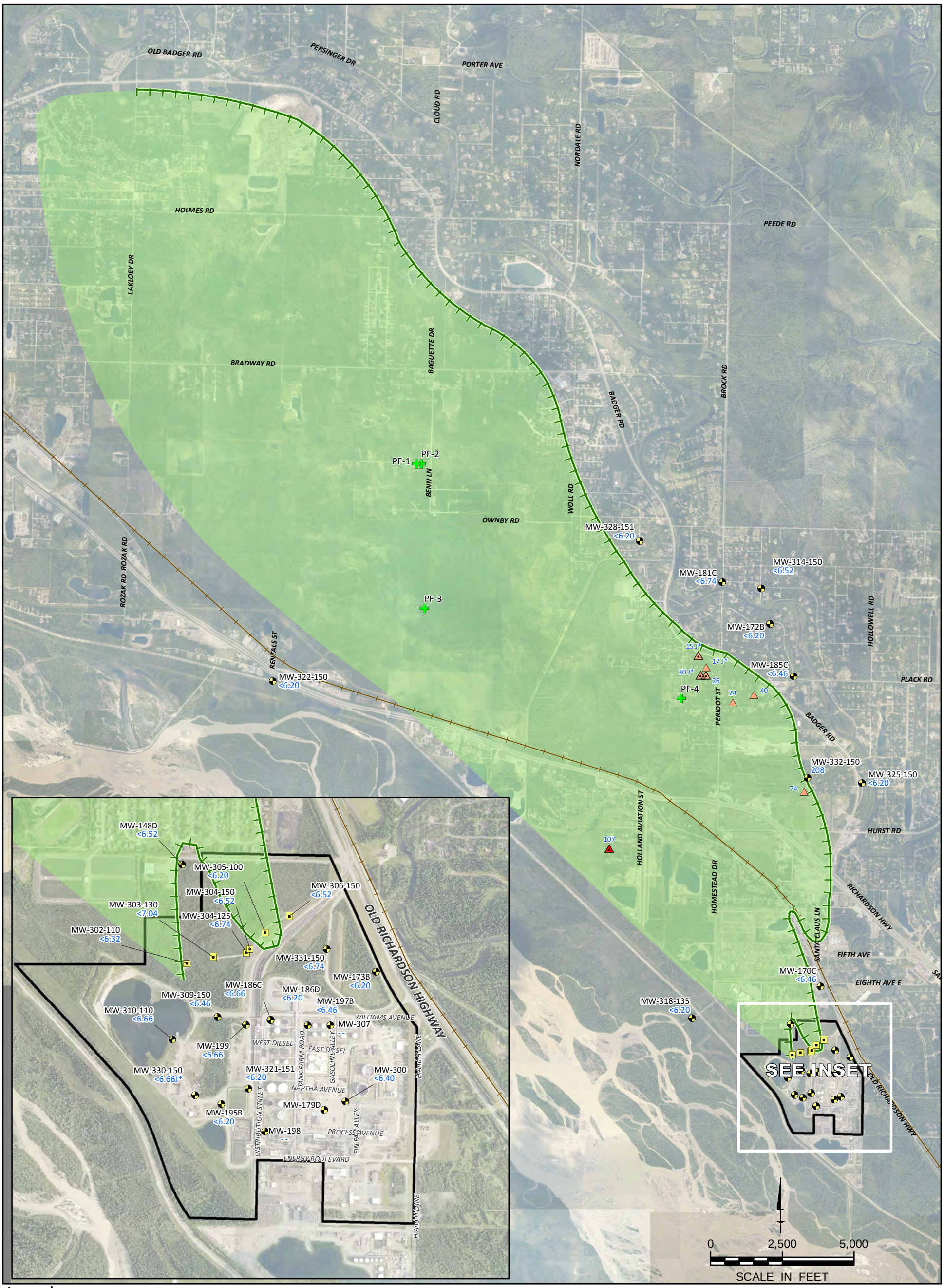
CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-16 Sulfolane_90_160ft.mxd 5/20/2013 12:28:26 PM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Approximate Sulfolane Isopleth in µg/L
- Permafrost Encountered Before Well Boring Reached Monitoring Zone

22.5 Sulfolane concentration (µg/L)
J* Result is considered estimated (no direction of bias), due to QC failures (flag applied by SWI)
< Not detected; detection limit listed
-- Well frozen or obstructed

Notes:

Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to April 30, 2013
Image provided courtesy of Pictometry International 2012

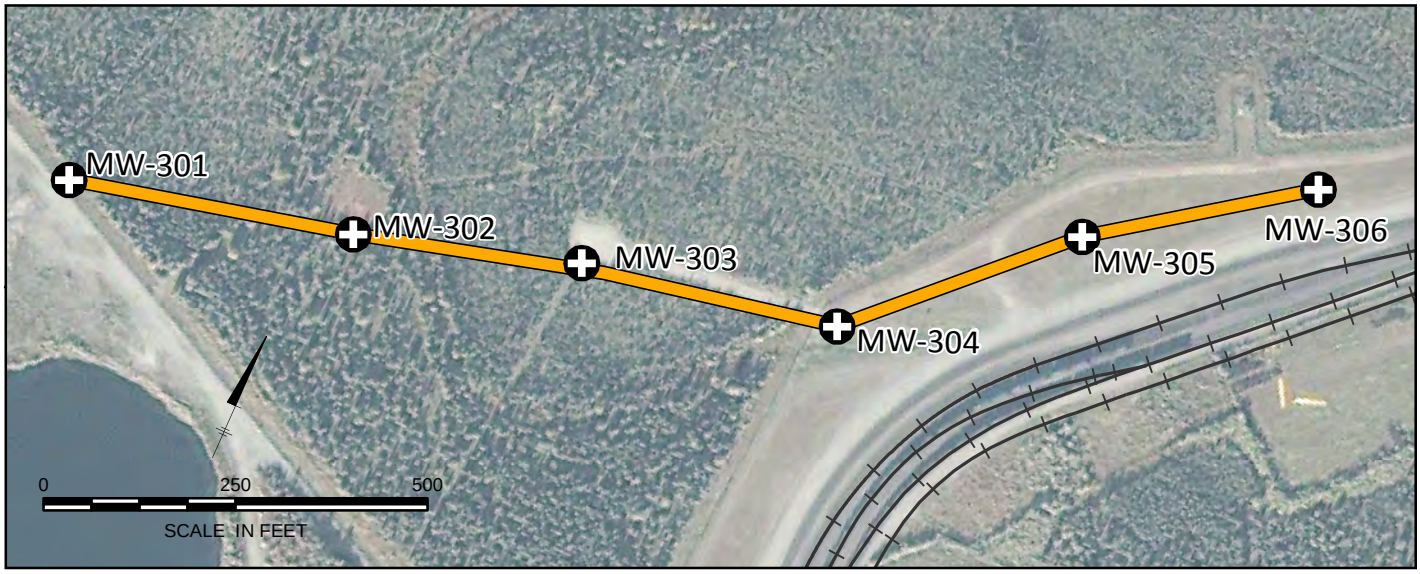
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

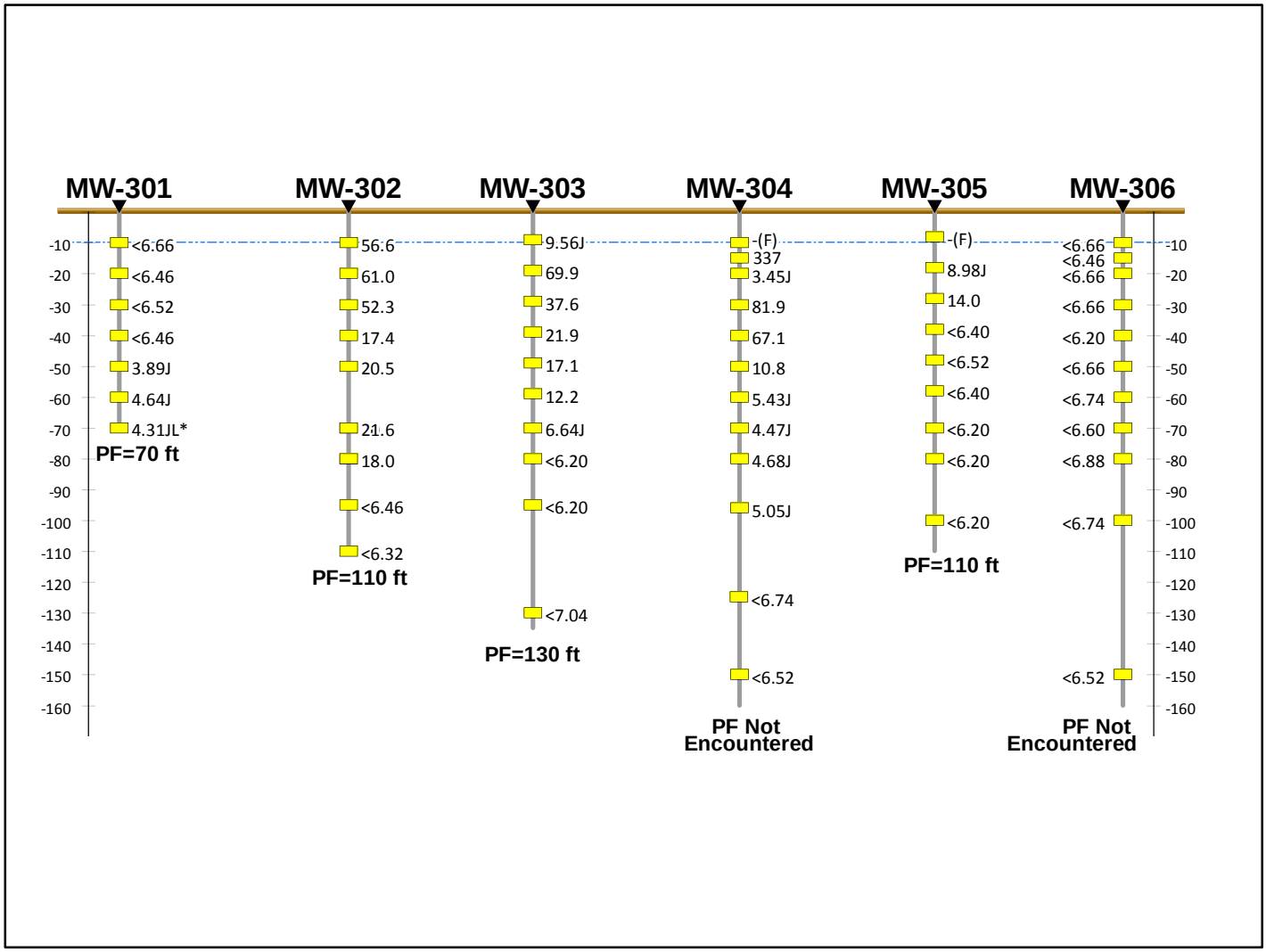
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 90-160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-16





LEGEND:

- Sulfolane Results
- Ground Surface
- Approximate Groundwater Surface
- Well Profile

NOTES:

Profile has a vertical exaggeration of 5x
- = No Result
(F) = Frozen/Obstructed well
J = Estimated concentration
JL* = Result is considered estimated, biased low, due to QC failures (flag applied by SWI)
PF= Permafrost encountered at bottom of boring.

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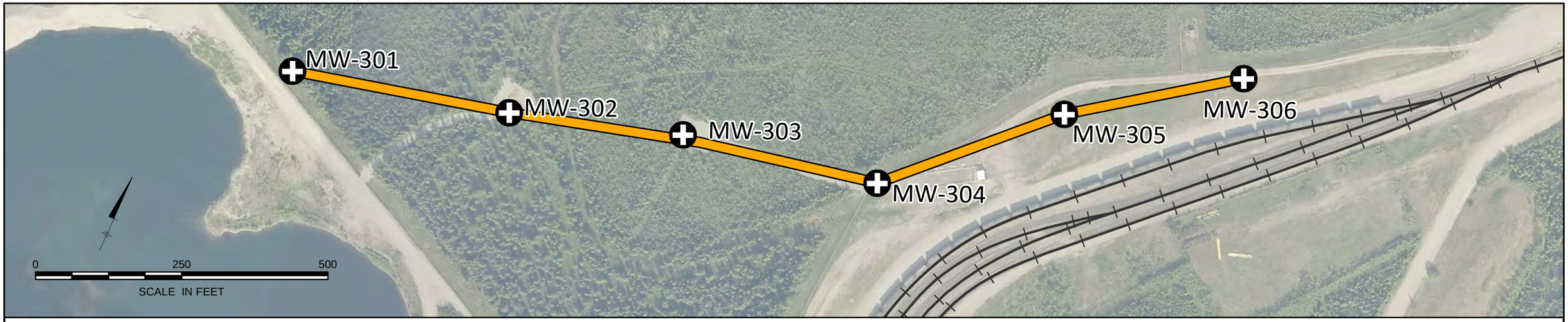
FIRST QUARTER 2013 GROUNDWATER MONITORING REPORT

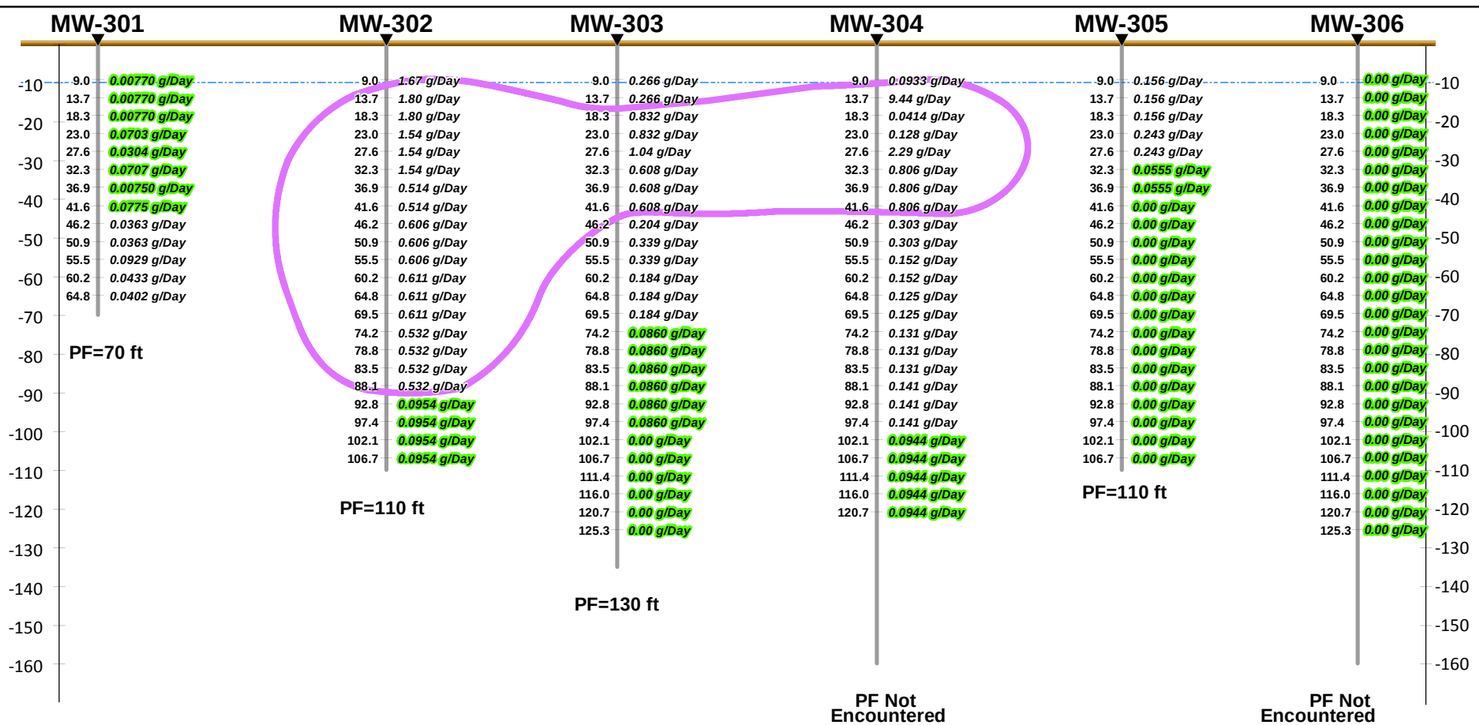
SULFOLANE AT THE VERTICAL PROFILING TRANSECT

ARCADIS

FIGURE
4-17

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGriffith LD: G FRANCE
Path: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-17 Sulfolane_VPT_Profile.mxd Date: 5/16/2013 Time: 11:17:50 AM





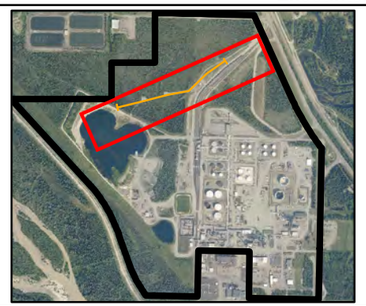
LEGEND:

- Vertical Profile Transect Well
- Ground Surface
- Approximate Groundwater Surface
- Well Profile
- Approximate extent of the majority of total mass flux

Notes:

Mass flux values shown were calculated using the Mass Flux Toolkit.
Depths associated with flux values were determined by the Toolkit.
PF = Permafrost encountered at bottom of boring.
g/Day = grams per day

Highlighted mass flux values are based on non-detect sulfolane concentrations.



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NORTH POLE REFINERY, NORTH POLE, ALASKA
FIRST QUARTER 2013 GROUNDWATER MONITORING REPORT

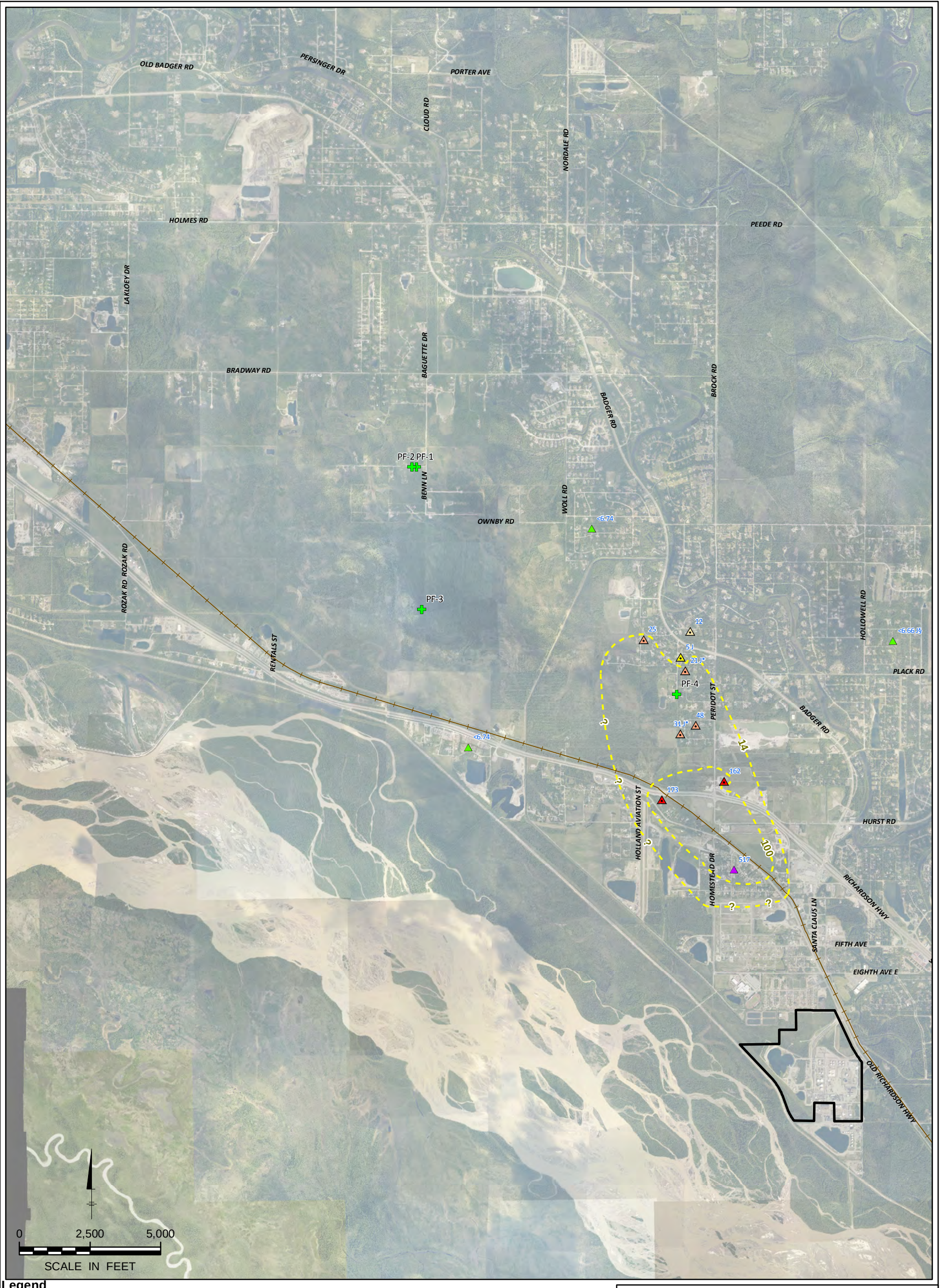
SULFOLANE MASS FLUX RATES
1ST QUARTER 2013

ARCADIS

FIGURE
4-18

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGriffith LD: G FRANCE
Path: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-18 Sulfolane_MassFlux_2013Q1_11x17landscape.mxd Date: 5/31/2013 Time: 12:15:30 PM

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-19 Sulfolane_below160ft.mxd 5/20/2013 11:27:51 AM



Legend

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

- Approximate Sulfolane Isopleth in µg/L

25 Sulfolane Concentration (µg/L)
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
J* Result is considered estimated (no direction of bias) due to QC failures (flag applied by SWI)
J§ Result potentially biased; pending flag. Sample results indicate sample location may have been downstream of a water-treatment system. The sample location will be examined during the second quarter sampling and the flag finalized, if applicable.
< Not detected; detection limit listed

Notes:

Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to April 30, 2013
Image provided courtesy of Pictometry International 2012

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FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE GREATER THAN 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-19

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-20 DEEPRESIDENTIAL.MXD DATE: 5/17/2013 TIME: 5:27:22 PM

Legend

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Permafrost Boring
- FHRA Property Boundary
- 25 Sulfolane Concentration (µg/L)
- J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
- < Not detected: detection limit listed

0 2,000 4,000
SCALE IN FEET

Notes:

Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Image provided courtesy of Pictometry International 2012

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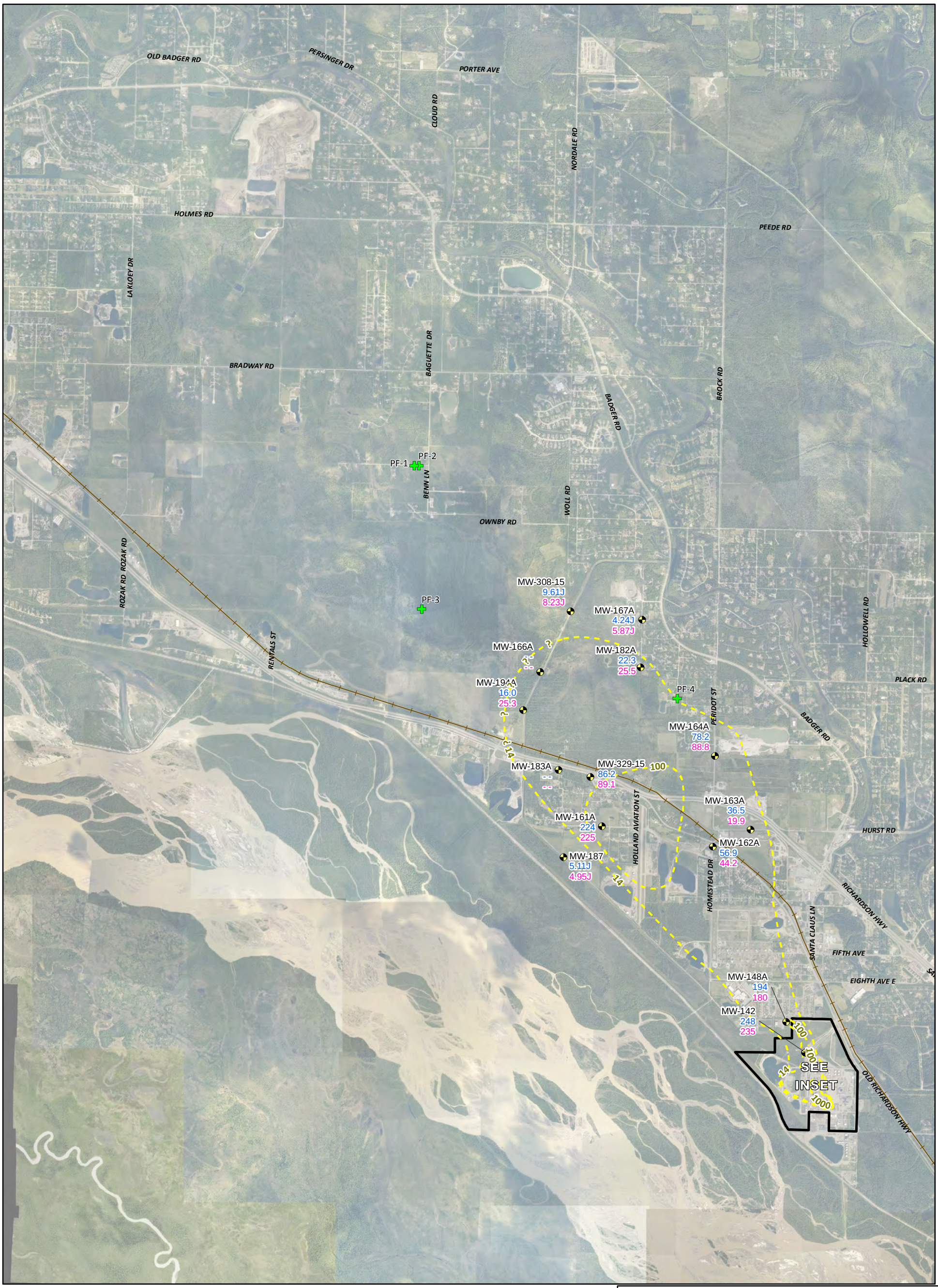
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

DEEP RESIDENTIAL SULFOLANE RESULTS - FIRST QUARTER 2013

ARCADIS

FIGURE
4-20

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-21 SULFOLANE_WATERTABLE.MXD DATE: 5/30/2013 TIME: 8:05:16 AM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Approximate Sulfolane Isopleth in µg/L
- FHRA Property Boundary

248 Sulfolane Concentration (µg/L)
235 Sulfolane Concentration (µg/L) Second Sampling Event
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
- - Well frozen or obstructed

0 2,500 5,000
SCALE IN FEET

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Image provided courtesy of Pictometry International 2012

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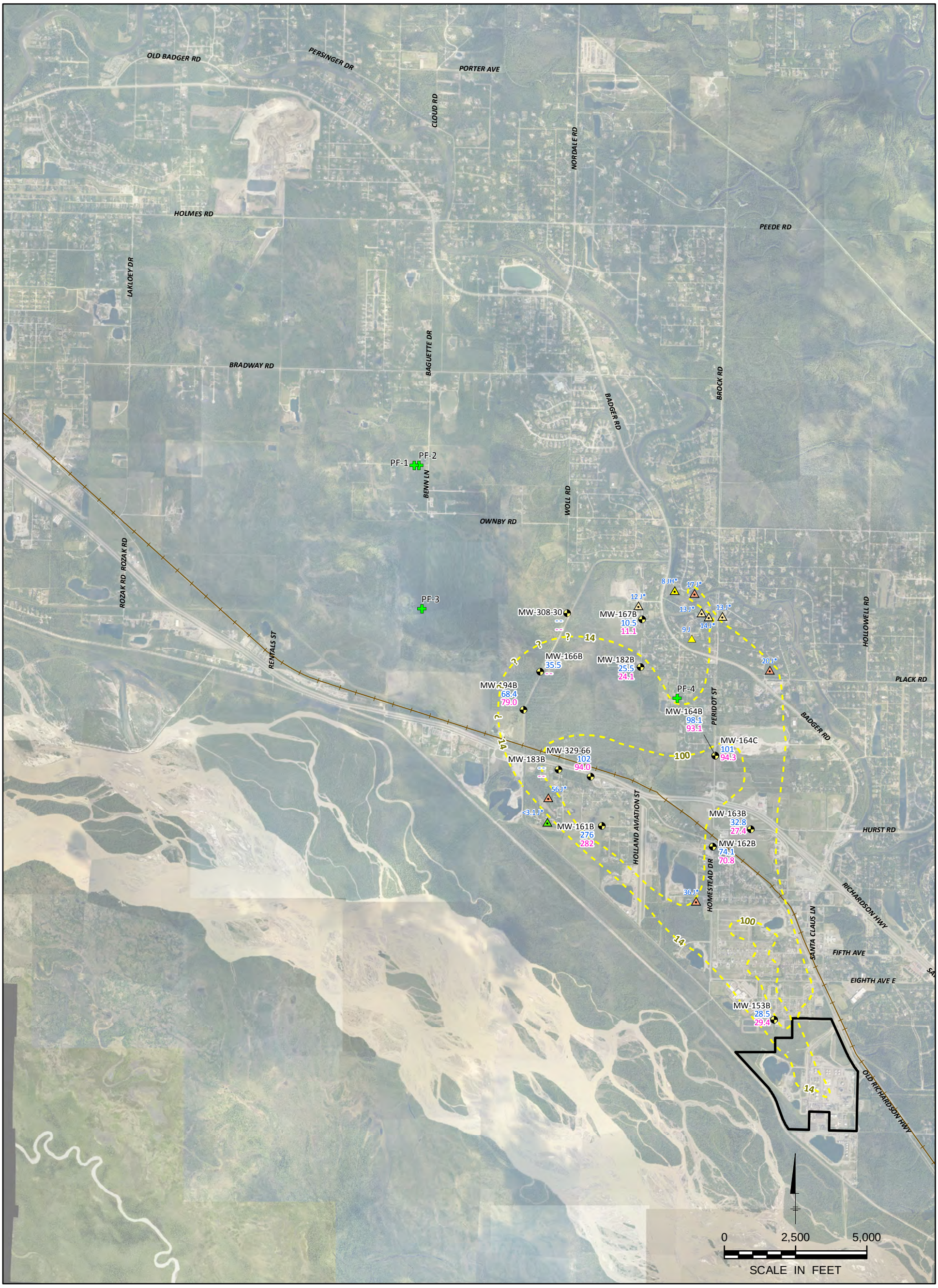
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE AT WATER TABLE - SECOND SAMPLING EVENT

ARCADIS

FIGURE
4-21

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-22 Sulfolane_10-55ft.mxd 5/20/2013 12:14:15 PM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Approximate Sulfolane Isopleth in µg/L

248 Sulfolane Concentration (µg/L)
235 Sulfolane Concentration (µg/L) Second Sampling Event
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
JH* Estimated results biased high due to sulfolane-d8 surrogate failure (flag applied by SWI)
J* Result is considered estimated (no direction of bias) due to QC failures (flag applied by SWI)
< Not detected; detection limit listed
- - Well frozen or obstructed

Notes:

Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to March 31, 2013
Image provided courtesy of Pictometry International 2012

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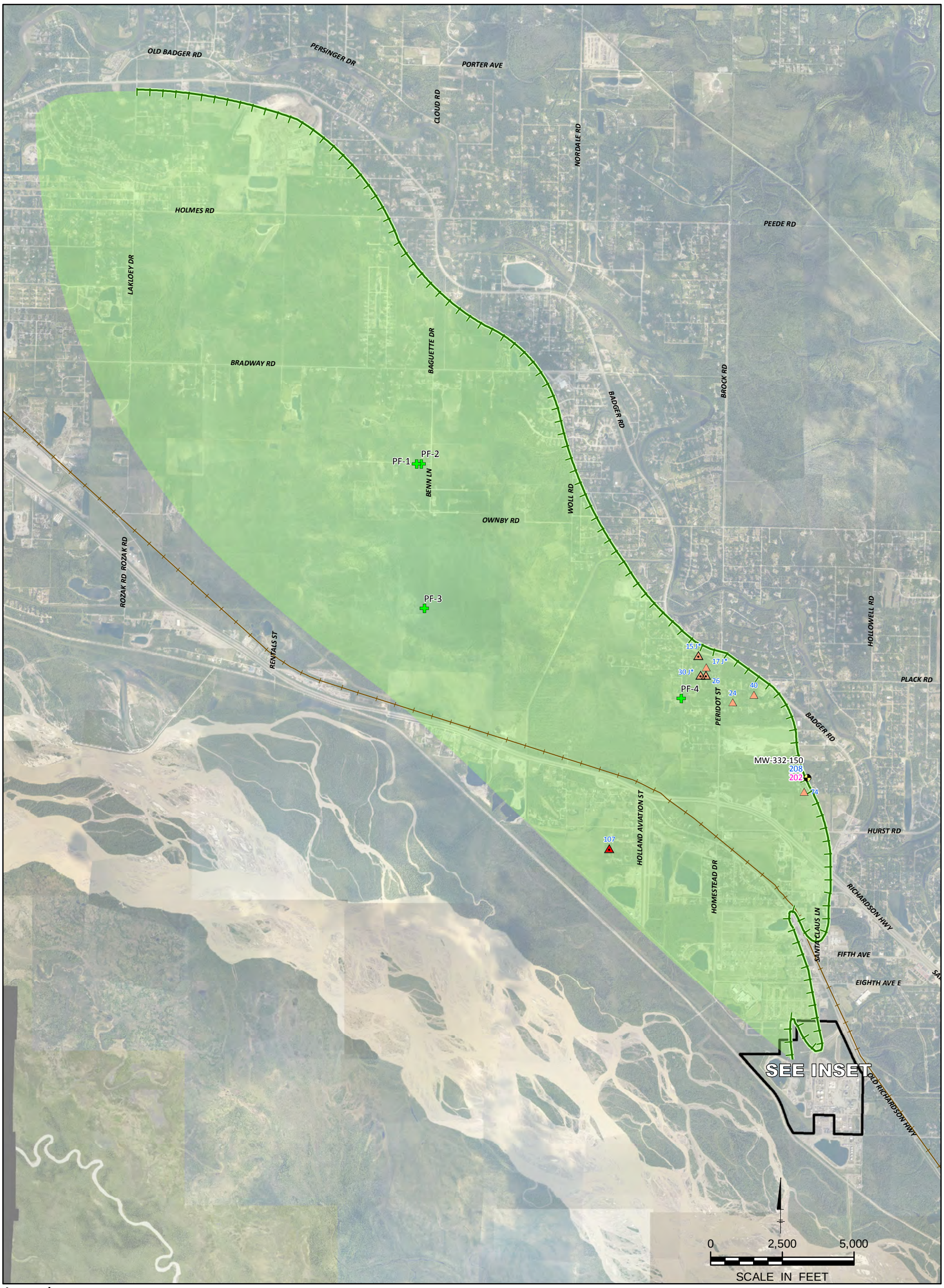
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE
10-55 FEET BELOW WATER TABLE
SECOND SAMPLING EVENT

ARCADIS

FIGURE
4-22

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-23 Sulfolane_90_160ft.mxd 5/20/2013 12:27:00 PM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Approximate Sulfolane Isopleth in µg/L
- Permafrost Encountered Before Well Boring Reached Monitoring Zone

248 Sulfolane Concentration (µg/L)
235 Sulfolane Concentration (µg/L) Second Sampling Event
J* Result is considered estimated (no direction of bias) due to QC failures (flag applied by SWI)

Notes:

Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to April 30, 2013
Image provided courtesy of Pictometry International 2012

FLINT HILLS RESOURCES ALASKA, LLC
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FIRST QUARTER 2013 GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 90-160 FEET BELOW WATER TABLE SECOND SAMPLING EVENT

ARCADIS

FIGURE
4-23

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-24 AirSparge_PilotTest_Layout.mxd 5/16/2013 12:46:48 PM

Legend

- Monitoring Well
- Air Sparge
- Sparge Monitoring Point
- Air Distribution Piping
- Blower Building

0 20 40
SCALE IN FEET

Notes:

Image provided courtesy of Pictometry International 2012

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NORTH POLE REFINERY, NORTH POLE, ALASKA

FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

AIR SPARGE PILOT TEST
SITE LAYOUT

ARCADIS

FIGURE
4-24