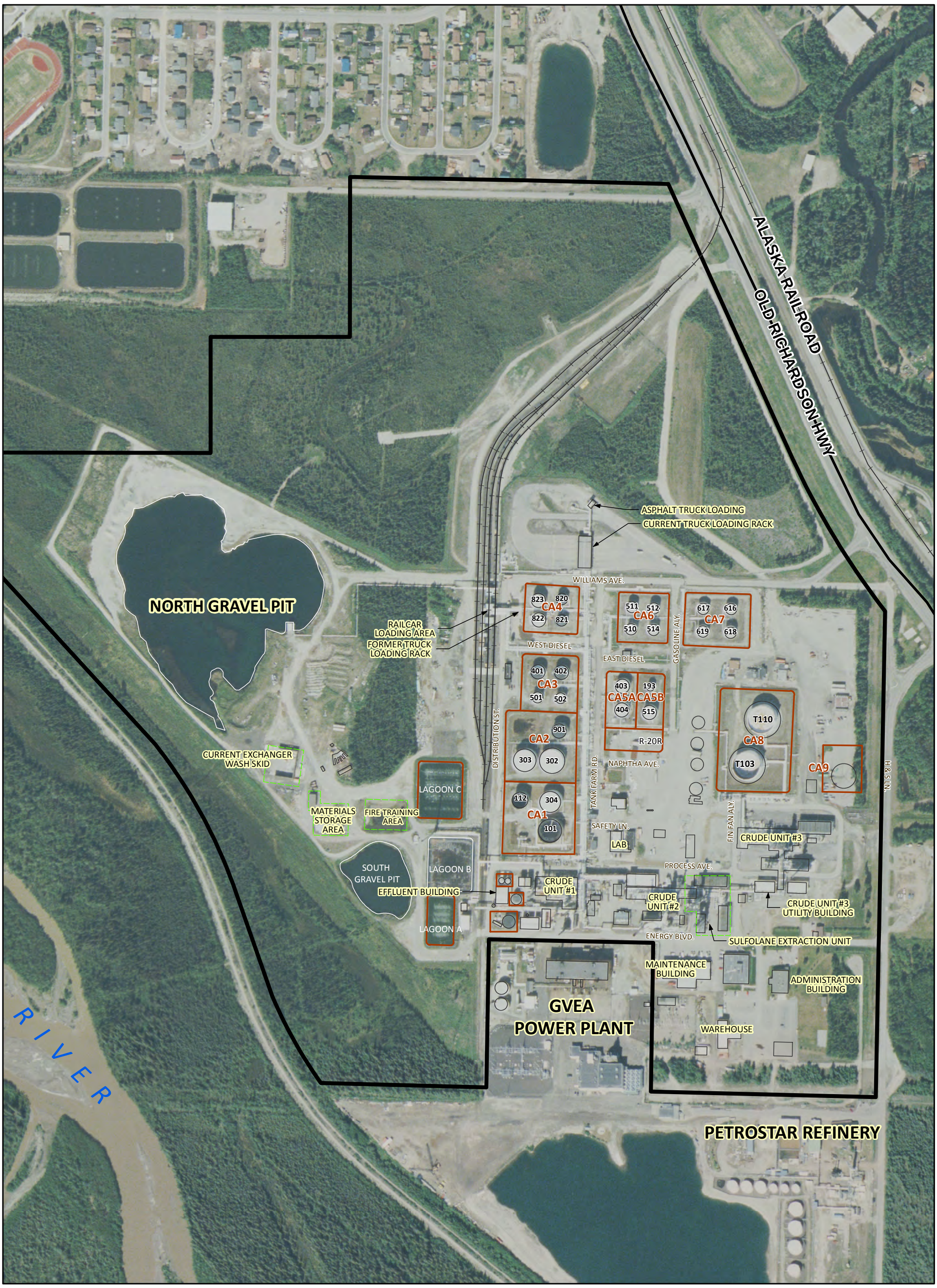
CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 1-2 SiteFeatures.mxd 1/14/2013 12:29:10 PM



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

Notes:
Image Date June 9, 2007

0 400 800
SCALE IN FEET

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

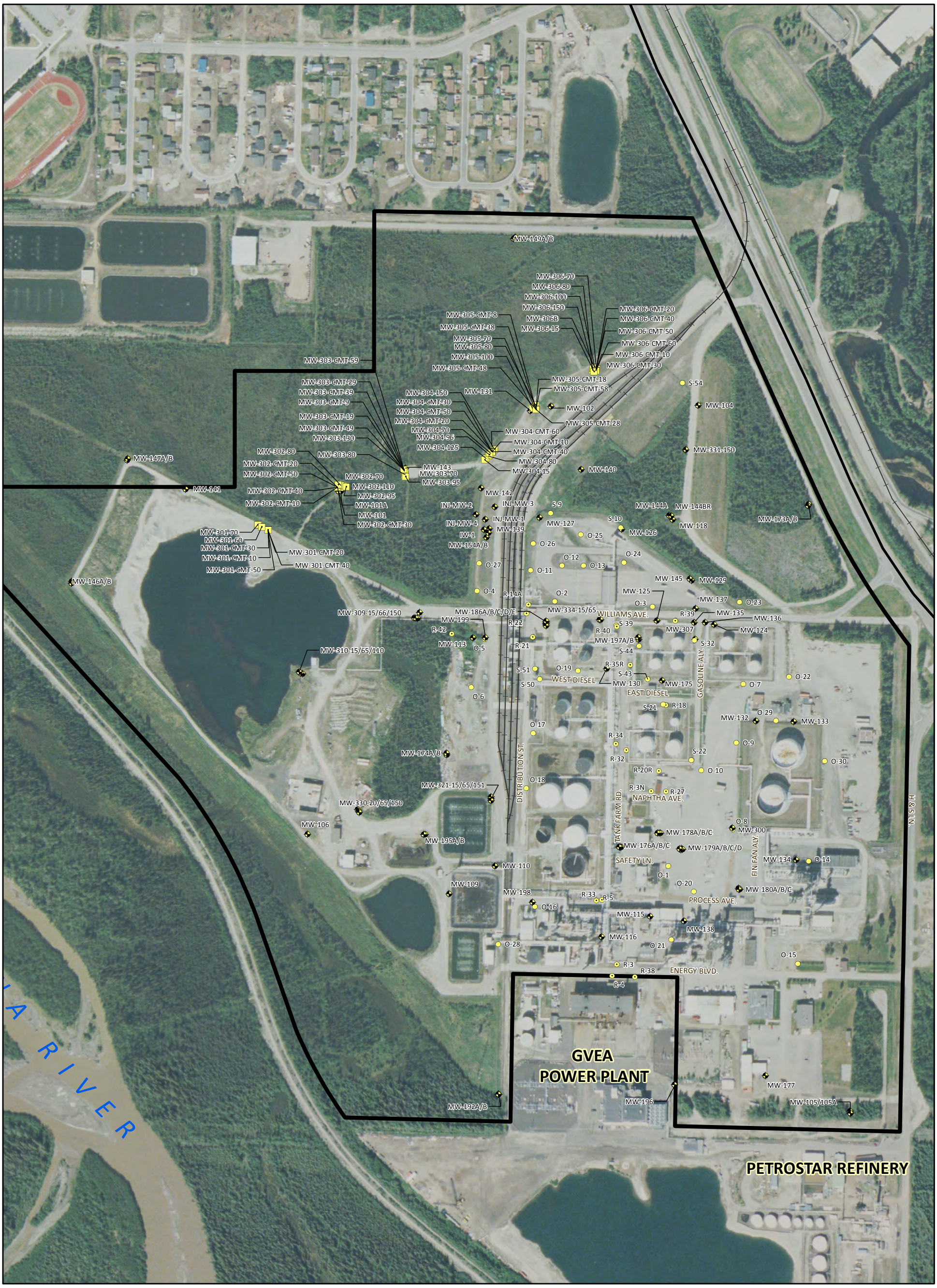
IRAP ADDENDUM

CURRENT SITE FEATURES

ARCADIS

FIGURE
1-2

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 1-3 SitePlanOnsite.mxd 1/17/2013 3:58:45 PM



Legend
- Monitoring Well
- Recovery Well
- Observation Well
- Vertical Profile Transect Well
- FHRA Property Boundary

Note:
Image Date June 9, 2007

0 400 800
SCALE IN FEET

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

IRAP ADDENDUM

SITE PLAN - ONSITE

ARCADIS

FIGURE
1-3

CITY: SF DIV/GROUP: ENV/IM DB: K ERNST LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 1-4 SitePlanOffsite.mxd Date: 1/17/2013 Time: 4:14:55 PM

Legend:

- Monitoring Well
- Recovery Well
- Observation Well
- Vertical Profile Transect Well
- FHRA Property Boundary
- RAIL LINE
- Highway
- Major Road
- Local Road

0 3,300 6,600 Feet
GRAPHIC SCALE

Notes:
Image Date June 9, 2007

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

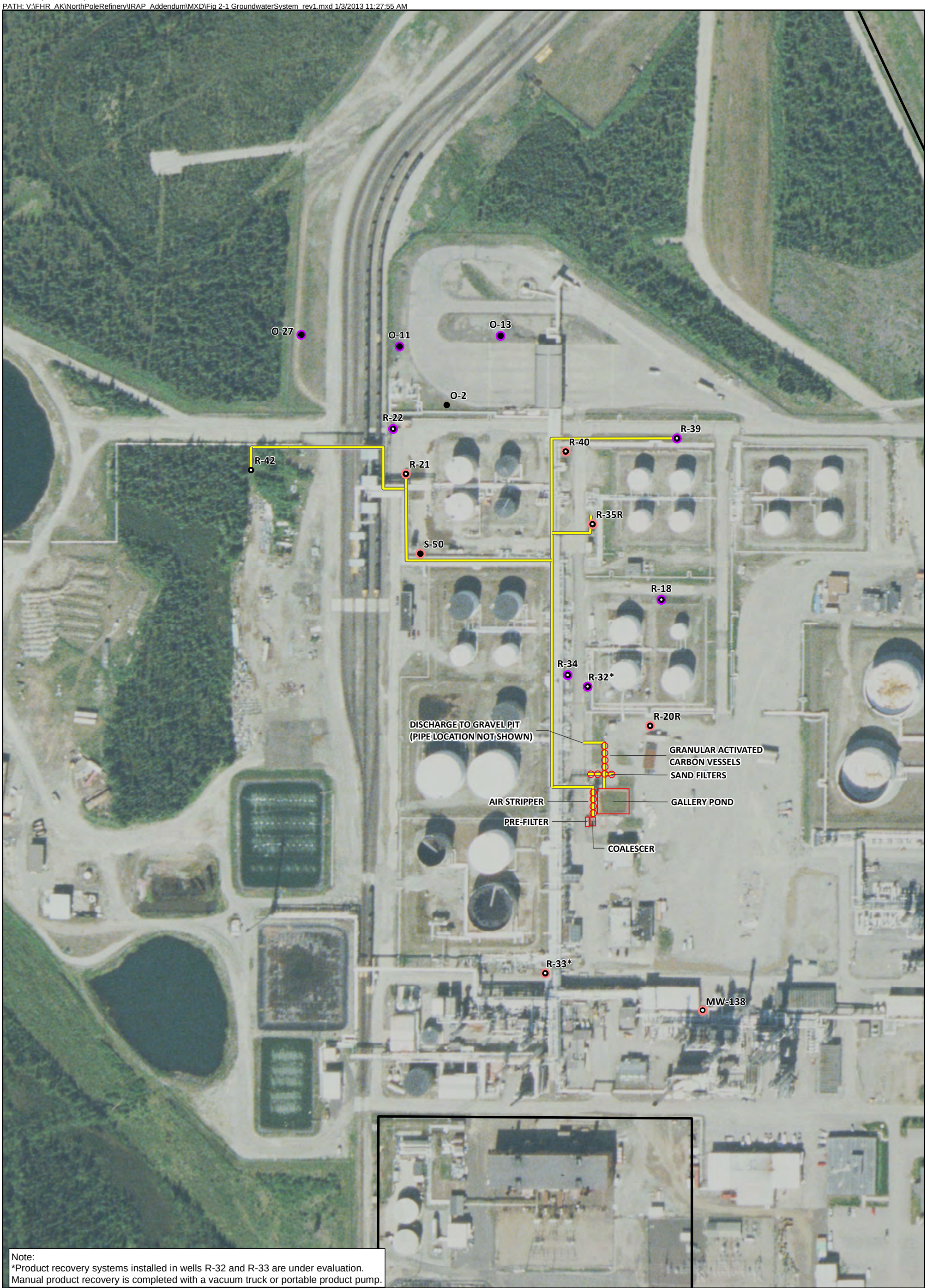
IRAP ADDENDUM

SITE PLAN - OFFSITE

ARCADIS

FIGURE
1-4

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 2-1 GroundwaterSystem_rev1.mxd 1/3/2013 11:27:55 AM



Note:
*Product recovery systems installed in wells R-32 and R-33 are under evaluation.
Manual product recovery is completed with a vacuum truck or portable product pump.

LEGEND

- Monitoring Well
- Recovery Well
- Observation Well
- Installed Product Recovery System
- Manual Product Recovery
- Remediation System Piping
- FHRA Property Boundary

0 200 400
SCALE IN FEET

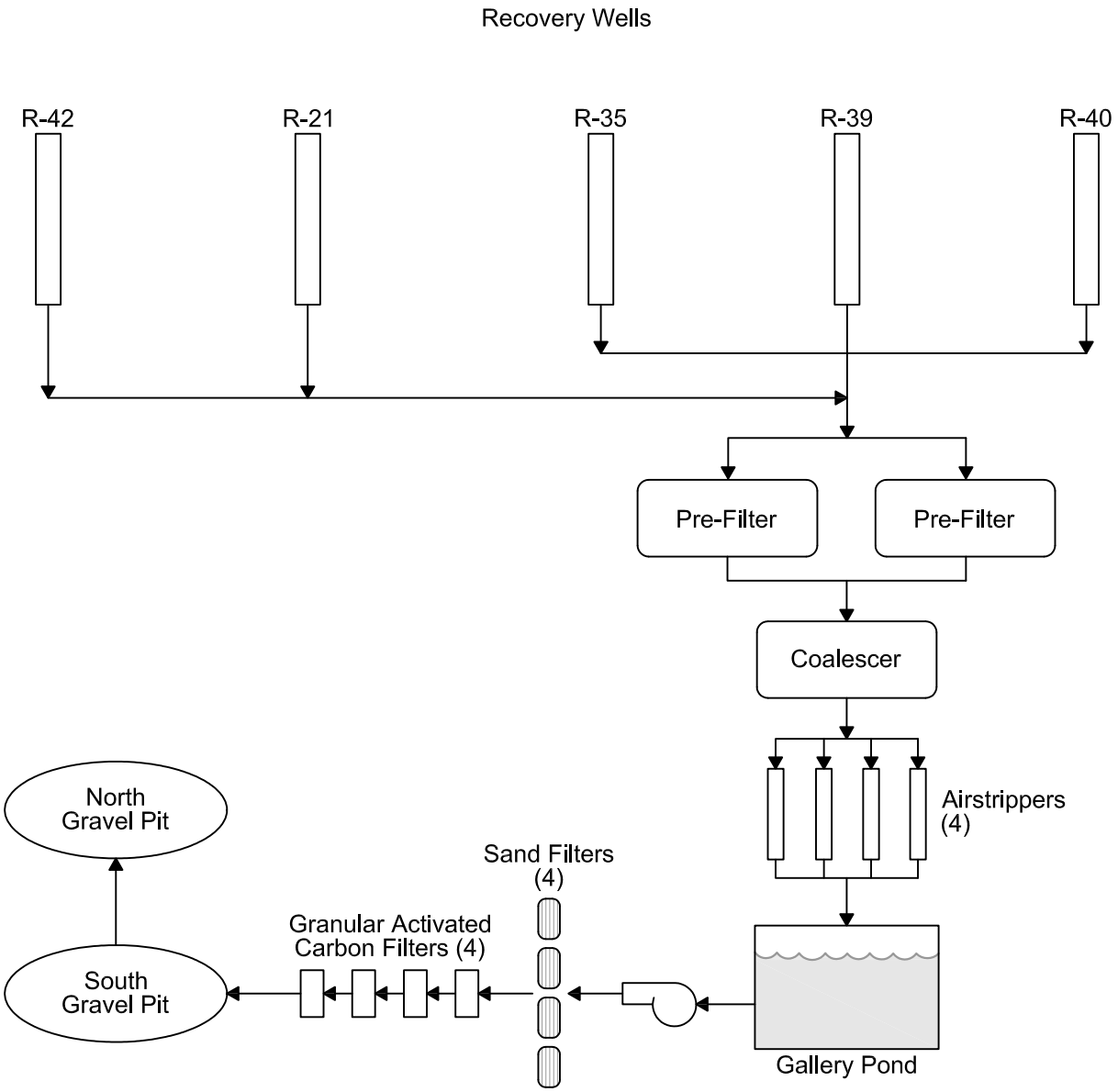
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

IRAP ADDENDUM

GROUNDWATER RECOVERY AND TREATMENT SYSTEM LAYOUT

ARCADIS

FIGURE
2-1



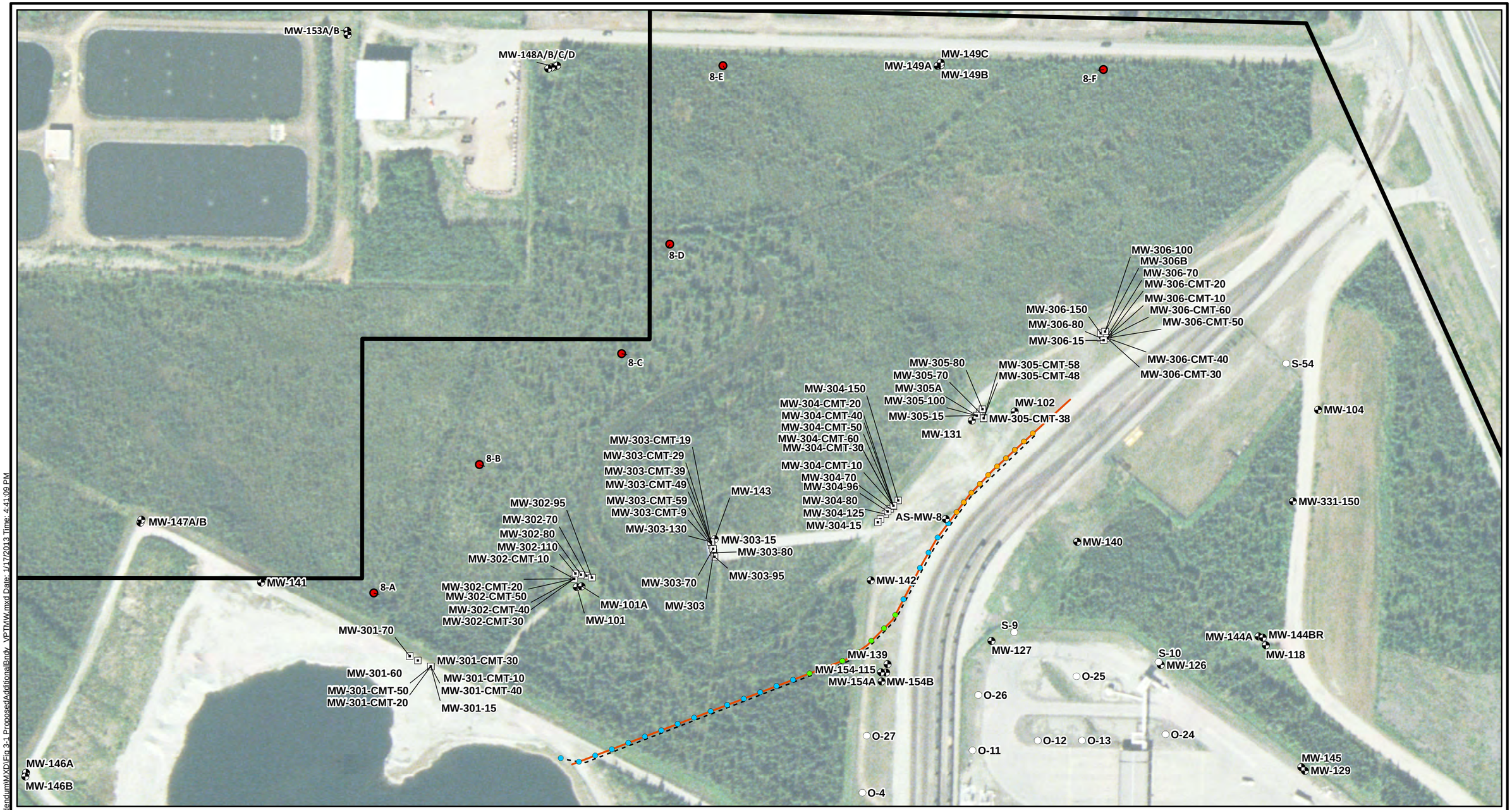
NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
IRAP ADDENDUM

**CURRENT PROCESS FLOW DIAGRAM-
GROUNDWATER CAPTURE AND
TREATMENT SYSTEM**

ARCADIS

FIGURE
2-2

CITY: PETALUMA, CA GROUP: ENVCAD DB: (P. WISTED), J. HARRIS
G:\ENVCAD\Petaluma\ACT\B0081981\0030\00001\DWG\81981T02.dwg LAYOUT: 2-2 SAVED: 1/4/2013 12:01 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: SETUP1 PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 1/17/2013 7:39 AM BY: HARRIS, JESSICA
XREFS: IMAGES: PROJECTNAME: ---
Fig 2-2 Process Flow Diagram_harris.jpg



Legend:

- Monitoring Well
- Observation Well
- Vertical Profile Transect Well
- Approximate proposed well locations
- Shallow Sparge Wells
- Intermediate Sparge Wells
- Deep Sparge Wells
- Air Sparge Barrier Cross Section
- Proposed Air Conveyance Piping Run
- FHRA Property Boundary

Note:
PF = Permafrost

0 200 400 Feet
GRAPHIC SCALE

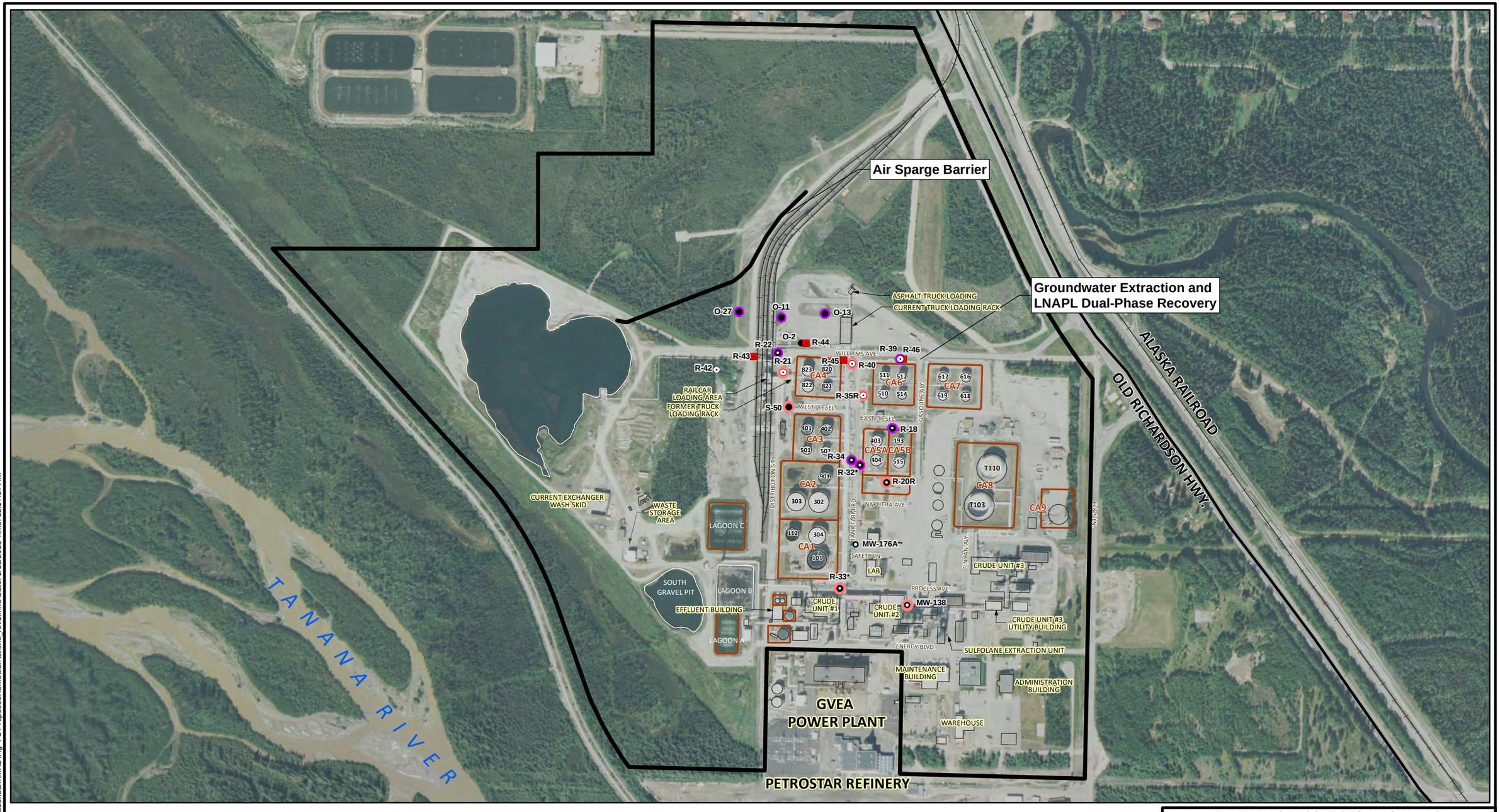
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
IRAP ADDENDUM

PROPOSED ADDITIONAL NORTH PROPERTY BOUNDARY AND VPT MONIORING WELLS

ARCADIS

FIGURE
3-1

CITY: SF DIV/GROUP: ENV/IM DB: BGriffith LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 3-1 ProposedAdditionalBndy_VPTMW.mxd Date: 1/17/2013 Time: 4:41:09 PM



Legend:

- Monitoring Well
- Recovery Well
- Observation Well
- New Extraction Wells
- Active Recovery Wells
- Manual Product Recovery
- Installed Product Recovery System
- Air Sparge Barrier
- Bermed Containment Areas (CA)
- FHRA Property Boundary

Notes:
*LNAPL recovery systems installed in wells R-32 and R-33 are under evaluation.
Manual product recovery is completed with a vacuum truck or portable product pump.
LNAPL = Light non-aqueous phase liquid
Image Date June 9, 2007

0 500 1,000 Feet
GRAPHIC SCALE

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

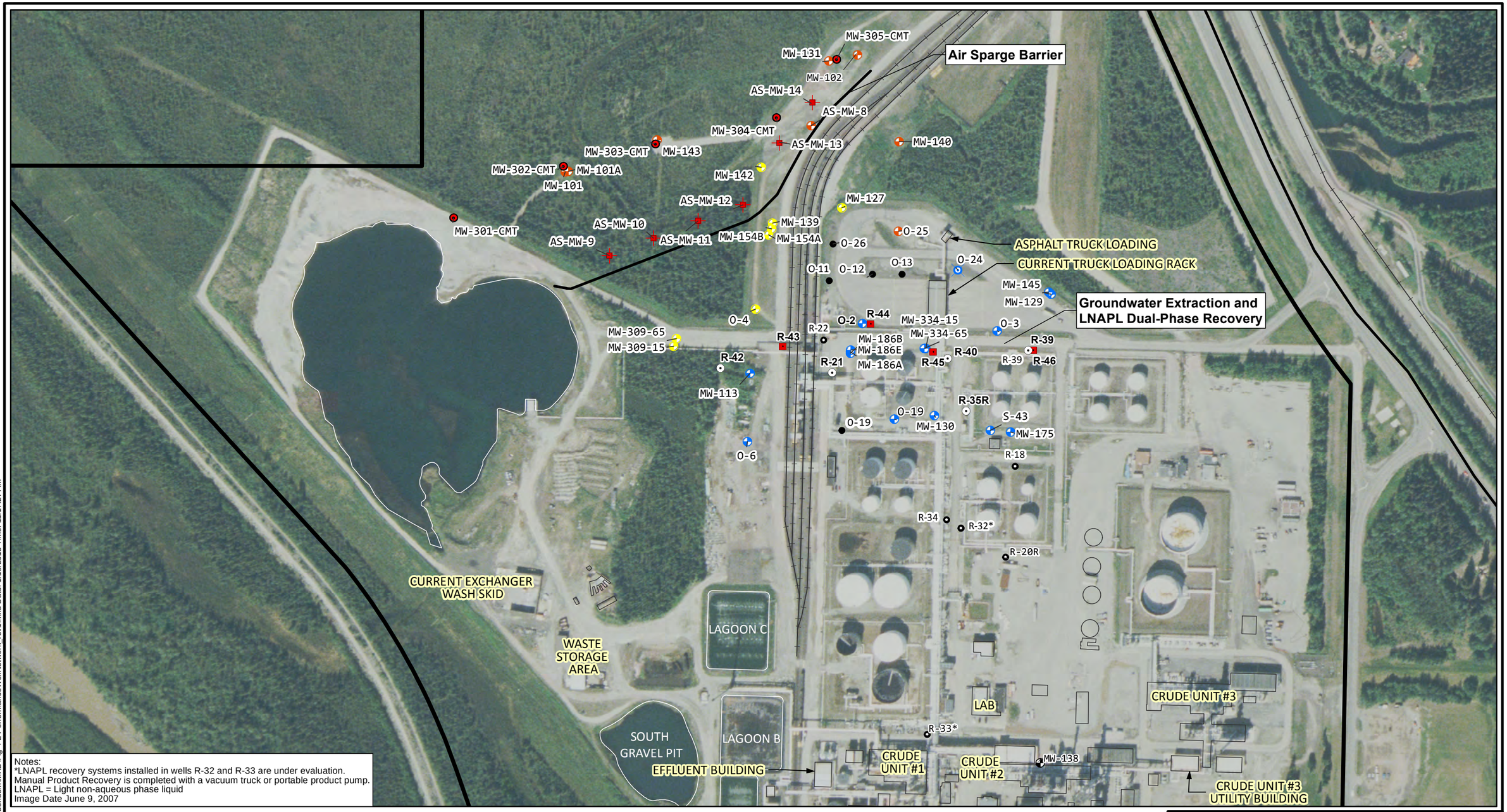
IRAP ADDENDUM

PROPOSED REMEDIAL ACTIONS

ARCADIS

FIGURE
4-1

CITY: SF DIV/GROUP: ENV/IM DB: K ERNST LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 4-1 ProposedRemedialActions_rev1.mxd Date: 1/18/2013 Time: 11:17:37 AM



Notes:
*LNAPL recovery systems installed in wells R-32 and R-33 are under evaluation.
Manual Product Recovery is completed with a vacuum truck or portable product pump.
LNAPL = Light non-aqueous phase liquid
Image Date June 9, 2007

Legend:

WELL TYPES
- EXISTING MONITORING WELL
- PROPOSED MONITORING WELL
- EXISTING WELL CLUSTER

PERFORMANCE MONITORING WELL NETWORKS
- GROUNDWATER EXTRACTION
- AIR SPARGE BARRIER
- GROUNDWATER EXTRACTION AND AIR SPARGE BARRIER

- Observation Well
- Recovery Well
- EXISTING RECOVERY WELLS
- NEW EXTRACTION WELLS
- AIR SPARGE BARRIER

0 300 600 Feet
GRAPHIC SCALE

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

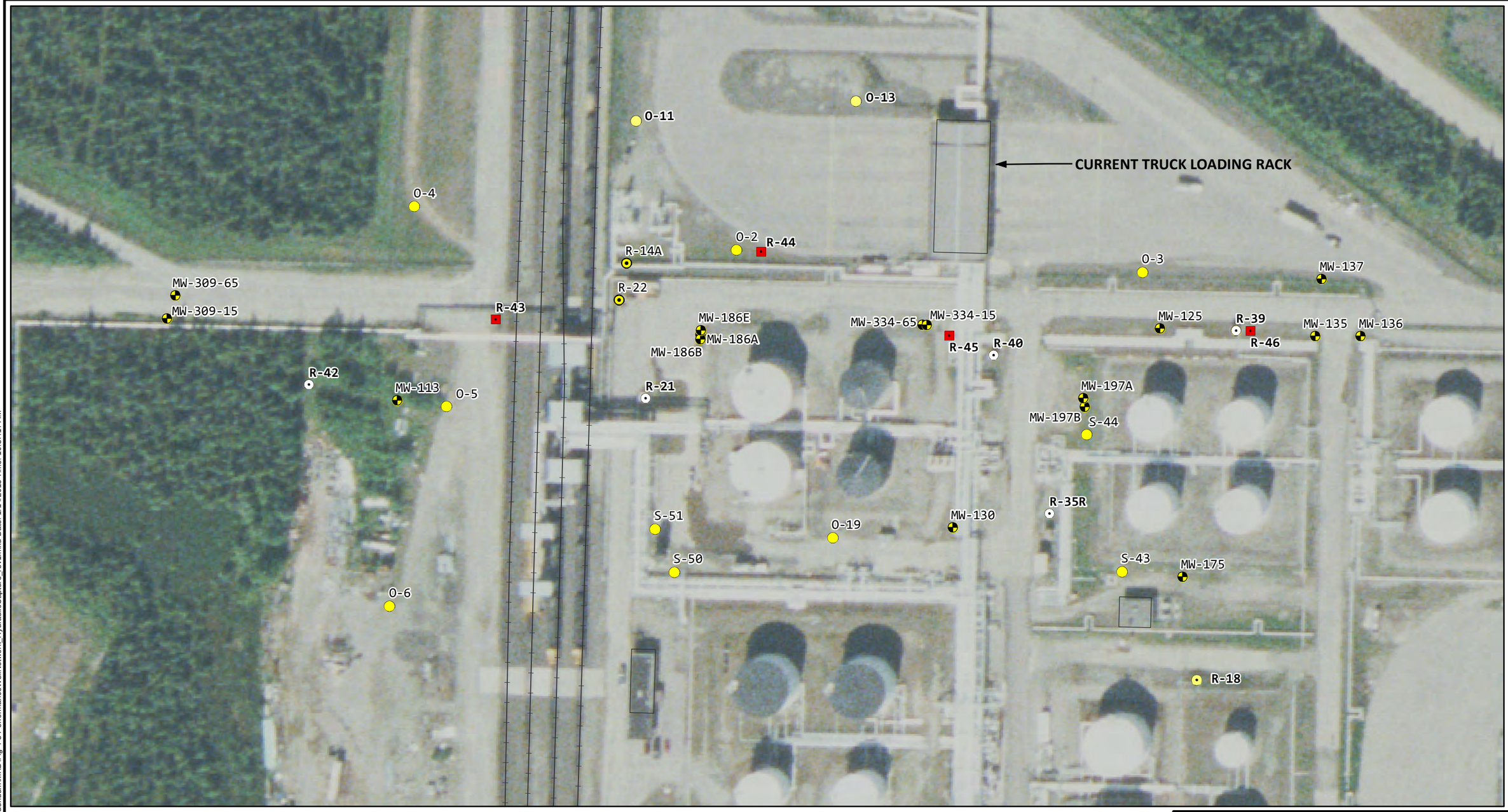
IRAP ADDENDUM

PERFORMANCE MONITORING WELL NETWORKS – SULFOLANE

ARCADIS

FIGURE
4-2

CITY: SF DIV/GROUP: ENV/IM DB: K ERNST LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_AddendumMXD\Fig 4-2 PerformanceWellNetwork_rev1.mxd Date: 1/18/2013 Time: 11:17:27 AM



LEGEND:

- MONITORING WELL
- OBSERVATION WELL
- RECOVERY WELL
- ACTIVE RECOVERY WELLS
- NEW EXTRACTION WELLS

Note:
Image Date June 9, 2007

0 100 200 Feet
GRAPHIC SCALE

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

IRAP ADDENDUM

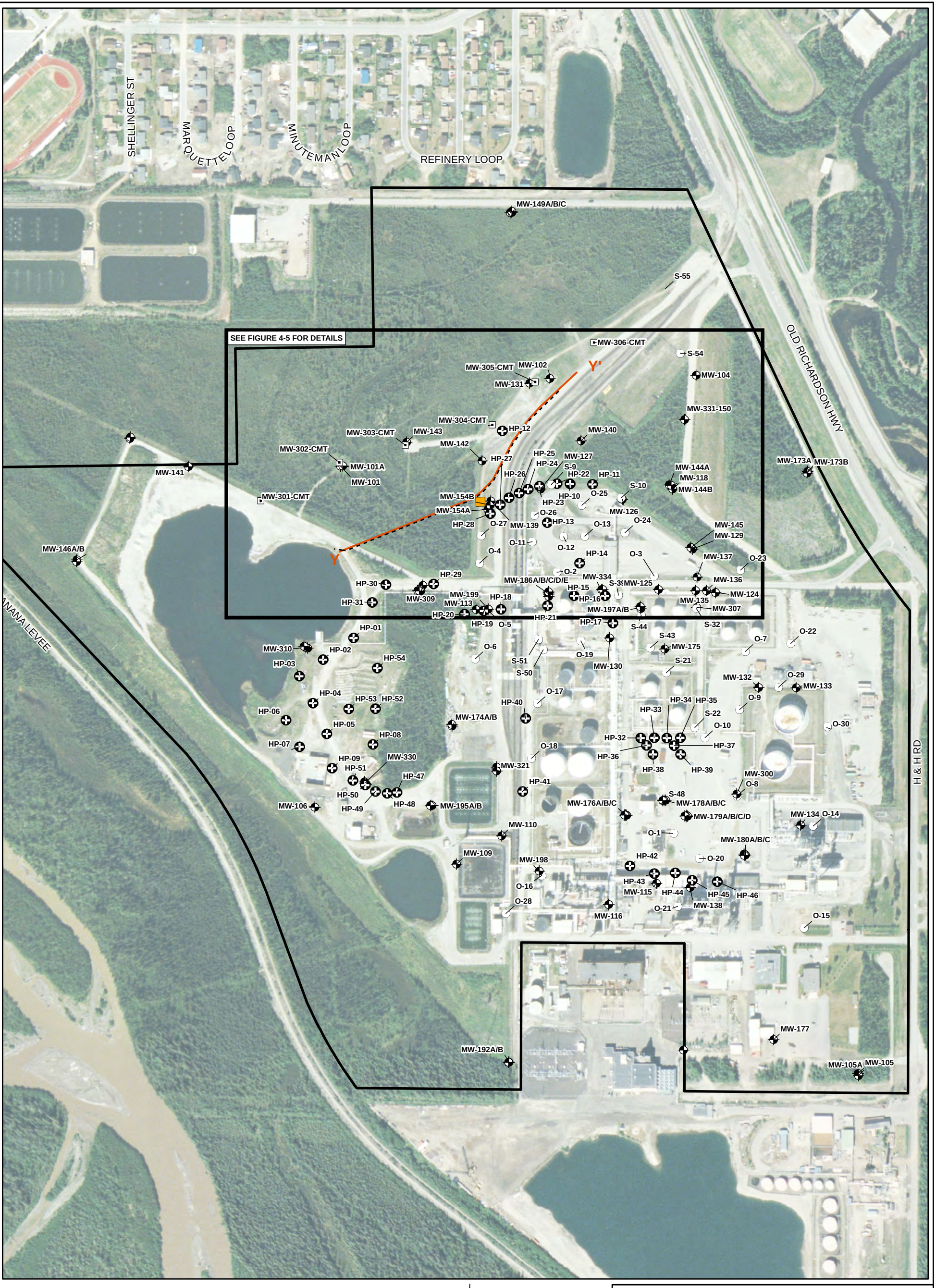
PROPOSED PERFORMANCE MONITORING WELL NETWORK - HYDRAULIC CAPTURE

ARCADIS

FIGURE
4-3

CITY: SF DIV/GROUP: ENV/IM DB: K ERNST LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 4-3 PerformanceWellNetwork_HydraulicCapture_rev1.mxd Date: 1/14/2013 Time: 10:37:17 AM

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 4-4 PlanViewProposedAS_BarrierSystem.mxd 1/14/2013 12:14:04 PM



Legend

- Hydropunch Location
- Monitoring Well
- Observation Well
- Vertical Profile Transect Well
- Air Sparge Barrier Cross Section
- Proposed Air Conveyance Piping Run
- Treatment Building
- FHRA Property Boundary

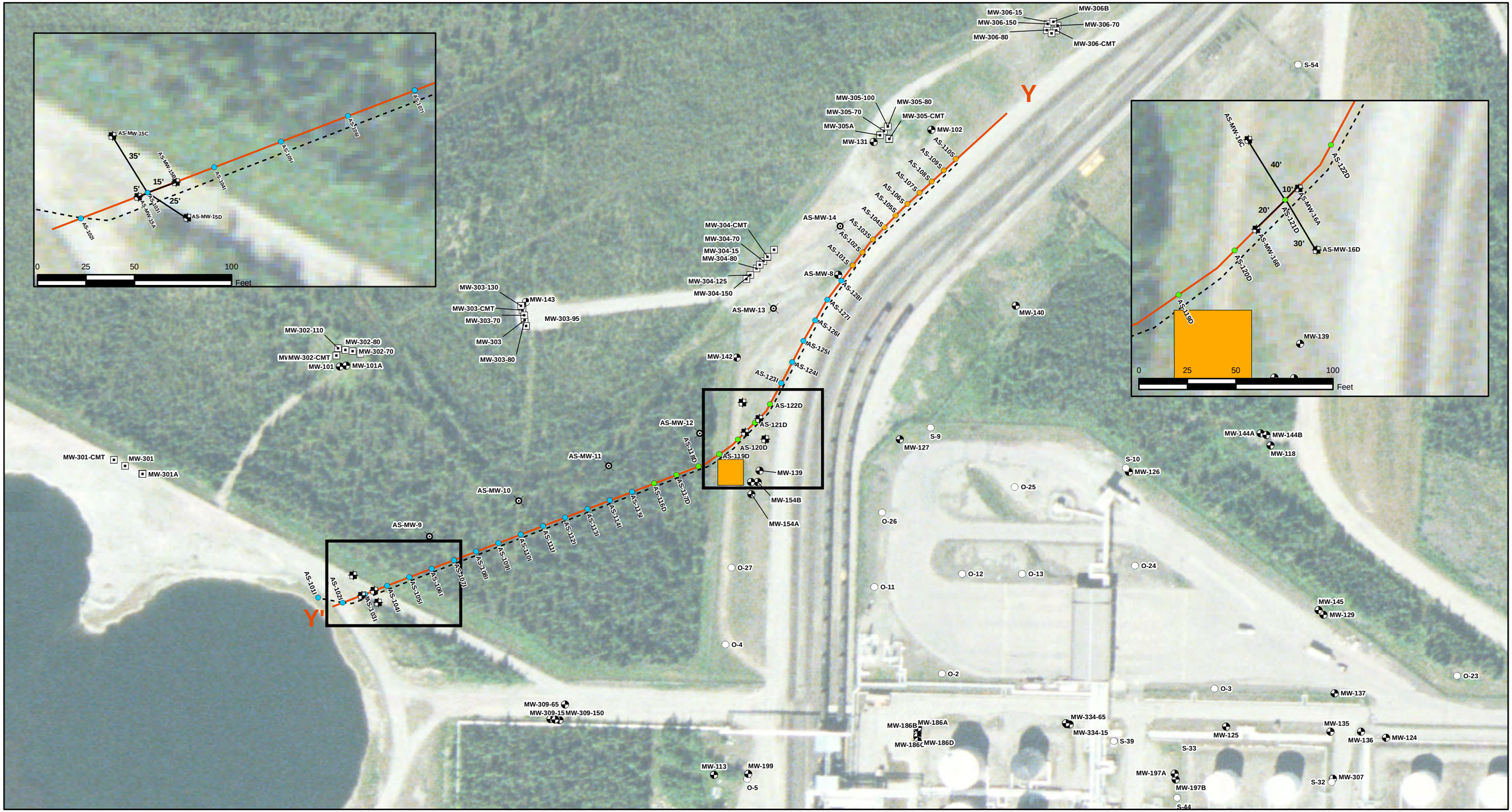
0 200 400 600 800
SCALE IN FEET

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

PLAN VIEW OF PROPOSED AIR SPARGE BARRIER SYSTEM

ARCADIS

FIGURE
4-4



Legend:

- Monitoring Well
- Observation Well
- Vertical Profile Transect Well
- Sparge Design Testing Monitoring Well Nest
- Air Sparge Monitoring Well
- Shallow Sparge Wells
- Intermediate Sparge Wells
- Deep Sparge Wells
- Air Sparge Barrier Cross Section
- Proposed Air Conveyance Piping Run
- Treatment Building

0 150 300 Feet
GRAPHIC SCALE

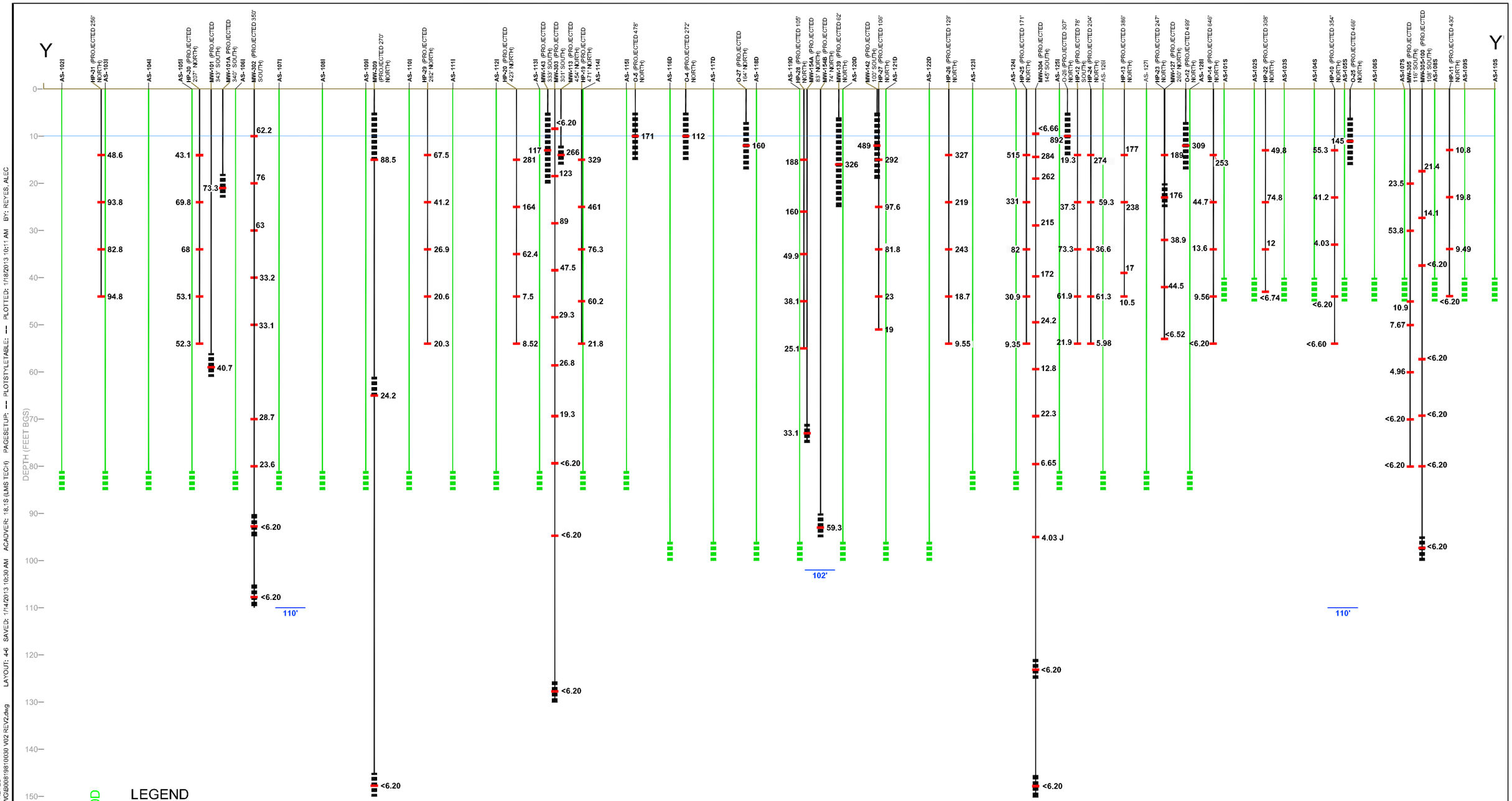
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
IRAP ADDENDUM

CROSS SECTION PLAN VIEW OF PROPOSED AIR SPARGE BARRIER SYSTEM

ARCADIS

FIGURE
4-5

CITY: SF DIV/GROUP: ENV/IM DB: BGriffith LD: G FRANCE PIC: PM: TM: TR:
Project (Project #) B0081981.0006.00001
Path: V:\FHR_AK\NorthPoleRefinery\IRAP_Addendum\MXD\Fig 4-5 Y-Y'CrossSection_ProposedASSystem_3.mxd Date: 1/17/2013 Time: 5:04:46 PM



LEGEND

AS-100D — WELL ID

GROUND SURFACE

DEPTH TO GROUNDWATER (FEET BELOW GROUND SURFACE)

AIR SPARGE POINT SCREEN INTERVAL

110' — DEPTHS AT WHICH PERMAFROST OBSERVED (FEET BELOW GROUND SURFACE)

11.5 — SULFOLANE CONCENTRATION (µg/L)

bgs — BELOW GROUND SURFACE

<6.20 — NOT DETECTED, VALUE LISTED IS LIMIT OF DETECTION

NOTES:

1. GROUNDWATER SULFOLANE CONCENTRATIONS FROM JUNE-AUGUST 2012 SITE CHARACTERIZATION ANDTHE HIGHEST DETECTION FROM FOUR QUARTERS OF GROUNDWATER SAMPLING (3RD QUARTER 2011 - 2ND QUARTER 2012)
2. BOLDED VALUES EXCEED ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION ALTERNATIVE CLEAN UP LEVEL FOR SULFOLANE (14 µg/L).
3. DEPTH TO WATER IS APPROXIMATE.

0 20' 40'
VERTICAL SCALE IN FEET

0 80' 160'
HORIZONTAL SCALE IN FEET

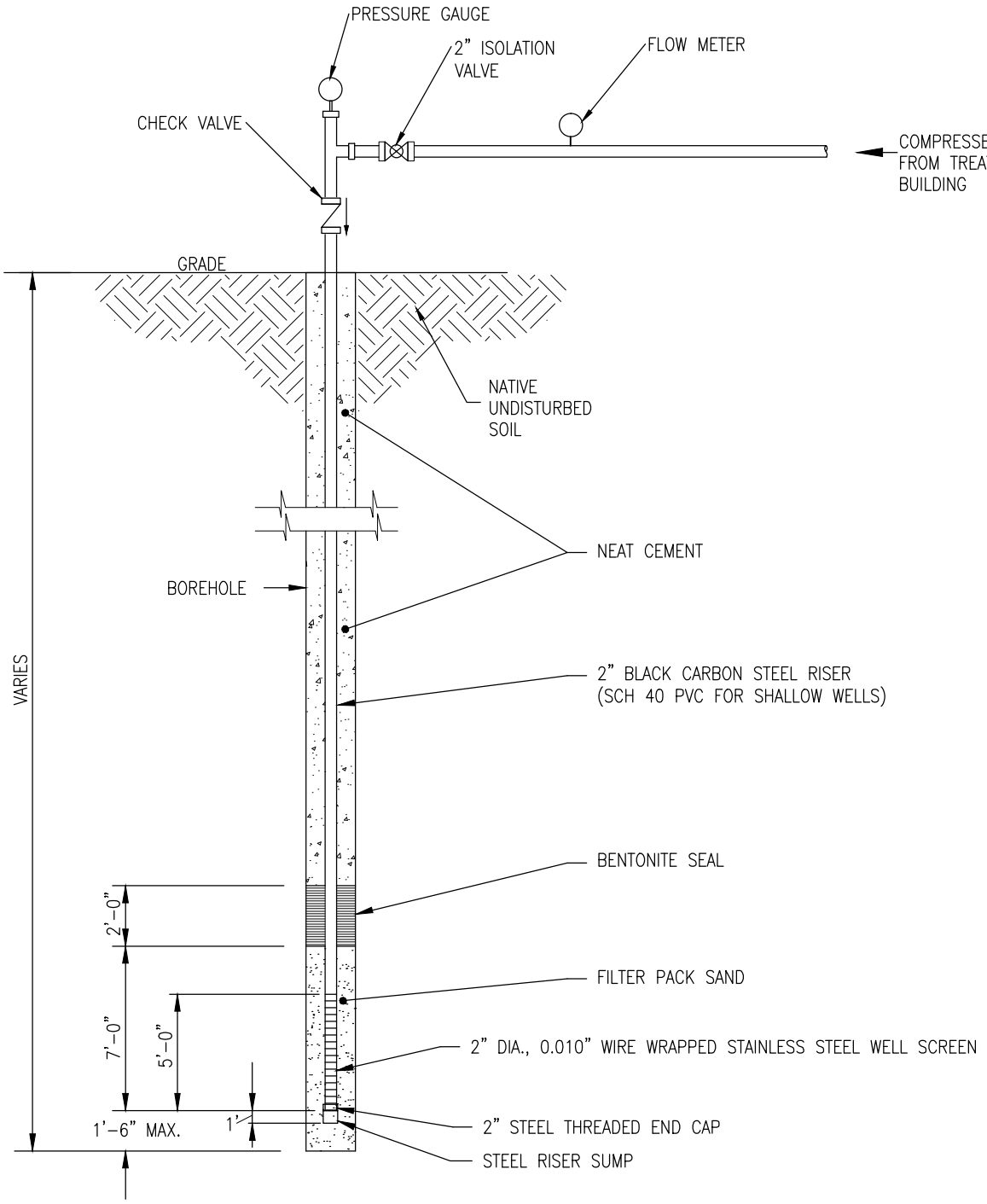
NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
IRAP ADDENDUM

AIR SPARGE BARRIER CROSS SECTION Y-Y'

ARCADIS

FIGURE
4-6

CITY: EMERYVILLE, CA DIV/GROUP: ENV DB: A. REYES
G:\ENVCAD\Emeryville\ACT\B0081981\0030\00001\DWG\B0081981\0030 V02 REV2.dwg LAYOUT: 4-6 SAVED: 1/14/2013 10:30 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/18/2013 10:11 AM BY: REYES, ALEC



TYPICAL AIR SPARGE WELL DETAIL

NOT TO SCALE

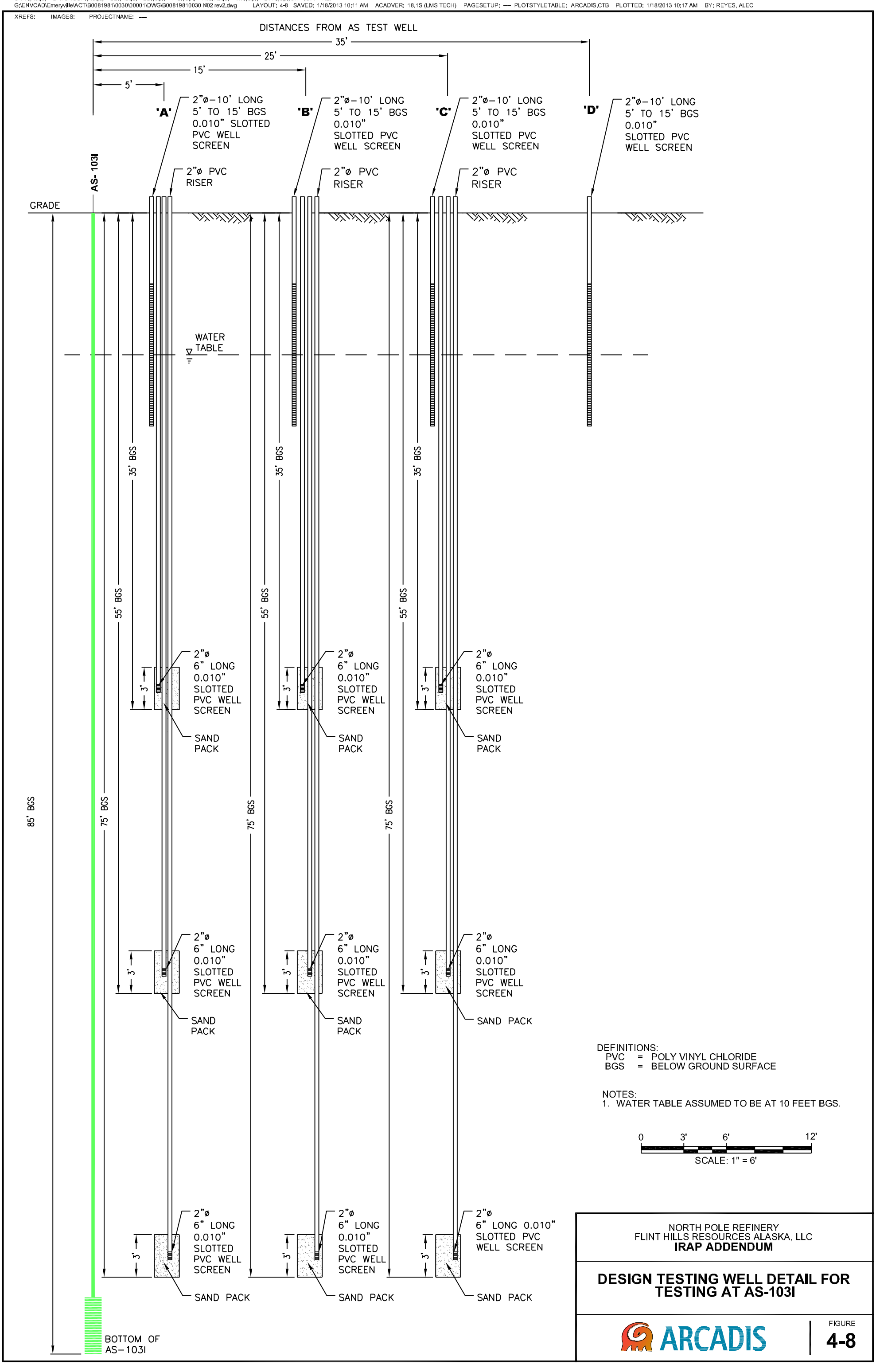
NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
IRAP ADDENDUM

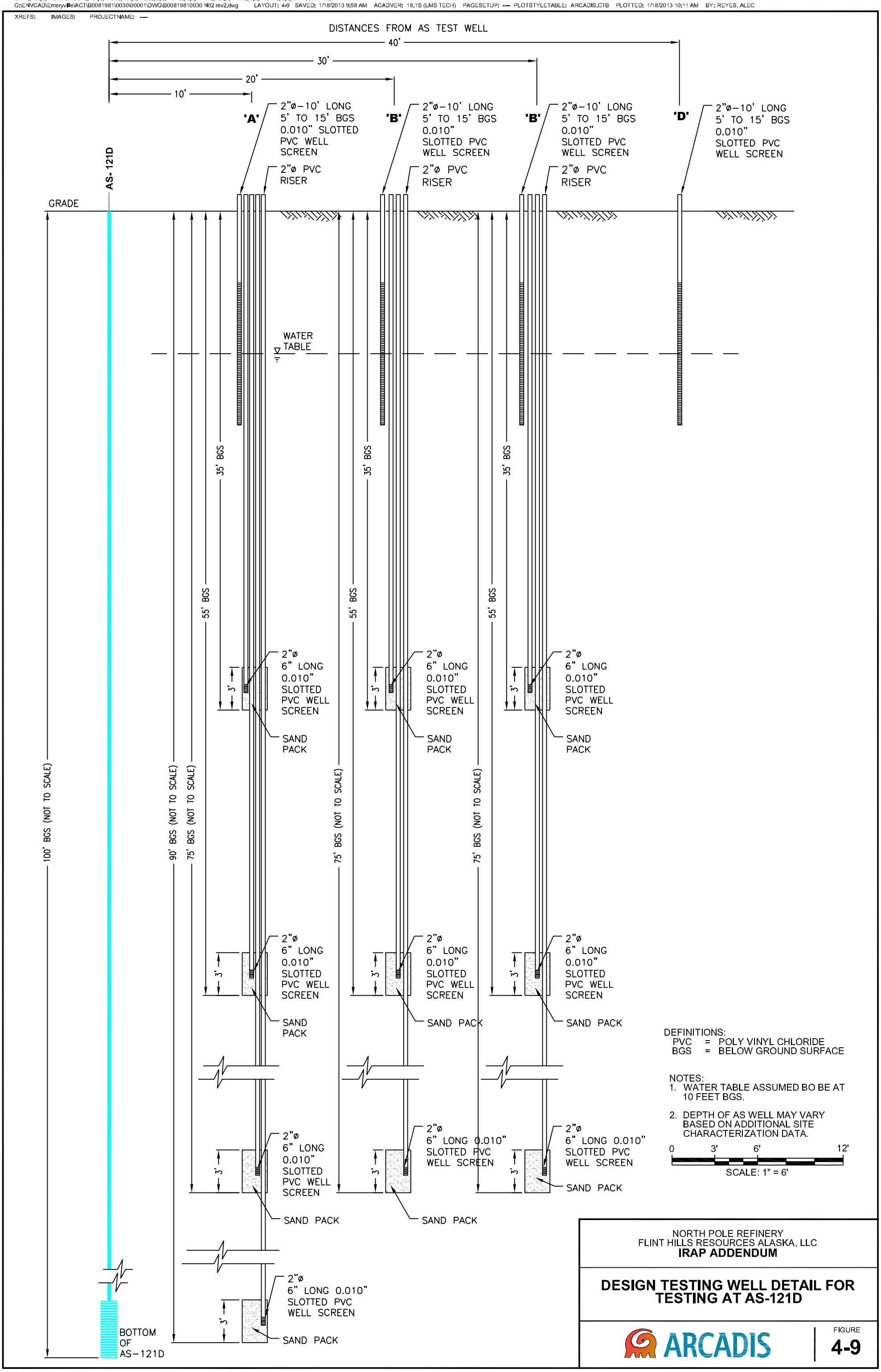
CONCEPTUAL AIR SPARGE WELL DETAIL

ARCADIS

FIGURE
4-7

CITY:COSTA MESA DIV/GROUP:ENV_CAD DB:ENV_CAD
G:\ENVCAD\Emeryville\ACT\B0081981\0030\00001\DWG\B0081981003 0 N01.dwg LAYOUT: 4-7 SAVED: 1/14/2013 10:32 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/18/2013 10:33 AM BY: REYES, ALEC


DISTANCES FROM AS TEST WELL
35'
25'
15'
5'
'A'
'B'
'C'
'D'
2"ø–10' LONG 5' TO 15' BGS 0.010" SLOTTED PVC WELL SCREEN
2"ø PVC RISER
AS-103I
GRADE
WATER TABLE
35' BGS
55' BGS
75' BGS
85' BGS
2"ø 6" LONG 0.010" SLOTTED PVC WELL SCREEN
3'
SAND PACK
BOTTOM OF AS–103I
DEFINITIONS:
PVC = POLY VINYL CHLORIDE
BGS = BELOW GROUND SURFACE
NOTES:
1. WATER TABLE ASSUMED TO BE AT 10 FEET BGS.
0 3' 6' 12'
SCALE: 1" = 6'
NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
IRAP ADDENDUM
DESIGN TESTING WELL DETAIL FOR TESTING AT AS-103I
ARCADIS
FIGURE
4-8


DISTANCES FROM AS TEST WELL
40'
30'
20'
10'
'A'
'B'
'B'
'D'
2"ø-10' LONG 5' TO 15' BGS 0.010" SLOTTED PVC WELL SCREEN
2"ø PVC RISER
AS- 121D
GRADE
WATER TABLE
35' BGS
55' BGS
75' BGS (NOT TO SCALE)
90' BGS (NOT TO SCALE)
100' BGS (NOT TO SCALE)
3'
2"ø 6" LONG 0.010" SLOTTED PVC WELL SCREEN
SAND PACK
BOTTOM OF AS-121D
DEFINITIONS:
PVC = POLY VINYL CHLORIDE
BGS = BELOW GROUND SURFACE
NOTES:
1. WATER TABLE ASSUMED BO BE AT 10 FEET BGS.
2. DEPTH OF AS WELL MAY VARY BASED ON ADDITIONAL SITE CHARACTERIZATION DATA.
0 3' 6' 12'
SCALE: 1" = 6'
NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
IRAP ADDENDUM
DESIGN TESTING WELL DETAIL FOR TESTING AT AS-121D
ARCADIS
FIGURE
4-9

Appendix **A**

NPR Facility Map

Appendix **B**

Current Conceptual Site Model

Appendix **C**

Remediation Well Installation
Technical Memorandum

Appendix **D**

Updated Air Sparge Pilot Test Report

Appendix **E**

Technical Memorandum – Potential Metabolites of Aerobic Sulfolane Biodegradation by Microorganisms

Appendix **F**

Technical Memorandum –
Toxicological Assessment of Potential Intermediates of Sulfolane Breakdown

Appendix **G**

Sulfur Hexafluoride Material Safety Data Sheet

Appendix **H**

Geotech Keck Spoiler Cut Sheet

Appendix I

Proposed Implementation Schedule