Figure 90
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90' BELOW THE WATER TABLE
FOURTH QUARTER 2010
North Pole Refinery
Flint Hills Resources Alaska, LLC

- Monitoring Well with Sulfolane Concentration (µg/L)
- City Well
- Approximate Sulfolane Isopleth in µg/L

Depth To Permafrost
- 0 - 24.9 Ft
- 25 - 49.9 Ft
- 50 - 74.9 Ft
- 75 - 99.9 Ft
- 100 - 124.9 Ft
- 125 - 150 Ft

- Aquifer Frozen at 55'
- Aquifer Frozen at 90'
- Below the Water Table
- FHRA Property Boundary

Sulfolane Concentration (µg/L)
- 118
- 59.0

Depth to Permafrost (feet BGS)
Figure 91
SULFOLANE CONCENTRATIONS IN GROUNDWATER
90-160' BELOW THE WATER TABLE
FOURTH QUARTER 2010
North Pole Refinery
Flint Hills Resources Alaska, LLC
Figure 92
SULFOLANE CONCENTRATIONS IN GROUNDWATER AT THE WATER TABLE FIRST QUARTER 2011 North Pole Refinery Flint Hills Resources Alaska, LLC

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

118 Sulfolane Concentration (µg/L)
J Estimated value
JL Estimated value, biased low
NS Not Sampled
Monitoring Well

Approximate Sulfolane Isopleth in µg/L

FHRA Property Boundary

Sulfolane Concentration (µg/L)

Estimated value

Estimated value, biased low

The analyte was not reported above the limit

of quantitation; however, the limit of quantitation
is estimated because ice was observed in the sample.

Not Sampled

Figure 93

SULFOLANE CONCENTRATIONS
IN GROUNDWATER

10-55’ BELOW THE WATER TABLE

FIRST QUARTER 2011

North Pole Refinery
Flint Hills Resources Alaska, LLC

MW-167B
MW-161A
MW-161B
MW-162B
MW-163B
MW-164B
MW-165B

MW-180B
MW-181B
MW-184
MW-185B
MW-187B
MW-188

MW-190B
MW-191B
MW-192B
MW-195B

MW-196B
MW-197B
MW-198
MW-200
MW-205

0 750 1,500 3,000 Feet
Figure 94
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90' BELOW THE WATER TABLE
FIRST QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC
Figure 95
SULFOLANE CONCENTRATIONS IN GROUNDWATER
90-160' BELOW THE WATER TABLE
FIRST QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Table: Sulfolane Concentrations

<table>
<thead>
<tr>
<th>Monitoring Well</th>
<th>Depth to Permafrost (BWT)</th>
<th>Sulfolane Concentration (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-167B</td>
<td>25-49.9 Ft</td>
<td>124.78</td>
</tr>
<tr>
<td>MW-164B</td>
<td>0-24.9 Ft</td>
<td>121.3</td>
</tr>
<tr>
<td>MW-169B</td>
<td>50-74.9 Ft</td>
<td>118</td>
</tr>
<tr>
<td>MW-162B</td>
<td>75-99.9 Ft</td>
<td>118</td>
</tr>
<tr>
<td>MW-163B</td>
<td>100-124.9 Ft</td>
<td>118</td>
</tr>
<tr>
<td>MW-165B</td>
<td>125-149.9 Ft</td>
<td>118</td>
</tr>
</tbody>
</table>

Legend:
- Monitoring Well
- City Well
- FHRA Property Boundary
- Aquifer Frozen at 55' Below the Water Table
- Aquifer Frozen at 90' Below the Water Table
- Sulfolane Concentration (µg/L)
- Depth to Permafrost (feet BGS)

*Extent of aquifer frozen at 160' below the water table is unknown.
Figure 96: Sulfolane Concentrations in Groundwater

**Sulfolane was analyzed by EPA Method 1625B with iso-dilution**
**Sulfolane was analyzed by EPA Method 1625B with iso-dilution**
Figure 98
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90’ BELOW THE WATER TABLE
SECOND QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC
Figure 100
SULFOLANE CONCENTRATIONS IN GROUNDWATER
10-55' BELOW THE WATER TABLE
THIRD QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution.
Wells were gauged for LNAPL July 14 and 15, 2011.
Figure 101
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90' BELOW THE WATER TABLE
THIRD QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution.
Wells were gauged for LNAPL July 14 and 15, 2011.
Figure 102
SULFOLANE CONCENTRATIONS IN GROUNDWATER
90-160' BELOW THE WATER TABLE
THIRD QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Monitoring Well
Depth to Permafrost (BWT)

- 0 - 24.9 Ft
- 25 - 49.9 Ft
- 50 - 74.9 Ft
- 75 - 99.9 Ft
- 100 - 124.9 Ft
- 125 - 149.9 Ft

City Well
FHRA Property Boundary

Aquifer Frozen at 55' Below the Water Table
Aquifer Frozen at 90' Below the Water Table
Sulfolane Concentration (µg/L)

<10.3

59.0 Depth to Permafrost (feet BGS)

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

Wells were gauged for LNAPL July 14 and 15, 2011.
Wells were gauged for LNAPL July 14th & 15th, 2011.

Sulfolane was analyzed by EPA Method 1625B with Iso-dilution.

Samples with duplicate data are represented by the greater of the two results.

Monitoring Well
Recovery Well
Observation Well

Figure 103
SULFOLANE CONCENTRATIONS
IN GROUNDWATER
AT THE WATER TABLE
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with Iso-dilution.
Wells were gauged for LNAPL, July 14th & 15th, 2011.
Plume delineation is based on historical data.
SULFOLANE CONCENTRATIONS IN GROUNDWATER
10-55' BELOW THE WATER TABLE
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Figure 104

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution.
Wells were gauged for LNAPL July 14th & 15th, 2011.
Plume delineation is based on historical data.
Figure 105
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90' BELOW THE WATER TABLE
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with isodilution.
Wells were gauged for LNAPL July 14th & 15th, 2011.
Plume delineation is based on historical data.

Sulfolane Concentration (μg/L)
Approximate Sulfolane Isopleth in µg/L
Depth to Permafrost (feet BWT)
Aquifer Frozen at 55' Below the Water Table
Aquifer Frozen at 90' Below the Water Table
Monitoring Well
City Well
FHRA Property Boundary

City Well
FHRA Property Boundary
Aquifer Frozen at 55' Below the Water Table
Aquifer Frozen at 90' Below the Water Table
Approximate Sulfolane Isopleth in µg/L
Sulfolane Concentration (μg/L)
Depth to Permafrost (feet BWT)
Monitoring Well
City Well
FHRA Property Boundary
Aquifer Frozen at 55' Below the Water Table
Aquifer Frozen at 90' Below the Water Table
Approximate Sulfolane Isopleth in µg/L
Sulfolane Concentration (μg/L)
Depth to Permafrost (feet BWT)
Monitoring Well
City Well
FHRA Property Boundary

Figure 105
SULFOLANE CONCENTRATIONS IN GROUNDWATER
55-90' BELOW THE WATER TABLE
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with isodilution.
Wells were gauged for LNAPL July 14th & 15th, 2011.
Plume delineation is based on historical data.
Figure 106
SULFOLANE CONCENTRATIONS IN GROUNDWATER
90-160' BELOW THE WATER TABLE
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with isodilution.
Wells were gauged for LNAPL July 14th & 15th, 2011.
Plume delineation is based on historical data.
SULFOLANE MASS FLUX RATES
North Pole Refinery
Flint Hills Resources Alaska, LLC

Figure 107

LEGEND:

CLUSTER WELLS
APPROXIMATE GW
GROUND SURFACE
MASS FLUX CONTOUR

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.
Figure 108

SULFOLANE CONCENTRATIONS IN GROUNDWATER FROM PRIVATE WELLS
North Pole Refinery
Flint Hills Resources Alaska, LLC
Figure 109
SULFOLANE CONCENTRATIONS IN GROUNDWATER FROM PRIVATE WELLS-
EXTENDED VIEW
North Pole Refinery
Flint Hills Resources Alaska, LLC

Private Wells
- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10 µg/L - 25 µg/L
- 25 µg/L - 100 µg/L
- Greater than 100 µg/L

Data through December 19, 2011
Figure 110
SULFOLANE CONCENTRATIONS IN GROUNDWATER
10-55' BELOW THE WATER TABLE
FROM PRIVATE WELLS
FOURTH QUARTER 2011
North Pole Refinery
Flint Hills Resources Alaska, LLC

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with Iso-dilution.
Wells were gauged for LNAPL July 14th & 15th, 2011.
Plume delineation is based on historical data.
Private well data from 2009-2011.