SITE CHARACTERIZATION ACTIVITIES
2008 – 2012

AIR NORTH/BEN LOMOND METRO FIELD PROPERTY
BLOCK 6, METRO INDUSTRIAL PARK
FAIRBANKS, ALASKA

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1.0 EXECUTIVE SUMMARY

This report documents site characterization activities performed from 2008 through 2012 at the Air North/Ben Lomond Metro Field (the Site) at 2209 Donald Avenue in Fairbanks, Alaska. The Alaska Department of Environmental Conservation (ADEC) File Number for this Site is 100.38.119. The only documented release of aviation fuel (AVGAS) from the Air North operation occurred in 1983. Air North ceased operations at the Site in the mid-1980s and the property was acquired and used by Ben Lomond, Inc to store equipment and building materials. A Site Characterization Report dated September 12, 2007 includes a detailed history of the site and documents the fieldwork and laboratory results from 2005 to 2007. This report documents the activities that were approved by ADEC in September 2008, as well as follow-up activities from 2009 through 2012. These activities include installation of an upgradient monitoring well, on and off site testing of drinking and groundwater monitoring wells, pilot-scale excavation and landfarm treatment of contaminated soil.

Three groundwater sampling events from 2008 to 2012 confirmed the 2005-2007 shallow groundwater data. Field observations and analytical results indicate the presence of two possible source areas: the 1983 release location near DP-21 and another location near DP-26. The hydraulic gradient was determined to be generally northwest, consistent with the regional hydraulic gradient.

Contaminants of concern (COCs) are consistent with AVGAS, with gasoline range organics (GRO), benzene, toluene, ethylbenzene, and total xylenes (BTEX), and 1,2-dibromomethane (EDB), above the ADEC cleanup levels in on-site groundwater near former source areas. Benzene is the best indicator compound and the only COC detected in groundwater in the off-site monitoring wells. Dissolved benzene contamination extends beneath approximately 4.1 acres of the Site and approximately 6.9 acres off-site to the west. Contaminant concentrations appear generally stable or decreasing site-wide. The existing 17 direct-push steel casings have become fouled and are no longer usable. These should be decommissioned and replaced with up to eight new direct-push pre-packed microwells as part of an approved long-term monitoring program at the Site.

Monitored natural attenuation is expected to be the primary remediation method for most of the area. Geochemical analysis in 2008 indicated the existing plume is anaerobic and biological degradation is occurring through iron reduction, sulfate reduction, nitrate reduction, and methanogenesis. Biological degradation will continue to effectively reduce dissolved contaminants across the plume. Confirmation of these geochemical results in the new monitoring wells and detailed trend analysis on contaminant concentrations are recommended to evaluate timeframe for remediation.

Active groundwater remediation in the source areas could be used to accelerate the pace of natural attenuation by removing contaminant mass from the source areas. Although small quantities of free product have been observed occasionally in DP 26 and

DP 29, recoverable product has not been observed in the recovery culvert installed near DP 26 in 2008. Free product was not observed in the 2012 sampling event and free product monitoring and recovery is not expected to be necessary as part of an active remediation effort. A few-day test of a mobile dual phase extraction (DPE) system was undertaken in October 2010 to evaluate water extraction at the recovery culvert. The DPE system was able to draw down the water level in the culvert approximately two feet and analytical results indicate that the treatment effectively removed a significant percentage of the COCs from groundwater. Based on these results, a DPE pilot study is recommended for up to two months under an approved work plan detailing specific operations and goals to further evaluate active remediation at the Site.

Continued testing of drinking water systems at the Badger Towing and Dave Bridges properties during the 2008 to 2012 period continues to show that off-site receptor exposure pathways have been eliminated. Results indicate that Badger Towing met the drinking water standards at the most recent test in 2008 and the owners have not permitted access for testing since that time. Water samples from the Dave Bridges system met the drinking water standards during this period. These unfiltered samples from deeper in the aquifer indicate that vertical mixing and transport is limited as well as confirmation that this potential exposure pathway has been controlled. Periodic testing of these wells with continued permission from the owners is recommended as part of the long term monitoring plan.

In addition to the potential for active groundwater remediation, a landfarm pilot project was undertaken to evaluate on-site, ex-situ treatment of contaminated gravel from the known source area near DP 21. Approximately 300 cubic yards of the estimated 1,500 cubic yards of gravel that could be excavated for treatment were excavated and placed in a landfarm in 2008. The depth of the excavation was limited to the gravel pad (2 -3 feet deep) because the native sand/silt below the gravel pad was not adequately stable for operation of the heavy equipment. Laboratory sampling at the limits of excavation confirmed elevated contaminant concentrations remaining in the sidewalls and bottom. Excavation of the sand/silt layer between the gravel pad and the top of the smear zone may not be possible.

The landfarm was covered during the winter and left open to the atmosphere during the summer. Fertilizer was added in 2008 and the material was mixed with a loader every year or two. Periodic field screening and laboratory results from the landfarm show contaminant concentrations in the landfarm dropped more than three orders of magnitude since 2008, but benzene remained slightly above the cleanup level in 2012. Once this material is tested to confirm it meets cleanup levels, the landfarm will be decommissioned with the gravel disposed of on Site. These results indicate that landfarming can be an effective treatment option for the gravel pad material that can be excavated. Future landfarm treatment should be completed under an approved work plan and additional fertilizer and more frequent mixing is expected to accelerate the time of treatment per landfarm cell.

2.0 PROJECT LOCATION AND HISTORY

2.1 Site Location and History

The Air North/Ben Lomond Metro Field property (the Site) is located in the SW ¼ of Section 21, Township 1 South, Range 1 West, Fairbanks Meridian (see Figure 1). The property is located in the Metro Industrial Park and consists of three lots (2, 3, and 14) on Block 5 and eight lots (1, 2, 3, 4, 13, 14, 15, and 16) on Block 6 as shown in Figure 2. Donald Avenue provides access to Block 5 lots on the north side and Block 6 lots on the south side. Air North operated on Block 6 lots and used the airstrip south of Block 6 during the 1970s and early 1980s as a commercial air facility. Air North went bankrupt around 1985. In 1986, Ben Lomond obtained the property from the Alaska Industrial Development Authority (AIDA). Transaction documents indicated Ben Lomond assumed the Air North loan from AIDA at this time with no specific documents regarding potential environmental concerns at the site. Around 1991, Ben Lomond transferred ownership to a subsidiary. Transaction documents included several pages generally indicating AIDA was not responsible for property environmental contamination that may be encountered, but these documents did not outline specific concerns.

Most structural development on the Site dates back to Air North operations. Two buildings are present on the property: a shop with a residential apartment on Lot 3, and a cold storage building on Lot 2. The building on Lot 3 was the Air North terminal and offices. The building on Lot 2 is assumed to have been storage or a hangar for small planes. The concrete pad of a former hangar is present on Lot 1. Ben Lomond has used the primary building as a shop and the remainder of the lots for storage of miscellaneous scrap materials, primarily metal, since acquiring ownership. A significant percentage of the scrap materials have been disposed or recycled since 2005.

ADEC documents indicated on May 3, 1984 Air North reported a small AVGAS spill on or about February 25, 1984. The release was attributed to a crack in an underground pipe fitting approximately 30 feet south of the main refueling island. The release was reportedly identified through periodic fuel system pressure testing. Less than 25 gallons was reportedly released, however more than 40 gallons of fuel were recovered by May 25, 1984. ADEC file photographs showed the release area near a round concrete pad. An undated hand sketch had a round object labeled “Fuel Island” located south of the eastern building.

Sporadic testing of two water wells (installed as drinking water wells during Air North operations) has taken place since 1984. Well testing appeared related to the use as a public water source by Air North. A 1987 lab report indicated benzene concentration was more than 300 times the cleanup level. Documents in the ADEC file from the early 1990s referred to violations and poor environmental conditions at a used oil/heat recovery operation on this or a neighboring property, however, the elevated benzene in the drinking water wells predated the used oil operation. The ADEC file was closed in the mid-1990s because of a lack of information, but ADEC reopened the file because the site had not been adequately characterized. In November 2004, Ben Lomond had the western drinking water well sample tested, and results exceeded the benzene cleanup level.

Between 2005 and 2007, ***NORTECH*** and Ben Lomond, Inc. completed initial characterization efforts at the Site. Activities included excavation and removal of several hundred feet of abandoned fuel line, installation and sampling of fourteen monitoring wells on and off the property, and identification and testing of drinking water wells located west of the property. The results were summarized in the September 2007 Site Characterization Report and indicated soil contamination was present in multiple locations from the former fuel system, groundwater contamination existed beneath the site and was migrating off-site, and drinking water wells at two off-site properties were impacted.

Off-site residents were advised of their properties' drinking water results. A filtration system and a new well were installed at the Badger Towing property. The new well was installed to approximately 110 feet deep, below the deeper permafrost layer. This met the drinking water standards and the filter system was removed. The adjacent property (Dave Bridges) also had detectable concentrations of benzene, but met the drinking water standards in 2007.

Concurrently, western property owner Great Northwest, Inc. (GNI) operated a gravel pit by pumping a large amount of groundwater (approximately 10 million gallons a day resulting in greater than 40 feet drawdown) for several years. Adjacent property owners raised concerns during the ongoing permit renewal including fear of potential contamination movement from the Ben Lomond property towards the gravel pit. ADEC requested additional characterization to document Site conditions and the potential for contaminant migration from the property. This pumping stopped in approximately 2008.

2.2 Local Geology and Groundwater Conditions

Local topographic maps place property elevation at approximately 440 feet above mean sea level. There is little topographic relief across most of the Site and surrounding area, except for water-filled gravel pits. Surface water elevation of the gravel pits is typically five to ten feet below the surrounding ground surface. The Site and surrounding properties have gravel surfaces placed over the native tundra. Site drainage appears to be primarily through infiltration and evaporation.

The Fairbanks area is in the Tanana Lowlands physiographic province, an arcuate band between the Alaska Range to the south and the Tanana upland to the north. The present day lowland consists of a vegetated floodplain, and low benches of the Tanana and Chena Rivers. Typical soils in the Tanana flood plain consist of several feet of silt, underlain by alluvial sands and gravels to a considerable depth. These granular deposits generally become coarser with depth, exhibit wide variability in structure and stratification, and apparently represent ancient glacio-alluvial deposition. Silt-filled swales and oxbow lakes generally represent former positions of rivers and streams. The thickness of alluvial sediments overlying bedrock in the region can be 400 to 500 feet. Lenticular deposits of silt, sand, and gravel produce a wide range of permeability and transmissivity rates.

Runoff from spring snowmelt and summer storms causes periodic flooding over parts of the floodplain, typically near creeks and sloughs. Levees about one-half mile south of the Site channel the Tanana River and protects the south Fairbanks area from flooding. The water table throughout the Tanana floodplain is shallow and usually 10 to 20 feet below the surface, depending on ground elevation and groundwater stage. Water table fluctuations of two to four feet are not uncommon during rapid recharge events.

Below flood stages, the Tanana typically acts as a recharge source for the area while the Chena River, located several miles to the north and west of the site, acts as a drain. Other groundwater recharge sources are snowmelt and precipitation. A United States Geological Survey (USGS) multi-year study in the 1990s showed area groundwater to flow generally northwest. Flow rate analysis by Army Corps of Engineers and USGS indicates groundwater flow is between 400 and 1,000 feet per day, with 400 feet per day commonly accepted in site-specific risk analyses. Transient effects are likely during periods of rapid water level elevation change. The local groundwater elevation should be substantially similar to water level changes in the gravel pit south of the Site.

Discontinuous permafrost exists throughout the Fairbanks area. Permafrost was documented in a number of deep drinking water wells 50 to 100 feet deep located along Peger Road and in the south Fairbanks area. Shallow permafrost was observed at depths up to 15 feet during development at several locations. Shallow permafrost is often thawed naturally by removing the vegetative mat. The deeper permafrost is generally not penetrated. New shallow permafrost growth can occur in heavily used and plowed driveways.

2.3 Previous Investigations in the Area

A number of known contaminated sites are present in the south Fairbanks area. Many are industrial or commercial sites with underground storage tanks (USTs) for heating oil. ADEC considered, but did not pursue, an area-wide study in the South Fairbanks area in the mid-1990s.

As part of the dewatering permit process, GNI was required to install several groundwater monitoring wells in the early 2000s. These were reportedly to evaluate drawdown of the aquifer resulting from dewatering activities. Two wells (G3 and G5) are situated within or near the edges of the benzene-contaminated groundwater and have been incorporated into the Air North investigation area.

2.4 Task Investigation Objectives

The September 2007 Site Characterization Report identified recommendations to continue the characterization and release investigation. ADEC concurred with most recommendations and requested several additional efforts in a letter dated December 19, 2007. A ***NORTECH*** August 2008 Work Plan (WP) outlined 15 tasks to address each of these concerns. ADEC agreed the technical approach to most concerns was appropriate while recognizing funding was limited. This scope was narrowed to specifically focus on work that could be completed in the fall of 2008, including the following:

September/October 2008

- Groundwater sampling
  - Analyzed Primary COC BTEX
  - Collected natural attenuation geochemisty parameters (DO, Fe^{2+}, S^{2-}, NO_3^-, SO_4^{2-}, Methane)
  - Collected field parameters (Temperature, Turbidity, pH, TDS, DO, ORP)
  - Installed upgradient groundwater monitoring well (DP 51)
  - Analyzed BTEX in Drinking water well samples
- Landfarm Pilot Project
  - Excavated 300 cubic yards of soil
  - Constructed a pilot-scale on-site landfarm
  - Collected five soil samples from the excavation
  - Collected seven soil samples from the landfarm

These activities were completed, but were not reported in 2008. Due to the lack of reporting, ***NORTECH*** and Ben Lomond continued the goals of the 2008 work plan with the following activities that are also discussed in this report:

September 2009 and 2010

- Groundwater sampling (2010)
  - Analyzed Primary COCs BTEX, GRO
  - Collected field parameters (Temperature, Turbidity, pH, TDS, DO, ORP)
- Landfarm field screening (2009 and 2010)
- Evaluation of DPE technology in the source area (2010)

September/October 2012

- Groundwater sampling nine monitoring wells
  - Analyzed Primary COCs BTEX, GRO
  - Collected field parameters (Temperature, Turbidity, pH, TDS, DO, ORP)
- Landfarm field screening and laboratory sampling

3.0 METHODOLOGY

NORTECH generally followed the UST Procedures Manual and Standard Sampling Procedures (SSP) during 2008 and 2010 activities and the 2010 Draft Field Sampling Guidance (FSG) during 2012 activities. In the case of differences between these guidance documents, ***NORTECH*** followed the methodology that had been used during previous activities at the site to maintain consistency and comparability of the site data over time.

3.1 Direct Push Well Installation (Task 8)

NORTECH contracted with Soils Alaska to install an upgradient steel direct push well (DP 51) similar to the other steel direct push wells at the Site. This consists of a 10-foot long, 1.25-inch diameter slotted galvanized screen with steel riser welded on in the field. The well was advanced until the screen was at the appropriate depth. Since this was driven directly with no drive casing, the pipe is directly sealed from the surface by the soil and no sand pack or bentonite seal is installed.

3.2 Groundwater Sampling (Tasks 4, 6 and 9)

In 2008, 2010, and 2012, ***NORTECH*** sampled both onsite and offsite groundwater monitoring wells using a peristaltic pump in accordance with the ADEC guidance documents. The initial step consisted of measuring the depth to water and depth to bottom in each well with an interface probe. These measurements were used to calculate the total volume of water in each monitoring well.

During purging with the peristaltic pump, the flow rate of the pump was adjusted to be approximately equal to or less than the recharge rates of the well so no bubbles were entrained in the tubing. A flow-through cell was connected to the pump outlet tubing and allowed to fill. Once filled, a Horiba U-22XD portable water quality monitor sensor was placed in the cell and the initial measurements for each parameter were recorded. The process was repeated at least two more times for each additional well volume passing through the flow through cell. The Horiba unit measured DO, pH, conductivity, turbidity, temperature, TDS, ORP and salinity.

Water samples for laboratory analysis were collected in acid-preserved containers provided by the laboratory. Sample containers were placed in a chilled cooler after sampling was complete and kept chilled until delivered to SGS Environmental Services in Fairbanks, Alaska. Samples were analyzed by the following methods:

- BTEX by EPA Method 8021B (2008, 2010, 2012)
- GRO by Method AK 101 (2010, 2012)
- Methane by EPA Method RSK-175 (2008)

During the 2008 groundwater monitoring event, geochemical parameters related to natural attenuation were measured by Shannon & Wilson personnel using a HACH colorimetric kit. Water samples were provided to the Shannon & Wilson personnel at the same time as the laboratory samples were collected. The HACH kit was used in accordance with the manufacturer's directions to measure nitrate, total iron, ferrous iron, sulfate, and sulfide.

3.3 Drinking Water Sampling (Task 10)

The approved work plan included periodic sampling of drinking water at the Badger Towing and Dave Bridges' properties. These samples were collected from raw water spigots installed prior to filters that were installed during previous activities at these properties. Water was purged from these sample locations through a hose to a sink or the exterior until the water temperature has stabilized indicating that water is representative of the groundwater conditions. The purge hose is then removed and samples are collected directly into laboratory-provided glassware. Samples are chilled until delivery to SGS Environmental Services in Fairbanks, Alaska. Samples were analyzed by the following methods:

- BTEX by EPA Method 8021B (2008, 2012)
- Ethylene Dibromide (EDB) using EPA Method 504.1 (2008)

3.4 Soil Field Screening (Task 12)

A PhotoVac 2020 Hand Held Air Monitor/photoionization detector (PID) was used to field screen soil for VOC contamination during excavation for the landfarm and subsequent evaluation of landfarm treatment progress. The PhotoVac-2020 is approved for use in Class 1, Division 2, Groups A, B, C, & D Hazardous Locations.

Headspace field screening by a PID involved measuring vapor concentrations generated by VOC contaminants in soil. The PID yielded real time (< 10 minutes) semi-quantitative concentrations for soil gas in reference to a certified isobutylene gas standard.

Important PhotoVac PID specifications are as follows:

Detection Limit:	0.1 ppm
Response Time:	Less than 5 seconds
Calibration:	Certified Isobutylene Standard (nominal 100 ppm)
Operating Temperature Range:	32 to 105^{o}F (0 to 40^{o}C)

PID calibration was performed in accordance with manufacturer's specifications and recorded in the field notebook. The PID calibration was checked at the beginning and end of the day.

The following field screening headspace method was used in general accordance with Section 5.1 of the approved 2008 WP, the SSP, and the FSG. Using disposable gloves, headspace screening consists of partially filling (33-50 %) a new re-sealable bag with freshly uncovered soil. Excavation equipment or a small digging tool was used to expose a minimum of six inches beneath the soil surface if the excavation is open for less than one hour. If the excavation was open greater than one hour a minimum of 18 inches is removed before sampling.

VOC vapors developed for at least 10 minutes and not more than one hour. The bags were agitated at the beginning and end of the headspace development period. The soil and headspace were tested at a minimum temperature of at least 40 degrees Fahrenheit (5 degrees Celsius), determined by touch, and sometimes require a brief warming period inside the field vehicle. A small opening was made in the top of the bag, the PID probe inserted into the headspace, and vapors drawn from the center above the soils. The highest reading from each sample was recorded.

3.5 Soil Laboratory Sampling (Task 12)

Soil samples were collected during construction and subsequent evaluation of the landfarm, including samples from the excavation limits, baseline sampling of the landfarm, and evaluation of the treatment progress. Samples were collected using hand equipment (such as shovels and picks) and disposable sampling equipment (such as gloves). Samples were containerized, chilled, and delivered to SGS Environmental Services in Fairbanks, Alaska. Samples were analyzed by the following methods:

- BTEX by EPA Method 8021B
- GRO by Method AK 101
- DRO by Method AK 102 (Location with highest field screening result)

In addition to these analytes, the sample with the highest field screening value during the 2008 landfarm baseline evaluation was also analyzed by the following methods:

- Polycyclic Aromatic Hydrocarbons (PAHs) by EPA Method 8270 SIMS
- Ethylene dibromide (EDB) using EPA Method 504.1
- RCRA 8 Metals by EPA Method SW 6020 and EPA Method SW7471B

3.6 Soil and Groundwater Contaminants of Concern

The initial project site cleanup goals were determined using ADEC’s Method 2, migration to groundwater for soil and ADEC drinking water standards for groundwater, as outlined in ADEC regulations (18 AAC 75.341, Tables B2 and C). The reported Site release was aviation gasoline, with GRO and BTEX as the primary contaminants of concern (COCs). GRO and BTEX soil and groundwater cleanup goals are summarized below. These results are also shown in the analytical summary tables in Appendix 2.

Soil and Groundwater Cleanup Levels

Compound	ADEC Method 2 Soil (mg/Kg)	ADEC Drinking Water (mg/L)
Benzene (B)	0.025	0.005
Toluene (T)	6.5	1.0
Ethylbenzene (E)	6.9	0.7
Total Xylenes (X)	63	10.0
Gasoline Range Organics (GRO)	300	2.2

Notes: mg/Kg = milligrams per Kilogram
mg/L = milligrams per Liter

3.7 Conceptual Site Model

The ADEC Contaminated Sites program requires the submission of site-specific Conceptual Site Model (CSM) with work plans and characterization reports. ADEC has developed a standardized form for the CSM that provides a relatively uniform way to organize and evaluate Site risks and risk reduction objectives. A draft conceptual site model (CSM) scoping form was completed and was provided in the 2007 Site Characterization Report and used to identify the pathways with the most significant potential exposures on and off the Site. An updated CSM reflecting the 2012 site conditions was developed based on the results presented in this report and is discussed in Section 8.6.

4.0 2008 AND 2009 FIELD ACTIVITIES

4.1 Groundwater Monitoring

On September 29, 2008, ***NORTECH*** mobilized in conjunction with Soils Alaska to install one additional steel monitoring well approximately 200 feet east of the former dispenser island (see Figure 3). The new well, MW 51, was developed by purging 13 gallons using a peristaltic pump and then allowed to equilibrate for the rest of the day prior to sampling. Well MW 51 and 16 of the existing wells were measured for depth to water and depth to bottom, purged, and sampled, as described in the work plan and methodology with the following observations and exceptions:

- Field monitoring parameters were collected during purging to verify groundwater conditions had stabilized. These are summarized in Table 6.

- Field duplicates were collected from MW 21 and MW 51. These were submitted blind to the laboratory as DP-20 and DP-50 respectively.

- A water level measurement and sample could not be obtained from MW 11 due to an obstruction above the water table. This well was considered no longer usable.

- Three MWs (01, 02 and 03) showed evidence of frost jacking since the 2006 wellhead elevation survey. MW 03 was not sampled due to inadequate water volume. This well was purged dry but did not recharge, possibly due to the water table beyond the screened interval, frost jacking, deposit accumulation or a combination of these factors. MW 30 was purged and sampled in lieu of MW 03 based on proximity.

- MW 26, MW 29, and the free product recovery culvert installed near MW 26 in late 2007 contained measurable quantities of free product using the interface probe. In MW 26, after removal of approximately one cup of free product, the well was purged three well volumes. No free product was detected when the well recharged. In MW 29, 0.01 feet of free product was measured with no product after purging. The recovery culvert had less than 0.01 feet of free product. Based on the lack of recharge of free product, MW 26 and MW 29 were sampled in accordance with the work plan.

- Soapy foam was observed in MWs 27 and 30. Water from these wells has very little surface tension, which makes collecting bubble-free VOAs for GOR/BTEX analysis very difficult.

- Shannon and Wilson measured geochemical parameters for evaluation of natural attenuation from wells 02, 21, 26, 28, 30, 43, 51, G3, and G5. These results are shown in Table 5. Methane laboratory samples were also collected from these wells.

NORTECH attempted to repeat the 2008 groundwater sampling event for BTEX in October 2009. Field observations indicated that the wells were either dry or frozen and depth to water measurements and/or water samples could not be obtained. This was assumed to be due to the onset of winter conditions. No groundwater sampling was completed in 2009.

4.2 Drinking Water Sampling

On October 8, 2008, ***NORTECH*** personnel collected drinking water samples from the David Bridges and Badger Towing properties. Purging and sampling was performed as described in the methodology and in the same manner as previous sampling events.

During sampling at Badger Towing, the owner indicated that he had not received the results from a sampling event during the previous winter. Additionally, the owner reported that the sampler had dumped the purge water on his steps, which had then frozen. The owner also expressed concerns that “the Government” would use the presence of contamination on the property “to take his property without compensation or recourse.” After the sampling was complete, ***NORTECH*** reviewed existing records and could not find any documentation of a field visit, sampling event, or laboratory results consistent with the work described, nor an employee matching the description provided by the owner. Due to these issues, the owner indicated it was unlikely that anyone would be permitted to collect another sample Badger Towing drinking water or perform additional work on the property in the future.

Drinking water sampling was not performed in 2009.

4.3 Soil Excavation and Landfarm Construction

Excavation Area
On October 8, 2008, Ben Lomond personnel at the direction of ***NORTECH*** excavated approximately 300 CY of contaminated soil from the fuel island source area just east of MW 21 using their loader. A shallow primary excavation averaged approximately three feet below ground surface (bgs) and was limited to the imported gravel pad. A much smaller secondary excavation was advanced in the center to seven feet bgs, extending through the imported gravel pad and into original soils. The native soil interface was marked by tight peaty silts with evidence of native surface vegetation buried beneath the imported gravel pad. A sour odor was observed becoming stronger with increasing depth below the surface, and was especially strong in the peaty soil at the original soil interface. The excavation was left open with the sides caved in and tires placed around

the depression. The excavation location, profile, field screening locations and results, and laboratory sample locations are shown in Figures 4 and 5.

Headspace samples were collected from 35 locations and analyzed with the PID following the standard methodology. Headspace sample locations and results are shown in Figure 5 and all but five exhibited elevated results. Based on these observations, clean limits were not obtained in any direction or depth within the excavation. Four laboratory samples were collected in the secondary center excavation along the sidewall at three, four, five and seven feet bgs. The field duplicate pair (EX3 and EX5) was collected at five feet bgs. Laboratory samples were collected and analyzed as described in the methodology.

Landfarm Construction and Baseline Sampling

As approved in the work plan, excavated soils were placed 18 inches deep on an unlined rectangular area near the former fuel dispenser island approximately 180 feet long by 35 feet wide. Once completed, a 6-mil polyethylene sheeting was used to cover the landfarm for the winter.

A 7-foot-by 15-foot grid was established on the landfarm for baseline sampling. Forty-eight screening samples were collected at approximately 12 to 18 inches below the surface (near the bottom of the landfarm) and screened with the PID using the headspace method. Locations and results are shown in Figure 6 and summarized in Table 16. Results ranged from 3.5 to greater than 2,000 parts per million (ppm). Six primary samples and one field duplicate were collected from the landfarm for laboratory analysis as described in the methodology. LF-5 was selected for analysis by AK Method AK102 DRO.

The landfarm grid was reestablished in September 2009 and the landfarm was re-screened in the same locations and at the same depth. Results ranged from 1.8 to 851 ppm and are shown in Figure 6 and summarized in Table 16. No laboratory samples were collected because some locations were obviously still above the ADEC cleanup levels.

5.0 2010 FIELD ACTIVITIES

5.1 Groundwater Monitoring

On September 27, 2010, ***NORTECH*** personnel mobilized to the site to perform a groundwater monitoring and sampling event as outlined in the 2008 work plan and following the methodology described above and used during previous sampling events. Using the 2008 groundwater results, ***NORTECH*** selected 10 groundwater monitoring wells to confirm conditions in the source area and plume edges (see Figure 3). The field inspection indicated that each well had water at the expected range, but recharge was limited to the point of not being able to sample in each well. Based on the age and construction of the wells, this was assumed to be related to scale/fouling of the slots. Each well was treated with a small amount (less than 3 cups) of acid and surged with a pressure block to remove the scale. Following this treatment, each well was purged of up to 5 well volumes or purged dry three times and allowed to equilibrate until September 29.

On September 29, 2010, ***NORTECH*** mobilized to the site to complete the groundwater sampling event. The ten wells were measured for depth to water and depth to bottom, purged, and sampled, as described in the work plan and methodology with the following observations and exceptions:

- The recharge rate in MWs 21, 28, 42, and 43 was insufficient to obtain adequate water to measure field parameters using the Horiba Meter, but the recharge was sufficient to collect water samples except from MW 42.

- Soapy film was observed in MW 27, which had very little surface tension.

- A sheen was observed from MW 26 on the surface of purged water, but no free product. No field parameters were collected.

5.2 Dual Phase Extraction System – Preliminary Evaluation

A ***NORTECH***-owned mobile dual phase extraction (DPE) system was brought to the site for troubleshooting and repairs in mid-September 2010. The system had been damaged during operation at another site and the Air North site provided the 3-phase power and large-diameter well necessary to diagnose and repair the unit. In addition, the contaminants at the Air North site were expected to be readily treated using the DPE system, which includes an air stripper for final water treatment. After discussions with Ben Lomond personnel, the system was connected to power in the cold storage warehouse and extracted water from the culvert near MW 26 (see Figure 4). Treated water was discharged to the surface in a depression excavated approximately 15 feet from the recovery culvert.

The DPE system was operated for several hours a day over a ten-day period and allowed to run overnight for one night in late September following repairs. The system ran for a total of 45-50 hours. During testing, the lid of the recovery culvert was sealed using spray foam insulation to allow the system to develop a higher vacuum and operate more efficiently. Water drawdown in the culvert was approximately 18 inches, which produced flow rates of approximately 5 – 7 gallons per minute. The evaluation was stopped due to continued problems with the vacuum pump on the DPE system. A water sample was collected from the influent and effluent sides of the air stripper to evaluate steady-state treatment on September 29 and analyzed for AK 101 GRO and Method 8021B BTEX.

5.3 Landfarm Evaluation

On September 30, 2010, ***NORTECH*** personnel established a 10-foot-by-12.5-foot grid on the landfarm, originating five feet from the south and east edge of the landfarm. Fifty-four screening samples were collected at the grid nodes, approximately 18 inches bgs and screened with the PID in accordance with the SSP and 2008 WP. Results ranged from 0.1 to 1,498 ppm, with all but three results under 4.0 ppm, as shown in Figure 6 and summarized in Table 16. No laboratory samples were collected because some locations were obviously still above the ADEC cleanup levels.

6.0 2012 FIELD ACTIVITIES

6.1 Groundwater Monitoring

On September 24, 2012, ***NORTECH*** personnel arrived on site to prepare for groundwater monitoring and sampling of the 10 MWs selected in 2010. Each well was inspected and purged to evaluate recharge rates based on the problems observed in 2010. During this inspection, MW 42 was observed to have frost jacked, with the riser almost seven feet above the ground surface. Additionally, 0.01 feet of free product was measured in MW 21 and 0.04 feet measured in MW 26. Most wells were either slow to recharge or were quickly purged dry. The recovery culvert remained sealed and was not inspected.

On September 27, 2012, ***NORTECH*** personnel returned to assess the recharge rate since September 24 and to clean the well casings using a wire bristle brush and one cup of acid. During water level monitoring, MWs 21 and 26 water were observed to have a sheen and odor but no free product. After cleaning, each well was purged to remove loosened scale and cleaning fluids, as well as determine if recharge was increased. Cleaning did improve function in most wells and each well was purged of up to five (5) well volumes or purged dry three (3) times and allowed to equilibrate for several days.

On October 3, 2012, ***NORTECH*** mobilized to the site to complete the groundwater sampling event. The ten wells were measured for depth to water and depth to bottom, purged, and sampled, as described in the work plan and methodology with the following observations and exceptions:

- The recharge rate in MW 42 and 43 were insufficient to obtain adequate water to measure field parameters using the Horiba Meter, but the recharge was sufficient to collect a water sample in both wells.
- Recharge rates in MWs 21, 27, 28 and 51 were sufficient for only one or two measurements with the Horiba Meter prior to sampling
- Soapy film was observed in MW 27, which had very little surface tension.
- No sheen was observed on any of the wells.

6.2 Drinking Water Sampling

On September 26, 2012, ***NORTECH*** personnel collected drinking water samples from the David Bridges property. Purging and sampling was performed as described in the methodology and in the same manner as previous sampling events. Badger Towing was contacted and confirmed their 2008 statements that drinking water sampling would not be permitted.

6.3 Landfarm Evaluation

On September 24, 2012, ***NORTECH*** personnel laid out a 10-foot-by-10-foot grid on the landfarm, starting approximately five feet from the end and ten feet from side. Fifty-four screening samples were collected at approximately 18 inches bgs from the landfarm and screened with the PID. Results ranged from 0.2 to 14.3 ppm, with all but two results under 6.5 ppm as shown in Figure 6 and summarized in Table 16. The highest field screening results were significantly lower than previous sampling events and within the range expected for successful treatment. Based on these observations, four primary and one duplicate lab sample were collected from the landfarm and analyzed for AK 101 Method GRO and Method 8021B BTEX.

7.0 RESULTS

Summary tables for each of the soil and groundwater sampling events from 2008 through 2012 and are located in Appendix 2. Appendix 2 also contains historic summaries of groundwater, drinking water, and landfarm results. Complete copies of the SGS laboratory reports are included in Appendix 5. ADEC Laboratory Data Review Checklists (LDRCs) for these lab reports are located in Appendix 5. The table below provides a cross reference for the figures (Appendix 1) and tables (Appendix 2) presenting data by media and sampling event. Major data quality concerns are also identified, while specific details regarding other minor concerns can be reviewed in the individual LDCRs.

7.1 Results Summary

Description	APPENDIX 1	APPENDIX 2
Groundwater COC Results by Year	Figure 3	Tables 1 – 3
Drinking Water Results and QA/QC 2005-2012	NA	Tables 4-6
Historic Groundwater Results Summary 2005-2012	NA	Table 7
Groundwater Natural Attenuation Data 2008	NA	Table 8
Water Quality Field Parameters 2008-2012	NA	Tables 9-11
Dual Phase Influent/Effluent Results, 2010	Figure 4	Table 12
Excavation Soil Results 2008-2012	Figures 5	Table 13
Landfarm COC Results by Year	Figure 6	Tables 14-15
Landfarm PID Results Summary	Figure 6	Table 16

7.2 Quality Control Summary

Nine field duplicate pairs were collected for groundwater, drinking water, and soil characterization efforts from 2008 through 2012. This met the minimum of one field duplicate pair for each 10 primary samples. The only sampling set that did not have a field duplicate was the DPE system evaluation because this was considered a preliminary evaluation. The field duplicate quality control summaries are shown in each table with the respective laboratory results. The relative percent differences (RPD) in each sample pair was acceptable (less than 50%); except for total xylenes that was 69% in the excavation soil samples duplicate pair (Ex-3/Ex-5). This was believed to be related to the natural heterogeneity of the contaminant distribution in the soil. The field duplicate pair results were above the cleanup levels for each COC, so the results are considered adequate to confirm the soil conditions at this location.

Other QA/QC parameters were evaluated using the ADEC LDCRs, which were completed for each laboratory report. These are presented in Appendix 5 following the laboratory reports in Appendix 5. No significant quality control issues were noted during the review of these reports and completion of the LDCRs. A few minor quality control issues, such as method blank or surrogate recovery concerns, were noted in the 2008 soil samples, mostly related to the samples that had results well above the cleanup levels. All data was considered usable for the purposes described in this report.

8.0 ANALYSIS

Contamination at the Air North / Ben Lomond Metro Field property dates back to at least the early 1980s when the facility was used for commercial air transport services, including passenger terminals, aircraft refueling, and aircraft maintenance. Ben Lomond, Inc. acquired the property in the late 1980s and has used the property as a storage and maintenance facility to support construction activities. ***NORTECH*** has been working with Ben Lomond to delineate contamination and reduce potential human exposure since 2005. Most of this work was completed from 2005 to 2007 and documented in a report from September 2007. In 2008, a work plan was approved to continue groundwater sampling and treat contaminated soil using landfarming and those activities have been continued through 2012. The section discusses the 2008 – 2012 activities and provides a discussion of these results in the context of the previously completed work and the updated CSM, which is discussed in more detail in Section 8.6.

8.1 Sources, Source Control, and Free Product

8.1.1 Primary Source(s)

Overall, the primary sources of the contamination are believed to be the former Air North storage tanks, buried distribution system, and refueling activities. Additional sources, such as spills during maintenance activities during Air North operations, are not expected to be significant relative to the refueling systems. As of 2008, all identified buried piping runs have been removed and the piping system extent coincides reasonably well with groundwater contamination. Review of historic air photos has not been able to positively identify the bulk storage tank(s), but the piping and contamination suggest the tank(s) were aboveground at the known ends of the piping system.

Additional potential sources from Ben Lomond operations included aboveground storage tanks, stored materials, and stored vehicles. As of 2008, the aboveground tanks (most of which were not used) and most materials and vehicles had been removed from the site. Based on the data available, the sources are documented adequately and are no longer contributing to groundwater contamination. No aboveground sources remain on the site and additional investigation for buried sources (piping and tanks) is not considered necessary.

8.1.2 Secondary Sources

Secondary source soil associated with the buried piping system is present across the site as mapped in 2005-2006 and remains in place. Analytical samples collected during piping removal and the shallow portion of the excavation for the pilot landfarm indicate that the concentrations of most COCs in the gravel pad (approximately 2-3 feet thick) are less than one order of magnitude above ADEC cleanup levels. Due to the large area of the piping system, approximately 1500 cubic yards of contaminated gravel pad are present, but low concentrations indicate the contamination in the gravel pad is a relatively minor concern in relation to groundwater issues.

The gravel pad was installed over the original tundra/vegetation surface, which covered the native sandy silt across the Site. The landfarm excavation shows that these finer materials, starting 2 – 3 feet below the existing ground surface, have significantly higher concentrations of most COCs. The extent of contamination in this sandy silt is expected to be in the areas beneath the former piping system, and the total quantity is estimated to be approximately 1,500 cubic yards, similar to gravel pad. Multiple test pits and the pilot landfarm excavation have shown that this material has very little weight bearing capacity and significant sloughing occurs once the excavation reached the water table. The relative concentrations of COCs suggest that this soil has at least 10 times the contaminant mass as the gravel pad, but the depth and composition of this material make excavation for remediation difficult. Additional characterization through soil borings and/or pilot projects will be necessary to evaluate the need and potential success of remediation methods for this material.

8.1.3 Free Phase Petroleum

Small quantities of free product have been observed in a couple of wells on a few occasions. In September 2008, MW 26, MW 29, and the free product recovery culvert (near MW 26) contained measurable quantities of free product. Each of these is in the general vicinity of the Cold Storage building. In MW 26, after free product removal, the well was purged three well volumes. No free product was detected when the well recharged. In MW 29, 0.01 feet of free product was measured with no product after purging. In the recovery culvert, only a small amount was removed and product did not recharge. In September 2010, MW 26 was noted with a sheen on the surface but no free product was measured. In 2012, during initial water level monitoring and purging on September 24, 0.01 feet of free product was measured in MW 21 and 0.04 feet measured in MW 26. This was product was purged with the water in the structure. On September 27, 2012, prior to cleaning, MW 26 was noted with a sheen and odor but no free product. The total quantity of free product removed to date is less than two cups.

MW 26 and MW 21 have historically shown the highest concentrations of dissolved contaminates, making these locations the most likely to have residual product in the smear zone soils that can become slightly mobile during annual groundwater fluctuations. These observations are consistent with other contaminated sites at which small amounts of residual product accumulate in monitoring well structures between annual sampling events. The consistent lack of free product recharge after purging indicates the well slots act as a one-way filter for free product over the time between sampling events and/or during unusual groundwater conditions.

Based on these observations, recoverable free product is not believed to exist at the Site. Free product should be noted removed from wells when observed during groundwater monitoring or sampling. Free product recovery is not expected to have a significant impact on the overall cleanup at the site and will not be a cost effective means to accelerate the pace of soil or groundwater remediation. A program specifically to monitoring and/or recover free product is not recommended.

8.2 Contaminants of Concern (COCs)

Historical records indicate aviation fuel is the petroleum product that was used the most at the Site and was documented to have been released. In addition to free or residual product, ADEC guidance indicates the potential COCs for a release aviation fuel are GRO, BTEX, PAHs, and lead. In addition, ADEC requires analysis for lead scavenger EDB for sites involving leaded gasoline and aviation fuel. Based on the observations at the Site, the discussion of COCs has been divided into four categories: soil, on-site groundwater, off-site groundwater, and drinking water.

8.2.1 Soil and Landfarm

Previous sampling efforts were focused on GRO and BTEX as the primary COCs. Soil results from the 2008 excavation and the 2008 baseline landfarm samples indicated GRO and BTEX exceed ADEC Method 2 cleanup levels. Benzene exceeded the cleanup level in each location tested in the excavation and landfarm, exceeding the ADEC cleanup level by 2-4 orders of magnitude. GRO was detected in each location, exceeding the cleanup level at each location from the excavation and three out of six samples collected from the landfarm. The other BTEX compounds followed the same general trends in both the landfarm and excavation. This data supports previous soil results (and groundwater results) that benzene has the highest proportional exceedance of the ADEC cleanup levels.

In addition to GRO and BTEX, the highest field screening location from the excavation and landfarm were tested for DRO. The DRO concentration from EX-3 (excavation limits) was 295 mg/kg, slightly above the Method 2 cleanup level of 250 mg/kg. The DRO concentration in LF-5 (landfarm) was 170 mg/kg, below the Method 2 cleanup level. Based on these results, no additional DRO testing is considered necessary at the Site unless a previously unidentified release of another petroleum product is suspected.

The highest baseline landfarm sample (LF-5) was also analyzed for PAHs, EDB, and RCRA 8 metals. Five of the 18 PAH compounds (phenanthrene, fluorene, naphthalene, 1-methylnaphthalene and 2- methylnaphthalene) were detected, each at least an order of magnitude below the Method 2 cleanup levels. The EDB concentration of 12.2 mg/Kg was well above the Method 2 cleanup level of 0.00016 mg/Kg. RCRA metal analysis indicated that arsenic slightly exceeded the Method 2 cleanup level, but is below the established Fairbanks background concentration. Barium, chromium, and lead were detected at concentrations well below the Method 2 cleanup levels. These results confirm the earlier groundwater results indicating that EDB is a COC at the Site, while PAHs and metals are not.

8.2.2 On-Site Groundwater

The 2007 Characterization Report details the 2005 property and 2006 offsite groundwater characterization. GRO and benzene exceeded ADEC cleanup levels across the site. Toluene and ethylbenzene exceeded the ADEC cleanup levels in the source areas, but not across the remainder of the site. Xylenes were detected in most samples below the cleanup level. EDB analyzed in four samples was detected above the cleanup level in the source areas, but not at the down gradient property edge.

The September 2008 sampling event was limited to BTEX included an additional upgradient well defining the contaminant plume eastern boundary. The upgradient well had no detected BTEX compounds, while the remainder of the wells confirmed the earlier results regarding the size and location of the dissolved contaminant plume. Sampling events in 2010 and 2012 included a smaller number of on-site wells and showed the same patterns of contaminants. In addition to BTEX compounds, GRO analyses in 2010 and 2012 confirmed this is also a COC on the Site. EDB has not been tested for since 2005 and is assumed to remain a COC in the on-site groundwater.

Based on these results, benzene is considered a reasonable indicator compound of the extent of contamination on the Site. BTEX analysis is recommended for all periodic and delineation samples. Based on the soil results, testing for DRO should be conducted when the new wells are installed to determine if it is a groundwater COC. At the time that benzene is approaching the cleanup level and/or some or all of the site is evaluated for closure, additional analysis for GRO and EDB will be necessary.

8.2.3 Off-Site Groundwater

Groundwater and drinking water results from 2005 through 20012 have consistently shown that benzene is the only COC that has migrated off-site with the groundwater migration. DP-02 is located in the middle of the dissolved plume at the down gradient edge of the Site and benzene has historically exceeded the ADEC cleanup level. EDB and GRO were not detected and other BTEX compounds were below cleanup levels in this well in 2005 and the benzene concentration has decreased since that time. Other perimeter wells confirm that benzene is the only contaminant that is migrating off-site. Benzene is also the only COC that has been detected with any regularity and reported above the cleanup level in any off-site well.

Since benzene is the only COC migrating off the site, off-site laboratory analysis should be limited to BTEX. This includes periodic sampling, future delineation (if needed) and closure sampling.

8.2.4 Drinking Water

Each drinking water well in the area has been tested at least once since 2005. The original water testing was for the VOCs full suite, including BTEX compounds, by EPA

Method 524.2. The five closest wells were also tested for EDB in 2005 and the two closest wells, Badger Towing and Dave Bridges, were tested again in 2008. Table 6 summarizes the drinking water testing that has been completed at nearby properties. With the exception of one detection of xylenes just above the detection limit in a well that did not have benzene, this data shows that benzene is the only compound detected in offsite drinking water wells.

This data provides another line of evidence that benzene is the only COC that is migrating from the Site. Based on these results, future drinking water laboratory analysis should be limited to BTEX at each location when tested.

8.3 Contaminant Migration and Flow Direction

The source of contamination at this Site is the former Air North aviation fuel distribution system from piping, spills, and possibly storage tanks. Field observations indicated each system component leaked or failed and contaminants were released to the soil, including surface soils (0 – 2 feet below grade) and subsurface soils (2 – 15 feet below grade). No known injection wells or other means of direct release to groundwater have been identified at the Site. Excavation at the Site indicates that the top 2 -3 feet of soil are an imported gravel pad, which was placed over the organic vegetation layer, which was grassy with shrubs. Sandy silt is present below the organic layer and extends to the groundwater. Field observations indicate that the contaminant concentrations are higher in the organic material and the sandy silt, which is typical at similar sites due to the smaller grain size of the material.

From the shallow soils, the petroleum contaminants migrated horizontally and vertically through the soil to the shallow groundwater, approximately 12 feet below grade. Regional groundwater studies in the early 1990s show the hydraulic gradient moves generally to the west-northwest in this area of Fairbanks during both high water and low water. The Tanana River acts to recharge the aquifer while the Chena River is acting as a drain. A multi-year study conducted in the late 1990s by the USGS determined that regional groundwater flow trends to the northwest. This regional gradient can be seen in the on-site gradient to the northwest, as observed from 2005 – 2007 using surveyed monitoring well elevations. In addition, the on-site and off-site dissolved benzene concentration pattern indicates transport to the west-northwest. The plume size is consistent with a large-scale fuel release over several decades.

Natural dispersion processes have some vertical mixing component to move dissolved contaminants deeper into the aquifer with motion along the path of the hydraulic gradient. In addition, limited areas of shallow permafrost may be developing in building shadows, which may also create the potential for vertical dispersion. Remnant chunks of deeper permafrost are also present in the aquifer at about 50 feet below grade (well below the groundwater surface), as observed during the effort to provide a deeper well at Badger Towing and reported to be present at the Great Northwest gravel pit. While the deeper permafrost presents a barrier to vertical migration, the extent of shallow and deep permafrost is not known. The potential changes in groundwater flow around the shallow and deep permafrost are also not documented.

The impacts to contaminant migration of dewatering of the Great Northwest gravel pit approximately 0.5 mile west of the Site during the late 1990s and early 2000s is not known. This activity is known to have pumped millions of gallons a day out of the aquifer and drawn down the water level in the gravel pit approximately 40 feet during the summer months. Theoretically, this would have had the potential to increase the rate of flow of groundwater and pull these dissolved contaminants in a more westerly direction.

At this point, the release is at least 30 years old and most likely older. With the sources of the release removed, the best means to assess these concerns is through evaluation of existing data and contaminant trends. This data indicates that benzene has mixed down to the top of the permafrost at low levels, but is not present below the permafrost. Drilling through the permafrost in additional locations to evaluate contaminant migration that does not appear to be occurring creates the potential for new preferential pathways for this migration. Further evaluation of vertical mixing and permafrost areas is not considered necessary because the potential exposure pathways from this deeper groundwater have already been confirmed to not be complete.

The existing wells have jacked and the original wellhead elevation survey is no longer considered valid for calculating the hydraulic gradient. In addition, the temporary wells have become scaled to the point that water no longer recharges without significant cleaning prior to sampling. The existing wells should be decommissioned in accordance with ADEC guidance. A new array of permanent, pre-packed direct push wells is recommended to be installed as part of the long-term monitoring plan for this Site. These should be surveyed one time after installation to verify the hydraulic gradient, but long-term observations indicate that the hydraulic gradient is consistent across the Site. Continued surveying and calculation of the hydraulic gradient is not considered necessary following the initial confirmation in the new wells.

8.4 COC Trend Analysis

A detailed trend analysis of this data, such as the Man-Kendall Test or other statistical technique, has not been completed. The sampling events have been completed during the late fall and are considered representative of similar groundwater conditions over time. In wells with more than three sampling events, contaminant concentrations have generally remained within the same order of magnitude (DP-21, DP-23, DP-27, DP-29, DP-42, GNI-03, GNI-05) or decreased by at least an order of magnitude (DP-2, DP-26, DP-43). In wells that decreased, the decrease was generally between 2008 and 2012.

These observations are consistent with the age of the plume and the continued biological degradation of the dissolved contaminants. While the impacts of the previous dewatering will not be known, the continued reduction of COC concentrations in Great Northwest wells (GNI-3 and GNI-5) at the down gradient edge of the plume suggest that any expansion of the plume due to dewatering may be degraded quickly relative to the source areas now that the dewatering has stopped.

The installation of a new array of long-term monitoring wells will make trend analysis more difficult as differences in the well construction and location will introduce new variables into the long-term data set. To minimize these concerns, the new wells should be located in close proximity to the existing wells to maintain geographic continuity with the existing data set. In addition, soil borings are recommended at each long-term well location to verify soil conditions at the time the new wells are installed. Field screening is recommended, but collection of laboratory soil samples is not expected to be necessary from these soil borings. The objectives and methods to continue the long-term trend analysis should be outlined in the long-term monitoring program.

8.5 Groundwater Geochemistry for Natural Attenuation

Petroleum hydrocarbons are consumed in natural groundwater through a variety of biological mechanisms. Each of these reactions has a specific geochemical signature that provides additional evidence about the location and edges of contaminant plumes. The most common of these are aerobic respiration (consumption of dissolved oxygen), denitrification (NO_3^- reduction), Fe reduction, SO_4^{2-} reduction, and methanogenesis (carbon dioxide reduction). In September 2008, groundwater geochemistry parameters were evaluated to evaluate the potential for reduction of contaminant mass over time through biological processes (natural attenuation). These parameters were DO, NO_3^-, total Fe, Fe^{2+}, SO_4^{2-}, and S^{2-} through field measurements and methane through laboratory analysis.

The DO concentrations observed in 2008 showed some variability, but were less than 1.3 mg/L across the site, including the upgradient well. This suggests that aerobic respiration is not a significant component of biological mass reduction at the site. While this is expected due to the overall size of the plume, the lack of DO in the upgradient well suggests that this area is naturally low in DO or this location is downstream of another contaminant plume. With DP-51 clean and near the property boundary, additional investigation is not considered necessary as actual contaminants do not appear to be migrating across the property line in either direction.

After aerobic respiration, denitrification (NO_3^- reduction) becomes the dominant pathway for hydrocarbon oxidation. Nitrate present in the groundwater system is consumed during the oxidation process and nitrate is typically lower inside plumes than in background areas. In 2008, NO_3^- levels had some variability, but were low in all tested wells, including the upgradient well (similar to DO). These results confirm that most available nitrate is likely to be consumed, although denitrification may not a significant factor in biological activity at this Site because of the low levels that appear to be present in the area.

Once nitrate is depleted in a groundwater system, iron reduction becomes the dominant hydrocarbon oxidation pathway. Ferric iron (Fe^{3+}) is oxidized to ferrous iron (Fe^{2+}). Fe^{3+} may be present throughout the aquifer in both dissolved and solid forms, so the Fe^{2+} concentration is typically used to be indicative of biological degradation. Field methods measured both total Fe and Fe^{2+}. Concentrations of Fe^{2+} in MWs 21 and 26 were higher than other wells, suggesting active iron reduction in these contaminated areas.

After Fe reduction, SO_4^{2-} reduction becomes an important oxidation pathway. Sulfate in the aquifer is reduced to hydrogen sulfide (H_2S), which is extremely reactive and generally dissipates rapidly. Higher concentrations of SO_4^{2-} in DP-42 and GNI-5 suggest the potential for higher background concentrations outside or near the edge of the plume, but H_2S concentrations are uniformly low across the Site. This suggests that most SO_4^{2-} has already been consumed, so very little H_2S is being produced. The presence of H_2S does confirm that the plume is anaerobic, but that sulfate reduction is probably not significant across most of the Site.

Methanogenesis is the lowest energy oxidation pathway and is a two-step process that includes fermentation and respiration. The fermentation step produces acetate and hydrogen. Additional fermentation of the acetate produces methane and carbon dioxide. Respiration of the hydrogen and carbon dioxide produces additional methane and water. Methane concentrations ranged from 4.5 mg/L (DP-28) and non-detect (DP-2). Methanogenesis is occurring at most locations across the plume.

The 2008 geochemical parameters confirm that anaerobic biological degradation is occurring in the groundwater, both on-site and off-site. The geochemistry results indicate that different reduction pathways may be more active at different parts of the site, most likely due to natural heterogeneity in the geology of the aquifer across this Site. The results suggest that the upgradient well (DP-51) may be down gradient from a natural or anthropogenic area that is also anaerobic. The geochemical results are support by field observations and the ORP results during each field sampling event except for the field meter DO measurements, suggesting the DO meter results are biased high. One additional round of geochemical analysis is recommended as part of the long-term monitoring plan to confirm the observed biological degradation following installation of the permanent wells at the Site.

8.6 Remediation Strategies and Risk Reduction

Remaining surface and subsurface soil contaminant concentrations suggest a large percentage of the contamination migrated to the groundwater smear zone in the 30 years since Air North left the site. By 2012, consistent with the contamination age, the groundwater contaminant plume appears to be generally stable. In order to identify the potential exposure pathways associated with this remaining contamination, the CSM has been revised based on conditions observed in 2012 and the updated CSM scoping form and graphic are included in Appendix 3.

This scoping form indicates contaminated media include soil, groundwater, and air and potential receptors include current and future residents, commercial workers, visitors, and construction workers. Exposure pathways include incidental soil ingestion, ingestion of groundwater, and inhalation of indoor and outdoor air. Environmental concerns have been grouped into four categories: on-site soil contamination, on-site groundwater contamination, off-site groundwater contamination, and indoor/outdoor air. Each of these concerns requires a different long-term strategy, discussed below.

8.6.1 On-Site Soil

On-site soil contamination is present in the unsaturated soil located between the ground surface and top of the groundwater smear zone (approximately eight to ten feet below the surface), which is also referred to as the vadose zone. The primary contamination source was a leaking piping system buried 6” to 18” below the surface. Assessment confirmed the most extensive contamination was at pipe joints, where piping rose vertically towards the ground surface, to known dispensers and transfer locations, as well as probable tank locations. Although the remaining piping was removed in 2005, the remaining contaminated soils may continue act as secondary sources that allow leaching contaminants to the groundwater from precipitation infiltration.

The piping removal assessment indicated that approximately 75% of the 1,400 linear feet of piping was contaminated based on field screening. Based on observations during the excavation of the landfarm pilot project discussed above, approximately 1,500 cubic yards of contaminated gravel pad are present and an additional 1,500 cubic yards of sandy silt are contaminated with between the gravel pad and the top of the smear zone. Contaminants of concern in the soil are GRO, BTEX, and EDB. The relative concentrations of COCs indicate that the sandy silt has at least 10 times the contaminant mass as the gravel pad in some areas.

The primary risks associated with on-site soil contaminants are incidental ingestion, continued to migration to groundwater, and volatilization to indoor and outdoor air. The Site is primarily commercial and the gravel pad has low levels of contaminants, so incidental soil ingestion is considered a minimal risk except from open excavations and landfarms. Although several buildings are present, the only winterized building that is capable of accumulating vapors is the shop. The shop is about 100 feet from the closest documented soil contamination, so vapor migration to indoor air is not considered a significant concern. Volatilization to outdoor air is generally not considered a significant concern. Based on these factors, the primary exposure route for contaminated soil remaining at the Site is continued migration to groundwater.

Landfarm Treatment Progress
The existing landfarm is approximately 300 cubic yards, which is about 10% of the estimate volume of contaminated vadose zone soil at the Site. Table 16 includes a chart showing the peak, average, and median of the field screening results from the four field screening events of the landfarm from 2008 to 2012. Over that time, the average

concentration dropped from 910 ppm to 1.8 ppm and the percentage of results below 2 ppm increased from 0% to 84%. Based on this significant reduction in field screening results, the landfarm was resampled for GRO and BTEX at the five highest PID locations in 2012. The only COC that exceeded the Method 2 cleanup level was benzene, which was less than twice the Method 2 cleanup level at two locations. GRO and other BTEX compounds were below cleanup levels, if detected.

Based on these results, the existing landfarm should be field screened and sampled for closure. A PID cutoff of 5 ppm in the landfarm is expected to indicate that the soil samples will meet the Method 2 cleanup level. EDB analysis should be completed at the location with the highest field screening result to verify that the EDB concentrations have been adequately reduced through landfarm treatment.

The success of the landfarm for treatment of the gravel pad is consistent with the relatively coarse material of the gravel pad and the relatively volatile nature of aviation fuel. This also demonstrates that the sandy silt can also be treated in a landfarm in conjunction with the gravel. The pace of landfarm treatment could be accelerated through more frequent tilling and the addition of fertilizer on an annual basis. This indicates that landfarming can be a successful remediation method for soil at the Site. While successful, the use of landfarming for soil remediation should be based on the risk-based need for secondary source soil remediation.

In-situ Soil Contamination

Although the landfarm pilot project is considered a success, landfarm treatment of most vadose zone soil is not expected to be viable as the primary soil remediation method due to difficulty of excavation and treatment timeframes. The gravel pad was reasonably easy to excavate and treat during the landfarm pilot project, but this will not remove the bulk of the contaminant mass located in the sandy silt. Small batch landfarming of several hundred yards at a time will be difficult from an excavation standpoint and will require decades to complete treatment of the contaminated areas, so it is not considered a reasonable remediation strategy. A large scale excavation to remove this soil is expected to result in the removal of several thousand cubic yards to be done safely in this material. The landfarm needed to treat this soil would cover most of the remaining surface at the Site and would require the addition of fertilizer and other efforts to accelerate treatment to be completed in a few seasons.

The most expedient means to treat the on-site soil is excavation and thermal remediation. This has a proven track record and a number of sites across the Interior and the main impediment to this scale of treatment is cost. A number of options existing to reduce the cost slightly, such as using treated soil from the treatment facility as backfill to reduce the cost of backfill and hauling. However, these savings are relatively minor compared to the overall cost. Additional soil delineation is recommended before considering this option.

Another possible option is to use the treated water from the dual phase extraction system to “wash” the soil. Under this scenario, extracted groundwater is treated and then discharged to the ground surface using a sprinkler or other means to spread the water across the surface. This water would then percolate through the soil to the groundwater. Theoretically, this would increase the rate of removal from the soil through stripping and the biological degradation rate in the soil through the increased water availability and oxygen. The water discharge area should be upgradient of the groundwater extraction area to minimize the potential for increasing groundwater contamination. The existing excavation at the former fuel island provides an excellent location to have a small scale pilot project to evaluate treatment of the sandy silt layer at a known source area that has very little chance to negatively impact potential off-site receptors. ***NORTECH*** recommends exploring the potential for a pilot project of this sort with ADEC to identify the potential regulatory concerns and the monitoring necessary to properly document the pilot project.

Other options include chemical oxidation through a product like RegenOx or the additional of microbial agents and nutrients. The addition of chemicals, nutrients, and/or biological agents is likely to disrupt the existing anaerobic mass reduction that is occurring. The potential success of these options will need to be weighed against the cost and the potential disruption during a conceptual design and evaluation process after the soil boring data is available.

8.6.2 On-Site Groundwater

Groundwater benzene concentrations exceeding the ADEC cleanup level have been identified beneath approximately 4.1 acres (50%) of the site (as shown in Figure 3). The release age and groundwater monitoring data obtained between 2005 and 2012 indicate contamination is relatively stable within the groundwater. The existing groundwater data indicate the former fuel dispensing island area at MW 21 and near MW 26 are the most contaminated and active remediation of the groundwater in these two areas may expedite the cleanup of the whole site.

The Site has two water wells that can be used for domestic water and result in ingestion of groundwater: The East well north of the Shop and the West well north of the cold storage building. Testing of these wells in 2005 indicated that BTEX contaminants are present at levels below the ADEC cleanup levels. While this is a potential exposure pathway, the existing results indicate that this exposure pathway is not complete. Additionally, the on-site wells are not used for drinking water. The primary exposure risk associated with on-site groundwater is continued migration of contaminants off-site to locations where groundwater is used for drinking water.

Several alternatives for active remediation have been successful at treating benzene groundwater contamination in the Fairbanks area. As with soil, the groundwater can be treated in place or pumped and surface treated. In-situ treatment methods include stimulating natural biological degradation, through addition of oxygen by air sparging or oxygen injection techniques and nutrient addition to facilitate biological activity. These systems usually have a soil vapor extraction system that removes volatilized contaminants and/or degradation byproducts. Ex-situ techniques consist of pumping the water, treating it using air stripping or other technology and then disposing the treated water. With proper permitting, surface disposal or re-injection of the treated water into the aquifer may be able to provide an additional oxygen source for biological consumption of contaminant mass.

Systems that pump and treat water aboveground have limited success in Fairbanks in winter due to freezing. Several locations in Fairbanks have shown significant improvement over several years using these systems only in the summer months. Ben Lomond has an air stripping system at the site intended for a different purpose, but this system potentially could be utilized successfully for treating the contaminated groundwater with proper documentation of the system capabilities. Pump and treat systems generally rely on the movement of large amounts of water through the subsurface as contaminant mass removal is generally limited to the dissolved phase.

Another active alternative is the mobile dual phase extraction system that was briefly installed in the free product recovery well near MW 26. Use of these systems at other sites in Fairbanks has shown these systems remove contaminant mass relatively quickly at treatment points. Treatment of the most contaminated areas at a site then leads to a long-term decrease in dissolved contaminated at the treatment area and in down gradient locations. The drawdown of the water level at the treatment location allows the high vacuum to strip residual contaminants directly from the soil matrix in the smear zone, as well as removal of dissolved phase contaminants. In addition, the increased air and water flow through the smear zone is stimulates biological activity in these areas as nutrients are moved through the soil and water. Pre- and post-treatment lab results of extracted indicate the COCs can be removed from the water for re-use at the Site with proper calibration of the treatment system.

As a passive treatment method, natural attenuation has been used successfully at Fairbanks sites. As discussed in Section 7.2 Groundwater Geochemistry, natural attenuation is a broad term encompassing naturally occurring processes degrading contaminants and limit their movement in the subsurface. These processes include dilution, dispersion, sorption, precipitation, volatilization, and biodegradation. The length of time needed to cleanup petroleum contaminants by means of natural attenuation depends on the amount of contaminant in the soil and the ability of the existing microbial population to degrade the contaminants.

Due to the size of the on-site groundwater plume, natural attenuation is expected to be the primary mechanism of remediation across most of the site. Sampling and analysis of geochemical parameters suggests that this is effective across the plume and will continue to slowly reduce the contaminant mass. As indicated above, the geochemical parameters should be confirmed again after the new long-term monitoring wells are installed. However, the existing groundwater trends indicate that natural attenuation will most likely require several decades to be successful at the current rates.

Based on past experience and observations from other contaminated properties across the Interior, a hybrid approach to on-site groundwater remediation may significantly accelerate the groundwater remediation process. This approach would utilize the existing anaerobic biological processes around the perimeter combined with active treatment of the most contaminated area(s) within the plume to accelerate the removal of contaminants. As discussed above, ***NORTECH*** recommends working with ADEC to develop the parameters of a pilot project that combines DPE treatment of the soil and groundwater in the former fuel island area. A pilot project lasting 1-2 months in this area would provide the opportunity to assess the potential success and costs associated with active treatment at the Site.

8.6.3 Off-site Groundwater

The same basic active and passive options exist for remediation of the off-site groundwater. Based on the large size and relatively low concentrations of COCs in the off-site groundwater, active remediation in the off-site areas is not expected to be cost effective. Treatment of the on-site contamination and continued natural attenuation is expected to successfully treat the off-site groundwater contaminants. A steady decrease in contaminant concentrations is already observable in the perimeter and off-site wells (DP-2, DP-28, DP-42, DP-43, and GNI-3). This suggests natural attenuation, including biological degradation as observed by geochemical results, has already started shrinking the off-site contaminant mass following the discontinuation of dewatering by Great Northwest.

NORTECH recommends continued monitoring of GNI-3 and GNI-5 as representative of the down gradient edge of the plume and sentinel wells respectively. DP-42 should be decommissioned. Replacement is not considered necessary unless a specific concern during long-term monitoring requires additional investigation.

The primary risk associated with the off-site groundwater is direct ingestion as drinking water. A well search and testing program in the down gradient area indicates that the Badger Towing and Dave Bridges properties are the only two that had impacts to the drinking water systems. These concerns have been addressed through well reconfiguration and continued testing. ***NORTECH*** recommends continuing monitoring these wells to the extent permitted by the landowners. Additional testing of other private wells is not considered necessary unless a specific concern is identified by a landowner.

8.6.4 Outdoor and Indoor Air

The relatively shallow depth of the smear zone and the volatility of aviation fuel COCs indicates that vapor migration is a potentially complete exposure pathway from contaminated soil and groundwater. However, the known potential preferred pathway (the buried piping system) has been removed and no other preferred pathways have been identified at the Site. The Site has one building near vadose zone contamination, but the building is not occupied. One on-site and two off-site buildings are located over the dissolved groundwater plume, but professional literature and Fairbanks-area data indicate the migration of vapors from dissolved COCs to indoor air is generally considered minimal. Potential outdoor exposures and each potential indoor exposure route are discussed in detail below.

Outdoor Air

Exposure to contaminants migrating from subsurface vapors to outdoor air is considered minimal under normal ambient conditions. Volatility of most contaminants is relatively low during most of the year due to subsurface soil temperatures, while natural mixing will disperse the contaminants before they have a chance to concentrate and/or reach the breathing zone. The exception to this is during excavation activities at the Site, during which workers near an open excavation have noted a strong odor associated with the contaminants remaining in the soil. Some odors were also noted near the landfarm. From a practical perspective, migration to outdoor air is not considered a significant concern except for construction and remediation workers conducting excavation at the Site. Based on this, excavation activities in contaminated areas should be limited to individuals knowledgeable and trained to work safely around petroleum contamination.

On-Site Buildings

The Shop is the only conditioned building on the Site and consists of a vehicle maintenance are on the ground floor with a residential apartment unit on the second floor. The structure is in fair condition and the apartment has not been used in several years. The shop and apartment are only used by employees or relatives of Ben Lomond owners. The closest soil contamination associated with the former piping system is at least 75 feet from the Shop. Groundwater data also shows that wells closest to the Shop meet the ADEC cleanup levels. Based on these conditions, the potential for vapor migration into the Shop structure is considered minimal and the potential for impacts to the upper level residential space is further mitigated by the presence of the shop space. No additional assessment is considered necessary to address these concerns.

The Cold Storage Building sits within 30 feet of documented soil contamination and groundwater results indicate the dissolved contamination above the ADEC cleanup levels (and vapor intrusion screening levels) is present beneath the building. The Cold Storage Building consists of a corrugated metal shell with some insulation. Visible gaps are present around doors and at some other joints. The building has a heating system, but has not been heated for many years due to the high expense associated with the poor building construction. Site workers enter the building for short periods of time to load and/or unload stored materials. Work in the building on the DPE system indicated the building is only one to two degrees above the outdoor temperature. While the Cold

Storage Building provides protection from rain and snow, the building has limited use and very little potential to accumulate vapors and no soil gas testing or other vapor intrusion assessment is considered necessary.

A large concrete slab from a former hangar is present on the Site to the west of the Cold Storage Building. The hangar collapsed in the early 1990s and the pad is used for vehicle parking and material storage. The closest documented soil contamination is more than 100 feet from the slab, but dissolved groundwater contamination is present at levels above the ADEC cleanup level and vapor intrusion screening levels. While the soil beneath the slab has the potential to collect and concentrate soil vapors, no building or workers are present above the slab. Based on this, no subslab or nearby soil gas sampling is considered necessary at the current time. This potential exposure pathway should be explored again if a building is construed on this slab in the future.

Off-Site Buildings

The Badger Towing property to the west has two structures: an office/residence and a shop. These structures are several hundred feet from the closest soil contamination, but are above the dissolved benzene plume that exceeds the ADEC cleanup levels and the vapor intrusion screening levels. The office/residence structure is believed to be a modular units or trailer above a skirted crawlspace several feet high, based on inspections associated with the water system testing. The shop has not been inspected because the building was constructed after access to the property was been denied. Inspection from the street suggests that it is a slab on grade with a Quonset-hut metal building. Vapor intrusion into the office/quarters is unlikely due to the limited potential for vapor migration from the groundwater to the surface and through the crawlspace into the living area. Vapor migration through the new concrete slab of the shop is also considered minimal. In addition, the owner is unlikely to provide access to the property for additional testing of any type. No additional assessment is recommended based on the limited potential concerns. If additional assessment of vapor intrusion is considered necessary based on conditions at Badger Towing, initial screening, soil gas sampling, and/or subslab testing should be completed at the similar on-site structure (Cold Storage Building or former hangar slab). This would provide the opportunity to evaluate the potential concern at a more accessible location with higher groundwater concentrations that are considered more likely to lead to vapor intrusion.

9.0 CONCLUSIONS AND RECOMMENDATIONS

This work continued characterization and release investigation completed and detailed in the 2007 Report and August 2008 WP. Groundwater sampling, the landfarm pilot study, and natural attenuation monitoring were completed from 2008 through 2012 and discussed in this report. A limited testing program of a dual phase extraction system was also completed. Based on the field observations and laboratory results, ***NORTECH*** has drawn the following conclusions:

Sources and Source Control

- The AVGAS soil and groundwater below ground piping connecting aboveground storage and pumping devices contamination source were removed
  - No known features of the Air North fuel system remain on the site
  - Additional investigation for buried tanks and piping is not necessary
- Soil contamination is present adjacent to and beneath approximately 75% of the 1,400 feet of the former buried piping system
  - Up to 1,500 cubic yards of the gravel pad are contaminated
    - The gravel pad extends from the surface to 2-3 feet below grade across the site
    - Contaminant concentrations are slightly above ADEC cleanup levels
  - Approximately 1,500 cubic yards of unsaturated native sandy silt are contaminated beneath the gravel pad
    - This material extends from the bottom of the gravel pad to the smear zone
    - Contaminant concentrations are approximately 10 times those in the gravel pad
  - Soil borings should be advanced during installation of monitoring wells to
    - Verify these conditions are present across the site
    - Evaluate the need and potential success of potential remediation options for the gravel pad and unsaturated zone soils
- Ben Lomond had a bermed and lined aboveground tank farm for storing used oil
  - Most tanks were never used
  - These tanks were removed and no contamination was observed
- Leaks or spills were not observed after removal/relocation of vehicles and other materials formerly stored at the Site
- Small amounts of free product have been observed in three wells since 2005
  - Product is consistent with old aviation fuel
  - Product does not recharge for weeks or months after removal
  - Free product should be purged and collected when observed
  - A program to monitor and recover free product will not be cost effective or accelerate the rate of remediation at the Site

Soil Contaminants of Concern (COCs)

Compound/ Contaminant	On-Site Soil/Landfarm Baseline	Existing Landfarm	On-Site Water	Off-Site Water	Off-site Drinking Water
Benzene	Yes	Yes	Yes	Yes	Yes
Other BTEX	Yes	No	Yes	No	No
GRO	Yes	No	Yes	No	NS-NDW
EDB	Yes	NT	Yes	NS-NDW	No
DRO	Yes	No	NT	UM-TNN	UM-TNN
PAHs	No	NS	NS	NS	NS
Metals	No	NS	NS	NS	NS

Yes – One or more results above ADEC cleanup level
No – No results above ADEC cleanup level
NS – Not suspected to be present
BPT – Based on previous testing
NDW – Not detected in nearest well (s)
NT – Not Tested
UM-TNN – Unlikely to migrate to this location based on solubility, testing not necessary

Contaminant Migration and Trend Analysis

- Petroleum contaminants migrated vertically from the surface and shallow subsurface to the groundwater
- Delineation results and gradient calculations indicate dissolved contamination migrated to the northwest with the documented regional aquifer conditions
- Past dewatering at the Great Northwest gravel pit during summer months may have:
  - increased the flow rate
  - pulled contaminants more to the west
  - Increased vertical mixing near the gravel pit
  - Dewatering is no longer active and specific investigation of these issues is not considered necessary
- Vertical dispersion has been observed based on drinking water well results
  - Remnant permafrost lobes are present between 50 and 100 feet below the surface
  - Specific evaluation of vertical mixing and permafrost impacts has not been performed at the Site
  - This is not considered necessary due to deeper wells and other actions that have reduced potential exposures

- Detailed statistical trend analysis has not been completed
  - Sampling events have been completed during late fall to provide consistent data set for trend analysis
  - Contaminant concentrations appear to be generally stable or decreasing
    - The following wells have had results within the same order of magnitude since 2005: DP-21, DP-23, DP-27, DP-29, DP-42, GNI-03, GNI-05
    - The following wells have shown a decrease of at least an order of magnitude since 2005: DP-2, DP-26, DP-43
  - Periodic sampling and detailed trend analysis is expected to confirm contaminant concentrations are decreasing concentrations over time
- A new permanent well array is recommended to replace the existing array of temporary sampling points installed in 2005
  - Existing steel well points should be decommissioned
  - New direct-push pre-packed wells are recommended based on a long term monitoring program that includes:
    - Fewer wells located based on existing results
    - Well locations selected to maintain comparability with existing data set
    - On-site elevation survey of new pre-packed shallow wells at the time of installation
- Soil borings should be advanced adjacent to new well locations to evaluate and verify soil conditions
    - Field screening should be performed to verify and delineate contaminated soil zones
    - Laboratory sampling is not recommended unless conditions are observed that are not consistent with the rest of the site

Natural Attenuation Geochemistry

- Groundwater geochemistry indicates that anaerobic degradation of petroleum contaminants is occurring at the site
  - Different electron receptors appear to be dominant at different locations
  - upgradient results suggest that groundwater in this area may be anaerobic naturally or due to an upgradient plume
- Geochemical parameters should be tested one time on the new well array to confirm biological degradation continues to reduce contaminant mass

Remediation and Risk Reduction

- A landfarm pilot project was undertaken to evaluate remediation potential in the unsaturated zone
  - The gravel pad is easily excavated and remediated in a landfarm
  - The native silty sand has been treated in the landfarm, but is difficult to excavate safely

  - Excavation and off-site (or on-site) thermal remediation would be very disruptive to the site and very costly to execute safely with the documented soil conditions
  - A pilot project to accelerate unsaturated zone soil remediation should be discussed with ADEC that includes:
    - Excavation and landfarming of contaminated gravel pad in a documented source area
    - In-situ treatment of contaminated silty sand using the treated water from the dual phase extraction system
  - Other chemical and/or biological methods for in-situ treatment may also warrant additional feasibility study based on soil results

- Groundwater impacts on the Site covered approximately 4 acres
  - Contaminant concentrations are significantly higher at a few suspected source areas than the remainder of the Site
  - Natural attenuation has been demonstrated to degrade remaining contaminants
  - Seasonal operation of active remediation systems has successfully treated source-area groundwater at similar sites in Fairbanks
  - A pilot project to evaluate seasonal dual phase extraction should be discussed with ADEC that includes:
    - High vacuum extraction of groundwater from the down gradient side of a documented source area
    - Treatment of extracted water with surface disposal on in-situ contaminated silty sand on the upgradient side of the same source area

- Groundwater impacts off the Site covered approximately 7 acres
  - Contaminant concentrations are significantly lower than on-site levels
    - Only benzene has been detected above the groundwater cleanup level
    - The highest concentration is approximately one order of magnitude above the cleanup level, similar to the perimeter of the Site
  - Drinking water wells around the edges of the contamination have been identified and tested
    - Badger Towing's well was extended to approximately 110 feet (below the permafrost) and met the drinking water standard in 2008
    - Dave Bridges well has been tested and now meets the drinking water standard
    - Other wells in the area were not impacted
    - Continued annual monitoring of Dave Bridges and Badger Towing (if permitted) is recommended

- Active remediation is not expected to be effective off-site due to the low benzene concentration and large impacted area
- Natural attenuation is expected to be effective at degrading residual benzene
  - This should be established through establishment and periodic monitoring for stable or decreasing benzene concentrations in off-site wells
  - Geochemical parameters should be tested in off-site wells when tested in on-site wells to verify mass reduction is continuing

- Outdoor air exposure pathways are potentially complete
  - Natural dispersion in outdoor air will prevent vapor concentrations from increasing to levels of concern for most site users
  - Increased levels of vapors will be present during excavation of contaminated soil
  - Excavation workers should have training to understand the risks associated with handling petroleum contaminated soil

- Indoor air exposure pathways are potentially complete
  - The Shop is the only on-site structure that is conditioned and used regularly
    - The building is outside the area with soil and groundwater contamination that is likely to lead to vapor intrusion
    - Residential use is intermittent and limited to the second floor
    - Subslab or indoor air testing is not recommended unless future soil or groundwater delineation indicates contamination is closer to the building
  - The Cold Storage Building location meets the screening criteria for potential vapor intrusion
    - The Cold Storage Building is not conditioned or used frequently
    - Vapors are unlikely to accumulate due to natural air turnover
    - Soil gas sampling is not recommended near or within the Cold Storage Building unless the building shell is tightened
  - The former hangar slab location meets the screening criteria for potential vapor intrusion
    - The slab does not have any structures
    - Natural air dispersion will prevent vapors from accumulating above the slab
    - Soil gas sampling is not recommended unless a new structure is planned for the slab or surrounding area
  - The Badger Towing property has a trailer with a crawlspace and a slab on grade shop
    - The vapor migration potential from groundwater to these is minimal
    - Access for additional groundwater or soil gas sampling is unlikely
    - Soil gas or subslab testing at Badger Towing is not recommended

Administrative

- This report should be submitted to ADEC to document the activities that occurred between 2008 and 2012
- This report should also be used to obtain ADEC approval and/or comments on the proposed future activities

10.0 FUTURE PROPOSED ACTIVITIES

The WP submitted in August 2008 identified 15 specific tasks that were expected to be addressed over a multi-year period. The Work Plan tasks outlined below provide an update on the status, planned activities, and rationale for each of these tasks. This is intended to provide the basis of discussion with ADEC to identify and prioritize tasks within the available funding for cleanup. Focused work plans for each year can be developed for expedited review as appropriate.

Task 1 – Work Plan Development
This task will be ongoing on an annual basis.

- 2017: Review of this section and development/approval of a work plan limited to prioritized tasks
- 2018: Development/approval of a work plan limited to tasks identified following 2017 report
- Beyond: As needed on an annual basis

Task 2 – Plume Delineation
The plume has been basically delineated over the years. Additional access for off-site delineation between Peger Road and Tibor Street has been limited by landowner cooperation and saturated conditions that prevented drill rig access. The existing results indicate that the plume is stable or decreasing at the edges. Within the contaminated area, potential receptors have been identified and exposure routes have been assessed, with corrective action takes as necessary to control/eliminate the exposures. No additional on-site or off-site delineation is considered necessary.

Task 3 – Vertical Gradient/Transport
The primary concern with vertical migration is the potential to impact groundwater wells, particularly with the dewatering that was undertaken by Great Northwest. At this time, Great Northwest has not dewatered for at least seven years. Existing drinking water wells have been tested and deepened to reduce the potential exposure. Installation of temporary groundwater sampling points and new drinking water wells has confirmed that discontinuous shallow (surface to 15 feet) permafrost is present on some lots, while a second layer of permafrost from approximately 60 to 100 feet below the ground surface is suspected to be present across a larger area. This suggests that variable groundwater flow directions and rates could be present around frozen material, but the analytical data indicates that the potential receptors have been assessed and exposures eliminated. No additional evaluation of vertical transport is considered necessary.

Task 4 – Annual Sampling Events
Many of the 17 existing temporary steel wells are difficult or impossible to sample due to mineralization, obstruction, and/or frost jacking. These wells should be decommissioned and replaced with 8-10 pre-packed DP monitoring wells at targeted locations.

- 2017: Replace existing temporary steel well points with direct-push, pre-packed microwells for long-term monitoring
  - Proposed new microwell locations are shown in Figure 7
  - Testing after installation will be limited to GRO/BTEX to verify similarity to previous results
- 2017: Continued analytical testing
  - GRO/BTEX in all wells
  - Monitored Natural Attenuation parameters in all wells
  - DRO and EDB in on-site wells
- Beyond: Details of annual event to be identified in the annual work plan

Task 5 – Groundwater Elevation Variations
The intent of this task was to collect benzene concentrations during fluctuations in groundwater elevation in relation to seasonal changes and the stage of the Tanana River. This data would be used to verify the “worst-case” season/condition/elevation and then continue annual testing during that period. This is considered less important that establishing that the new microwells are substantially similar to existing results.

- 2017: Not planned
- 2018 or later: Install level loggers in up to 3 wells to verify link between site conditions and Tanana River elevations
- Beyond: Up to three BTEX sampling events of no more than four wells during high water events based on Tanana River elevations as outlined in future work plan

Task 6 – 2009 Comprehensive Sampling Event
This task has been grouped together with Task 4 for all future years.

Task 7 – 2009 Contaminants of Concern Variations
This task has been grouped together with Task 4 for all future years.

Task 8 – 2009 Monitored Natural Attenuation Evaluation
This task has been grouped together with Task 4 for all future years.

Task 9 – 2010 Comprehensive Sampling Event
This task has been grouped together with Task 4 for all future years.

Task 10 – Badger Towing and Bridges Property Drinking Water Testing
Results indicate that contaminant concentrations have been reduced to ADEC standards at both locations. Annual testing is recommended as access is allowed for at least two more events

- 2017: Bridges and Badger Towing (if permitted) for BTEX by 524.2
- 2018 (or later): Bridges and Badger Towing (if permitted) for BTEX by 524.2
- Beyond: Consider discontinuing if on-site perimeter wells show stable or shrinking plume

Task 11 – Former Tank Farm Liner Removal
This task was not completed in 2008 remained in place at the Site in 2012. The task will be completed in 2017 unless Ben Lomond removes the liner before that time.

- 2017: Complete tasks as described in 2008 (or subsequent) WP
- Beyond: No work anticipated

Task 12 – Pilot Scale Soil Remediation
The existing landfarm is expected to meet ADEC cleanup levels, but requires additional testing based on 2012 results

- 2017: Field screening and laboratory sampling for BTEX and EDB, disposal of treated landfarm on Site
- Beyond: No work anticipated

Task 13 – Pilot Scale Groundwater Remediation
A very limited test of a dual phase extraction system was completed in 2010 and successfully removed contaminated groundwater. A detailed work plan should be developed during 2017 that will provide for a 30 – 60 day pilot project during the 2017 or 2018 field season.

- 2017: Develop dual phase extraction pilot project work plan
- 2017 or 2018: Complete and evaluate dual phase extraction pilot project
- Beyond: Identify future potential based on cost-effectiveness of pilot project

Task 14 – Vapor Intrusion Assessment
The CSM indicates that vapor intrusion is not a significant concern on or off-site due to building locations, construction, and uses. In addition, research into potential vapor intrusion impacts from petroleum releases indicates that these contaminants are less likely to volatilize than expected when the 2008 work plan was developed. No additional evaluation of vapor intrusion is considered necessary unless changes to groundwater contaminant concentrations or building uses change significantly.

Task 15 – Reporting
This task will be ongoing on an annual basis.

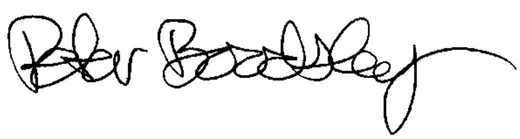
11.0 LIMITATIONS

NORTECH provides a level of service performed within the standards of care and competence of the environmental engineering profession. However, it must be recognized that limitations exist within any site investigation or assessment. This report provides results based on a restricted work scope and from the analysis and observation of a limited number of samples. Therefore, while it is our opinion that these limitations are reasonable and adequate for the purposes of this report, actual site conditions may differ. Specifically, the unknown nature of exact subsurface physical conditions, sampling locations, the analytical procedures' inherent limitations, as well as financial and time constraints are limiting factors.

The report is a record of observations and measurements made on the subject site as described. The data should be considered representative only of the time the site investigation was completed. No other warranty or presentation, either expressed or implied, is included or intended. This report is prepared for the exclusive use of the Ben Lomond, Inc. If it is made available to others, it should be for information on factual data only, and not as a warranty of conditions, such as those interpreted from the results presented or discussed in the report. We certify that except as specifically noted in this report, all statements and data appearing in this report are in conformance with ADEC's Standard Sampling Procedures. ***NORTECH*** has performed the work, made the findings, and proposed the recommendations described in this report in accordance with generally accepted environmental engineering practices.

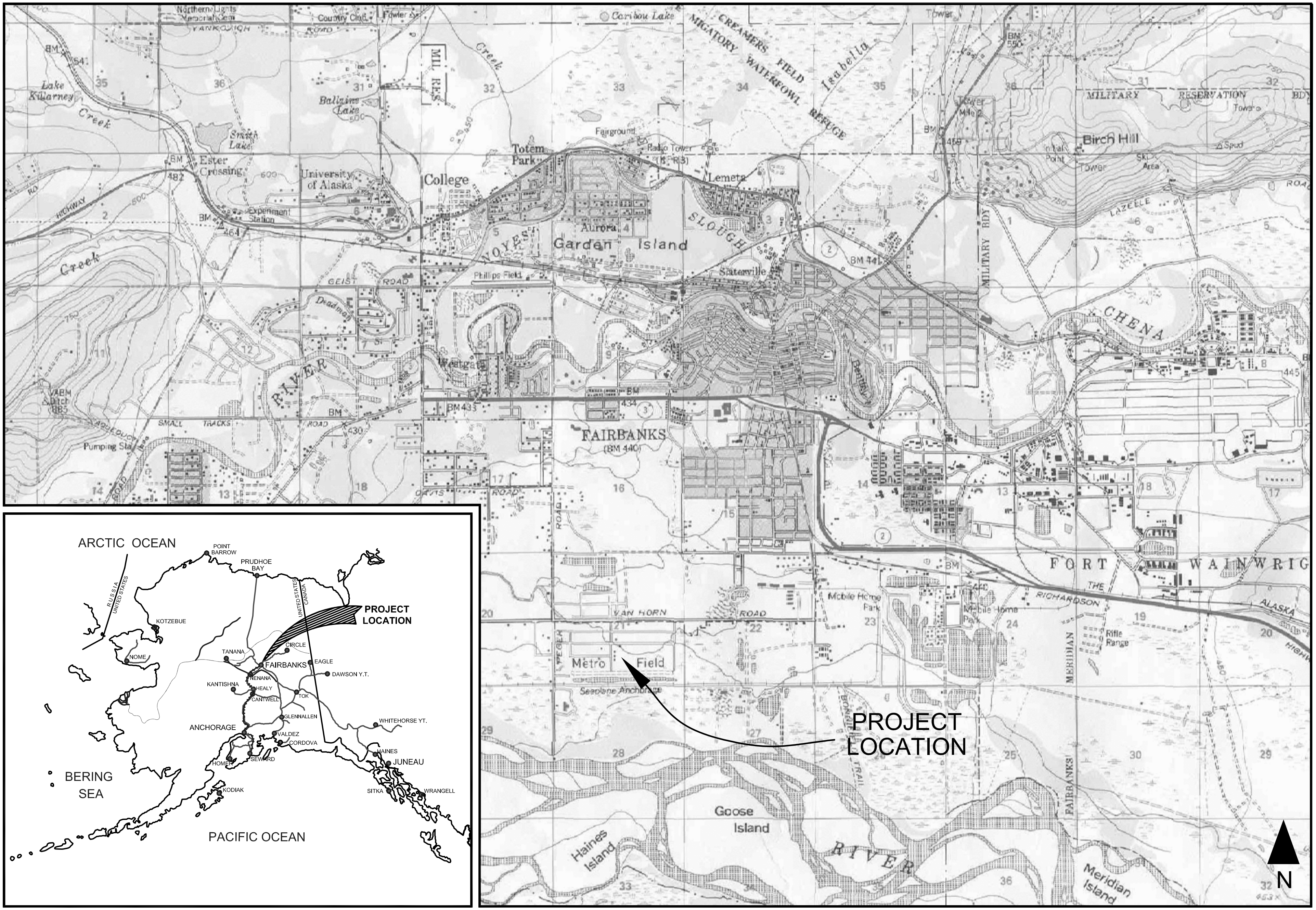
12.0 SIGNATURE OF ENVIRONMENTAL PROFESSIONALS

Peter Beardsley, PE, Project Manager has a B.S. in Environmental Engineering from Rensselaer Polytechnic Institute in Troy, New York. Peter is licensed as a Registered Professional Civil Engineer (CE 10934). He has more than 20 years of experience in environmental engineering design, data analysis, and fieldwork. His experience includes all aspects of Phase I and II site investigations, UST retrofit and removal, noise and indoor air quality assessments, conceptual site models for human health risk assessment, and screening and sampling of soil, sediment, water, and wastewater. He also has experience conducting asbestos, lead-based paint, and hazardous materials investigations, spill prevention countermeasures and control (SPCC) and SWPPP compliance audits, and occupational safety audits. He has extensive project management and field experience in urban and rural Alaska, including multiple projects in the Fairbanks/North Pole area, Kaktovik, Coldfoot, and several other villages.



Peter Beardsley, PE
Environmental Engineer

Appendix 1



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5438 Shaune Dr, Suite B, Jnu., Alaska 99801 Ph: 907-586-6813

Location Map
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 1 mi
DESIGN:	PLB	PROJECT:	05-1036
DRAWN:	PLB	DWG:	051036h(01)

FIGURE
1

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Vicinity Map
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 500 ft
DESIGN:	PLB	PROJECT:	05-1036
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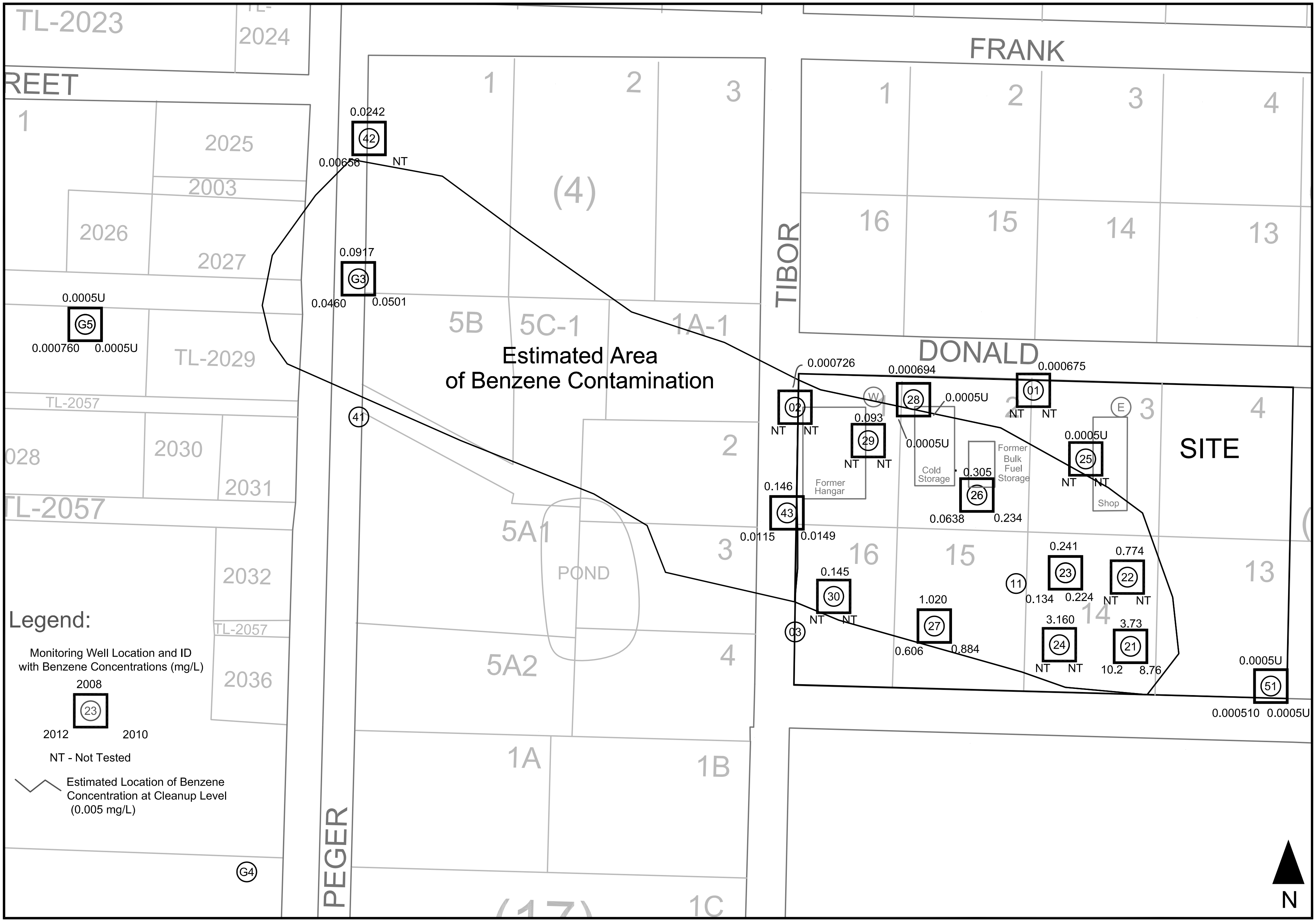
FIGURE 2



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2008, 2010, & 2012 MWs Sampled & Benzene Results
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 200 ft
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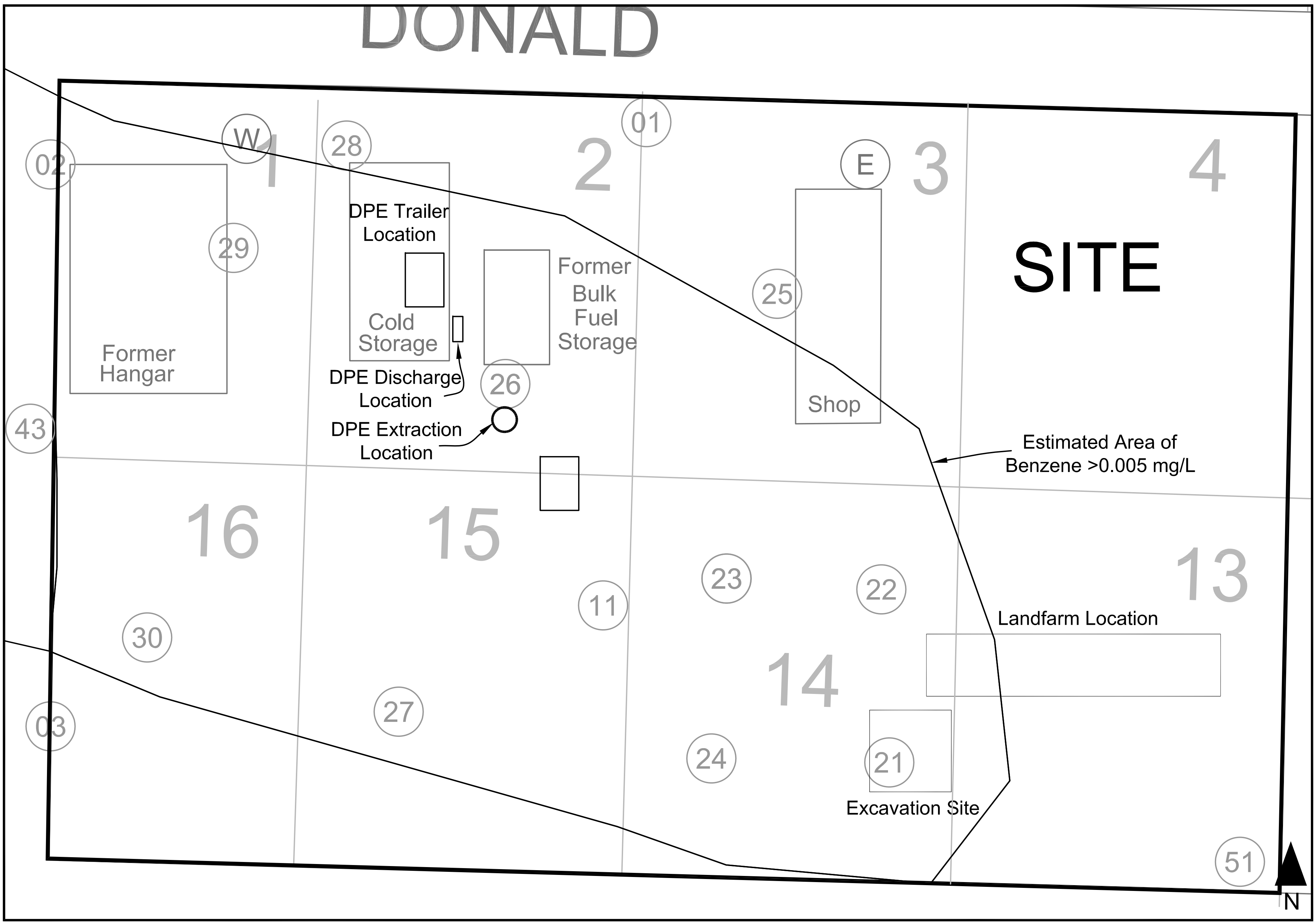
DRAWN:	PLB	DWG:	051036h(03)

FIGURE
3



ENVIRONMENTAL ENGINEERING HEALTH & SAFETY
NORTECH
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5438 Shaune Dr, Suite B, Jnu., Alaska 99801 Ph: 907-586-6813

Site Map with DPE, Excavation, & Landfarm Locations
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 80 ft
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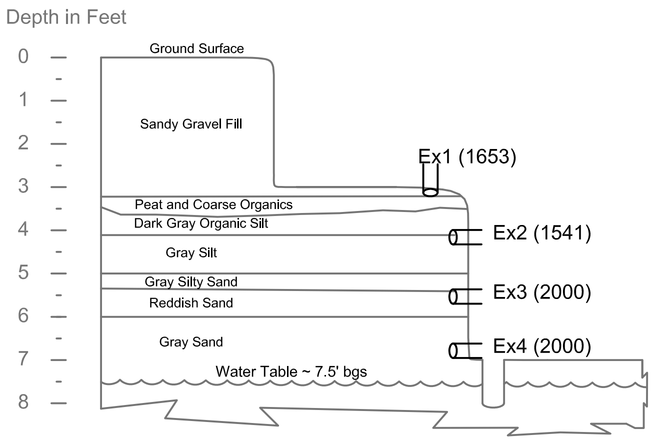
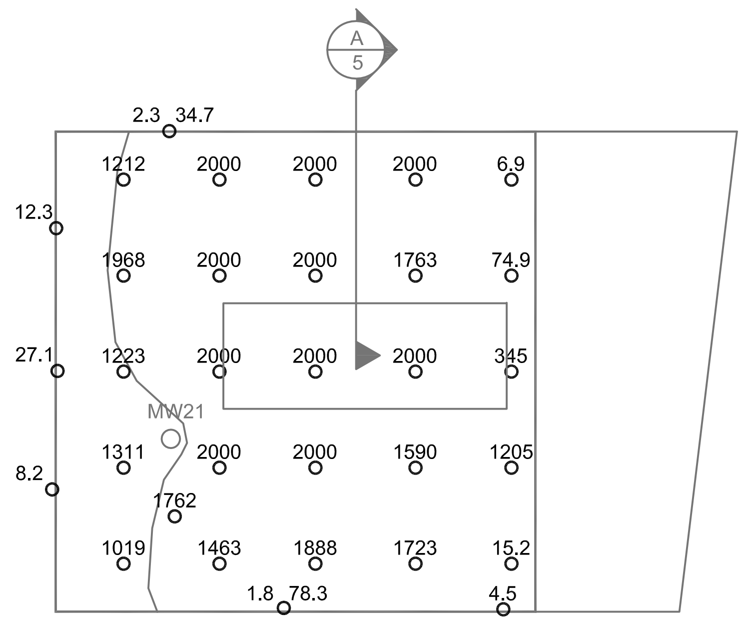
FIGURE 4



Excavation Profile - Section A



Excavation Limits

All excavation screening samples collected at 3' bgs unless otherwise noted

Legend

ExX (xxxx) Excavation Soil Sample Location and PID Result (ppm)

xxxx o Field Screening Location and PID Result (ppm)

N

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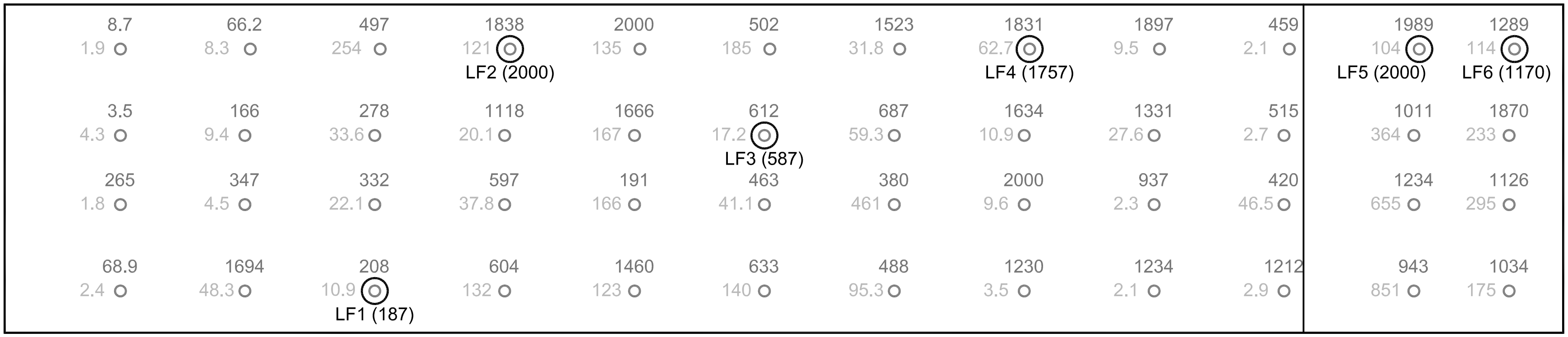
3105 Lakeshore Dr. Anch, Alaska 99517 Ph: 907-222-2445
5438 Shaune Dr, Suite B, Jnu., Alaska 99801 Ph: 907-586-6813

Excavation Plan and Profile with Field Screening Results
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 20 ft
DESIGN:	PLB	PROJECT:	05-1036
DRAWN:	PLB	DWG:	051036h(05)

FIGURE 5



Legend 2008/2009 (Above)

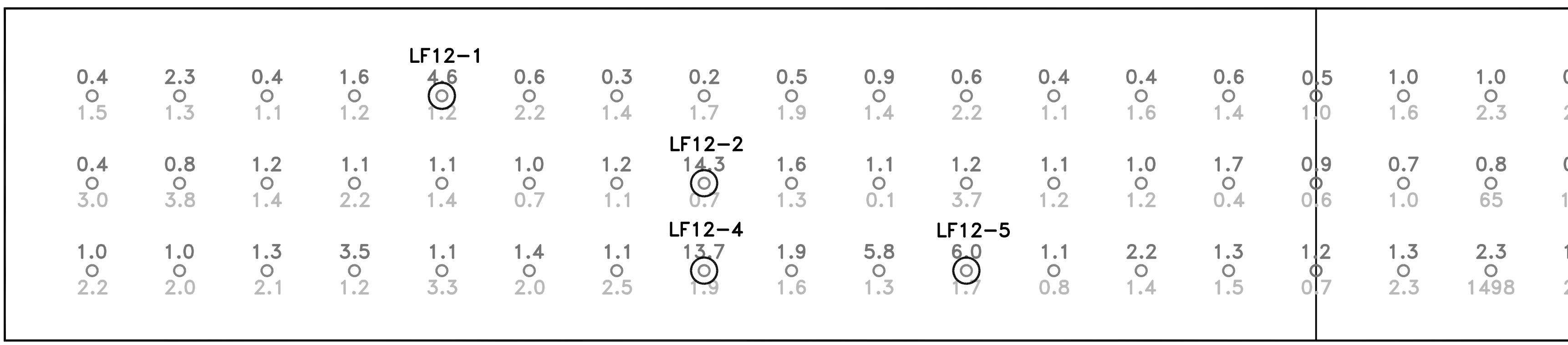
2008
2009 Field Screening Location with 2008 & 2009 Field Screening Results (ppm)

LFx-x Landfarm Soil Sample (PID Result)

Legend 2010/2012 (Below)

2008
2009 Field Screening Location with 2010 & 2012 Field Screening Results (ppm)

LFx-x Landfarm Soil Sample (PID Result)



N

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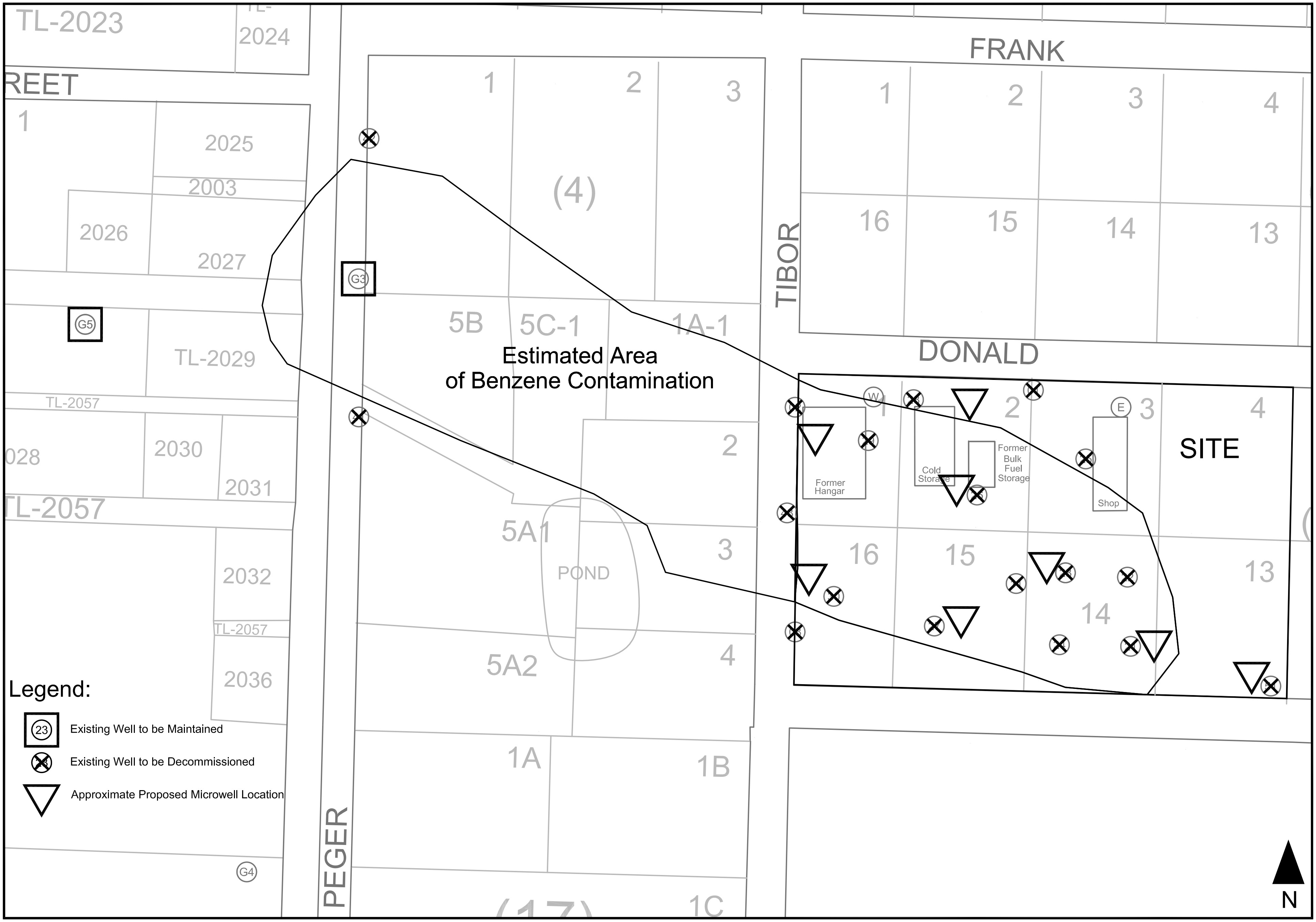
3105 Lakeshore Dr. Anch, Alaska 99517 Ph: 907-222-2445
5438 Shaune Dr, Suite B, Jnu., Alaska 99801 Ph: 907-586-6813

2008-2012 Laboratory and Screening Results (Landfarm)
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 20 ft
DESIGN:	PLB	PROJECT:	05-1036
DRAWN:	PLB	DWG:	051036h(06)

FIGURE
6



NORTECH

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3105 Lakeshore Dr. Anch, Alaska 99517 Ph: 907-222-2445
5438 Shaune Dr, Suite B, Jnu., Alaska 99801 Ph: 907-586-6813

Planned Decommissioning and Installation Locations
Ben Lomond Metro Field/Air North
Fairbanks, Alaska

DATE:	11/01/2016	SCALE:	1"= 200 ft
DESIGN:	PLB	PROJECT:	05-1036
DRAWN:	PLB	DWG:	051036h(07)

FIGURE
7

Appendix 2

Table 1
Groundwater Laboratory Results and QA/QC Summary
September 28-29, 2008

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylene	Comment
Units	mg/L	mg/L	mg/L	mg/L	
Method	8021B	8021B	8021B	8021B	
ADEC Limit	0.005	1.0	0.7	10	
DP-01	0.000675	0.002U	0.002U	0.002U	
DP-02	**0.00726**	0.004U	0.004U	0.004U	
DP-21	**3.7300**	**1.690**	**1.060**	2.760	
DP-20(dup)	**3.8000**	**1.860**	**1.190**	2.905	
DP-22	**0.774**	0.0328	0.696	0.6497	
DP-23	**0.241**	0.00200U	0.00402	0.0465	
DP-24	**3.160**	0.0121	0.238	0.4708	
DP-25	0.0005U	0.002U	0.002U	0.002U	
DP-26	**0.3050**	**5.870**	**1.610**	4.791	
DP-27	**1.0200**	0.002U	0.028	0.010	
DP-28	0.0007	0.002U	0.002U	0.002U	
DP-29	**0.0929**	0.002U	0.017	0.013	
DP-30	**0.1450**	0.020U	0.002U	0.002U	
DP-42	**0.0242**	0.020U	0.020U	0.020U	
DP-43	**0.1460**	0.002U	0.002U	0.002U	
DP-51	0.0005U	0.002U	0.002U	0.002U	
DP-50(dup)	0.0005U	0.002U	0.002U	0.002U	
GNW-03	**0.0917**	0.020U	0.020U	0.020U	
GNW-05	0.0005U	0.002U	0.002U	0.002U	

Notes:

U	Compound not detected at detection limit
shade	Detected below ADEC cleanup levels
bold	Result is above ADEC regulatory limit
GNW	Great Northwest, Inc. wells

QA/QC					
Sample ID	DP-21	DUP (DP-20)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
B	3.73	3.80	3.7650	0.070	**2%**
T	1.69	1.86	1.775	0.170	**10%**
E	1.06	1.19	1.125	0.130	**12%**
X	2.76	2.905	2.833	0.145	**5%**

Notes:

RPDs for field duplicate pair DP-51/DP-50 can not be calculated due to non-detect results

NA	The calculation is not applicable.
RPD	Relative percent difference as described in the lab data review checklist
ND	Analyte not detected

Table 2
Groundwater Laboratory Results and QA/QC Summary September 29, 2010

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylene	GRO	Comment
Units	mg/L	mg/L	mg/L	mg/L	mg/L	
Method	8021B	8021B	8021B	8021B	AK101	
ADEC Limit	0.005	1.0	0.700	10	2.2	
21	**8.760**	**8.440**	**2.000**	6.250	**48.3**	
23	**0.224**	0.002U	0.002U	0.00208	0.549	
26	**0.234**	**9.750**	**1.740**	5.080	**24.3**	
27	**0.884**	0.002U	0.0112	0.00469	**2.31**	
28	0.0005U	0.002U	0.002U	0.002U	0.100U	
42	NT	NT	NT	NT	NT	No recharge
43	**0.0149**	0.002U	0.002U	0.002U	0.100U	
51	0.0005U	0.002U	0.002U	0.002U	0.100U	
52 Dup of 21	**8.400**	**8.110**	**1.940**	6.056	**44.8**	
GNW-3	**0.0501**	0.002U	0.002U	0.002U	0.123	
GNW-5	0.0005U	0.002U	0.002U	0.002U	0.100U	

Notes:

U	Compound not detected at limit of quantitation
shade	Above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit
GNW	Great Northwest, Inc. wells

QA/QC						
Sample ID	21	52	Average	Difference		RPD
Analyte	mg/L	mg/L	mg/L	mg/L		%
B	8.760	8.400	8.580	-0.36		**-4%**
T	8.440	8.110	8.275	-0.33		**-4%**
E	2.000	1.940	1.970	-0.06		**-3%**
X	6.250	6.056	6.153	-0.19		**-3%**
GRO	48.3	44.8	46.55	-3.50		**-8%**

Notes:

NA	The calculation is not applicable.
RPD	Relative percent difference as described in the lab data review checklist
ND	Analyte not detected

Table 3
Groundwater Laboratory Results and QA/QC Summary October 3, 2012

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylene	GRO	Lab Comment
Units	mg/L	mg/L	mg/L	mg/L	mg/L	
Method	8021B	8021B	8021B	8021B	AK101	
ADEC Limit	0.005	1.0	0.7	10	2.2	
EX-21	**10.200**	**6.760**	**1.710**	5.517	**44.9**	
EX-23	**0.134**	0.001U	0.001U	0.002U	0.315	
EX-26	**0.0638**	0.841	**1.370**	3.415	**13.3**	
EX-27	**0.606**	0.001U	0.001U	0.002U	1.49	
EX-28	0.0005U	0.001U	0.001U	0.002U	0.100U	
EX-42	0.00656	0.00129	0.001U	0.002U	0.100U	
EX-43	**0.0115**	0.001U	0.001U	0.002U	0.100U	
EX-51	0.000510	0.001U	0.001U	0.002U	0.100U	
EX-52 Dup of 21	**10.700**	**6.800**	**1.750**	5.434	**46.0**	
EX-G3	**0.0460**	0.001U	0.001U	0.002U	0.109	
EX-G5	0.00076	0.001U	0.001U	0.002U	0.100U	

Notes:

U	Compound not detected at limit of quantitation
shade	Above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit
NT	Not Tested
G	Great Northwest, Inc. wells

QA/QC						
Sample ID	EX-21	EX-52	Average	Difference		RPD
Analyte	mg/L	mg/L	mg/L	mg/L		%
B	10.200	10.700	10.45	0.50		**5%**
T	6.760	6.800	6.78	0.04		**1%**
E	1.710	1.750	1.73	0.04		**2%**
X	5.517	5.434	5.476	-0.083		**-2%**
GRO	44.9	46.0	45.45	1.10		**2%**

Notes:

NA	The calculation is not applicable.
RPD	Relative percent difference as described in the lab data review checklist
ND	Analyte not detected

Table 4
Historical Groundwater Results Summary

Well ID	Date	GRO	Benzene	Toluene	Ethyl-benzene	Total Xylene	Ethylene dibromide
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method		AK101	8021B	8021B	8021B	8021B	504.1
ADEC Limit		2.2	0.005	1.0	0.7	10	0.00005
DP-01	9/6/2005	0.090U	0.0005U	0.002U	0.002U	0.002U	NT
DP-01	9/28/2008	NT	0.000675	0.002U	0.002U	0.002U	
DP-02	9/6/2005	0.900U	**0.0973**	0.020U	0.0323	0.0925	0.0000212U
DP-02	7/26/2006	NT	**0.0638**	0.00797	0.0312	0.00794	
DUP-01	7/26/2006	NT	**0.0544**	0.00677	0.0295	0.03733	NT
DP-02	9/28/2008	NT	**0.00726**	0.0040U	0.0040U	0.0040U	NT
DP-03	9/6/2005	0.090U	0.0005U	0.002U	0.002U	0.002U	NT
DP-03	7/26/2006	NT	0.000616	0.002U	0.002U	0.002U	NT
MW-11	9/6/2005	**2.3**	**0.679**	0.020U	0.0248	0.1817	NT
DP-21	9/6/2005	**26.4**	**4.670**	**3.54**	**1.380**	4.073	**0.0015**
DUP2	9/6/2005	**26.8**	**4.360**	**3.25**	**1.310**	3.818	NT
DP-21	7/26/2006	NT	**3.940**	**2.11**	**1.370**	7.500	NT
DP-21	9/28/2008	NT	**3.730**	**1.69**	**1.060**	2.760	NT
DP-20(dup)	9/28/2008	NT	**3.800**	**1.86**	**1.190**	2.905	NT
DP-21	9/29/2010	**48.3**	**8.760**	**8.440**	**2.000**	6.250	NT
DP-52(Dup)	9/29/2010	**44.8**	**8.400**	**8.110**	**1.940**	6.056	NT
DP-21	10/3/1012	**44.9**	**10.200**	**6.760**	**1.710**	5.517	NT
DP-52(Dup)	10/3/1012	**46.0**	**10.700**	**6.800**	**1.750**	5.434	NT
DP-22	9/6/2005	**7.46**	**1.390**	0.020U	0.665	0.4440	NT
DP-22	9/28/2008	NT	**0.774**	0.03	0.696	0.6497	NT

Notes:

U	Compound was not detected at indicated detection limit
NT	Sample not tested for this analyte
shade	Result is above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit

Other 504.1 analytes were all below the detection limit

Table 4
Historical Groundwater Results Summary

Well ID	Date	GRO	Benzene	Toluene	Ethyl-benzene	Total Xylene	Ethylene dibromide
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method		AK101	8021B	8021B	8021B	8021B	504.1
ADEC Limit		2.2	0.005	1.0	0.7	10	0.00005
DP-23	9/6/2005	2.12	**0.882**	0.002U	0.007	0.0422	**0.0429**
DUP1	9/6/2005	2.07	**0.807**	0.002U	0.008	0.0490	NT
DP-23	7/26/2006	NT	**2.090**	0.002U	0.002U	0.0206	NT
DP-23	9/28/2008	NT	**0.241**	0.002U	0.002U	0.0465	NT
DP-23	9/29/2010	0.549	**0.224**	0.002U	0.002U	0.00208	NT
DP-23	10/3/2012	0.315	**0.134**	0.001U	0.001U	0.002U	NT
DP-24	9/6/2005	**12.6**	**4.920**	0.0369	0.591	0.7753	NT
DP-24	9/28/2008	NT	**3.160**	0.0121	0.238	0.4708	NT
DP-25	9/6/2005	0.090U	0.0005U	0.002U	0.002U	0.002U	NT
DP-25	9/28/2008	NT	0.0005U	0.002U	0.002U	0.002U	NT
DP-26	9/6/2005	**56.3**	**7.860**	**12.70**	**1.980**	5.580	**0.0314**
DP-26	7/26/2006	NT	**9.120**	**14.40**	**2.470**	7.070	NT
DP-26	9/28/2008	NT	**0.305**	**5.87**	**1.610**	4.791	NT
DP-26	9/29/2010	**24.3**	**0.234**	**9.750**	**1.740**	5.080	NT
DP-26	10/3/2012	**13.3**	**0.0638**	**0.841**	**1.370**	3.415	NT
DP-27	9/6/2005	9.00U	**0.601**	0.200U	0.200U	0.200U	NT
DP-27	7/26/2006	NT	**0.057**	0.002U	0.00346	0.002U	NT
DP-27	9/28/2008	NT	**1.020**	0.002U	0.0283	0.0103	NT
DP-27	9/29/2010	**2.31**	**0.884**	0.002U	0.0112	0.0469	NT
DP-27	10/3/2012	**1.49**	**0.606**	0.001U	0.001U	0.002U	NT

Notes:

U	Compound was not detected at indicated detection limit
NT	Sample not tested for this analyte
shade	Result is above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit

Other 504.1 analytes were all below the detection limit

Table 4
Historical Groundwater Results Summary

Well ID	Date	GRO	Benzene	Toluene	Ethyl-benzene	Total Xylene	Ethylene dibromide
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method		AK101	8021B	8021B	8021B	8021B	504.1
ADEC Limit		2.2	0.005	1.0	0.7	10	0.00005
DP-28	9/6/2005	0.090U	0.000889	0.002U	0.002U	0.002U	NT
DP-28	7/26/2006	NT	0.001060	0.002U	0.002U	0.002U	NT
DP-28	9/28/2008	NT	0.000694	0.002U	0.002U	0.002U	NT
DP-28	9/29/2010	0.100U	0.0005U	0.002U	0.002U	0.002U	NT
DP-28	10/3/2012	0.100U	0.0005U	0.001U	0.001U	0.002U	NT
DP-29	9/6/2005	0.1	**0.043**	0.002U	0.00843	0.01390	NT
DP-29	7/26/2006	NT	**0.224**	0.002U	0.0278	0.04431	NT
DUP-02	7/26/2006	NT	**0.155**	0.00212	0.0220	0.03575	NT
DP-29	9/28/2008	NT	**0.093**	0.002U	0.0165	0.0129	NT
DP-30	9/6/2005	**1.9**	**0.773**	0.020U	0.020U	0.0563	NT
DP-30	9/28/2008	NT	**0.145**	0.020U	0.002U	0.002U	NT
DP-41	7/26/2006	NT	0.001	0.002U	0.002U	0.002U	NT
DP-42	7/26/2006	NT	0.00383	0.002U	0.002U	0.002U	NT
DP-42	9/28/2008	NT	**0.0242**	0.020U	0.020U	0.020U	NT
DP-42	9/29/2010	NT	NT	NT	NT	NT	NT
DP-42	10/3/2012	0.100U	**0.00656**	0.00129	0.001U	0.002U	NT
DP-43	7/26/2006	NT	**0.181**	0.002U	0.002U	0.002U	NT
DP-43	9/28/2008	NT	**0.146**	0.002U	0.002U	0.002U	NT
DP-43	9/29/2010	0.100U	**0.0149**	0.002U	0.002U	0.002U	NT
DP-43	10/3/2012	0.100U	**0.0115**	0.001U	0.001U	0.002U	NT

Notes:

U	Compound was not detected at indicated detection limit
NT	Sample not tested for this analyte
shade	Result is above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit

Other 504.1 analytes were all below the detection limit

Table 4
Historical Groundwater Results Summary

Well ID	Date	GRO	Benzene	Toluene	Ethyl-benzene	Total Xylene	Ethylene dibromide
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Method		AK101	8021B	8021B	8021B	8021B	504.1
ADEC Limit		2.2	0.005	1.0	0.7	10	0.00005
DP-51	9/28/2008	NT	0.0005U	0.002U	0.002U	0.002U	NT
DP-50(dup)	9/28/2008	NT	0.0005U	0.002U	0.002U	0.002U	NT
DP-51	9/29/2010	0.100U	0.0005U	0.002U	0.002U	0.002U	NT
DP-51	10/3/2012	0.100U	0.000510	0.001U	0.001U	0.002U	NT
GNI-03	7/26/2006	NT	**0.0900**	0.00305	0.002U	0.002U	NT
GNI-03	9/6/2006	NT	**0.0992**	0.002U	0.002U	0.002U	NT
GNI-03	10/17/2006	NT	**0.0923**	0.002U	0.002U	0.002U	NT
GNI-03	2/26/2007	NT	**0.0679**	0.002U	0.002U	0.002U	NT
GNI-03	6/25/2007	NT	**0.0925**	0.002U	0.002U	0.002U	NT
GNI-03	9/28/2008	NT	**0.0917**	0.020U	0.020U	0.020U	NT
GNI-03	9/29/2010	0.123	**0.0501**	0.002U	0.002U	0.002U	NT
GNI-03	10/3/2012	0.109	**0.0460**	0.001U	0.001U	0.002U	NT
GNI-05	7/26/2006	NT	0.00130	0.002U	0.002U	0.002U	NT
GNI-05	9/6/2006	NT	0.0005U	0.002U	0.002U	0.002U	NT
GNI-05	10/17/2006	NT	0.0005U	0.002U	0.002U	0.002U	NT
GNI-05	2/26/2007	NT	0.0005U	0.002U	0.002U	0.002U	NT
GNI-05	6/25/2007	NT	0.000519	0.002U	0.002U	0.002U	NT
GNI-05	9/28/2008	NT	0.0005U	0.002U	0.002U	0.002U	NT
GNI-05	9/29/2010	0.100U	0.0005U	0.002U	0.002U	0.002U	NT
GNI-05	10/3/2012	0.100U	0.000760	0.001U	0.001U	0.001U	NT

Notes:

U	Compound was not detected at indicated detection limit
NT	Sample not tested for this analyte
shade	Result is above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit

Other 504.1 analytes were all below the detection limit

Table 5
Groundwater Natural Attenuation Monitoring Data
September 29, 2008

Well	Date	Time	D.O.	Fe^{2+}	Total Fe	S^{2}-	$SO_4{}^{2}$-	NO_3-	Methane	Clarity	Dilution
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	visual	
02	29-Sep	13:08	0.7	0.46	2.01	0.037	<7	<0.2	0.0072U	yellowish	Fe (1:10)
28	29-Sep	12:00	0.9	0.6	1.79	0.041	<7	<0.2	4.500	yellowish	Fe (1:10)
30	29-Sep	10:45	0.4	0.92	2.04	0.018	<7	0.6	0.036	clear, slight rust	Fe (1:10)
42	29-Sep	14:36	1.3	0.71	1.02	0.064	44	<0.2	0.060	clear, slight yellow	Fe (1:10)
G3	29-Sep	14:51	0.2	0.96	1.32	0.013	<7	0.2	0.279	clear	Fe (1:10)
21	29-Sep	9:30	0.5	2.44	3.13	0.003	<7	0.9	0.125	yellowish	Fe(1:10)
26	29-Sep	10:26	1.2	1.23	1.4	0.028	<7	<0.2	0.018	yellowish	Fe(1:20)
51	29-Sep	13:26	0.6	0.79	1.15	0.074	<7	<0.2	0.140	clear	Fe (1:20)
G5	29-Sep	15:29	0.3	0.2	1.11	0.033	31	<0.2	0.120	clear	Fe (1:4)

Notes: D.O. Dissolved Oxygen
Fe^{2+} Ferrous Iron
S^{2-} Sulfide
$SO_4{}^{2-}$ Sulfate
NO_3 Nitrate
mg/L milligrams per Liter

Table 6
Groundwater Quality Field Parameters Monitoring Data
September 28 & 29, 2008

Date	Well	Record #	pH	Cond	Turb	DO	Temp	TDS	ORP
		Units			NTU	mg/L	C°	g/L	
28-Sep	1	1	6.45	0.119	4.4	10.11	6.1	0.8	-66
28-Sep	1	2	6.44	0.122	4.1	10.07	6.1	0.8	-65
28-Sep	1	3	6.44	0.122	3.7	10.1	6.1	0.8	-67
28-Sep	2	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
28-Sep	3	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
28-Sep	25	1	5.83	82.8	424	10.66	7.4	0.52	-68
28-Sep	25	2	5.88	81.2	182	7.49	7.4	0.52	-60
28-Sep	25	3	5.84	81.3	93.6	5.94	7.4	0.52	-60
28-Sep	23	1	6.5	50.7	80.1	6.69	3.5	0.32	-147
28-Sep	23	2	6.49	49.8	36.8	6.59	3.4	0.32	-149
28-Sep	23	3	6.48	49.5	26.4	6.48	3.4	0.32	-150
28-Sep	22	1	6.33	0.121	194	7.7	5.2	0.8	-123
28-Sep	22	2	6.32	0.121	138	8.45	5.2	0.8	-120
28-Sep	22	3	6.32	0.12	119	8.08	5.2	0.8	-120
28-Sep	24	1	6.75	94.6	269	8.35	6.4	0.58	-160
28-Sep	24	2	6.47	92.3	280	8.3	6.1	0.59	-156
28-Sep	24	3	6.45	92.2	240	8.38	6.1	0.59	-155
28-Sep	28	1	6.14	47	436	9.66	5.5	0.31	-51
28-Sep	28	2	6.13	47	210	8.32	5.5	0.3	-49
28-Sep	28	3	6.13	46.9	182	8.86	5.4	0.3	-48
28-Sep	29	1	6.3	35.3	104.2	9.59	5.3	0.23	-55
28-Sep	29	2	6.29	36.3	19.4	10.39	5.3	0.25	-52
28-Sep	29	3	6.26	40.1	5.1	10.18	5.2	0.27	-56
28-Sep	43	1	6.19	74.7	NA	8.86	5.1	0.48	-108
28-Sep	43	2	6.22	75.5	NA	6.82	5	0.48	-112
28-Sep	43	3	6.23	75.4	NA	7.14	5	0.48	-109
28-Sep	27	1	6.23	63.1	69.5	8.9	5	0.4	-88
28-Sep	27	2	6.19	62.8	42.3	8.84	5	0.4	-74
28-Sep	27	3	6.18	62.7	32.5	9.3	5	0.4	-73
28-Sep	30	1	6.53	65.7	120	9.96	7.2	0.42	-140
28-Sep	30	2	6.54	66.6	112	10.47	7.2	0.43	-140
28-Sep	30	3	6.55	66.6	118	10.64	7.2	0.43	-143

Notes:

Cond	Conductivity
Turb	Turbidity in Nephelometric Turbidity Units (NTU)
DO	Dissolved Oxygen in milligrams per Liter (g/L)
TDS	Total Dissolved Solids in grams per liter (g/L)
ORP	Oxygen-Reduction Potential
NA-IR	Not analyzed - Insufficient Recharge

Table 6
Groundwater Quality Field Parameters Monitoring Data
September 28 & 29, 2008

Date	Well	Record #	pH	Cond	Turb	DO	Temp	TDS	ORP
		Units			NTU	mg/L	C°	g/L	
29-Sep	42	1	6.08	76.1	570	10.36	4.7	0.49	-99
29-Sep	42	2	6.33	76.9	521	7.74	4	0.49	-141
29-Sep	42	3	6.27	75.8	503	7.83	4.1	0.49	-138
29-Sep	GNW3(Dp)	1	7.08	45.1	379	8.59	1.5	0.29	-169
29-Sep	GNW3(Dp)	2	6.95	44.8	366	6.4	1.5	0.29	-172
29-Sep	GNW3(Dp)	3	6.87	45	336	6.31	1.5	0.29	-169
29-Sep	GNW(Sh)	4	6.73	44.7	434	6.33	1.9	0.29	-159
29-Sep	GNW(Sh)	5	6.71	45.2	216	6.03	1.6	0.29	-163
29-Sep	GNW(Sh)	6	6.69	45	79.2	5.89	1.5	0.29	-168
29-Sep	21	1	5.71	73.3	110	9.12	5.3	0.47	-177
29-Sep	21	2	6.14	71.4	112	6.83	5.1	0.46	-206
29-Sep	21	3	6.24	72.8	89.2	6.16	5.2	0.47	-223
29-Sep	26	1	6.52	67.8	131.3	7.2	0.43	-159	
29-Sep	26	2	6.48	66.6	127.1	6.6	0.43	-158	
29-Sep	26	3	6.49	66.8	142.3	6.7	0.43	-158	
29-Sep	51	1	6.44	60.6	480	8.89	5.6	0.39	-144
29-Sep	51	2	6.39	61.4	273	8.69	5.6	0.39	-145
29-Sep	51	3	6.3	58.9	212	8.79	5.7	0.38	-147
29-Sep	GNW5	1	6.83	42.2	191	9.65	4.3	0.28	-105
29-Sep	GNW5	2	6.76	42.3	169	8.75	4	0.27	-109
29-Sep	GNW5	3	6.7	42.3	139	7.89	3.9	0.28	-113

Notes:

Cond	Conductivity
Turb	Turbidity
DO	Dissolved Oxygen
TDS	Total Dissolved Solids
ORP	Oxygen-Reduction Potential
NA-IR	Not analyzed - Insufficient Recharge

Table 7
Groundwater Quality Field Parameters Monitoring Data
September 29, 2010

Date	Well	Record #	pH	Cond	Turb	DO	Temp	TDS	ORP
		Units			NTU	mg/L	C°	g/L	
29-Sep	23	1	6.56	0.566	83.8	12.95	5.96	0.35	-111
29-Sep	23	2	6.56	0.53	870	10.4	4.54	0.34	-117
29-Sep	23	3	6.63	0.527	423	9.49	4.54	0.3	-126
29-Sep	43	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
29-Sep	27	1	6.29	0.77	42.5	10.62	5.69	0.49	-77
29-Sep	27	2	6.35	0.77	36.3	7.65	5.47	0.5	-81
29-Sep	27	3	6.34	0.76	28.2	NA	5.45	0.49	-84
29-Sep	42	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
29-Sep	GNW3	1	6.83	0.548	27.6	4.36	1.44	0.35	-135
29-Sep	GNW3	2	6.87	0.545	20.6	3.29	1.39	0.35	-140
29-Sep	GNW3	3	6.88	0.544	14.6	2.84	1.34	0.35	-143
29-Sep	21	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
29-Sep	26	1	NA-S	NA-S	NA-S	NA-S	NA-S	NA-S	NA-S
29-Sep	51	1	6.51	0.716	30.7	10.53	5.53	0.45	-130
29-Sep	51	2	6.59	0.65	22.4	8.14	5.34	0.42	-136
29-Sep	51	3	6.64	0.63	20.7	6.34	5.33	0.4	-134
29-Sep	GNW5	1	6.53	0.541	684	6.22	5.53	0.33	-59
29-Sep	GNW5	2	6.81	0.513	239	2.71	3.68	0.33	-90
29-Sep	GNW5	3	6.86	0.513	172	2	3.49	0.33	-97
29-Sep	28	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR

Notes:

Cond	Conductivity
Turb	Turbidity in Nephelometric Turbidity Units (NTU)
DO	Dissolved Oxygen in milligrams per Liter (mg/L)
TDS	Total Dissolved Solids in grams per liter (g/L)
ORP	Oxygen-Reduction Potential
NA-S	Not analyzed - Petroleum Sheen Present
NA-IR	Not analyzed - Insufficient Recharge

Table 8
Groundwater Quality Field Parameters Monitoring Data
October 3, 2012

Date	Well	Record #	pH	Cond	Turb	DO	Temp	TDS	ORP
		Units			NTU	mg/L	C°	g/L	
3-Oct	23	1	7.17	1.2	5.1	NA	4.98	0.70	-189
3-Oct	23	2	7.45	0.92	NA	NA	3.84	0.53	-202
3-Oct	23	3	7.56	0.76	NA	NA	3.60	0.44	-205
3-Oct	23	4	7.59	0.66	739	NA	3.83	0.42	-207
3-Oct	43	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
3-Oct	27	1	6.16	43	-5?	NA	6.31	26	-157
3-Oct	27	2	6.34	33	-5?	NA	6.73	20	-166
3-Oct	27	3	6.45	25	0?	NA	7.52	16	-174
3-Oct	42	1	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
3-Oct	GNW3	1	8.25	0.54	122	NA	1.64	0.34	-203
3-Oct	GNW3	2	8.15	0.54	335	NA	1.25	0.34	-202
3-Oct	GNW3	3	8.12	0.54	308	NA	1.07	0.34	-202
3-Oct	21	1	6.80	7.7	762	NA	6.20	2.1	-157
3-Oct	21	2	6.45	3.4	178	NA	6.1	NA	NA
3-Oct	21	3	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
3-Oct	26	1	7.51	0.48	NA	NA	11.6	0.32	-162
3-Oct	26	2	7.52	0.56	NA	NA	6.36	0.36	-190
3-Oct	26	3	7.53	0.57	NA	NA	5.99	0.37	-194
3-Oct	51	1	6.09	0.21	NA	3.02	6.41	13	-157
3-Oct	51	2	6.35	0.20	NA	NA	3.97	13	-147
3-Oct	51	3	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
3-Oct	GNW5	1	9.07	0.50	NA	NA	2.91	0.33	-200
3-Oct	GNW5	2	8.97	0.52	NA	NA	1.26	0.34	-197
3-Oct	GNW5	3	8.90	0.53	NA	NA	1.19	0.34	-193
3-Oct	GNW5	4	3.63	0.46	522	NA	1.30	0.34	-159
3-Oct	28	1	6.34	0.82	NA	2.55	8.13	53	-133
3-Oct	28	2	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR	NA-IR
3-Oct	28	3	NA	NA	NA	NA	NA	NA	NA

Notes:

Cond	Conductivity
Turb	Turbidity in Nephelometric Turbidity Units (NTU)
DO	Dissolved Oxygen in milligrams per Liter (g/L)
TDS	Total Dissolved Solids in grams per liter (g/L)
ORP	Oxygen-Reduction Potential
NA	Not available due to instrument problem
NA-IR	Not analyzed - Insufficient Recharge

Table 9
Dual Phase Influent and Effluent Results 2010

Sample ID	GRO	Benzene	Toluene	Ethyl-benzene	Total Xylenes
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Method	AK101	8021B	8021B	8021B	8021B
Reg Limit	1.3	0.005	1	0.700	10
In	**65.2**	**0.3920**	**35.90**	0.362	1.322
Ef	0.469	**0.0072**	0.013	0.002U	0.002

Notes:

U	Compound not detected at limit of quantitation
shade	Above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit

Table 10
Drinking Water Laboratory Results and QA/QC Summary October 8, 2008

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylenes	Ethylene Dibromide (EDB)
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Method	524.2	524.2	524.2	524.2	504.1
ADEC Limit	0.005	1.0	0.7	10	0.00005
BTW-A	0.00280	0.000500U	0.000500U	0.00100U	0.0000193U
DBW-1	0.000580	0.000500U	0.000500U	0.00100U	0.0000179U
DBW-2 (DUP)	0.000530	0.000500U	0.000500U	0.00100U	0.0000190U

Notes:

U	Compound not detected at limit of quantitation
shade	Above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit
NT	Not Tested
BTW	Badger Towing Well
DBW	Dave Bridges Well

QA/QC					
Sample ID	DBW-1	DBW-2 (DUP)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
B	0.000580	0.000530	0.0006	-0.0001	**-9%**
T	0.000500U	0.000500U	NA	NA	**NA**
E	0.000500U	0.000500U	NA	NA	**NA**
X	0.00100U	0.00100U	NA	NA	**NA**
EDB	0.0000179U	0.0000190U	NA	NA	**NA**

Notes:

NA	The calculation is not applicable.
RPD	Relative percent difference as described in the lab data review checklist
ND	Analyte not detected

Table 11
Dave Bridges Drinking Water Laboratory Results and QA/QC Summary
September 26, 2012

Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylene
Units	mg/L	mg/L	mg/L	mg/L
Method	524.2	524.2	524.2	524.2
ADEC Limit	0.005	1.0	0.7	10
DBW-1	0.000500U	0.000500U	0.000500U	0.00100U
DBW-2 (DUP)	0.000500U	0.000500U	0.000500U	0.00100U

Notes:

U	Compound not detected at limit of quantitation
shade	Above detection limit, but below ADEC regulatory limit
bold	Result is above ADEC regulatory limit
NT	Not Tested
	Badger Towing would not grant access for sampling

QA/QC					
Sample ID	DBW-1	DBW-2 (DUP)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
B	0.000500U	0.000500U	NA	NA	**NA**
T	0.000500U	0.000500U	NA	NA	**NA**
E	0.000500U	0.000500U	NA	NA	**NA**
X	0.00100U	0.00100U	NA	NA	**NA**

Notes:

NA	The calculation is not applicable.
RPD	Relative percent difference as described in the lab data review checklist
ND	Analyte not detected

Table 12
Historic Drinking Water Results Summary

Well Info &/or Sample ID	Date	EDB	Benzene	Toluene	Ethyl-benzene	Total Xylenes	SGS W.O. #
		mg/L	mg/L	mg/L	mg/L	mg/L	exceptions as noted
		0.00005	0.005	1.0	0.7	10	
Badger Towing							
DW	9/5/05	NT	**0.028**	0.0005U	0.0005U	0.001U	1055617
DW	10/17/05	0.0000196U	**0.034**	0.0005U	0.0005U	0.001U	1056498
DW pre-filter	5/24/06	NT	**0.098**	0.0005U	0.0005U	0.001U	1062397
DW post-filter	5/24/06	NT	**0.041**	0.0005U	0.0005U	0.001U	1062397
DW pre-filter	8/16/06	NT	**0.100**	0.0005U	0.0005U	0.0005U	1064653
DW post-filter	8/16/06	NT	0.00071	0.0005U	0.0005U	0.0005U	1064653
New well	9/14/06	NT	0.00300	0.0005U	0.0005U	0.001U	AA-55135
New Well	11/16/06	NT	**0.0189**	0.0005U	0.0005U	0.0015U	1066433
Extended Well pre-filter	6/13/07	NT	0.0005U	0.0005U	0.0005U	0.0015U	1071972
Extended Well post-filter	6/13/07	NT	0.0005U	0.0005U	0.0005U	0.0015U	1071972
BTW-A	10/8/08	0.0000193U	0.00280	0.0005U	0.0005U	0.0015U	1085973*
Dave Bridges (Altrol)							
DBW	10/17/05	0.000187U	**0.027**	0.0005U	0.0005U	0.001U	1056498
DBW	6/5/06	NT	**0.006**	0.0005U	0.0005U	0.001U	1062669
DBW pre-filter	6/13/07	NT	0.00354	0.0005U	0.0005U	0.0015U	1071972
DBW-1	10/8/08	0.0000179U	0.000580	0.0005U	0.0005U	0.0015U	1085973*
DBW-2(Dup)	10/8/08	0.0000190U	0.000530	0.0005U	0.0005U	0.0015U	1085973*
DBW-1	9/26/12	NT	0.000500U	0.000500U	0.000500U	0.00100U	1128517
DBW-2(Dup)	9/26/12	NT	0.000500U	0.000500U	0.000500U	0.00100U	1128517

Notes:

U	Compound was not detected at listed detection limits
NT	Compound not tested
shade	Result is below ADEC regulatory limit, but above detection limit
bold	Result is above ADEC regulatory limit
EDB	1,2-Dibromoethane (ethylene dibromide)
AA	Sample collected by Ben Lomond personnel analyzed by Analytica Alaska
*	EDB Results from Subcontract Lab W.O.# G552-566

Table 12
Historic Drinking Water Results Summary

Well Info &/or Sample ID	Date	EDB	Benzene	Toluene	Ethyl-benzene	Total Xylenes	SGS W.O. #
		mg/L	mg/L	mg/L	mg/L	mg/L	exceptions as noted
		0.00005	0.005	1.0	0.7	10	
Lisa Peger							
Home	10/17/05	0.0000192U	0.00195	0.0005U	0.0005U	0.001U	1056498
Home	5/24/06	NT	0.0005U	0.0005U	0.0005U	0.001U	1062397
Apt.	5/24/06	NT	0.0005U	0.0005U	0.0005U	0.001U	1062397
Borealis Towing							
	10/17/05	0.0000186U	0.0005U	0.0005U	0.0005U	0.001U	1056498
Arctic Thunder Towing							
	10/17/05	0.0000198U	0.0005U	0.0005U	0.0005U	0.001U	1056498
Penny Watson							
PWW2	6/5/06	NT	0.0005U	0.0005U	0.0005U	0.001U	1062669
Don Davis							
PWW1	6/5/06	NT	0.0005U	0.0005U	0.0005U	0.0011	1062669
Arvil Seay							
ASW	6/5/06	NT	0.0005U	0.0005U	0.0005U	0.001U	1062669
J. Parker Shop							
JPW	5/24/06	NT	0.0005U	0.0005U	0.0005U	0.001U	1062397
Larry Dickman							
LD-01	11/16/06	NT	0.0005	0.0005U	0.0005U	0.001U	1066433
Ben Lomond (Air North)							
East	5/19/05	NT	0.00177	0.00226	0.00296	0.00594	1052633
West	5/19/05	NT	0.00168	0.002U	0.002U	0.002U	1052633
West	9/5/05	NT	0.00072	0.0005U	0.0005U	0.001U	1055617

Notes:

U	Compound was not detected at listed detection limits
NT	Compound not tested
shade	Result is below ADEC regulatory limit, but above detection limit
bold	Result is above ADEC regulatory limit
EDB	1,2-Dibromoethane (ethylene dibromide)
AA	Sample collected by Ben Lomond personnel analyzed by Analytica Alaska
*	EDB Results from Subcontract Lab W.O.# G552-566

Table 13
Excavation Soil Sampling Results and QA/QC Summary
October 8, 2008

Sample ID	ADEC	Ex-1	Ex-2	Ex-3	Ex-4	Ex-5 (DUP)
Analyte	Method 2	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Depth (ft bgs)		3	4	5	7	5
PID Result	ppm	1653	1541	>2000	>2000	
Petroleum Fractions and BTEX (Method 8021B)						
GRO	300	**946**	**1630**	**7170**	**1690**	**5460**
DRO	250	NA	NA	**295**	NA	NA
Benzene	0.025	**3.36**	**48.4**	**71.0**	**49.6**	**87.5**
Toluene	6.5	**8.57**	**199**	**434**	**165**	**360**
Ethylbenzene	6.9	**8.15**	**116**	**297**	**102**	**207**
Total Xylenes	63	39.32	**381.3**	**1094.0**	**344.0**	**530.2**

Excavation QA/QC

Sample ID	Ex-3	Ex-5 (DUP)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
GRO	7170	5460	6315	-1710	**-27%**
B	71.0	87.5	79	17	**21%**
T	434.0	360.0	397	-74	**-19%**
E	297.0	207.0	252	-90	**-36%**
X	1094.0	530.2	812	-564	**-69%**

Notes:

U	Analyte not detected at the listed detection limit
ppm	Parts per million
NA	Analyte not analyzed for
Shade	Analyte detected in concentration below the ADEC Cleanup level
Bold	Analyte detected in concentration exceeding the ADEC Cleanup level

Table 14
Landfarm Soil Sampling Results and QA/QC Summary October 8, 2008

Sample ID	ADEC	LF-1	LF-2	LF-3	LF-4	LF-5	LF-6	LF-7 DUP
Analyte	Method 2	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
PID Result	ppm	208	1838	612	1831	1989	1789	
Petroleum Fractions and BTEX (Method 8021B)								
GRO	300	16.4	211	93	**693**	**2130**	**1320**	**950**
DRO	250	NA	NA	NA	NA	170	NA	NA
Benzene	0.025	**0.0333**	**0.290**	**0.0776**	**2.58**	**61.4**	**20.4**	**2.52**
Toluene	6.5	0.0297U	4.580	0.109	**10.4**	**194**	**137**	**9.05**
Ethylbenzene	6.9	0.0297U	0.573	0.270	5.64	**111**	**100**	5.17
Total Xylenes	63	0.234	2.393	0.947	55.3	**380**	**342.1**	58.3
Detected Polycyclic Aromatic Hydrocarbons (PAHs, Method 8270C SIMS)								
Phenanthrene	3000	NA	NA	NA	NA	0.0104	NA	NA
Flourene	220	NA	NA	NA	NA	0.00724	NA	NA
Naphthalene	20	NA	NA	NA	NA	0.224	NA	NA
2-Methylnaphthalene	6.1	NA	NA	NA	NA	0.357	NA	NA
1-Methylnaphthalene	6.2	NA	NA	NA	NA	0.199	NA	NA
EDB (Method 504)								
EDB	0.00016	NA	NA	NA	NA	**12.200**	NA	NA
RCRA Metals (Method 6020 and Method 7471B for Mercury)								
Arsenic	3.9	NA	NA	NA	NA	**4.06**	NA	NA
Barium	1100	NA	NA	NA	NA	59.7	NA	NA
Cadmium	5.0	NA	NA	NA	NA	0.237U	NA	NA
Chromium	25	NA	NA	NA	NA	10.1	NA	NA
Lead	400	NA	NA	NA	NA	19.6	NA	NA
Mercury	1.4	NA	NA	NA	NA	0.0485U	NA	NA
Selenium	3.4	NA	NA	NA	NA	0.592U	NA	NA
Silver	11.2	NA	NA	NA	NA	0.118U	NA	NA

QA/QC Landfarm

Sample ID	LF-4	LF-7 (DUP)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
GRO	693	950	821.50	257.000	**31%**
B	2.580	2.520	2.55	-0.060	**-2%**
T	10.400	9.050	9.73	-1.350	**-14%**
E	5.640	5.170	5.405	-0.470	**-9%**
X	55.300	58.300	56.800	3.000	**5%**

Notes:		
	U	Analyte not detected at the listed detection limit
	NA	Analyte not analyzed for
	Shade	Analyte detected in concentration below the ADEC Cleanup level
	Bold	Analyte detected in concentration exceeding the ADEC Cleanup level
	EDB	1,2-Dibromoethane also known as Ethylene Dibromide

Table 15
Landfarm Soil Sampling Results and QA/QC Summary September 24, 2012

Sample ID	ADEC	LF 12-1	LF 12-2	LF 12-4	LF 12-5	LF 12-6 DUP
Analyte	Method 2	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
PID Result	ppm	4.6	14.3	13.7	6.0	14.3
Petroleum Fractions and BTEX (Method 8021B)						
GRO	300	11.7	36.7	15.7	34.1	46.4
Benzene	0.025	0.016U	**0.0439**	0.017	**0.0407**	**0.0618**
Toluene	6.5	0.032U	0.0471	0.0205U	0.0407	0.058
Ethylbenzene	6.9	0.032U	0.0243U	0.0205U	0.031U	0.0475U
Total Xylenes	63	0.0767	0.386	0.1835	0.423	0.340

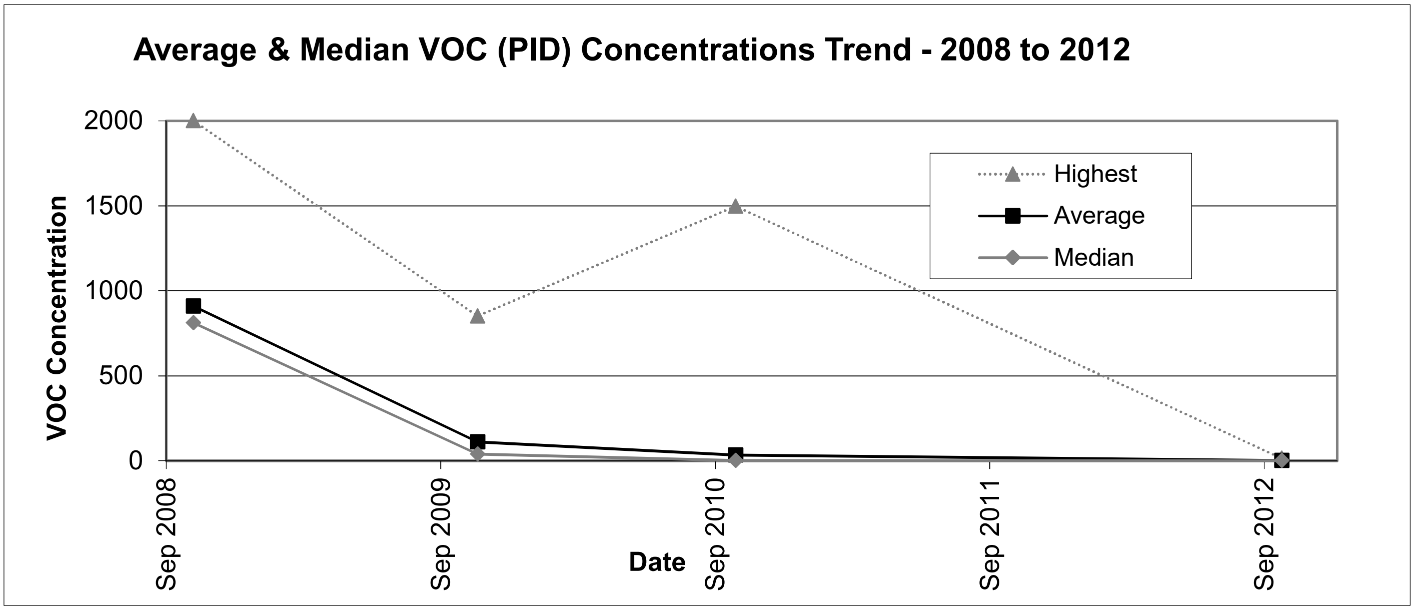
QA/QC Landfarm

Sample ID	LF 12-2	LF 12-6 (DUP)	Average	Difference	RPD
Analyte	mg/L	mg/L	mg/L	mg/L	%
GRO	36.7	46.4	41.55	9.700	**23%**
B	0.0439	0.0618	0.05	0.018	**34%**
T	0.0471	0.058	0.05	0.011	**21%**
E	0.0243U	0.0475U	NA	NA	**NA**
X	0.386	0.340	0.363	-0.046	**-13%**

Notes:

U	Analyte not detected at the listed detection limit
NA	Analyte not analyzed or not applicable
Shade	Analyte detected in concentration below the ADEC Cleanup level
Bold	Analyte detected in concentration exceeding the ADEC Cleanup level

Table 16
Landfarm Field Screening Summary



Date	Oct 2008	Oct 2009	Sep 2010	Sep 2012	2008, 2009	2008, 2009	2010	2010	2012	2012
Location Number	Photoionization Detector (PID) Reading in Parts Per Million (ppm)				Axis Sample Location					
					x	y	x	y	x	y
1	68.9	2.4	1.5	0.4	5	7	5	30	10	10
2	265	1.8	1.3	2.3	5	14	15	30	20	10
3	3.5	4.3	1.1	0.4	5	21	25	30	30	10
4	8.7	1.9	1.2	1.6	5	28	35	30	40	10
5	1694	48.3	1.2	4.6	20	7	45	30	50	10
6	347	4.5	2.2	0.6	20	14	55	30	60	10
7	166	9.4	1.4	0.3	20	21	65	30	70	10
8	66.2	8.3	1.7	0.2	20	28	75	30	80	10
9	208	10.9	1.9	0.5	35	7	85	30	90	10
10	332	22.1	1.4	0.9	35	14	95	30	100	10
11	270	33.6	2.2	0.6	35	21	105	30	110	10
12	497	254	1.1	0.4	35	28	115	30	120	10
13	604	132	1.6	0.4	50	7	125	30	130	10
14	597	37.8	1.4	0.6	50	14	135	30	140	10
15	1118	20.1	1.0	0.5	50	21	145	30	150	10
16	1838	121	1.6	1.0	50	28	155	30	160	10
17	1460	123	2.3	1.0	65	7	165	30	170	10
18	191	166	2.0	0.4	65	14	175	30	180	10
19	1666	167	3.0	0.4	65	21	5	17.5	10	20
20	2000	135	3.8	0.8	65	28	15	17.5	20	20
21	633	140	1.4	1.2	80	7	25	17.5	30	20
22	463	41.1	2.2	1.1	80	14	35	17.5	40	20
23	612	17.2	1.4	1.1	80	21	45	17.5	50	20
24	502	185	0.7	1.0	80	28	55	17.5	60	20
25	488	95.3	1.1	1.2	95	7	65	17.5	70	20
26	380	461	0.7	14.3	95	14	75	17.5	80	20
27	687	59.3	1.3	1.6	95	21	85	17.5	90	20

Table 16
Landfarm Field Screening Summary

Date	Oct 2008	Oct 2009	Sep 2010	Sep 2012	2008, 2009	2008, 2009	2010	2010	2012	2012
Location Number	Photoionization Detector (PID) Reading in Parts Per Million (ppm)				Axis Sample Location					
					x	y	x	y	x	y
28	1523	31.8	0.1	1.1	95	28	95	17.5	100	20
29	1230	3.5	3.7	1.2	110	7	105	17.5	110	20
30	2000	9.6	1.2	1.1	110	14	115	17.5	120	20
31	1634	10.9	1.2	1.0	110	21	125	17.5	130	20
32	1831	62.7	0.4	1.7	110	28	135	17.5	140	20
33	1234	2.1	0.6	0.9	125	7	145	17.5	150	20
34	937	2.3	1.0	0.7	125	14	155	17.5	160	20
35	1331	27.6	65	0.8	125	21	165	17.5	170	20
36	1897	9.5	180	0.8	125	28	175	17.5	180	20
37	997	2.9	2.2	1.0	140	7	5	5	10	30
38	420	46.5	2.0	1.0	140	14	15	5	20	30
39	515	2.7	2.1	1.3	140	21	25	5	30	30
40	459	2.1	1.2	3.5	140	28	35	5	40	30
41	943	851	3.3	1.1	155	7	45	5	50	30
42	1234	655	2.0	1.4	155	14	55	5	60	30
43	1011	364	2.5	1.1	155	21	65	5	70	30
44	1989	104	1.9	13.7	155	28	75	5	80	30
45	1034	175	1.6	1.9	170	7	85	5	90	30
46	1126	295	1.3	5.8	170	14	95	5	100	30
47	1870	233	1.7	6.0	170	21	105	5	110	30
48	1289	114	0.8	1.1	170	28	115	5	120	30
49			1.4	2.2	185	7	125	5	130	30
50			1.5	1.3	185	14	135	5	140	30
51			0.7	1.2	185	21	145	5	150	30
52			2.3	1.3	185	28	155	5	160	30
53			1498	2.3			165	5	170	30
54			2.5	1.5			175	5	180	30
Number	48	48	54	54						
Highest	2000	851	1498	14.3						
Average	910	111	34	1.8						
Median	812	39.5	1.5	1.1						

Appendix 3

Photo 1: *August 3, 2005. Looking east during excavation and removal of buried fuel piping.*

Photo 2: *October 16, 2007. Looking south at the free product recovery culvert during installation near well no. 26.*

Photo 3: *October 8, 2008. Looking east at the excavation and placing soil on the pilot landfarm in the former source area.*

Photo 4: *October 8, 2008. Looking northeast at the excavation profile during sampling. The landfarm is in the background.*

Photo 5: *October 8, 2008. Close up of the excavation down to groundwater at sample location EX-4, approximately 7.5 feet bgs.*

Photo 6: *September 3, 2009. Looking east at the pilot landfarm during field screening.*

Appendix 4

Print Form

Human Health Conceptual Site Model
Scoping Form

Site Name: Air North

File Number: 100.38.119

Completed by: Susan Vogt, Nortech

Introduction

The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, summary text about the CSM and a graphic depicting exposure pathways should be submitted with the site characterization work plan and updated as needed in later reports.

General Instructions: Follow the italicized instructions in each section below.

1. General Information:

Sources *(check potential sources at the site)*

- ☐ USTs
- ☒ ASTs
- ☒ Dispensers/fuel loading racks
- ☐ Drums
- ☐ Vehicles
- ☐ Landfills
- ☐ Transformers
- ☐ Other:

Release Mechanisms *(check potential release mechanisms at the site)*

- ☒ Spills
- ☒ Leaks
- ☐ Direct discharge
- ☐ Burning
- ☐ Other:

Impacted Media *(check potentially-impacted media at the site)*

- ☒ Surface soil (0-2 feet bgs*)
- ☒ Subsurface soil (>2 feet bgs)
- ☐ Air
- ☐ Sediment
- ☒ Groundwater
- ☐ Surface water
- ☐ Biota
- ☐ Other:

Receptors *(check receptors that could be affected by contamination at the site)*

- ☐ Residents (adult or child)
- ☒ Commercial or industrial worker
- ☒ Construction worker
- ☐ Subsistence harvester (i.e. gathers wild foods)
- ☐ Subsistence consumer (i.e. eats wild foods)
- ☒ Site visitor
- ☒ Trespasser
- ☐ Recreational user
- ☐ Farmer
- ☐ Other:

* bgs - below ground surface

2. **Exposure Pathways:** *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) Direct Contact -

1. Incidental Soil Ingestion

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site-specific basis.) ☒

If the box is checked, label this pathway complete: Complete

Comments:

2. Dermal Absorption of Contaminants from Soil

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Can the soil contaminants permeate the skin (see Appendix B in the guidance document)? ☐

If both boxes are checked, label this pathway complete: Incomplete

Comments:

b) Ingestion -

1. Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, or are contaminants expected to migrate to groundwater in the future? ☒

Could the potentially affected groundwater be used as a current or future drinking water source? Please note, only leave the box unchecked if DEC has determined the ground-water is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350. ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

2. Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water, or are contaminants expected to migrate to surface water in the future? ☐

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities). ☐

If both boxes are checked, label this pathway complete:

Comments:

3. Ingestion of Wild and Farmed Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild or farmed foods? ☐

Do the site contaminants have the potential to bioaccumulate (see Appendix C in the guidance document)? ☐

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. soil within the root zone for plants or burrowing depth for animals, in groundwater that could be connected to surface water, etc.) ☒

If all of the boxes are checked, label this pathway complete: Incomplete

Comments:

c) Inhalation-

1. Inhalation of Outdoor Air

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Are the contaminants in soil volatile (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

2. Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be occupied or placed on the site in an area that could be affected by contaminant vapors? (within 30 horizontal or vertical feet of petroleum contaminated soil or groundwater; within 100 feet of non-petroleum contaminted soil or groundwater; or subject to "preferential pathways," which promote easy airflow like utility conduits or rock fractures) ☒

Are volatile compounds present in soil or groundwater (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

3. **Additional Exposure Pathways:** *(Although there are no definitive questions provided in this section, these exposure pathways should also be considered at each site. Use the guidelines provided below to determine if further evaluation of each pathway is warranted.)*

Dermal Exposure to Contaminants in Groundwater and Surface Water

Dermal exposure to contaminants in groundwater and surface water may be a complete pathway if:

- Climate permits recreational use of waters for swimming.
- Climate permits exposure to groundwater during activities, such as construction.
- Groundwater or surface water is used for household purposes, such as bathing or cleaning.

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Volatile Compounds in Tap Water

Inhalation of volatile compounds in tap water may be a complete pathway if:

- The contaminated water is used for indoor household purposes such as showering, laundering, and dish washing.
- The contaminants of concern are volatile (common volatile contaminants are listed in Appendix D in the guidance document.)

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Fugitive Dust

Inhalation of fugitive dust may be a complete pathway if:

- Nonvolatile compounds are found in the top 2 centimeters of soil. The top 2 centimeters of soil are likely to be dispersed in the wind as dust particles.
- Dust particles are less than 10 micrometers (Particulate Matter - PM_{10}). Particles of this size are called respirable particles and can reach the pulmonary parts of the lungs when inhaled.
- Chromium is present in soil that can be dispersed as dust particles of any size.

Generally, DEC direct contact soil cleanup levels in Table B1 of 18 AAC 75 are protective of this pathway because it is assumed most dust particles are incidentally ingested instead of inhaled to the lower lungs. The inhalation pathway only needs to be evaluated when very small dust particles are present (e.g., along a dirt roadway or where dusts are a nuisance). This is not true in the case of chromium. Site specific cleanup levels will need to be calculated in the event that inhalation of dust containing chromium is a complete pathway at a site.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Direct Contact with Sediment

This pathway involves people's hands being exposed to sediment, such as during some recreational, subsistence, or industrial activity. People then incidentally ingest sediment from normal hand-to-mouth activities. In addition, dermal absorption of contaminants may be of concern if the the contaminants are able to permeate the skin (see Appendix B in the guidance document). This type of exposure should be investigated if:

- Climate permits recreational activities around sediment.
- The community has identified subsistence or recreational activities that would result in exposure to the sediment, such as clam digging.

Generally, DEC direct contact soil cleanup levels in 18 AAC 75, Table B1, are assumed to be protective of direct contact with sediment.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

4. Other Comments *(Provide other comments as necessary to support the information provided in this form.)*

HUMAN HEALTH CONCEPTUAL SITE MODEL GRAPHIC FORM

Site: Air North; 100.38.119

Completed By: Susan Vogt

Date Completed: July 17, 2013

***Instructions*: Follow the numbered directions below. Do not consider contaminant concentrations or engineering/land use controls when describing pathways.**

(1) *Check the media that could be directly affected by the release.*

(2) *For each medium identified in (1), follow the top arrow and check possible transport mechanisms. Check additional media under (1) if the media acts as a secondary source.*

(3) *Check all exposure media identified in (2).*

(4) *Check all pathways that could be complete. The pathways identified in this column **must** agree with Sections 2 and 3 of the Human Health CSM Scoping Form.*

(5) *Identify the receptors potentially affected by each exposure pathway: Enter "C" for current receptors, "F" for future receptors, "C/F" for both current and future receptors, or "I" for insignificant exposure.*

Media / Transport Mechanisms

Media	Transport Mechanisms	
☑ Surface Soil (0-2 ft bgs)	Direct release to surface soil	check soil
	☑ Migration to subsurface	check soil
	☑ Migration to groundwater	check groundwater
	☑ Volatilization	check air
	☐ Runoff or erosion	check surface water
	☐ Uptake by plants or animals	check biota
	☐ Other (list):____	
☑ Subsurface Soil (2-15 ft bgs)	Direct release to subsurface soil	check soil
	☑ Migration to groundwater	check groundwater
	☑ Volatilization	check air
	☐ Uptake by plants or animals	check biota
	☐ Other (list):____	
☑ Ground-water	Direct release to groundwater	check groundwater
	☑ Volatilization	check air
	☐ Flow to surface water body	check surface water
	☐ Flow to sediment	check sediment
	☐ Uptake by plants or animals	check biota
	☐ Other (list):____	
☐ Surface Water	Direct release to surface water	check surface water
	☐ Volatilization	check air
	☐ Sedimentation	check sediment
	☐ Uptake by plants or animals	check biota
	☐ Other (list):____	
☐ Sediment	Direct release to sediment	check sediment
	☐ Resuspension, runoff, or erosion	check surface water
	☐ Uptake by plants or animals	check biota
	☐ Other (list):____	

Exposure Media / Exposure Pathway/Route / Current & Future Receptors

Exposure Media	Exposure Pathway/Route	Residents (adults or children)	Commercial or industrial workers	Site visitors, trespassers, or recreational users	Construction workers	Farmers or subsistence harvesters	Subsistence consumers	Other
☑ soil	☑ Incidental Soil Ingestion		C/F	C/F	C/F			
	☐ Dermal Absorption of Contaminants from Soil							
	☐ Inhalation of Fugitive Dust							
☑ groundwater	☑ Ingestion of Groundwater		C/F	C/F	C/F			
	☐ Dermal Absorption of Contaminants in Groundwater							
	☐ Inhalation of Volatile Compounds in Tap Water							
☑ air	☑ Inhalation of Outdoor Air		C/F	C/F	C/F			
	☑ Inhalation of Indoor Air		C/F	C/F	C/F			
	☐ Inhalation of Fugitive Dust							
☐ surface water	☐ Ingestion of Surface Water							
	☐ Dermal Absorption of Contaminants in Surface Water							
	☐ Inhalation of Volatile Compounds in Tap Water							
☐ sediment	☐ Direct Contact with Sediment							
☐ biota	☐ Ingestion of Wild or Farmed Foods							

Appendix 5