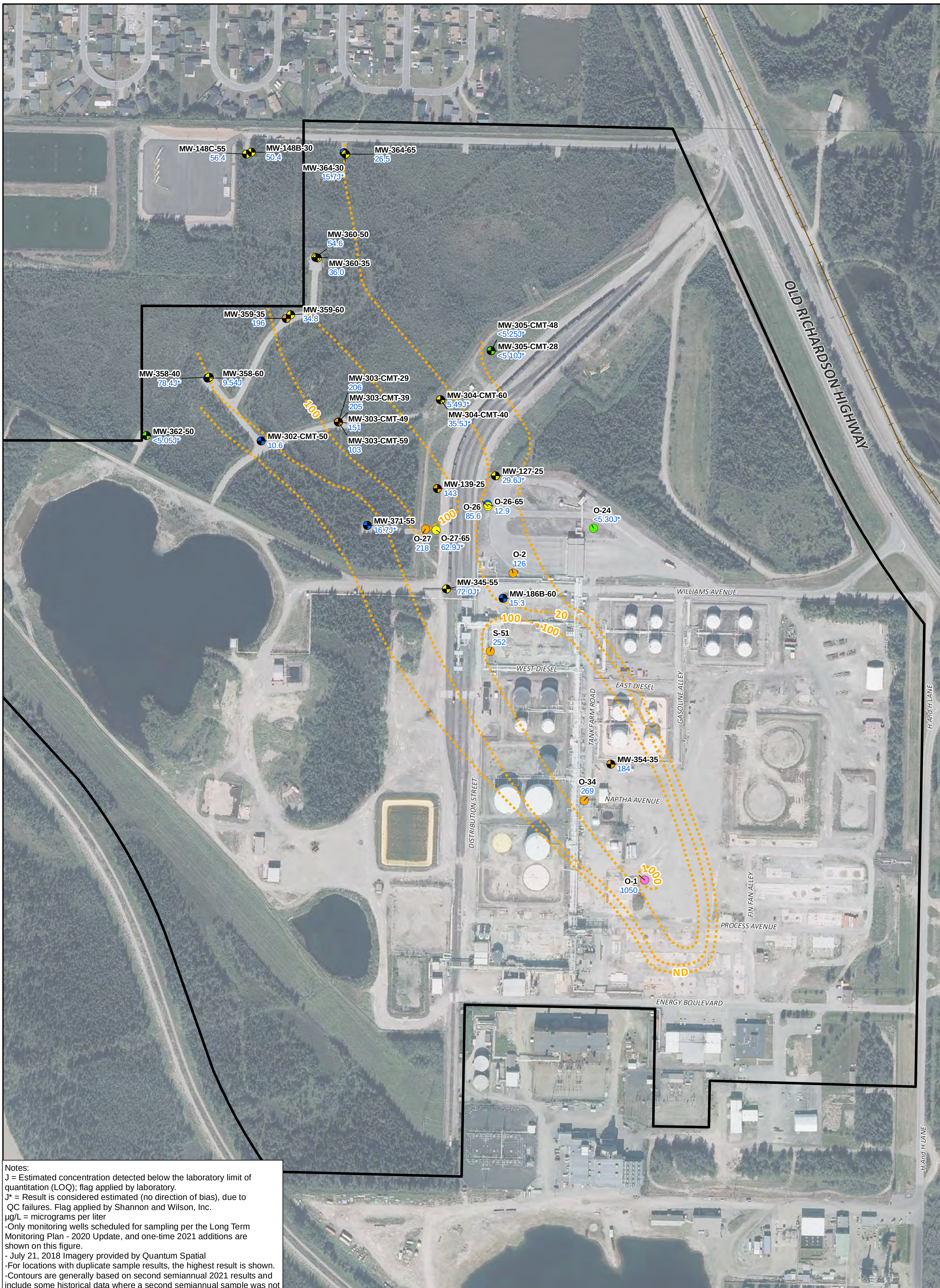
ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS WATER TABLE

ARCADIS

FIGURE
3-16

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-17 3Q20 OnsiteGWSulfolaneResults_10to55.mxd Date: 11/18/2021 Time: 10:37:52 AM



Notes:
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.
µg/L = micrograms per liter
-Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 Update, and one-time 2021 additions 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 second semiannual 2021 results and include some historical data where a second semiannual 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 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 10 TO 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-17

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-18 3Q20 OnsiteGWSulfolaneResults_55to90.mxd Date: 11/18/2021 Time: 10:41:07 AM

Notes:
J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
µg/L = micrograms per liter
-Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 Update and one-time 2021 additions 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 second semiannual 2021 results and include some historical data where a second semiannual 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 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 55 TO 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-18

CITY: Citrix DIV/GROUP: IM/DV DB: K Sinsabaugh LD: G FRANCE
Path: T:_ENV\FHR\FHR_AK\NorthPoleRefinery\GW_Monitoring\2021_Q3\MXD\Fig 3-19 3Q20 OnsiteGWSulfolaneResults_90to160.mxd Date: 11/18/2021 Time: 10:42:27 AM

Notes:
J = Estimated concentration detected below the laboratory limit of quantitation (LOQ); flag applied by laboratory.
µg/L = micrograms per liter
-Refer to Figure 3-16 for estimated contours
-Only monitoring wells scheduled for sampling per the Long Term Monitoring Plan - 2020 Update and one-time 2021 additions 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
- Monitoring Well
- 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

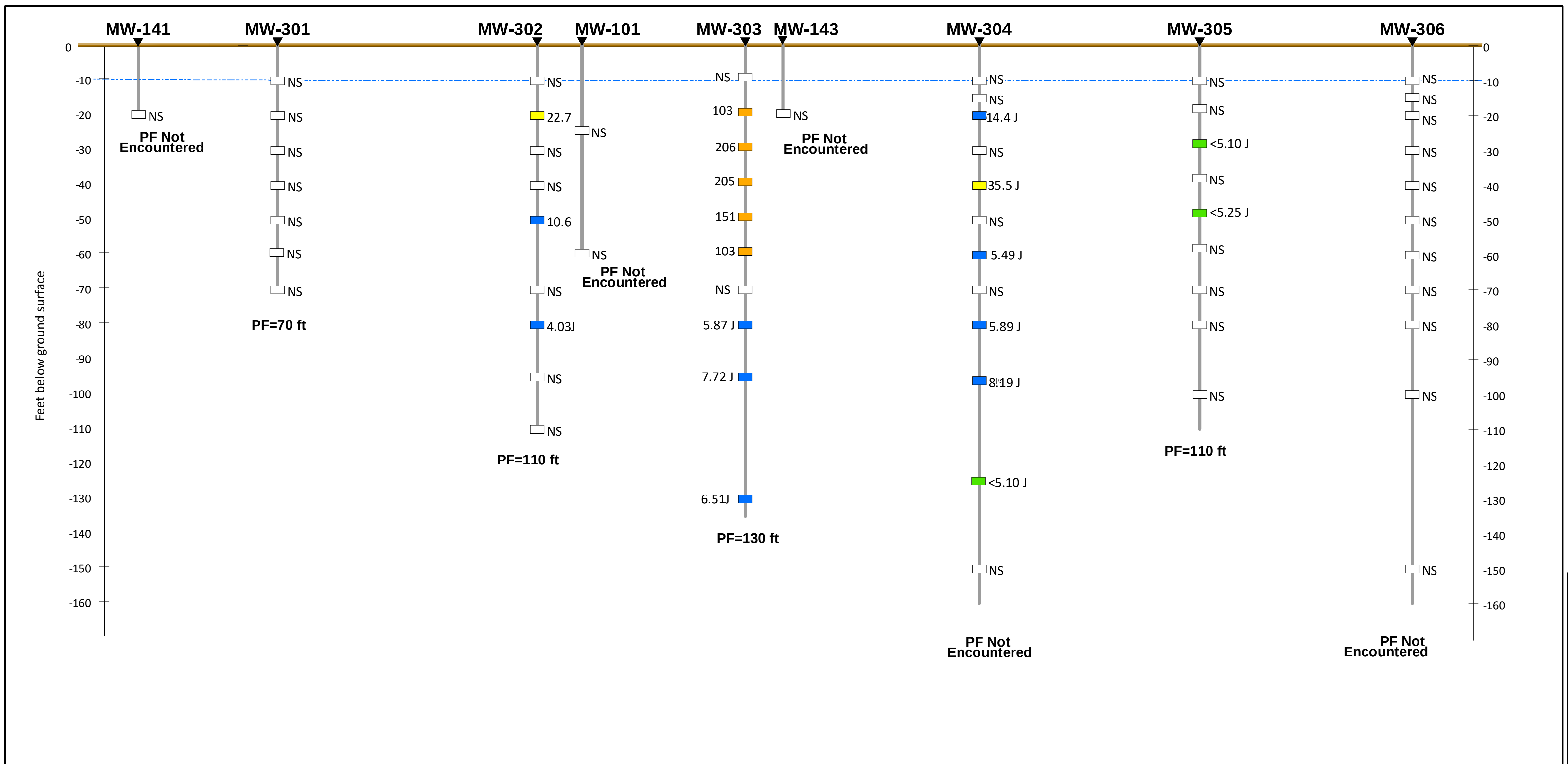
NORTH POLE TERMINAL, NORTH POLE, ALASKA

ANNUAL 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 ONSITE SULFOLANE GROUNDWATER ANALYTICAL RESULTS - 90 TO 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
3-19



Legend:

Sulfolane Results

- Not Detected
- 3.14 - < 20 µg/L
- 20 - < 100 µg/L
- 100 - < 400 µg/L
- Ground Surface
- Approximate Groundwater Surface
- Well Profile

NOTES:
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 2021 ONSITE GROUNDWATER MONITORING REPORT

SECOND SEMIANNUAL 2021 SULFOLANE AT THE VERTICAL PROFILING TRANSECT

ARCADIS

FIGURE **3-20**