REMEDIAL PRE-DESIGN INVESTIGATION
SOIL CHARACTERIZATION
SOIL REMEDIATION PILOT TEST
DEEP BEDROCK GROUNDWATER

FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

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ENGINEER'S CERTIFICATION

Pursuant to the Order on Consent and Administrative Settlement (Index #89-0571-00-01) for the Frontier Chemical Site in Niagara Falls, New York, this September 2010 Remedial Pre-Design Investigation Report has been prepared by Conestoga-Rovers & Associates (CRA) in general accordance with the Supplemental Soil Characterization and Pilot Test Work Plan, November 2007.

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1.0 INTRODUCTION

This Remedial Pre-Design Investigation Report has been prepared by Conestoga-Rovers & Associates (CRA) on behalf of the Potentially Responsible Parties Group (Group) for the Frontier Chemical Site (Site) located in Niagara Falls, New York. This Investigation has been performed in accordance with the Order on Consent and Administrative Settlement (Index #89-0571-00-01) entered into between the New York State Department of Environmental Conservation (NYSDEC) and the Group on August 15, 2008, and with the NYSDEC approved Work Plan attached to the Order. The purpose of the Investigation was to provide additional information sufficient to select and then design the final remedial action for the entire Site. The components of the final remedy for Operable Unit 1, as selected by the NYSDEC, were presented in the Record of Decision (ROD) that was issued in March 2006. A final NYSDEC selected remedy for the entire Site will encompass all of the components of Operable Unit 1 (which include the surface features, overburden soil, overburden groundwater, and shallow bedrock groundwater Zones A and B) and for Operable Unit 2 (which covers the deep bedrock groundwater Zones C, D, and E).

The additional information that has been collected in support of the final design for what has been administratively named Operable Unit 1 includes:

- Further delineation of the horizontal and vertical extent of soils containing elevated chemical concentrations which are to be addressed as a source control measure.
- A pilot test of an ex-situ soil vapor extraction method to treat the soils containing elevated chemical concentrations.
- Information on the groundwater volume and quality that infiltrates into the local sanitary sewer system.
- A soil vapor study to assess vapor intrusion and migration potential to fulfil the requirements of recently promulgated New York State regulations.

In addition to these Operable Unit 1 components, an investigation of the conditions in the deep bedrock groundwater was performed in accordance with the Work Plan. Although the deep bedrock groundwater is a component of what was administratively named Operable Unit 2, it was agreed in discussions with the NYSDEC that it would be appropriate to complete this phase of the work. Obtaining this information ensures that the remedial program selected and implemented for this Site results in a comprehensive and final remedy covering all aspects of the Site. It will also ensure compatibility between the various components and Operable Units.

The scope of the activities and evaluations performed for these investigations were presented in the "Supplemental Soil Characterization and Pilot Test Work Plan" prepared by CRA in November 2007. The Work Plan was subsequently approved by the NYSDEC on December 14, 2007. The results of these investigations were submitted to the NYSDEC in the report entitled "Remedial Pre-Design Investigation – Soil Characterization – Soil Remediation Pilot Test – Deep Bedrock Groundwater" dated October 19, 2009. Based on comments provided by NYSDEC on December 31, 2009 and discussions held between the NYSDEC and Frontier Group since that time, the report has been revised and addresses each of the NYSDEC comments.

2.0 PREVIOUS STUDIES AND PURPOSE OF THIS DOCUMENT

The Frontier Chemical Site has been the subject of a considerable number of investigations in the past. The results of previous investigative activities and evaluation of the results have been presented in the following documents:

i) Wehran Engineering Corp., 1982, Hydrogeologic Investigation

ii) Thomsen Associates, 1985a, Frontier Chemical Hydrogeologic Investigation

iii) Thomsen Associates, 1985b, Frontier Chemical Hydrogeologic Investigation, Evaluation of Groundwater Quality

iv) Golder Associates, 1988, Results of the Phase I and II Hydrological Investigations, Frontier Chemical, Niagara Falls, New York

v) Ecco, Inc., 1990, Hydrologic Investigation Phase III, Frontier Chemical Waste Process, Inc.

vi) Ecco, Inc., 1991, Interim Remedial Measure Report, Frontier Chemical Waste Process, Inc.

vii) Woodward-Clyde Consultants and Conestoga-Rovers & Associates, 1992, Niagara Falls Regional Groundwater Assessment

viii) Ecology and Environmental Engineering, November 2002, Final Supplemental Remedial Investigation Report for the Former Frontier Chemical Waste Process, Inc. Site

ix) Ecology and Environmental Engineering, May 2004, Feasibility Study Report for the Former Frontier Chemical Waste Process, Inc. Site

All of these documents have been reviewed by the NYSDEC during the course of this project. It is not the intent of this report to provide a document encompassing all aspects of these previous studies. Neither is it the intent of this document to recommend a particular method of remediation or to propose appropriate Soil Cleanup Objectives, which remain the subject of the NYSDEC's selected remedial program. Rather, the purpose of this document is to report the results of the specific investigations and evaluations performed by CRA pursuant to its November 28, 2007 Supplemental Soil Characterization and Pilot Test Work Plan as modified and approved by the NYSDEC by letter of December 14, 2007. This document provides a broad overview of the results of the earlier studies and incorporates applicable and appropriate information from these documents to the extent that the data are relevant to the discussion of the study results reported herein.

3.0 SITE LOCATION AND HISTORY

The following text has been excerpted from the March 2006 ROD.

3.1 SITE LOCATION AND DESCRIPTION

The Frontier Chemical Site is approximately 9 acres in size and is located on the northwestern corner of the intersection of Royal Avenue and 47th Street in Niagara Falls (see Figure 3.1). A residential neighborhood is approximately 1/2-mile west of the Site. The Site is in the heavily industrialized area of Niagara Falls bounded on the north by Niagara Falls Blvd., on the south by the Niagara River, and on the west by Hyde Park Blvd. Numerous other inactive hazardous waste sites are within one mile of the Site. These include several Occidental Chemical waste and plant sites, as well as DuPont Chemical, Olin Chemical, and the Solvent Chemical sites.

The majority of the buildings on the Site have been demolished, although some smaller buildings and structures remain. The Site is completely fenced and the majority of the surface of the Site covered by either concrete or blacktop. Several large areas of demolition debris also occupy areas on the surface of the Site.

3.2 SITE HISTORY

3.2.1 OPERATIONAL / DISPOSAL HISTORY

The first development of the Site occurred in 1906 when a chemical manufacturing plant was established on the property. Over the years, various different industrial operations were conducted on the Site. Chemical manufacturing was no longer active when the Site was leased to Frontier Chemical Waste Process, Inc. in 1977. Frontier operated an NYSDEC permitted waste treatment, storage, and disposal facility (TSDF) on the Site until December 1992. While operating this NYSDEC permitted facility, Frontier treated or stored approximately 25,000 tons of chemical wastes per year. Figure 3.2 shows the facility layout in 2001. In December 1992, following documented releases of hazardous waste from numerous drums, the Site was ordered closed by the NYSDEC.

3.2.2 REMEDIAL HISTORY

Several investigations of the Site were performed between 1981-1990. These investigations were primarily focused on identifying areas of groundwater contamination, and were required under the terms of the facility's operating TSDF permit. The company's preliminary plans to implement corrective actions to address the identified groundwater contamination ended in 1992 when financial difficulties forced the company to discontinue its permitted business operations.

Following closure of the NYSDEC permitted facility in December 1992, an emergency removal action was initiated by the US Environmental Protection Agency (USEPA) to remove the stored hazardous wastes from the Site. In 1993-1994, under a voluntary agreement with the USEPA, a group of PRPs removed over 4,000 drums of waste from the Site. In a subsequent agreement with the USEPA, a second phase was conducted by the PRPs in 1994-1995 which resulted in the removal of wastes from the 45 storage tanks on the property.

In 1995, the NYSDEC listed the former TSDF as a Class 2 site on the Registry of Inactive Hazardous Waste Disposal Sites in New York State. A Class 2 site is a site where the NYSDEC has determined that hazardous waste presents a threat to the public health or the environment and action is required.

In January 2001, the Site was referred to the NYSDEC for action using State Superfund monies. In the summer of 2001, a work plan was prepared to perform a Supplemental Remedial Investigation (Supplemental RI) and Feasibility Study (FS) of the Site. The Supplemental RI was completed in 2002, and an FS for Operable Unit 1 was completed in 2004. The Operable Unit 1 ROD was issued for the Site in March 2006.

4.0 GEOLOGY AND HYDROGEOLOGY

4.1 SITE GEOLOGY

The surface of the Site is mostly covered by either asphalt or concrete. Up to 2 feet of fill material (generally gravel with some cinder, glass, wood, slag, bricks, etc.) overlies an overburden mostly comprised of a silty-clay, with some discontinuous seams of silty sand and clay. The total depth of the overburden is 14 to 17 feet.

The bedrock immediately beneath the overburden is Lockport Dolomite. Distinct horizontal fracture systems have been characterized during the remedial investigations. The upper 35 feet of bedrock has been characterized as follows:

i) The A-Zone is identified as the fracture system consisting of the upper 3 to 5 feet of weathered bedrock

ii) The B-Zone is identified as the fracture system approximately 8 to 10 feet below the A-Zone

iii) The C-Zone is identified as the fracture system approximately 20 feet below the B-Zone

While no previous Site investigations have targeted bedrock beneath the C-Zone, numerous deeper bedrock fracture systems have been confirmed and described at other locations within the region. The findings of the deep bedrock investigation performed as part of this Investigation are provided in Section 6.3. The bedrock A-Zone, B-Zone, and C-Zone are described in greater detail in Section 4.2.2 (Site Hydrogeology).

4.2 HYDROGEOLOGY

4.2.1 REGIONAL HYDROGEOLOGY

Regionally, bedrock groundwater is recharged by water from the upper Niagara River (above the Falls), transmitted through fractures in the rock, and discharged to the lower Niagara River (at the gorge downstream from the Falls). There are two man-made structures which exert a significant influence on the flow of bedrock groundwater in the region: the New York Power Authority Conduits (Power Conduits) and the Falls Street Tunnel (FST). These structures and their effects on regional groundwater are described below.

NYPA Power Conduits

The Power Conduits are two parallel reinforced concrete lined tunnels which were excavated by open cut methods and installed within the bedrock to convey upper Niagara River water to the Robert Moses power generating station in Lewiston, New York. They are each approximately 65 feet high by 46 feet wide and run 4 miles in length in a south (river intake end) to north (power plant location) direction. The conduits pass approximately 1,100 feet to the west of the Site (see Figure 3.1 for location).

The NYPA conduits were constructed with a series of continuous drains along the outside of the concrete walls and floors. These drains are connected to the inside of the conduits at two locations and were designed to regulate the bedrock groundwater height around the exterior of the conduits. Given the length and depth of the NYPA conduits, the drain systems intersect and influence a significant portion of the upper bedrock groundwater in the Niagara Falls area. The drain systems essentially create a preferential pathway for upper bedrock groundwater, and the result is a groundwater "sink" along the length of the conduits. It has been estimated that the influence of the conduits on the bedrock groundwater flow regime extends approximately 3,000 to 4,000 feet to the east and west of the conduits' alignment.

The NYPA conduits pass under the unlined bedrock FST (described in detail below) on Royal Avenue. A significant amount of bedrock groundwater transmitted along the NYPA conduit drain system flows upward and into the FST at this crossing. A 2003 estimate performed on behalf of New York Power Authority calculated infiltration of approximately 6.5 million gallons of bedrock groundwater per day into the FST from the Power Conduit drain system.

Falls Street Tunnel

The Falls Street Tunnel (FST) is an unlined bedrock sewer tunnel that passes along the south side of the Site. It runs east to west for approximately 3.5 miles from 56th Street to the Niagara Gorge. The FST is approximately 7 feet wide by 6 feet high (in the vicinity of the Site on Royal Avenue) and it intersects the Site B-Zone bedrock fracture system. The FST has drop shafts constructed at all major street intersections. These drop shafts are brick lined within the overburden and unlined within the bedrock.

Other Local Sewers

In the immediate vicinity of the Site, there are several sewers that either influence Site hydrogeology or play a role in the collection and discharge of local groundwater and stormwater. As discussed above, the FST is a major sewer which runs under Royal

Avenue along the south side of the Site. Running parallel, and also located beneath Royal Avenue just south of the FST, is the South Side Interceptor (SSI). In addition, the New Road Tunnel runs along the eastern side of the Site under 47th Street. The SSI and the New Road Tunnel (47th Street Tunnel) are described in detail below.

South Side Interceptor

The FST was originally constructed as a combined storm and sanitary sewer. However, most of the waters from east of 47th Street were diverted after 1972, when the concrete lined SSI was constructed. The SSI is located slightly south of the FST and runs from the intersection of 47th Street and Royal Avenue to its discharge point at the Niagara Falls wastewater treatment plant (WWTP). The SSI sewer serves various industrial waste dischargers with connections between its origin and its termination at the WWTP. Regulating dams, constructed in the FST just west of 47th Street (and adjacent to the Site) and at 38th Street (about 1/2- mile to the west) divert normal FST flows to the SSI. High water flows within the FST (such as those accompanying significant storm events) result in an "overtopping" of the diversion dams, and allow flow to continue along the FST to the west instead of being diverted to the SSI.

47th Street Tunnel

The 47th Street Tunnel is an unlined bedrock sewer tunnel that passes along the eastern side of the Site. It runs from north to south under 47th Street, and connects into the FST at Royal Avenue. The 47th Street Tunnel is approximately 6 feet wide by 5 feet high, and like the FST, the tunnel intersects the B-Zone bedrock fracture system.

4.2.2 SITE HYDROGEOLOGY

Depth to groundwater within the overburden ranges from about 2 to 10 feet below ground surface. However, the groundwater in the overburden exists only as a perched water zone with the majority of the overburden being in a dewatered state due to the presence of the FST and the 47th Street Tunnel. There is a horizontal overburden groundwater gradient in the perched zone toward the southeast, with a localized overburden 'sink" (inwardly directed groundwater depression) in the south-central portion of the Site. A downward vertical groundwater gradient exists between the overburden and the top of the bedrock. Information obtained during the 2008 and 2010 investigations has found that a considerable portion of the overburden on the Site is in a dewatered state with minimal groundwater present.

Within the upper 35 feet of bedrock, 3 distinct horizontal fracture zones have been identified. The A-Zone consists of the highly weathered upper 3 to 5 feet of bedrock. The B-Zone is a fracture system which is up to 2 feet thick and is located approximately 8 to 10 feet below the A-Zone. A downward vertical groundwater gradient exists from the A-Zone to the B-Zone. The C-Zone is a fracture system approximately 20 feet below the B-Zone. The data available prior to the 2008 investigation showed that the C-Zone has a slight upward vertical groundwater gradient from the C-Zone to the B-Zone. The bedrock between the three defined horizontal fracture zones contains some vertical fractures that provide some groundwater communication between the zones. The overburden and bedrock hydrogeologic units are presented in cross-sections on Figures 4.2 and 4.3. The locations of the cross-sections are shown on Figure 4.1.

The FST and the 47th Street Tunnel run along the south and east sides of the Site respectively. As both of these tunnels intersect the bedrock B-Zone fracture system, Site bedrock groundwater from the B-Zone infiltrates into these tunnels. This infiltration in turn promotes a downward groundwater gradient from the Site overburden and upper weathered bedrock into the B-Zone. The influence of these tunnels also imparts an upward groundwater gradient from the lower C-Zone fracture system into the B-Zone. The effect of the FST as an upper bedrock groundwater interceptor has been well documented in numerous hydrogeologic studies of the area. The location, depth, and hydraulic influence of the tunnels have effectively intercepted Site overburden and upper bedrock groundwater and have prevented it from migrating beyond the Royal Avenue and 47th Street Tunnel alignments.

At the Site, groundwater within the bedrock C-Zone and some of the lower bedrock fracture systems are also influenced by the Power Conduit drain system. Since significant amounts of the conduit drain system water flows into the FST, it would be expected that at least some of the C-Zone and lower site bedrock groundwater also infiltrates into the FST.

5.0 PREVIOUS CHEMICAL CHARACTERIZATION

Previous chemical characterization of subsurface soils (unsaturated and saturated) and groundwater has been presented in the Supplemental Remedial Investigation Report (Ecology & Environment – November 2002). Summaries of the chemical characteristics, as defined by the previous studies, are provided in the following sections.

5.1 SOIL

5.1.1 SURFACE SOIL

The majority of the Site is currently covered with either concrete or asphalt pavement. As such, surface soil samples were not collected as part of the Supplemental Remedial Investigation sampling program.

5.1.2 SUBSURFACE SOIL

Volatile organic contamination is widespread in overburden soils in the central and south-central portions of the Site. Monochlorotoluene (MCT) is present in high concentrations within the central area of the Site, specifically in the southwestern quadrant of the Site, with MCT concentrations detected as high as 7,884 ppm. There is an equally large area of soil with high concentrations of total VOCs (as high as 2,089 ppm) in the central and southern portion of the Site.

It should be noted that maximum VOC concentrations were detected at depths from 3 to 13 feet below ground surface. The heterogeneous nature of the overburden contributes to the vertical and horizontal distribution of contaminants. The high concentrations of VOCs and MCT detected within overburden soils suggest that non-aqueous phase liquid (NAPL) exists within the soil matrix. Since many of the VOCs are more dense than water, it is likely that the NAPL is a dense NAPL (i.e., DNAPL).

5.2 GROUNDWATER

Site groundwater has been contaminated by both TSDF and prior manufacturing operations. As a large percentage of the overburden soil has been contaminated by various VOCs, associated overburden groundwater has been similarly affected. Due to the influence of the adjacent unlined bedrock tunnels on the overburden groundwater (drawing it downward into the fractured bedrock aquifer), some of the Site contamination (both dissolved phase and NAPL) has migrated downward into the fractured bedrock. Groundwater impacts to each zone are described in the following subsections. As described in Section 4.2.2, the location and influence of the FST and 47th Street tunnel have effectively intercepted the lateral movement of overburden and upper bedrock groundwater and prevented it from migrating off Site beyond the FST and 47th Street tunnel alignments.

As noted in the ROD, although the nearby tunnels provide an effective groundwater control system for the Site, achievement of groundwater standards on the former TSDF within a reasonable time frame is considered technically impracticable.

5.2.1 OVERBURDEN GROUNDWATER

The historic overburden groundwater data show that high concentrations of VOCs are distributed over a large area of the Site from the center to the southwestern corner. A sample of DNAPL containing mostly MCT was taken during a 1988 sampling event from overburden well BH-4B, located in the southwestern quadrant of the Site, immediately downgradient of a former sludge settler lagoon. The highest concentrations of VOCs within overburden groundwater were detected in the center of the Site. MCT was detected at 264,000 ppb at BH87-4B(R) and total VOCs (not including MCT) were detected at 394,300 ppb at PZ-01-4.

5.2.2 BEDROCK GROUNDWATER

The studies conducted up through 2003 showed that the bedrock groundwater contamination is concentrated in the upper bedrock zones and that the concentrations decrease significantly in the deeper bedrock (C-Zone).

A-Zone Bedrock Groundwater

The distribution of groundwater contamination within the A-Zone is detected throughout the center, southern, and southwestern portions of the Site. The highest concentrations of VOCs within the A-Zone groundwater unit are located in the same proximity as the overburden groundwater VOC highs. MCT was detected at 42,900 ppb at MW88-3A(R) and total VOCs (without MCT) were detected at up to 354,064 ppb at MW-88-8A.

B-Zone Bedrock Groundwater

B-Zone groundwater contamination is generally less widespread than the A-Zone. The influence of the FST is apparent as the highest concentrations of VOCs and MCT are present along the southern side of the Site near Royal Avenue. MCT was detected at 47,400 ppb at MW-11 and total VOCs (without MCT) were detected at 93,271 ppb, also at MW-11. Samples of DNAPL were obtained in 1988 from B-Zone wells MW-11 and MW-87-1A. The DNAPL from MW-11 contained mostly MCT, dichlorobenzenes, trichlorobenzenes, tetrachloroethene, and trichloroethene. The DNAPL from MW-87-1A was almost entirely MCT.

C-Zone Bedrock Groundwater

Three groundwater monitoring wells were installed in the C-Zone as part of the previous investigations and show that the groundwater in the C-Zone is of considerably better quality than the overlying B-Zone. One of the three wells was damaged and therefore was not sampled during the Supplemental Remedial Investigation. One of the two remaining C-Zone bedrock wells sampled (near the eastern Site boundary) in the Supplemental Remedial Investigation did not contain VOCs at detectable concentrations. The other well (in the south-central area) contained concentrations of MCT at 4,410 ppb and total VOCs (without MCT) at 3,590 ppb. This south central well location corresponded to an area of high B-Zone chemical concentrations. This reduction in chemical concentrations with depth is significant and establishes that historic chemical loadings to off-site areas from the C-Zone would be on the order of 3 pounds/year (based on data from the 1990s and early 2000s) or only 10 percent of the loading for the B-Zone. As requested by the NYSDEC, the magnitude and extent of C-Zone and deeper contamination has been the subject of the recent investigation and will be further assessed in Section 6.3.

5.3 SUMMARY OF HUMAN EXPOSURE PATHWAYS

The only identified potential pathways of exposure to Site chemicals on this industrial property are for utility workers entering adjacent or on-Site utilities and structures. These potential pathways are:

i) Dermal (skin) contact with contaminated subsurface soils and groundwater

ii) Inhalation of organic vapors

As a result, the chemical exposure potential associated with this Site is very limited.

5.4 SUMMARY OF REMEDIATION GOALS

Goals for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375-1.10. At a minimum, the remedy selected must eliminate or mitigate significant threats to public health and/or the environment presented by the hazardous waste disposed at the Site through the proper application of scientific and engineering principles.

The remediation goals for this Site are to eliminate, reduce, or control to the extent practicable:

i) Exposure of persons at or around the Site to VOCs and SVOCs in soils, groundwater, or air

ii) The release of contaminants from soil into groundwater that may create exceedances of groundwater quality standards [if considered feasible by the NYSDEC]

iii) The release of VOC vapors from soils or groundwater into ambient air within Site structures or subsurface utilities

iv) The off-site migration of VOCs and SVOCs within the overburden groundwater and within the bedrock groundwater zones of concern

Further, the remediation goals for the Site include attaining to the extent practicable:

i) Ambient groundwater quality standards (although the NYSDEC ROD notes that achievement of this goal in a reasonable timeframe is considered technically impracticable)

ii) NYSDEC Part 375 Recommended Soil Cleanup Objectives

5.5 REMEDY SELECTED IN THE ROD

The elements of the selected remedy described in the 2006 Operable Unit 1 ROD were as follows:

1. A remedial design program will be implemented to provide the details necessary for the construction, operation, maintenance, and monitoring of the remedial program.

2. Existing Site buildings, above grade structures, and demolition debris will be removed from the Site.
3. Contaminant source area soils will be excavated and treated/disposed off-site at an appropriate disposal facility. This method of source control is being investigated as part of this Design Investigation to determine whether equally effective but more cost efficient alternatives are available.
4. Soil removal areas will be backfilled with clean soil or other suitable material.
5. The Site surface will be covered through placement of clean soil or asphalt pavement over the unpaved portions of the Site. If clean soil is used as the cover material, a layer of geotextile material will be included in those areas below the clean soil for fixture "demarcation" of potentially contaminated soils.
6. Appropriate storm sewers will be constructed to collect and discharge Site storm water to the Niagara Falls Water Board's sewers under appropriate permit requirements.
7. Site groundwater will be controlled/treated in one of two ways. Either an agreement with the Niagara Falls Water Board will be reached which allows for Site groundwater control/treatment utilizing City utilities, or a Site groundwater control/treatment system will be constructed on-Site, with permitted discharge of effluent to the Water Board's sewer system.
8. Development of a Site Management Plan (SMP) to: (a) address contaminated soils that may be excavated from the Site during future redevelopment. The plan will require soil characterization and, where applicable, disposal/reuse in accordance with NYSDEC regulations; (b) evaluate the potential for vapor intrusion for any buildings constructed on the Site, including provisions for mitigation of any impacts; (c) identify any use restrictions; and (d) provide for the operation and maintenance of the components of the remedy.
9. Imposition of an institutional control in the form of an environmental easement that will: (a) require compliance with the approved SMP; (b) limit use and development of the property to commercial or industrial uses only; (c) restrict the use of groundwater as a source of potable water; and (d) require the property owner to complete and submit to the NYSDEC a periodic certification.
10. The property owner will provide periodic certification, prepared and submitted by a professional engineer or such other expert acceptable to the NYSDEC, until the NYSDEC notifies the property owner in writing that this certification is no longer needed. This submittal will contain certification that the institutional controls and engineering controls are still in place, allow the NYSDEC access to the Site, and that nothing has occurred that will impair the ability of the control

to protect public health or the environment, or constitute a violation or failure to comply with the SMP.

11. The operation of the components of the remedy will continue until the remedial objectives have been achieved, or until the NYSDEC determines that continued operation is technically impracticable or not feasible.
12. Since the remedy results in untreated hazardous waste remaining at the Site, a long-term groundwater monitoring program will be instituted. This program will allow the effectiveness of the groundwater control/treatment system to be monitored and will be a component of the operation, maintenance, and monitoring for the Site.

6.0 PREDESIGN INVESTIGATIONS AND PILOT TEST

The NYSDEC identified areas where additional data collection and assessment were needed prior to finalization of the design of the remedial program components for the Site. A Work Plan describing the collection of this additional data and the required assessments was submitted to the NYSDEC in November 2007 and approved in December 2007. The Work Plan was made a part of the Order on Consent and Administrative Settlement. The supplemental data collection / assessment proposed in the Work Plan included the following:

- Additional chemical delineation in soil
- A pilot test for ex-situ treatment of soil
- Deep bedrock groundwater investigation
- Evaluation of groundwater impact on tunnels
- Soil vapor intrusion evaluation

The following sections describe the supplemental investigations that were performed in 2008, 2009, and 2010 to fulfill this requirement.

6.1 ADDITIONAL CHEMICAL DELINEATION IN SOIL

The remedy selected by NYSDEC in the Operable Unit 1 ROD included the removal and off-site disposal of soils impacted with elevated chemical concentrations. At the time the ROD was issued, very little information concerning the chemical concentrations in the soil were available. In fact, there were only 29 soil samples from which data had been collected. Concern was expressed that the selection of an excavation and off-site disposal option based on such limited data was unreliable since the volume of soil estimated to contain elevated chemical concentrations could far exceed initial expectations. Consequently, a supplemental soil characterization program was developed as part of the Work Plan that was implemented by the Frontier Group in support of the final design of a comprehensive Site remedy.

The supplemental soil characterization program involved the installation of 20 boreholes in 2008 that provided an additional 114 soil samples to better delineate the vertical and horizontal extent of "source area" soils subject to remediation. "Source area" soil was defined in the NYSDEC approved Work Plan as soil with total VOC concentrations exceeding 1,000 ppm. Consequently, the discussion in this section of this report focuses on soils exceeding 1,000 ppm total VOCs (including MCT). An additional 13 boreholes and 60 soil samples were collected and analyzed in 2010 following discussions with the NYSDEC to further delineate the vertical and horizontal extent of "source area" soils and to assist in the determination of disposal characterizations and costs. In the Operable Unit 1 ROD, the recommended cleanup level for soil was 100 ppm of the sum of total VOCs and MCT. After issuance of the ROD, revised regulatory soil cleanup criteria were promulgated in 6 NYCRR Part 375-6 which became effective December 14, 2006.

The soil investigation work performed in 2008 and 2010 further refined the chemical concentrations in the soils as specified in the approved Work Plan.

Prior to initiating the supplemental soil delineation program, a comparison of the available soil data was made to the "source area" criteria for total VOCs (including MCT). The results of this comparison showed that there are six soil sample locations which exceed the "source area" criteria, as described in the Work plan, of 1,000 ppm. The locations of these six samples are shown on Figure 6.1. Review of the analytical results for the individual organic compounds show that all of the compounds which exceed their individual criteria for direct contact in an industrial setting (as set forth in the revised 6 NYCRR Part 375-6) are also found at these six locations that exceed the "source area" criteria for total VOCs.

6.1.1 BOREHOLE INSTALLATIONS / SAMPLE COLLECTION

Based upon this data review, a grid pattern consisting of 19 soil borehole locations was developed covering the six previously identified exceedance locations. The locations of the 19 boreholes are also shown on Figure 6.1.

Each borehole involved the collection of continuous soil samples from the ground surface to the top of bedrock. The soil samples were collected using split-spoon soil samplers which were advanced with a drill rig and decontaminated hollow stem augers in a manner consistent with ASTM D-1586. The split spoon samplers were two-inch diameter and two-feet-long and advanced ahead of the hollow stem augers in discrete two-foot intervals. Soil retrieved from the split-spoon samplers was accessed by removing one half of the split-spoon assembly. Disassembly of the split-spoons was performed with a minimal amount of movement so as not to disturb the sample and to preserve the volatile compounds present to the maximum extent possible.

Representative soil samples were collected from each two-foot interval and placed into separate ziplock bags for volatile organic headspace screening with a photoionization detector calibrated with a 100 parts per million (ppm) isobutylene standard. Each two-foot soil interval was examined by an on-Site geologist and logged based on geologic properties, staining, odor, and visible free product in a bound field notebook, using the New York Department of Transport soil description procedure (NYSDOT Soil Mechanics Bureau STP-2 dated May 1, 1975, as amended). A complete set of stratigraphic logs for the soil characterization program is presented in Appendix A.

Soil samples from each two-foot soil interval in the fill and permeable soils from each boring were submitted for laboratory analysis. In addition, at least one two-foot soil interval collected from the underlying low permeability clay/till layer was collected for laboratory analysis.

The soil samples were analyzed for VOCs and MCT only since these are the compounds driving the soil remedy. All sample containers were documented on laboratory-supplied Chain-of-Custody Forms; labeled with the sample location, date, time, and analysis to be performed; packed in ice to maintain a temperature of 4°C; and transported to the laboratory (Test America Laboratories) by courier in sealed coolers.

All completed boreholes were backfilled with cement grout containing five percent bentonite to control shrinkage. Soil cuttings were temporarily containerized in 55-gallon drums and included in the ex-situ SVE pilot test.

All sampling equipment was decontaminated in the field in accordance with the procedures outlined in the Work Plan and consistent with ASTM D-5088-90 guidelines.

An additional 13 boreholes were drilled in 2010 to further refine the extent of "source area" soils, as defined in the approved Work Plan. The locations of these additional boreholes are also shown on Figure 6.1 and the stratigraphic logs are included in Appendix A.

6.1.2 ANALYTICAL RESULTS

The analytical data from the 19 boreholes installed in 2008 were validated in accordance with the procedures outlined in the Quality Assurance Project Plan. All of the data were found to be suitable for their intended purpose. The results of these analyses are presented in Table 6.1. The results show that elevated chemical concentrations in excess of 1,000 ppm total VOCs were present in four of the 19 borehole locations. Based upon these data, one additional soil borehole location (BH-20 which is also shown on Figure 6.1) was drilled and sampled to complete the delineation effort of the "source area" total VOC level.

Of the 20 boreholes installed in 2008, the locations that exhibited total VOC concentrations in excess of 1,000 ppm are as follows:

BH-5	10 to 12' below grade
BH-8	8 to 14' below grade
BH-12	2 to 6' below grade
BH-16	4 to 6' below grade

The results of the additional 13 boreholes installed in 2010 were subject to the same Quality Assurance procedures as for those collected in 2008. The results were also found to be suitable for their intended use and are presented in Table 6.1. Of the 13 additional boreholes installed in 2010, the locations that exhibited total VOC concentrations in excess of 1,000 ppm are as follows:

BH-22	2 to 4' and 10 to 12' below grade
BH-25	12 to 14' below grade
BH-28	12 to 14' below grade
BH-29	8 to 8.4' below grade
BH-31	4 to 9.2' below grade
BH-33	12 to 12.7' below grade

In addition to these ten boreholes from the 2008 / 2010 investigations that had exceedances of 1,000 ppm total VOCs, there were six historic borehole locations where total VOC concentrations in excess of 1,000 ppm were identified to be present. These historic locations are:

PZ 01-05	11 to 13' below grade
PZ 01-10	8 to 10' below grade
BH87-4B	11 to 13' below grade
MW01-1OB	4 to 6' below grade
MW88-2OB	4 to 6' below grade
MW88-7OB	3 to 5' below grade

All of these exceedance locations are shown on Figures 6.2, 6.3, and 6.4. These figures provide the information for specific intervals of depth within the soil column; 0 to 6', 6 to 12', and 12 to 16', respectively.

When the soil concentration data are compared to the industrial cleanup criteria provided in 6 NYCRR Part 375-6 (the criteria for an individual compound – see Table 6.1), a similar list of exceedances is generated. For the 20 boreholes installed in 2008 and the 13 boreholes in 2010, the locations with exceedances of the direct contact criteria in an industrial setting for individual chemical compounds are:

BH-5	10 to 12' below grade
BH-8	8 to 14' below grade
BH-12	2 to 6' below grade
BH-16	4 to 6' below grade
BH-22	10 to 12' below grade
BH-25	12 to 14' below grade
BH-28	12 to 14' below grade
BH-31	4 to 9.2' below grade
BH-33	12 to 12.7' below grade

The chemicals for which the individual direct contact concentration criteria were exceeded are summarized in Table 6.2.

For the historic boreholes, there are six soil samples that exceeded an individual soil criterion for an industrial site. These are:

PZ 01-05	11 to 13' below grade (for tetrachloroethene)
PZ 01-10	8 to 10' below grade (for 1,4-dichlorobenzene)
MW-01-1OB	4 to 6' below grade (for monochlorotoluene)
BH87-4B	11 to 13' below grade (for monochlorotoluene)
MW-88-2OB	4 to 6' below grade (for monochlorotoluene)
MW-88-7OB	3 to 5' below grade (for monochlorotoluene)

In addition to the analytical data provided by the laboratory, photoionization detector readings were taken on the individual soil samples at the time of sample collection. These readings are also provided on Table 6.1. Comparison of the photoionization detector readings to the laboratory-derived data shows a very good correlation. All of the samples with concentrations exceeding the 1,000 ppm total VOC level also had elevated photoionization detector readings. Similarly, low laboratory results matched with low photoionization detector readings. Consequently, the photoionization detector can be a useful tool in helping to guide future soil remediation activities that involve soil excavation.

Based upon the analytical results, the intervals of elevated chemical presence typically are positioned in one of two soil layers. Most either overlie the clay stratigraphic layer that is common throughout the Niagara Falls area or are found in the lower reaches of the soil horizon, in the till layer that immediately overlies the bedrock. In most cases, these are the more permeable soil layers, whereas the clay layer is a very low permeable unit.

6.1.3 VOLUME OF IMPACTED SOIL

Using the analytical data available from the historic, 2008, and 2010 soil borehole programs, it is possible to provide a more accurate estimate of the volume of "source area" soil impacted with chemical concentrations. The volume has been estimated using a simple delineation method. This method uses the data from one borehole as being representative of the entire area around that borehole to a distance of halfway to all adjacent boreholes. This results in an estimated volume of impacted soil with chemical concentrations exceeding the "source area" concentration of 1,000 ppm of 4,000 cubic yards. This estimate uses the data from the 16 previously mentioned sample locations (six historic and 10 2008/2010 borehole locations) that have concentrations exceeding 1,000 ppm and applies one half the distance to the next closest sampling locations and depths to calculate the volume. It is understood that this estimating technique is subject to error; particularly since the sampling points are based on borehole locations which are typically on the order of 40 to 80 feet apart. Therefore the degree of interpolation between data points is still relatively coarse. Nonetheless, this estimate of impacted soils exceeding the 1,000 ppm "source area" concentration for total VOCs (based on 203 samples) is superior to the estimate used at the time the ROD was developed (based on 29 samples).

6.1.4 WASTE CHARACTERIZATION

As part of the 2010 soil investigation, samples of select soil intervals were also collected and submitted to the analytical laboratory to determine the hazard characterization of the soils. This characterization was performed to assist in determining how excavated soils would have to be handled if they were sent to an off-Site disposal facility. A total of seven soil samples from intervals exhibiting various levels of chemical presence (based on their photoionization detector readings) were submitted for analysis. The results of these analyses are presented in Table 6.3.

Of the seven samples submitted for characterization, three exceeded the TCLP criteria and therefore would be deemed hazardous from a soil disposal perspective. The three samples with exceedances, and the compounds for which they exceeded the TCLP criteria, are as follows:

- BH26-10 @ 12 to 14' tetrachloroethene
- BH29-10 @ 8 to 8.4' tetrachloroethene
- BH31-10 @ 8 to 9.2' benzene and corrosivity (pH = 12.7)

During the 2002 Supplemental Remedial Investigation, one of the three samples submitted for TCLP testing at that time was also identified as exhibiting hazardous characteristics. That occurred for the sample from MW-01-1OB @ 4 to 6' which was hazardous for trichlorothene.

6.1.5 CRITERIA FOR MONOCHLOROTOLUENE

One evaluation regarding cleanup criteria was also performed as specified in the Work Plan. MCT is one of the primary compounds present at the Site but New York does not have soil cleanup criteria for MCT. The NYSDEC requested that the Frontier Group develop criteria for MCT. This derivation of a cleanup criterion for MCT was completed and is provided in Appendix B. The evaluation concludes that the cleanup criteria for soil impacted with MCT in an industrial setting exceeds the "source area" definition set forth in the Work Plan of 1,000 ppm. Consequently, even though the risk based chemical criteria for MCT is higher than 1,000 ppm, the Soil Cleanup Objective for MCT (sum of chlorotoluenes) will be capped at 1,000 ppm, consistent with the New York practice of capping individual organic chemical Soil Cleanup Objectives at 1,000 ppm for industrial sites.

6.2 PILOT TEST – EX-SITU SOIL TREATMENT

When the Operable Unit 1 ROD was issued, it included the excavation and off-site disposal/treatment of soils with elevated VOC/MCT concentrations as a form of source control. Since the time the ROD was issued, the Part 375 cleanup standards have been revised. Although the additional delineation of the horizontal and vertical limits of the area of elevated chemical concentration is completed, the exact volume of impacted soil requiring remediation will not be known for certain until the excavation and remedy are complete.

A group of Frontier Site PRPs met with NYSDEC on June 26, 2007 to discuss alternate methods of source control that could achieve the desired cleanup goals for the Site but would be equally as effective and considerably less expensive to implement. One of these alternatives involves the excavation of source area soils coupled with on-Site soil vapor extraction (SVE) treatment to concentrations below cleanup criteria with the expectation that the treated soils would be returned to the excavation from which they came.

During the meeting, it was agreed that the primary compounds present are amenable to SVE (based on Henry's Law Constants) and that there is merit in further evaluating the ex-situ SVE alternative. It was suggested that a pilot test of this alternative would provide considerable insight into the practicality and feasibility of implementing this alternative. Consequently, a pilot test program was developed and submitted to the NYSDEC to evaluate ex-situ SVE. The following presents the details and results of the pilot test.

6.2.1 SOIL SELECTION FOR PILOT TEST

Based upon the results from the soil borehole program, it was decided that impacted soil from BH-8 would be used in the ex-situ soil treatment pilot test. The impacted soil from this borehole had the broad cross section of all of the primary chemical VOCs in its composition. The depth of impacted soil at this location (resting on the top of the bedrock) also made this location most suitable to learn about the excavation difficulties that could be encountered in a full-scale remediation program. Specifically, it was intended to provide information on odor issues, slope stability of deep excavations, and the difficulties that could arise from having to excavate soils below the water table.

6.2.2 IDENTIFIED CONDITIONS

The excavation of the soil at BH-8 identified the following conditions:

- The soils excavated were odorous but the cool weather of October/November helped keep them to manageable levels. The upper layers of soil were placed into a holding area and covered with polyethylene to minimize odors. The highly impacted soils were similarly covered as soon as possible. The rate of soil excavation was limited to one backhoe which also ensured minimal exposure of open soil faces; again minimizing odor production. For health protection, photoionization detector measurements were taken around the perimeter of the excavation. The measurements showed that the air quality was at background levels within 40 feet downwind of the excavation.

- The excavation encountered essentially no groundwater with only about 10 gallons of water accumulating in the open excavation. This is very important to the final program as it shows that water handling issues will not be a major factor for the excavation. The work should be able to be completed in a relatively dry operating mode making the work considerably easier to manage and therefore considerably less costly to perform. One shallow footing drain was encountered partway through the excavation of BH-8 that released about 15,000 gallons of water into the excavation. This water was transferred to on-Site Baker tanks and subsequently discharged to the City of Niagara Falls sanitary sewer system in compliance with the permit issued to the Site. The absence of groundwater in the overburden is likely due to the fact that the two neighboring sewer tunnels have completely dewatered the entire Site down to the elevation of the tunnels.
- Since minimal groundwater was encountered and the soils encountered were fairly dense, there was no slope stability issue observed during the excavation.
- The fact that the soils are fairly dense and contain some fine-grained material slightly increased the difficulty in excavating the material. In addition, these same characteristics caused the soils to be removed in blocks that maintained their blocky shape during soil handling operations.

6.2.3 TREATABILITY STUDY SET UP

The soils with elevated chemical concentrations were placed into a treatment cell that was constructed on the Site. The soils were moved and shaped over a couple of days as the treatment cell and associated piping was constructed. This additional handling caused additional volatilization of VOCs from the soils to occur. The cell contained about 60 cubic yards of impacted soil from BH-8. The cell was rectangular in shape and was approximately 20 feet in width by 24 feet in length and 6 feet in height. The cell consisted of a bottom and top polyethylene liner into which the soil was placed. Three 4-inch diameter air supply pipes were installed at the top and sides of the pile to provide the necessary outside air for the treatment. A central 4-inch diameter air extraction pipe was placed in the middle of the soil pile from which to draw the air. Both the air supply and extraction pipes were perforated. The extracted air was drawn through a blower at a rate of about 85 cubic feet per minute and exhausted through dual 5,000 pound carbon bed treatment units (arranged in series) to remove the VOCs extracted from the soil pile. A schematic of the treatment cell is presented in Figure 6.5.

6.2.4 TREATABILITY STUDY RESULTS

The treatment system was started up on November 20 and was shut down on December 22. During these 32 days of operation, the ambient air temperatures were cool with the extracted air ranging from 42°F at the start to 33°F by the conclusion of the test.

Two five-point composite samples of the soil were collected from the pile prior to startup of the blower. In addition, one five-point composite sample was collected at the conclusion of the test for comparison. (The final sample was split and analyzed twice; once obtaining estimated concentrations and once obtaining diluted sample concentrations.) The samples were collected using hand augers to penetrate two to three feet into the central core of the soil in the treatment cell. The depth of penetration of the sampling equipment ensured that the sample was as representative as possible of the middle of the soil pile; furthest from the air inlet and outlet pipes. The purpose of using a five point composite sample was to obtain as representative a sample as possible of the treatment soil pile. Table 6.4 presents the analytical data from the soil pile composite samples. The average total VOC concentrations measured in these sample sets were:

Startup concentration = 384 and 165 ppm for an average of 274 ppm
Concluding concentration = 31 and 623 ppm for an average of 327 ppm

This wide range of concentrations provides some insight into the variability of the makeup of the soil pile and illustrates some of the difficulties that will be involved in finalizing the remedy for the impacted soils.

The average result of the two starting and concluding soil concentrations increases slightly, emphasizing that the variability of the individual data points makes it difficult to draw firm conclusions from the data. It is known that the operation of the SVE system did reduce the chemical concentrations in the soil pile. It can even be calculated that the average concentration in the soil pile will have reduced by 150 ppm (as will be discussed later in this section). However, the variability of the soil sample data masks the certainty of the treatment impact. A reduction of 150 ppm means that the concentrations in the soil pile were at least reduced by a factor of 31% (using the assumption that 327 ppm is an accurate estimate of the concluding soil quality). Given the conditions under which this work was done (short duration, cold weather, no amendment of the soil within the pile, simple air inlet/outlet setup), these results are very encouraging.

There is one concern regarding the soil pile data that complicates the assessment of the effectiveness of the SVE system. It is noted that the original concentration of the soil at BH-8 from which these soils were excavated ranged from 1,481 to 2,431 ppm, yet the maximum concentration measured in the soil pile was only 623 ppm. It appears that either the individual soil samples collected from BH-8 were not very representative of the overall average concentrations in the soil that was excavated, or, the mere excavation and handling of these soils resulted in a significant reduction in the total VOC concentrations by the time the soils were placed into the treatment cell. Some volatilization of the VOCs in the soil occurred as the soils were excavated and during the handling / shaping steps that took place to construct the treatment pile. If these simple handling steps resulted in the significant concentration reductions, then it would appear that some form of on-Site ex-situ soil vapor extraction will work in stripping VOCs from the soil. The only requirement would be that the volatilization be performed in a controlled air environment to minimize untreated releases to the air. Regardless, the soil within the soil treatment cell was already well below the originally anticipated 1,000 to 2,000 ppm levels before the treatment system was even activated and was further reduced by the operation of the treatment cell.

Over the course of the 32 days of treatment, a number of sampling events were conducted on the air quality coming from the soil pile. Samples were collected on eight occasions and tested using hand-held instruments such as photoionization detectors (which provide total VOC concentrations with no speciation as to specific chemicals) and Draeger tubes (which provide concentrations of specific compounds). The samples were collected at the following locations in the air extraction process:

- In the extraction pipe exiting the soil pile (before the blower)
- Just before the air enters the carbon beds
- Between the two carbon beds
- Following the second carbon bed

The results of these measurements are provided in Table 6.5. These locations provide a complete overview of the air quality as it passes through the treatment process. The results show that immediately following startup of the blower on November 20, the concentrations being extracted from the soil pile were high, as expected. The concentrations reduced by a factor of about five by the second day and by another factor of three by Day 4. Within 12 days, the extraction rate had become stable with low concentrations being removed. Using the information from these hand-held instruments, it was estimated that about 20 pounds of chemicals had been removed on Day 1 with this rate being reduced to about 0.5 pounds per day by Day 12. The total estimated amount of VOCs removed over the duration of the 32-day Pilot Test using the field instrument measurements was 42 pounds.

A second, more precise set of air samples were collected and analyzed on four occasions. This second method involved the collection of Summa canister samples which were submitted to a laboratory for chemical analysis. The samples were collected immediately after startup of the blower, approximately 24 hours after startup, after two weeks, and just before shut down of the blower. The results from the Summa canisters show a similar trend of chemical concentrations with very high extraction on Day 1 with quickly dissipating concentrations thereafter, as shown in Table 6.6. Over the duration of the Pilot Test period, 26 pounds of total VOCs were removed from the soil pile, as calculated from the Summa canister sample data. The Summa canister data also confirm one important fact about the SVE system. Since the analytical data show that all of the major compounds are present in the extracted air, positive proof has been collected confirming that SVE is effective in removing all of the major on-Site chemicals.

Comparing the air sampling analytical results to the soil pile results provides valuable information concerning the effectiveness of the SVE system. Using the Summa canister data, 26 pounds of total VOCs were removed from the soil pile. Given that the soil pile contained 60 cubic yards of soil, the removal of 26 pounds of chemicals translates into a 150 ppm total VOC reduction from the soil pile. If it is assumed that the 274 ppm soil composite is an accurate measure of the starting chemical concentrations in the soil in the treatment cell, then 50% of the chemicals in the soil have been removed. If it is assumed that 327 ppb is an accurate measure of the final soil quality in the soil pile, then 31% of the chemicals in the soil pile have been removed. Using either case, the removal efficiency was very good considering the conditions under which the test was performed. It is also expected that SVE will be far more effective treating soil with higher initial chemical concentrations. Consequently, if the soils proposed for treatment are actually above 1,000 ppm, the SVE system will be far more effective than it was for the lower concentration soils that were treated under the Pilot Test.

6.2.5 TREATABILITY STUDY CONCLUSIONS

The Pilot Test has been successful in that it has provided the necessary treatment information. Based on the measured results, the following conclusions can be drawn:

- Acceptable air flow and vacuum can be achieved with standard SVE equipment
- Condensate and leachate accumulation are minimal (only 9 gallons accumulated in the knock-out drum)
- Significant VOC reductions can be achieved over short duration of operation and at low ambient temperatures
- All of the major VOCs present can be drawn from the soil using SVE
- Volatilization of Site VOCs readily occurs during excavation and handling of impacted soils and may be relied upon in developing a final on-Site ex-situ remedy for the Site soils

The above conclusions confirm that the use of ex-situ SVE is effective for reducing VOC concentrations in the Site soils. The efficiency of removal of VOCs could be enhanced by a number of means including the following that should be considered for use in a final ex-situ treatment system:

- Adding soil conditioners and/or using shredding or screening equipment to break up and homogenize the soil before placement into the soil pile. This would result in more even air flow through the soil, resulting in more thorough treatment.
- Adding more air inlet piping and / or longer perforated sections of air extraction piping within the soil pile to reduce the distances over which the air has to flow. This will increase the number of air pore volume exchanges, thereby improving treatment.
- Set up of the air supply and extraction pipe network in a manner that would allow the pipes to be used for either operation would add operational flexibility that would increase the treatment effectiveness.
- Simultaneous treatment of several larger piles would improve cost effectiveness.
- Conducting the treatment in warmer weather would significantly increase the vapor pressure of the VOCs and the efficiency of VOC removal from the soil.

In conclusion, the Pilot Test was successful in obtaining the necessary information and demonstrating that ex-situ SVE will work. It has also demonstrated that other on-Site ex-situ means of treatment (including mechanical manipulation of the soils with appropriate air controls) are possible.

6.2.6 OTHER CONSIDERATIONS

Regardless of which remedial alternative is selected, there will always be some uncertainty as to their effectiveness or their ability to meet the remediation goals. With the excavation and off-site disposal option, it is a concern that the volume of impacted soil requiring removal will not be known until the excavation limits are reached and all of the possible finger pathways of chemical migration have been fully tracked and excavated. The potential for excessive soil removal to access impacted pathways (currently estimated at 11,000 cubic yards to access the 4,000 cubic yards of impacted soil) remains very high. For the ex-situ soil vapor extraction alternative, the same excavation and tracking of elevated concentration pathways exist. There are also the concerns over the ability of the SVE system to extract the chemicals from dense and wet soils. However these SVE obstacles can be overcome by treating the soil for a longer period of time, by amending the soil and/or the design/operation of the SVE system, or by utilizing mechanical means to create the volatilizing conditions necessary to treat the soil. In the end, the Pilot Test has confirmed that the effectiveness of an SVE system can be engineered to be the same as the excavation and disposal alternative but the cost will be substantially lower.

As a further consideration for soil treatment effectiveness, it may be possible that remedial methods that incorporate a combination of on-Site ex-situ volatilization with on-Site in-situ technologies (such as chemical oxidation) can be efficiently implemented in a cost effective and "green remediation" manner.

6.3 DEEP BEDROCK GROUNDWATER CHARACTERIZATION

Pursuant to the Operable Unit 1 ROD, additional investigations were conducted to characterize the C-Zone and deeper bedrock groundwater (Operable Unit 2). Previous studies had characterized the shallower portions of the formation through the installation of groundwater monitoring wells into the A, B, and C Zones at the Site. These zones are found at the following depths:

- A Zone Upper 3 to 5 feet of bedrock
- B Zone Thin 2 foot layer at approximately 15 feet below the top of bedrock

- C Zone Permeable layer at a depth of approximately 35 feet below the top of bedrock

Of the wells that had been historically installed into the C Zone, only two (MW-88-4C and MW-88-5C) are operational and there are no on-Site wells for the deeper bedrock zones. Consequently, a deep bedrock groundwater investigation program was developed in the Work Plan approved by the NYSDEC and implemented.

6.3.1 WELL INSTALLATIONS

The investigation program involved the installation of three new deep bedrock groundwater monitoring well nests. Each well nest consists of the installation of a well in the C Zone, D Zone (approximately 55 feet below the top of bedrock) and the E Zone (approximately 85 feet below the top of bedrock). The primary purpose of these well nests was to determine the groundwater quality at depth and to evaluate the potential for off-site migration of chemicals via the fracture network in the deeper bedrock zones. The locations of the existing and new well locations are shown on Figure 6.6. The new wells are located adjacent to the east, south, and west Site boundaries.

The monitored depth interval selected for each well in each nest was determined through the use of packer/pump tests that were performed on each 15-foot interval of bedrock below the C-Zone as specified and approved in the Work Plan as the well installation progressed. The packer/pump tests involved the insertion of a hydraulic packer into the corehole after it had been drilled. The packer was inflated to seal the interval below the packer from the rest of the open corehole. A pump was then activated in the sealed interval to determine the hydraulic capacity of the sealed interval. Review of the pumping capacity in each test was used to determine which intervals were water-bearing and which strata should be monitored by the proposed wells. The results of the packer/pump tests, the stratigraphic logs of the coreholes, and the well installation details are presented in Appendix A.

During the course of the drilling for the wells and the packer/pump tests, specific observations were made for the presence of NAPL. None was observed in the overburden soils, bedrock cores, or groundwater encountered.

6.3.2 OTHER WELLS

To the extent available, groundwater monitoring wells from other investigations performed in the vicinity of the Frontier Site were incorporated into the data collection for the deep bedrock investigation. During performance of the Off-site Investigation Program by Occidental Chemical Corporation for its Buffalo Avenue Plant site, five bedrock wells (i.e., OW654D, C, and B; OW655D; and OW656D) were installed at three locations in close proximity to the Frontier Site (see Figure 6.6 for locations). These wells were installed at various depths in the bedrock. The designation of the depths of the bedrock zones for the Occidental Off-site Investigation program differ from the designations used at the Frontier Site. A comparison shows:

Occidental Wells		*Frontier Chemical*	
Depth below top of rock	*Zone Designation*	*Depth below top of rock*	*Zone Designation*
0' – 45'	D-Zone	0' – 5'	A-Zone
45' – 70'	C-Zone	11' – 17'	B-Zone
74' – 110'	B-Zone	31' – 37'	C-Zone
		49' – 63'	D-Zone
		70' - 92'	E-Zone

As can be seen from this comparison, the Occidental D-Zone wells monitor all three of the Frontier Site's A, B, and C-Zone wells and therefore the Occidental wells cannot be used to differentiate the hydraulic or chemical characteristics of the Frontier Site's A, B, and C-Zones. Nonetheless, two of the Occidental wells (OW 654 B which is equivalent to the E-Zone at Frontier and OW 654C which is equivalent to the D-Zone at Frontier) were accessible and were sampled during the deep bedrock investigation for the Frontier Site. The data have been included in this investigation.

6.3.3 HYDRAULIC MONITORING

In conjunction with the groundwater investigation program, a synoptic round of groundwater elevation measurements was also made on April 24, 2009. The groundwater elevation measurements are listed in Table 6.7 and have been used to generate groundwater flow diagrams for each of the bedrock zones. The flow diagrams for the B, C, D, and E Zones are presented in Figures 6.7 through 6.10, respectively. These figures show the following trends:

B Zone (Figure 6.7)

The groundwater elevations in the B Zone wells show a generally south and east direction of groundwater flow. This flow pattern is consistent with the draw of groundwater flow in the B Zone (and above) toward the 47th Street Tunnel and the Falls Street Tunnel which border the east and south Site property boundaries.

C Zone (Figure 6.8)

Similar to the pattern observed in the B Zone, the C Zone groundwater also flows in a southeasterly direction. This flow direction is also believed to be a result of the groundwater relief created by the dewatering effect of the 47th Street Tunnel and the Falls Street Tunnel, even though the C Zone is below the elevation of the tunnels. The fact that the B and C Zones are connected through vertical fractures creates a gradient that draws the C Zone water up toward the tunnels.

D Zone (Figure 6.9)

The D Zone groundwater flows in an easterly direction. Although there are only three wells within this zone from which to generate groundwater flow contours, the well (MW-1D) along the eastern Site property boundary has the lowest elevation. Thus flow is generally toward this eastern well. This generally easterly direction of groundwater flow is somewhat contrary to expectations as it is generally anticipated that groundwater flow would be toward the next largest groundwater discharge point in the area; the Power Conduits which are located about 1,100 feet to the west of the Frontier Site. However, this easterly direction of groundwater flow has also been observed in the Occidental studies of the deeper bedrock as well. (A copy of Figure 4.4 from Occidental's Off-site Investigation Report is provided in Appendix C.) It is believed that the exterior drain system that was constructed on the Power Conduits dewaters the shallow bedrock groundwater flow zones causing the groundwater from the surrounding shallow bedrock to be drawn to the west toward and into the drains. However, upon entering the drain system, the infiltrating groundwater cascades downward to the bottom of the drain system providing a new source of groundwater for the fracture network in the deep bedrock. This recharge to the deep bedrock causes flow within the deep bedrock groundwater system to be outward from the drain system. Consequently, in the deeper portions of the bedrock flow regime, the direction of groundwater flow is actually away from the Power Conduits. As is experienced at the Frontier Site, this causes groundwater in the D Zone to flow toward the east.

E Zone (Figure 6.10)

Similar to the conditions observed in the D Zone at the Frontier Site, the groundwater flow in the E Zone is also to the east, away from the Power Conduits.

6.3.4 VERTICAL GRADIENTS

The installation of the groundwater monitoring wells in nests provides the opportunity to compare groundwater elevations in the various zones at the same locations. This comparison makes it easy to determine the vertical groundwater gradients that exist at the Site. As is well known, and as established in the Supplemental Remedial Investigation Report, the groundwater in the upper zones at the Site is dewatered by the 47th Street Tunnel and the Falls Street Tunnel. As expected, this creates a strong downward gradient in the shallow groundwater flow zones. The dewatering effect of the tunnels has the opposite effect on flow zones beneath the tunnels. The Supplemental Remedial Investigation Report noted that there was an upward gradient present in the groundwater between the C Zone and the B Zone.

This upward gradient between the C Zone and B Zone was confirmed in the data collected from the new wells installed under the deep bedrock investigation program. In addition, it has been further determined that there is also an upward gradient between the E Zone and the D Zone and also between the D Zone and the C Zone as shown in the following table of groundwater elevations (measured in feet above mean sea level).

Zone	*MW-1*	*MW-2*	*MW-3*
B	546	548	549+
C	553.91	553.44	554.20
D	553.94	554.33	554.41
E	554.84	555.19	555.13

This progressively upward gradient from the deepest bedrock zone is significant in that it shows that groundwater present in the shallow portion of the bedrock (and any chemicals therein, barring the presence of DNAPL) should not be migrating to depth. Rather, groundwater is migrating in an upward direction from the deep bedrock groundwater flow zones to the B Zone beneath the Site.

Comparison of the groundwater elevations in the B and C Zones also show a significant feature. The groundwater in the B Zone has been dewatered to the extent that the groundwater elevations in the C Zone are in excess of five feet higher than those in the B Zone. Since both flow zones are essentially being recharged from the same source area (the upper Niagara River), one would have expected that their elevations would have been very similar. However, the five foot difference clearly shows the significance of the dewatering effect of the 47th Street Tunnel and the Falls Street Tunnel on the shallow groundwater flow regime. The reduced groundwater elevations show that the tunnels have dewatered the B Zone by on the order of at least five feet. The B Zone groundwater elevations are consistent with expectations. Given that the elevation of the base of the tunnels is approximately at elevation 540 (feet above mean sea level) and that the tunnels are open to atmospheric conditions and allow adjacent rock fractures to dewater to this elevation, groundwater elevations in the surrounding bedrock (B Zone) should be within the first fracture set above the elevation of the tunnel base. The groundwater elevation data shown above confirm that this is the case (bedrock groundwater elevations of 546 to 549 in the B Zone).

6.3.5 CHEMICAL CONCENTRATIONS

Upon completion of the well installations, the wells were developed using surge blocks and down-hole pumps. Thereafter, two rounds of groundwater samples were collected using low flow sampling procedures. The first sample round was conducted in December 2008 and the second in April 2009. Each sample was submitted to the Test America Laboratories for VOC analysis, including MCT. The analytical results from these sampling events were validated and found to be acceptable for their intended use. The results are listed in Table 6.8. It is noted that during the sampling events, specific observations for the presence of NAPL were made. Again, no NAPL was present.

The two rounds of groundwater sampling provide documentation of the existing conditions in the D and E Zones and further delineation and confirmation of conditions in the C Zone.

In general, the analytical results show that the groundwater in the C and E Zones are essentially clean, with minimal chemical presence. In the D Zone, there were some VOCs detected in the groundwater with concentrations on the order of 800 ppb being present in one of the three D Zone wells. The total VOC concentrations measured in each well are presented on Figure 6.11. A discussion of the results in each zone is provided in the following:

C Zone

There was minimal chemical presence in the C Zone groundwater. Of the five wells sampled (three new wells plus existing wells MW88-4C and MW88-5C), the highest total VOC concentration was only 74 ppb. This occurred at well MW-2C which is located along the southern property boundary in close proximity to the areas of elevated chemical concentrations in the overlying B Zone. A figure showing the individual VOC concentrations that exceed 10 ppb in the C Zone is presented in Figure 6.12. As can be seen, four of the five C Zone wells have no individual VOC with a concentration in excess of 10 ppb. Only MW-2C has any individual VOC concentration that exceeds 10 ppb and those are benzene (at 32 ppb) and chlorobenzene (at 25 ppb).

A table showing the frequency of detection of each VOC in the C Zone has been prepared for the December 2008 and April 2009 sample rounds (Table 6.9). Review of this table shows that very few VOCs are detected and even fewer are at concentrations that exceed the New York Class GA Groundwater Criteria. With the exception of one benzene concentration and one trichloroethene concentration, the exceedances of the individual criteria were by less than 2 ppb and therefore essentially meet the groundwater criteria.

It is interesting to note that the chemical concentrations measured in historic well MW88-5C are somewhat inconsistent with the historic sampling results. During the two rounds of sampling conducted in 2008/9, the total VOC concentrations in this well were only 23 and 22 ppb respectively. The results of the first sampling event conducted in this well (November 1988) showed there to be 563 ppb total VOCs present. While this is considerably higher than the current data, it did include many of the same compounds as being present as was shown in the 2008/2009 data (e.g., 1,1-dichlorethene, trans-1,2-dichloroethene, trichloroethene, and vinyl chloride). By comparison, the sample that was collected from this well in November 2001 contained 3,590 ppb and included a considerably larger variety of VOCs. A copy of the historic data from the two previously installed C Zone wells are presented in Appendix C. The inconsistency of these two historic samples seems to indicate that the November 2001 data do not belong to MW88-5C. They actually more closely match the chemicals present in either MW-9 or MW88-3B. It is therefore suspected that the November 2001 sample data have been erroneously reported in the Supplemental Remedial Investigation Report and that the first sample round is accurate and should be relied upon.

Using either historic data sampling round from MW88-5C, and comparing it to the 2008 and 2009 data, illustrates one distinctive fact. The concentrations in this well have significantly decreased from historic levels. Consequently, there currently is no or minimal impact on the C Zone groundwater from the Frontier Site.

The reason that there may be no impact on the C Zone groundwater from the Frontier Site is based upon the hydraulic gradient conditions that exist. For as long as the tunnels have been in existence adjacent to the Site, (since the early 1900s), a strong upward gradient will have existed in the groundwater flow regime. The dewatering of the shallow groundwater zones results in a strong upward gradient from the C Zone to the B Zone. This upward gradient is a strong deterrent to downward chemical migration. Upward groundwater flow restricts downward chemical migration. The net result is that the C Zone should have been the recipient of minimal or no impact from the Frontier Site. It is noted that it would be possible for dense NAPL to overcome such upward vertical gradients in the groundwater flow. However, none was noted to be present in any of the wells installed nor are there any elevated chemical concentrations present that would be indicative of such NAPL migration having occurred in the past.

D Zone

In the D Zone, the highest VOC concentrations were measured at MW-2D along the southern property boundary. The total VOC concentration was 879 ppb in December 2008 and 798 ppb in April 2009. Chlorobenzenes make up about 80 to 90 percent of this total. The total VOC concentrations at well MW-3D which is located on the western property boundary were on the order of 315 ppb with chlorobenzenes making up about one half of the compounds present. Since well MW-3D is on the upgradient boundary, there may be chemical contributions from other sites also affecting the water quality at this location. On the eastern property boundary at well MW-1D, the total VOC concentrations were only about 10 ppb. Given that the groundwater in the D Zone flows to the east, this well is in a downgradient position. While the location of MW-1D is not necessarily immediately downgradient of the elevated concentrations measured in well MW-2D, it is still on the downgradient boundary opposite the elevated chemical concentrations measured in the overburden soils and the bedrock groundwater B Zone. While other factors such as the connectivity of the bedrock fractures may also have a bearing on the concentrations of chemicals at this down-gradient location, MW-1D best represents the water quality migrating off-Site from this portion of the Site. Being at the downgradient Site boundary, the concentrations measured at MW-1D demonstrate that, based upon the best available data, there is minimal off-Site chemical migration from the Frontier Site via the D Zone.

Table 6.10 presents the frequency of detection in the D Zone for each of the individual VOCs for the December 2008 and April 2009 sample rounds. This table shows that there are 10 individual VOCs that exceed the Class GA Groundwater Criteria in at least one of the three D Zone wells. Figure 6.13 shows the individual VOCs that were present in concentrations in excess of 10 ppb. There were eight such compounds present in the upgradient well (MW-3D) and none in the downgradient well (MW-1D). Data from the Occidental Off-site program well (OW-654C) was also included on Figure 6.13 since the elevation of this well matches the D Zone study for the Frontier Site. This well shows the presence of a few additional compounds (primarily chlorinated aliphatics such as tetrachloroethene, trichloroethene, and cis-1,2-dichloroethene).

Given the continuing upward gradient from the D Zone to the C Zone to the B Zone, it is possible that the chemicals found in the D Zone are sourced from off-Site locations rather than from the Frontier Site, unless DNAPL was present. If DNAPL were migrating to depth at the Frontier Site, then the source of these chemicals in the D Zone would most likely be the Frontier Site. No DNAPL has been observed in any deep well.

E Zone

In the E Zone, the chemical concentrations are again significantly lower than those encountered in the D Zone**.** The highest concentrations were measured in the well along the southern property boundary (MW-2E). However, the total VOC concentration at this location was only 46 and 136 ppb for the two sampling rounds respectively. The most common compounds at MW-2E were chlorinated aliphatics which make up more than 90% of the chemicals present (see Figure 6.14). The concentrations at wells MW-1E and 3E are less than 36 ppb. Table 6.11 presents the frequency of detection for the E Zone wells for the two sampling events. This table shows that four compounds exceed their Class GA Groundwater Criteria; three of which are chlorinated aliphatics.

With the easterly direction of flow noted in the E Zone groundwater, the well at MW-1E is in the most down-gradient position. Although this well may not be representative of the entire downgradient boundary groundwater quality, being along this downgradient boundary makes the data from this well the best available to use in assessing off-Site impacts. With only 12 ppb of total VOCs present in this well, there is minimal chemical off-site migration from the Frontier Site via the E Zone. Given the continuing upward gradient from the E Zone through the B Zone, it is possible that the chemicals present at depth in the E Zone are not related to the Frontier Site. The fact that three of the four exceedances of the Class GA Groundwater Criteria are chlorinated aliphatics rather than the more prominent Frontier chemicals (monochlorotoluene and chlorobenzenes) support this postulation. That is not to say that there are no chlorinated aliphatics on the Frontier Site. They are present but they are not the most prominent compounds and are conspicuously absent from the E Zone groundwater if the chemicals in this zone are sourced from the Frontier Site.

6.3.6 OFF-SITE CHEMICAL LOADING CALCULATIONS

Using the groundwater data generated during this deep bedrock investigation, it is possible to calculate the chemical loading that is migrating from the Frontier Site onto adjacent properties. Although the deep bedrock groundwater quality measured at the available well locations along the downgradient property boundaries may not be representative of the groundwater quality along the entire downgradient boundary, the existing data from these wells is the best available and therefore makes the estimates of chemical loading to the off-Site properties as accurate as possible. The actual loadings may be higher or lower than this best estimate. Given that the downgradient wells used in these calculations are located within 200 feet of the main chemically impacted area on the Site, the use of these data in calculating off-Site chemical loadings is believed to be sufficiently accurate for estimation purposes. The data used in the calculations include: groundwater gradients, chemical concentrations, bedrock stratigraphy, and hydraulic properties.

An estimate of the total VOC loading for the C, D, and E Zones was calculated using the following information:

i) Groundwater levels measured on April 24, 2009

ii) An average of the December 2008 and April 2009 total VOC concentrations measured in the applicable downgradient property boundary well for each zone

iii) The geometric mean of the hydraulic conductivities measured in the equivalent bedrock zones tested during the Off-site Investigation performed for Occidental. (These data were used as they are the best available data and are in close proximity to the Frontier Site and therefore most representative of the conditions at the Frontier Site.)

The groundwater levels were used to calculate the hydraulic gradient for each zone. The flow direction for the C Zone was to the southeast. For the D Zone and E Zone, the flow direction was to the northeast. To account for these flow directions, the component of the gradient applicable to a particular property boundary was factored by the angle of the flow direction to the property boundary. No hydraulic testing has been performed on the newly installed bedrock wells. As a result, hydraulic data from the nearest wells (those from the Occidental Study) were used.

The parameters used and total VOC loading calculated for each zone are provided in Table 6.12.

In summary, the calculated total VOC off-site loading for each zone was:

Zone	*Total VOC Loading (lbs/day)*
C	0.00004
D	0.000002
E	0.000004

As can be seen from this summary table, there are minimal off-site loadings from the deep bedrock zones onto adjacent properties. Even if the highest groundwater concentration measured in each of these zones was used to calculate the chemical loadings, the off-site loading of chemicals from all three deep bedrock zones combined would not equal one pound per year. With such minimal off-site loading, there is no significant threat to human health or the environment resulting from the residual chemicals in the deep bedrock zones, regardless of the source of these chemicals.

6.3.7 FOCUSSED FEASIBILITY STUDY

The data collected during the deep bedrock groundwater study has been evaluated and used to perform a Focused Feasibility Study to assess possible remedies that will appropriately address the chemical conditions detected in the deep bedrock. It is recognized based on the remedial programs that have been implemented at the surrounding sites in Niagara Falls that there are a limited number of viable alternatives to be considered for the deep bedrock groundwater; thus the decision to perform an abbreviated Feasibility Study.

The Focused Feasibility Study was performed in a manner consistent with the USEPA guidance document "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" dated October 1988.

The Focused Feasibility Study included an evaluation of remedial technologies and alternatives. Following the evaluation that identifies which of the remedial technologies are applicable for the former TSDF Site, four remedial alternatives were developed. These alternatives are:

1: No Action

2: Monitored Natural Attenuation (MNA) with Institutional Controls

3: In-Situ Treatment Using Injected Agents Followed by MNA with Institutional Controls

4A: Hydraulic Containment/Collection with Treatment at the WWTP and Institutional Controls

4B: Hydraulic Containment/Collection with On-Site Treatment and Discharge to the WWTP and Institutional Controls

4C: Hydraulic Containment/Collection with On-Site Treatment and Discharge Back into the Aquifer and Institutional Controls

The remedial alternatives were further evaluated under the following criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, and Volume
- Short Term Effectiveness
- Implementability
- Cost
- Agency Acceptance
- Community Acceptance

Based upon the evaluations performed, Alternative 2, monitored natural attenuation with institutional controls, was selected as the preferred remedy. This selection was based upon the following primary conclusions:

- There is no significant threat to human health or the environment resulting from the chemicals present in the deep bedrock groundwater.
- There is limited chemical presence in the deep bedrock groundwater.

- The groundwater beneath the Site is not used and will be subject to institutional controls that will ensure that it is not used in the future.
- There is a strong upward gradient from the E Zone through each overlying zone up to the B Zone that restricts groundwater flow from the shallow impacted groundwater flow regime from reaching the deep bedrock groundwater zones. Therefore chemicals present in the shallow groundwater zones should not be migrating into the deep bedrock zones, unless DNAPL is present and migrating into the deep bedrock zones. DNAPL was not identified to be present during the additional investigation activities.
- If the chemicals that are detected in the deep bedrock groundwater (regardless of their source) were to migrate onto adjacent properties, the best available estimate of off-site chemical loading would be less than 0.1 pounds per year.

Thus the selection of monitored natural attenuation with institutional controls is an effective and appropriate remedy for the deep bedrock groundwater at the Frontier Site.

A copy of the complete Focused Feasibility Study Report is provided in Appendix D.

6.4 GROUNDWATER IMPACT ON TUNNELS

As a result of meetings with the NYSDEC and the City of Niagara Falls Water Board, it was determined that further characterization of groundwater infiltration and chemical loading into the Falls Street Tunnel and the 47th Street Tunnel was required. The Falls Street Tunnel is located along the southern property boundary of the Frontier Site and the 47th Street Tunnel is along the eastern property boundary as shown in Figure 6.15. In order to obtain the required information, a program of tunnel inspections and flow measurement and monitoring was developed which included:

- A visual inspection of the Fall Street Tunnel and 47th Street Tunnel conditions
- Measurement of the sewer flow conditions in the tunnels
- Collection of samples of groundwater infiltrating into the tunnels
- Collection of samples from the sewer flow

Details of each of these components of the tunnel investigation are presented in the following subsections.

6.4.1 VISUAL INSPECTION

As part of a collaborative effort with the Niagara Falls Water Board, both the Falls Street Tunnel and the 47th Street Tunnel were visually inspected from within. This required the use of a specialized contractor (Allen Marine) with the capability of performing confined space entries of this sort. The inspections were performed in December 2008 and June 2009 and involved two tunnel entrant personnel who were equipped with appropriate personal protection gear (dry suits, tyvek coveralls, gloves, boots, etc.) and supplied air. A host of surface attendants were also on hand for safety purposes and to assist with the operation. The entrants were in constant two-way communication with the surface staff and were also equipped with a video camera to document their observations. The video feed was supplied live to the surface staff who directed the entrants' inspection activities. Copies of the video have been provided to the NYSDEC and the Water Board.

Access to the tunnels occurred through the available drop shafts. The locations of the drop shafts are also shown on Figure 6.15. Based upon the inspections performed, the following general observations were made:

- The portion of the **Falls Street Tunnel** adjacent to the Frontier Site has considerable sediment accumulation that prohibited the tunnel entrants from traveling far from the access locations.
- The observations made at Regulator 8 show that all of the dry weather flow in the Falls Street Tunnel is directed to the Southside Interceptor Sewer at this location by a 3 foot high diversion dam that was constructed for this purpose. The connection between the Falls Street Tunnel and the Southside Interceptor Sewer is a 4-foot wide by 2 foot high connector pipe. The flow coming into Regulator 8 from the upstream side is considerable. No flow was passing downstream over the diversion dam.
- At drop shaft 14A, there was no observable flow. There was some standing water overlying a layer of sediment. The sediment fills the tunnel to the extent that it was not possible to travel more than five feet from the drop shaft location to further investigate this portion of the tunnel.
- It was possible to enter the **47th Street Tunnel** from both the north and south drop shafts. However, from the south drop shaft (at the intersection of Royal Avenue and 47th Street), it was only possible to travel about 30 feet to the north due to the dipping elevation of the tunnel ceiling.
- From the north drop shaft on 47th Street, it was possible to travel the full distance of the air supply line and safety line available to the tunnel entrants (about 460 feet in the tunnel). Along this length of the tunnel, it was observed that there was a layer of

sediment on the base of the tunnel and considerable flow within the sewer. No connection pipes into the tunnel were noted at any location other than at the drop shaft locations.

- There were three distinct locations at which groundwater was infiltrating through the wall of the 47th Street Tunnel. These were observed at distances of 120', 340', and 450' south from the north drop shaft. The locations of these infiltration points are shown on Figure 6.15.
- The lower portion of the tunnel in which active sewer flow was occurring was noted to have considerably undercut the tunnel walls. In most areas, the walls were observed to have been worn away to the point that there was on the order of two to three feet of additional width of tunnel on each side.
- Due to the length of available air supply line and safety line, it was not possible to inspect the entire 800-foot length of the tunnel between the access points. Approximately 270-feet could not be directly inspected although approximately 30-feet of this length was observed by shining a light down the tunnel once the entrants had reached the limit of their equipment.

Based upon the information gained from the December 2008 tunnel inspections, a supplemental plan to collect flow measurement and samples for chemical analysis was developed and submitted to the NYSDEC and the Niagara Falls Water Board in March 2009. The plan was approved in May 2009 and implemented in June 2009.

6.4.2 FLOW MEASUREMENTS

Allen Marine was retained again in June 2009, to perform the second phase of the tunnel investigation. The first component of this phase of the work involved the measurement of groundwater infiltration flows into the tunnels. This was to be done by two methods. The first method involved catching the observable groundwater infiltration seeps as they entered through the tunnel walls and ceiling. By catching all of the flow for a specific period of time, it was possible to physically measure the groundwater infiltration rate. The second method involved measuring the total flows in the tunnel to compare the upstream and downstream flows and then back calculate the infiltration volume.

Under the first method, the tunnels were re-inspected in June 2009 and found that the same three seeps noted during the December 2008 inspection were still the only observable infiltration points. All three of these infiltration points were in the 47th Street

Tunnel. Measurements of the three infiltration points in the 47th Street Tunnel were made and found to be as follows:

Seep 120' from north access	0.5 gallons per minute
Seep 340' from north access	1.0 gallons per minute
Seep 450' from north access	0.25 gallons per minute

Although the Falls Street Tunnel could not be visually inspected beyond the access points available, no infiltration was noted at these locations.

Using the second measurement method was not as successful. This was to be done at both upstream and downstream locations within the tunnels. It was intended that by making such measurements, it would be possible to determine the portion of the flow that was due to groundwater infiltration into the tunnel. With no contributing sewers adding flow into the test interval, a simple subtraction of the upstream flow from the downstream flow would provide the volume of flow being contributed by groundwater infiltration.

Unfortunately, the measurements of these flows were not as simple as was originally anticipated. The primary reason for this was the inability to insert the preassembled weir plates into the flow and adequately seal them against the tunnel walls. The irregular shape and extensive nature of the undercutting of the tunnel walls made this all but impossible. In addition, in the 47th Street Tunnel, the sewer flow was higher than originally anticipated. This created further difficulty in getting the weirs solidly in place. As a result of these conditions, it was not possible to install the weirs and therefore an alternate method for measuring the flows in the tunnels was used.

This alternate method involved the use of typical surface water measurement techniques. These techniques involve obtaining an accurate cross-sectional area of the flow and then measuring the velocity in the main flow stream at each cross-section. The flow volume is calculated by multiplying the velocity by the cross sectional area. For the 47th Street Tunnel, a cross section was set up at the north and south access locations. Based upon the cross-sectional area of flow and the measured velocities, the flow in the sewer at the upstream end of the 47th Street Tunnel was 1,230 gallons per minute. By comparison, the measurement at the downstream end was just slightly lower at 1,220 gallons per minute. This method of calculation is not as accurate as a weir measurement and therefore is subject to some degree of uncertainty. The fact that the calculated flows upstream and downstream of this segment of sewer are almost the same indicates that there is not a substantial contribution from groundwater infiltration.

However, the degree of accuracy of the method has to be taken into consideration. The only conclusion that can be made is that the volume of groundwater infiltration within this section of the tunnel is within the degree of accuracy of the method. Given that the downstream flow was actually lower than the upstream flow by 10 gallons per minute, gives an indication of the degree of accuracy of the method. Based upon this, it can only be stated from these data that the groundwater infiltration volume is low. Given that actual measurements of the groundwater seep volumes were made, the data from these individual seep measurements will be relied upon as being accurate of the groundwater infiltration conditions.

With regard to the Falls Street Tunnel, it is recognized that the diversion dam at Regulator 8 cuts off all through flow in the tunnel. Consequently, the flow measured at downstream location drop shaft 14A, is all due to groundwater infiltration. At the time the investigation was performed, there was 5 to 10 inches of standing water in the tunnel. The velocity was zero (or so low that it was not measurable) and consequently, the flow was determined to be zero gallons per minute. It is recognized that with 5 to 10 inches of standing water in the tunnel, a very small amount of groundwater infiltration into the tunnel would be almost undetectable. But since there was no perceptible velocity, it has been confirmed that if there is groundwater infiltration into the tunnel, it is a very small amount; likely less than a couple of gallons per minute. It is noted that as far as could be observed in either direction in the tunnel, there was no visual or audible indication of any groundwater infiltration occurring.

Based upon the observations and measurements made during the tunnel investigation, it is concluded that the groundwater infiltration into the Falls Street Tunnel from the Frontier Site is very low; most likely only a couple of gallons per minute. It must be remembered that for both tunnels, the volume of groundwater infiltrating the tunnels from the Frontier Site is only one half that actually measured. Since groundwater also flows into the tunnels from the east side of the 47th Street Tunnel and from the south side of the Falls Street Tunnel, any measured volume entering the tunnels is likely half from the properties opposite the Frontier Site. For the 47th Street Tunnel, the confirmed groundwater infiltration is 1.75 gallons per minute (from the 490 feet examined) as measured from the three seeps actually identified. About one half of this volume is likely attributable to properties to the east of 47th Street and therefore not from the Frontier Chemical Site. Extrapolating these 1.75 gallons over the 490 feet of tunnel that was examined to the total 1,450 foot length of the two tunnels adjacent to the Site results in a contribution from the Site of 2.6 gallons per minute as noted in the following calculation.

$1.75\ gpm / 490' = X / 1{,}450'$

Solving for X = 5.2 gpm
Since half of this volume comes from the properties adjacent to Frontier, X / 2 = the volume of groundwater infiltrating from the Frontier Site.
5.2 gpm / 2 = 2.6 gpm

In the end, this infiltration study has confirmed that the groundwater infiltration rate is very low; likely less than three gallons per minute.

This is consistent with the theoretical rate calculated in the NYSDEC approved Supplemental Remedial Investigation Report (Section 6.4.2). In that report, using the hydraulic gradients and conditions in the bedrock, it was estimated that the theoretical groundwater infiltration rate into the tunnel system was 0.5 gallons per minute (67,000 gallons per year from the A Zone and 217,000 gallons per year from the B Zone).

Another theoretical method that can be used to estimate groundwater infiltration involves the use of precipitation infiltration. Assuming that the entire drainage basin that passes through the Frontier Site to the tunnels contributes to the infiltration volume, the calculation is as follows:

Groundwater drainage basin area = 950,000 square feet
Annual precipitation in Niagara Falls = 36 inches
Runoff coefficient for asphalt and concrete surfaces and building roofs = 90%
Volume of water available for infiltration = 2,100,000 gallons per year
Maximum groundwater infiltration rate into tunnel from overburden and Zone A and Zone B in bedrock = 4 gallons per minute

Considering that the infiltration measurements made in the tunnel (and extrapolated to the full length of the tunnel adjacent to the Frontier Site) are consistent with two different theoretical estimates of the groundwater infiltration into the tunnels (groundwater migration and precipitation infiltration), it can be reasonably concluded that the estimates are substantially correct and that the actual volume of groundwater infiltration into the tunnels is very low; likely less than three gallons per minute.

6.4.3 GROUNDWATER INFILTRATION QUALITY

Samples were collected of each of the three seeps identified in the 47th Street Tunnel during the June 2009 investigation. Each sample was submitted to the Test America Laboratories for analysis of VOCs (including MCT). The results from these three samples are presented in Table 6.13.

The results from the three samples vary considerably. The following summarizes the results:

Seep 120'	3,700 ppb total VOCs, all of which is MCT
Seep 340'	22,200 ppb total VOCs, of which 14,200 is MCT, 5,400 is cis-1,2-dichloroethene, and 1,600 is vinyl chloride.
Seep 450'	is clean with only 13 ppb of total VOCs.

In order to determine the impact of these groundwater seeps, the concentrations from these seeps have been used to calculate the chemical loading of these seeps into the sewer. These loadings are as follows:

Seep 120'	0.02 pounds per day
Seep 340'	0.26 pounds per day
Seep 450'	0.00006 pounds per day

These loadings total 0.28 pounds per day. Given that the primary constituent in the loadings is MCT and the most prominent chemical compound found on the Frontier Site is MCT, it is believed that this loading is primarily sourced by the Frontier Site.

Although no samples were collected from groundwater seeps found leaking into the Falls Street Tunnel (as none were observed), it would be expected that a similar loading would be entering the Falls Street Tunnel from the Frontier Site. Based upon these results, it is believed that the chemical loading from the Frontier Site into the tunnels is less than one pound per day with 0.28 pounds per day entering the inspected portion of the 47th Street Tunnel. Using a similar ratio to calculate the loading for the remaining portions of the tunnels results in the following:

0.28 pounds / 490' = X / 1,450'
Solving for X = 0.83 pounds

This is also consistent with the theoretical calculations made using the Supplemental Remedial Investigation data. Using those conditions, the calculated loading was 0.3 pounds per day; essentially matching the low loading conditions found through the tunnel investigation.

6.4.4 SEWER WATER QUALITY

As another measure of the potential impact of groundwater infiltration into the tunnels, samples were also collected from the sewer flow within the tunnels. The intent was to measure and compare the water quality at the upstream and downstream end of the Frontier Site to try to determine whether the infiltrating groundwater between the sampling locations is affecting the sewer water quality. Two samples were collected in the 47th Street Tunnel; one upstream and one downstream at the drop shaft locations shown on Figure 6.15. The samples were collected from the center of the flow path within the tunnel with specific effort made to ensure that impact from contributing discharges (as was noted at the upstream drop shaft) and from sampler activity in the tunnel was minimized. The samples were collected as a single grab sample.

In the two samples collected up and downstream in the 47th Street Tunnel, an increase in total VOCs was observed; from 700 ppb in the upstream sample to 880 ppb in the downstream sample. Upon closer examination of the individual compounds present within the two samples, it becomes apparent that there was considerable variability in the sample constituents present in the flow which calls into question the comparability of the data. For example, while the concentrations of some compounds increased (acetone – from 490 to 660 ppb and MCT from <2 to 66 ppb), others decreased (methyl ethyl ketone – from 110 to 63 ppb). While infiltration of Frontier Site chemicals would be expected to result in an increase in chemical concentrations over the monitored length, it is unlikely that concentrations of other compounds would decrease so dramatically; especially when there has been no diluting effect caused by increased sewer flows. This comparison shows that the concentrations in the various flow paths within the sewer are not homogenized enough to make accurate comparisons for chemical loading possible. The increase of compounds such as MCT reflects that the infiltrating groundwater does create a chemical loading.

Although there was no evidence of groundwater infiltration into the Falls Street Tunnel, it is certainly suspected that some minor amount is occurring. A sample collected from drop shaft 14A confirms that this is the case. A sample was collected from the standing water at the drop shaft and, since the diversion dam upstream at Regulator 8 cuts off the through flow through this segment of the tunnel, it can be assumed that any chemicals present in the standing water in this section of the tunnel are sourced by groundwater infiltration. The sample collected from drop shaft 14A contained 50,000 ppb of total VOCs. The sample contained a wide variety of compounds including about 15,000 ppb of MCT, 17,000 ppb of compounds from the chlorobenzene family of compounds, and 12,000 ppb of chlorinated aliphatics (TCE, PCE, etc).

While most of these compounds are found on the Frontier Site, some are also present in the groundwater on the south side of the Falls Street Tunnel. The samples collected from well OW-654B and C (which are on the south side of the Falls Street Tunnel) also contain concentrations of the chlorinated aliphatics. Consequently, it is expected that some of the chemicals present in the Falls Street Tunnel are from alternate sources within the heavily industrialized area.

It is to be noted that the chemicals in this section of the Falls Street Tunnel would be expected to be flushed from this dormant area as part of the first flush of water when a storm event occurs that is of sufficient size to overflow the upstream diversion dam. Under storm conditions, the chemicals in this section of sewer would be quickly taken up into the sewer flow passing through the section. Being part of the first flush of this section of sewer, it is anticipated that the flow would be diverted to the Southside Interceptor Sewer at one of the downstream diversion connections and therefore be treated at the Niagara Falls Wastewater Treatment Plant.

Given the measured concentration in the sample, the standing water conditions in the tunnel (5 to 10 inches), and estimating an impacted length of groundwater within the tunnel of 500 feet, it is estimated that the chemicals present in this section of sewer is on the order of 7 pounds. Since this accumulation occurred over the period since the last overflow event, it is expected to be consistent with a chemical loading of less than one pound per day into the tunnels. Again, these chemicals are expected to be flushed into the Southside Interceptor Sewer with the first flush of flow through the tunnel. Over the course of an extended storm event, the tunnel would be expected to be flowing in an elevated (or possibly even full) state which would reduce the rate of groundwater flow into the tunnel and could actually be cause for exfiltration from the tunnel back into the fractures within the surrounding bedrock. Given that the estimated loading to the sewers is less than one pound per day, and that the flow could actually be reversed to an exfiltrating mode during storm events, there is minimal loading into the tunnel that could actually reach the Niagara River in an untreated state.

6.5 SOIL VAPOR INTRUSION EVALUATION

A soil vapor intrusion evaluation was performed on the Site to assess the potential for VOCs to be present in the unsaturated portion of the overburden and, if present, to assess the potential for the soil vapors to migrate. The evaluation involved the installation of four soil gas probes at locations requested by the NYSDEC along the southern property boundary adjacent to Royal Avenue as shown on Figure 6.16. These locations were selected based on their proximity to the Falls Street Tunnel which the

NYSDEC has suspected to be a possible pathway for off-site vapor migration. It was further recognized that there was little value in investigating soil vapor quality in the central area of the Site, as the soil in this area is planned to be remediated. Consequently, any data collected from the central area of the Site would be of limited future value since the Site conditions in this area will be dramatically changed by the soil remedy.

The work was performed in a manner consistent with the applicable requirements of the "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (February 2005 Public Comment Draft) as prepared by the New York State Department of Health.

6.5.1 GAS PROBE CONSTRUCTION

Each gas probe was installed as follows:

- A drill rig was used to create a 2-inch diameter borehole to a depth of 8 feet below the ground surface. (At this depth, the boreholes were keyed into the underlying clay layer observed in the soil stratigraphy).
- An implant consisting of a 1-foot long stainless steel well screen attached to an appropriate length of ¼-inch polyethylene tubing was inserted into the base of the borehole.
- The bottom 2-feet of the borehole (in the well screen interval) was backfilled with coarse sand.
- The remainder of the borehole (to within 6" of the ground surface) was backfilled with hydrated bentonite.
- The uppermost 6-inches of the borehole was backfilled with native material consistent with the surrounding area.
- A temporary protective casing was installed over the top of the borehole to protect the protruding end of the gas probe.

6.5.2 SOIL GAS SAMPLING

Following installation of the gas probes, one set of soil gas samples was collected on February 12, 2009. The samples were collected in Summa canisters (certified clean by the laboratory) in accordance with the prescribed methods and submitted to H2M Labs (a New York ELAP certified analytical laboratory). Each sample was analyzed for TCL

VOCs plus MCT using EPA Method TO-15. A request to analyze for the tracer gas was inadvertently omitted and therefore no such data are available.

6.5.3 SAMPLING RESULTS AND EVALUATION

The results from the soil gas investigation show that there are limited chemicals present in the vadose zone at the Site. A complete listing of the results is presented in Table 6.14. The results are also summarized on Figure 6.16.

In order to evaluate the significance of the chemicals present in the vadose zone, the NYSDOH document entitled "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York – October 2006" was consulted. The document provides guidance values pertaining to the five compounds of concern in New York: methylene chloride, PCBs, TCDD, tetrachloroethene (PCE), and trichloroethene (TCE). As required, the vadose zone samples were only analyzed for the VOCs and therefore no data on PCBs or TCDD are available or need be evaluated, nor are they expected to be present.

Of the three remaining New York guidance compounds, only TCE was detected at a concentration that exceeded the guidance value. This occurred at one of the four sample probes (SVP-1). At this location, the TCE concentration was 11.6 ug/m3 compared to the guidance value of 5 ug/m3. Based upon these data, the Guidance provides two decision matrices that compare sub-slab vapor results and indoor air results to determine potential future actions.

In Matrix 1, the results for TCE (one exceedance of guidance value at SVP-1) and carbon tetrachloride (all samples were non-detect) are compared to indoor air results to determine potential actions. The vadose zone samples are used as samples representative of sub-slab conditions. Since there are no on-Site buildings, there are no indoor air sample results to compare the sub-slab samples against. As a result, this leads to the conclusion that under the current conditions, there is no further action required. Although carbon tetrachloride is included on Matrix 1, it has no guidance value. Regardless, all of the samples were non-detect for carbon tetrachloride and therefore there would be no exceedance of any guidance value, even if there was one. Given the presence of the TCE, if buildings are constructed on the Site in the future, it is recommended that these buildings be constructed with protective measures to prevent soil vapor intrusion from occurring. Passive gas ventilation systems should also be constructed. As conditions will change at the Site over time, it is recommended that specific needs with regard to vapor intrusion prevention be re-evaluated at the time that any new building construction is planned. The property owner is aware of the need for an environmental easement on the property and has acknowledged that vapor intrusion prevention will need to be a component of any future commercial or industrial reuse of the property.

On Matrix 2, the PCE and 1,1,1-trichloroethane results are compared to indoor air results. PCE was not detected above its guidance value and 1,1,1-trichloroethane was only detected once but has no guidance value. Consequently, there are no exceedances and therefore no further action is required with regard to the compounds from Matrix 2. The comparisons to the matrix guidance values are presented in Table 6.15. Based upon these results, there is no current action required regarding soil vapors on the Frontier Site.

Further discussion of the results at each of the soil vapor probes is provided in the following:

SVP-1

SVP-1 is located at the western edge of the Site and had the highest detected chemical concentrations and the highest number of detected compounds. The total VOC concentration was 5,173 µg/m^3 and a total of 21 compounds were detected. Of the total VOC concentration, 97% were made up by two rather innocuous compounds (acetone at 4,320 µg/m^3 and methyl ethyl ketone at 708 µg/m^3). Although there are no New York guidance values for these compounds, the USEPA criteria for these two compounds are 310,000 µg/m^3 and 50,000 µg/m^3 respectively and therefore the concentrations detected are orders of magnitude below the criteria. The remaining 19 compounds were present in very low concentrations. Only TCE was detected at a concentration that exceeds the NYSDOH guidance value (11.6 µg/m^3 compared to the guidance value of 5 µg/m^3).

SVP-2

At SVP-2, there were only 2 compounds detected with a total VOC concentration of 5 µg/m^3 (excluding acetone which was present at 48 µg/m^3). There are no exceedances of the guidance values.

SVP-3

At SVP-3, there were only 4 compounds detected with a total VOC concentration of 11 µg/m^3 (excluding acetone which was present at 46 µg/m^3). There are no exceedances of the guidance values.

SVP-4

SVP-4 is located at the eastern end of the Site. There were only 6 compounds detected with a total VOC concentration of 87 $\mu g/m^3$ (excluding acetone which was present at 2,050 $\mu g/m^3$). There are no exceedances of the guidance values. The highest detected concentration was 80 $\mu g/m^3$ for methyl ethyl ketone.

Based upon the conditions present, there are minimal soil gas vapors present. It is further concluded that there is minimal potential for off-Site soil gas migration from the Frontier Site toward the Falls Street Tunnel. The conditions that support this conclusion are as follows:

- The sampling has shown that there is minimal chemical presence in the vadose zone on the Site adjacent to Royal Avenue.
- Only one compound (TCE) is detected at concentrations that exceed the guidance value and only by a small amount.
- The on-Site soils are mostly fine grained and therefore severely dampen the potential for soil vapor migration.
- The clay layer underlying the Site prevents soil gas migration to depth.
- The soil gas samples were collected from the Site in its current unremediated state. Following remediation of the Site soils (as is proposed under Operable Unit 1), the potential for soil gas generation and migration will be reduced even further.

Based upon these results, no further soil vapor investigation and no remediation is required at this time. Institutional controls that will be placed on the Site will ensure that any future buildings constructed on the Site have adequate provisions to prevent soil vapor intrusion to protect occupants.

7.0 SUMMARY

The remedial pre-design investigation has been completed in accordance with the approved Work Plan and provides information relevant to the development and selection of a comprehensive remedial action, incorporating both Operable Units 1 and 2 for the Frontier Chemical Site. The main determinations that have been made as a result of these investigations are as follows:

Soil Characterization

In accordance with the approved Work Plan, soils with concentrations exceeding 1,000 ppm total VOCs (including MCT) ("source area" soils) have been further refined from that available at the time the ROD was issued.

It has been estimated that the volume of soil with chemical concentrations in excess of 1,000 ppm total VOCs (including MCT) is on the order of 4,000 cubic yards. This calculation is based upon a simple interpolation method that assumes that a sample is representative of the area around the sampling location to a distance equal to one half the distance to an adjacent sampling point. Therefore, this estimate is preliminary.

Ex-Situ Soil Treatment Pilot Test

The ex-situ soil treatment pilot test has confirmed that it is possible to excavate through the on-Site soil layers (although this is somewhat difficult due to the density of the material) and to place soils with elevated chemical concentrations into a treatment cell and use soil vapor extraction to remove and treat the chemicals. It has also been learned that the soils are primarily fine grained and have a tendency to stay clumped together and therefore hamper excavation and treatment processes. These factors can be overcome through a combination of handling / preparation methods that could include soil amendment additions, physical separation / soil manipulation methods, extending treatment times, and selecting warmer weather conditions during which to perform such treatment.

Another valuable piece of information learned during the pilot test program is that the overburden soils are primarily unsaturated due to the dewatering effect of the local sewer tunnel system. This may be another of the reasons why the soils have become so dense and maintain their chunky appearance.

The pilot test also demonstrated that volatilization of chemicals from the Site soils occurs readily; even from the simple excavation and handling of impacted soils. This fact may be of use in identifying effective soil remediation solutions.

Deep Bedrock Groundwater

The deep bedrock groundwater has been found to be relatively clean by comparison to the shallow groundwater zones. There is minimal chemical presence in the C and E Zones while the D Zone contains up to 800 ppb of total VOCs. The water quality in the C Zone is considerably cleaner than was the case in the 1988 and 2001 sampling events.

The chemicals detected in the deep bedrock groundwater may not be solely sourced from the Frontier Site. The data collected show that there is a continual upward gradient in the bedrock from the E Zone to the D Zone to the C Zone to the B Zone. Consequently, unless there was some downward dense NAPL migration through these bedrock zones, a condition that was not observed, it would be unlikely that the chemicals in aqueous form in the shallow bedrock zone would migrate downward into these deep zones. The shallow groundwater zones are dewatered by the Falls Street Tunnel and the 47th Street Tunnel resulting in effective hydraulic capture and containment of all the shallow groundwater. Due to the depressed groundwater elevations in the shallow zone, the deeper bedrock zones act as recharge zones replenishing the shallow bedrock. These upward gradients restrict downward groundwater and chemical migration, unless DNAPL is present and migrating into the deeper zones (although no such DNAPL migration has been observed).

Regardless of the source of the chemicals present in the deep bedrock groundwater, the flow conditions and concentrations present are not significant from an environmental and human health perspective, particularly given the industrial nature of the area. If the groundwater flows upward, the chemicals are captured by the tunnel system. If they flow off-site, the best estimate of calculated loading using the available data is less than 0.1 pounds per year. If they remain in place, they will continue to be naturally depleted (as evidenced by comparison of the sampling rounds of data that have been collected over the past 20 years in the C Zone) and there is no current or future use planned for this groundwater. Institutional controls will ensure that future use does not occur until such time that the deep aquifer is restored to acceptable concentration levels.

Since there is no significant threat to human health or the environment associated with the deep bedrock groundwater, and natural attenuation is addressing the chemicals present in the deep bedrock groundwater, the Focussed Feasibility Study performed to evaluate remedial alternatives for the deep bedrock groundwater selected monitored natural attenuation with institutional controls as the preferred remedy.

This monitored natural attenuation remedial action, coupled with the Operable Unit 1 remedial program, provides a comprehensive remediation response that eliminates or abates any significant threats and is protective of human health and the environment.

Tunnel Investigation

The investigation of the groundwater infiltration into the Falls Street Tunnel and the 47th Street Tunnel have confirmed that:

- The volume of groundwater infiltration into the tunnels is low (likely less than three gallons per minute)
- The chemical loading to the tunnels is small (likely less than one pound per day)

These findings are consistent with the theoretical calculations made using two separate methods:

- Groundwater flow as calculated in the NYSDEC approved Supplemental Remedial Investigation Report
- Precipitation infiltration over the entire drainage basin flowing through the Frontier Site in the overburden, A Zone, and B Zone

These findings establish that there is no adverse impact on the operations of the City of Niagara Falls WWTP that receives and treats this discharge. It is further confirmed that this situation is and will continue to be an effective remedy addressing Site groundwater. Discussions will continue with the Niagara Falls Water Board to have this infiltration registered as a permitted discharge, thereby negating the need for an on-Site groundwater collection / treatment facility.

Soil Vapor Intrusion Study

The four soil vapor monitoring probes that were installed on Site confirm that there is minimal chemical presence in the soil vapors along Royal Avenue and the potential for off-site migration toward the Falls Street Tunnel is also minimal. Furthermore, once the Site soil remediation is completed and the major source of chemical presence in the soils is eliminated, the potential for soil vapor problems will be diminished even further. It is acknowledged that future buildings constructed on the Site should have appropriate vapor intrusion controls put in place at the time of construction to prevent any concerns regarding vapor intrusion.

8.0 OTHER CONSIDERATIONS

The information collected in conjunction with these additional investigations will support the final design efforts for a comprehensive Site remedy. However, there is one other factor that will have to be taken into consideration prior to finalizing the Site's remedial design. At the present time, the Niagara Falls Water Board is considering the closure of a 2,700 foot section of the Falls Street Tunnel; extending from Regulator 8 (immediately adjacent to the Frontier Site) to Hyde Park Boulevard. The purpose of this plan is to reduce the extensive groundwater infiltration (estimated at 6,500,000 gallons per day) that occurs where the Falls Street Tunnel passes over the Power Conduits (approximately 1,100 feet west of the Frontier Site). This infiltration is treated at the City of Niagara Falls WWTP.

The Water Board's plan involves closing this section of the Falls Street Tunnel and diverting the sewer flow from the area upstream of Regulator 8 into the Southside Interceptor Sewer. The closed section of the Falls Street Tunnel will be isolated through the construction of four bulkhead structures. The bulkheads will also sever the existing connections between the Falls Street Tunnel and the Southside Interceptor Sewer within that section of the tunnel. The abandoned section of the Falls Street Tunnel will be allowed to naturally fill with infiltrating groundwater. Since the tunnel will be isolated with no outlet, it will simply become a cavity like any other fracture in the bedrock. It will quickly fill with water and become part of the groundwater fracture network. Without an outlet to the Southside Interceptor Sewer, the groundwater elevations in the area will rise up and above the tunnel elevation and begin to fill the surrounding bedrock fractures that have been dewatered for the past 100 years. The water will continue to rise until it reaches an equilibrium elevation consistent with the available groundwater sinks and sources in the area. Based upon the information obtained during the investigation of the deep bedrock performed by the Frontier Group, it is expected that the B Zone groundwater will rise back to an elevation more consistent with the groundwater elevations in the C Zone which is fed by the upper Niagara River. Comparison of the B and C Zone groundwater at the Frontier Site shows that the B Zone is depressed by about 5 feet. Consequently, it is expected that the elevation of the B Zone groundwater near the Frontier Site will rise about 5 feet.

This change is subject to a number of factors including:

- Size of fractures in the bedrock surrounding the tunnel
- Connectivity of the fractures in the bedrock near the tunnel including vertical fractures

- Water elevations inside the Power Conduits and at the forebay that feeds the electrical generating station (which are known to impact groundwater flow in the area around the Power Conduits)
- Water elevation in the Niagara River
- Available outlets

The new groundwater equilibrium elevation in the B Zone will be directly influenced by the Falls Street Tunnel. Whatever outlets for groundwater exist in the vicinity of the tunnel will control the elevation to which the groundwater rises. Expected outlets include the 47th Street Tunnel and the dewatering drains on the outside of the Power Conduits (every 10 feet along its length). Being such a large and common opening, the Falls Street Tunnel will become an equalizing factor that connects all the fractures adjacent to the tunnel along its entire isolated length. As a result, the tunnel will subject all the adjoining fractures to a common hydraulic condition which will cause the groundwater to gravitate toward one common elevation along the entire isolated section of the tunnel. As a result, the B Zone groundwater elevation along the isolated section will be subject to the same source and outlet conditions and respond accordingly.

Based on this commonality, the bedrock groundwater in the B Zone from Hyde Park Boulevard to Regulator 8 will rise to a new common elevation that will be higher than the current steady state condition that has been artificially depressed by the discharge into the Falls Street Tunnel. The degree of connectivity of the fractures in the B Zone bedrock between the tunnel and these sources and outlets will be the determining factor as to how high the elevation rises.

Expectations are that the Power Conduit drain system will become the primary new outlet for groundwater discharge from the newly elevated bedrock groundwater position. At the present time, there actually is no bedrock around the Falls Street Tunnel where it passes over the Power Conduits. There is simply soil and rock material that was backfilled around the pipe that replaced the Tunnel. Consequently, this material will be more permeable than the bedrock fracture system and therefore will become the preferential pathway for groundwater migration from the new elevated condition.

In summary, the empirical impacts to the local hydrogeologic regime will be that:

- The groundwater levels will rise
- The direction of groundwater flow will change

One thing that can not be determined at the present time is the quantification of the impact that the closure of this section of the Falls Street Tunnel will have on the groundwater conditions and migration patterns beneath the Frontier Site. While reasonable predictions of the effect that will be created can be put forth, they remain as simple predictions. Until the closure actually occurs, and the groundwater re-equilibrates to the newly imposed conditions, the impact will not be fully known or understood. Under the current conditions, the groundwater beneath the Frontier Site and the chemicals therein are in a controlled state. The entire shallow groundwater flow regime migrates into the Falls Street Tunnel and 47th Street Tunnel and is directed to the City of Niagara Falls WWTP where it is effectively treated. This has been demonstrated to be a complete and effective remedy for the Site groundwater. The discharge has had no deleterious effect on the operation of the WWTP, operates effectively and efficiently in a totally unassisted manner, and has been accepted by the NYSDEC as an acceptable remedy as evidenced by its inclusion in the Operable Unit 1 ROD for the Site.

To this end, the Frontier Group has been working with the Niagara Falls Water Board for the past couple of years in an effort to obtain a permit for this discharge. One of the obstacles to obtaining a permit has been the absence of information allowing verified quantification of the volume of groundwater infiltration and the chemical loading associated with that infiltration. The tunnel study performed under this investigation has provided the necessary data to provide such quantification which confirms the validity of the theoretical estimates. The volume of groundwater infiltration is low (likely less than three gallons per minute) and the chemical loading is small (likely less than one pound per day). Based upon these data, the Frontier Group believes that the Water Board now has the supporting data to issue a permit to the Frontier Site for groundwater discharge/treatment.

Recognizing that the proposed closure of this section of the Falls Street Tunnel will have an impact on the groundwater conditions beneath the Site, risk managers may be apprehensive about the proposed closure of the Falls Street Tunnel. Under the current conditions, there already is an effective groundwater remedy in place for the Frontier Site. Furthermore, the Water Board now has the information necessary to allow them to issue a discharge permit or to execute an agreement with the Frontier Group to accept this discharge and be properly compensated. The proposed closure impacts both the existing groundwater remedy and the potential permit issuance.

The Frontier Group has suggested that the Water Board should be able to proceed with both the issuance of the permit (or an agreement) with the Frontier Group and their plans for closure of the Falls Street Tunnel simultaneously. The reasons for this are that:

- Under the proposed closure of the Falls Street Tunnel, the expectation is that the groundwater beneath the Frontier Site will now simply be directed to the 47th Street Tunnel; the closest available groundwater sink. (An explanation of this is provided later in this section of the report).
- The volume of groundwater infiltrating the tunnels and the chemical loading from this infiltration are known and can be used as a baseline to issue a permit (or execute an agreement).
- As additional remedial work is performed on the Site and as time goes on, the chemical loading from the Site will continue to decrease.
- Any increase of the volume of groundwater infiltration that occurs in the 47th Street Tunnel above the established baseline will have been caused by the closure of the adjacent section of the Falls Street Tunnel and is not attributable to current Site conditions or the Frontier PRP Group.

Based upon these factors, it is believed that the Water Board has the information necessary to issue a permit or execute an agreement with the Frontier Group and that this can be finalized as the shallow groundwater remedy. This will provide the necessary resolution to the ROD selected remedy for the Site groundwater.

As mentioned above, it is expected that the groundwater beneath the Frontier Site will be directed to the 47th Street Tunnel, once the section of the Falls Street Tunnel is closed. This expectation is based upon the following hydrogeologic considerations.

At the extreme eastern end of the proposed isolated section of the Falls Street Tunnel (adjacent to the Frontier Site), the tunnel is expected to become a source of replenishment of the B Zone bedrock fracture network. Once the tunnel has filled up and the new equilibrated groundwater elevation is established, expectations are that the bedrock groundwater will begin to flow to the next closest available outlet; the 47th Street Tunnel. Groundwater is expected to exit the Falls Street Tunnel, enter the fracture network beneath the Frontier Site, and migrate to and into the 47th Street Tunnel. Consequently the direction of B Zone groundwater flow beneath the Frontier Site will likely change from a southeasterly (toward the Falls Street Tunnel and the 47th Street Tunnel) to a northeasterly direction (toward the 47th Street Tunnel and away from the Falls Street Tunnel). Given that the 47th Street Tunnel is the only groundwater receptor in the area, the groundwater beneath the Site will still be captured at the Site boundary.

Being a source of groundwater recharge in the vicinity of the 47th Street Tunnel, it is expected that no groundwater from beneath the Frontier Site will enter the Falls Street Tunnel. Groundwater will be exfiltrating from the isolated section of the Falls Street Tunnel into the B Zone. With outward flow from this section of the Falls Street Tunnel, no groundwater or Site chemicals will be able to enter the tunnel.

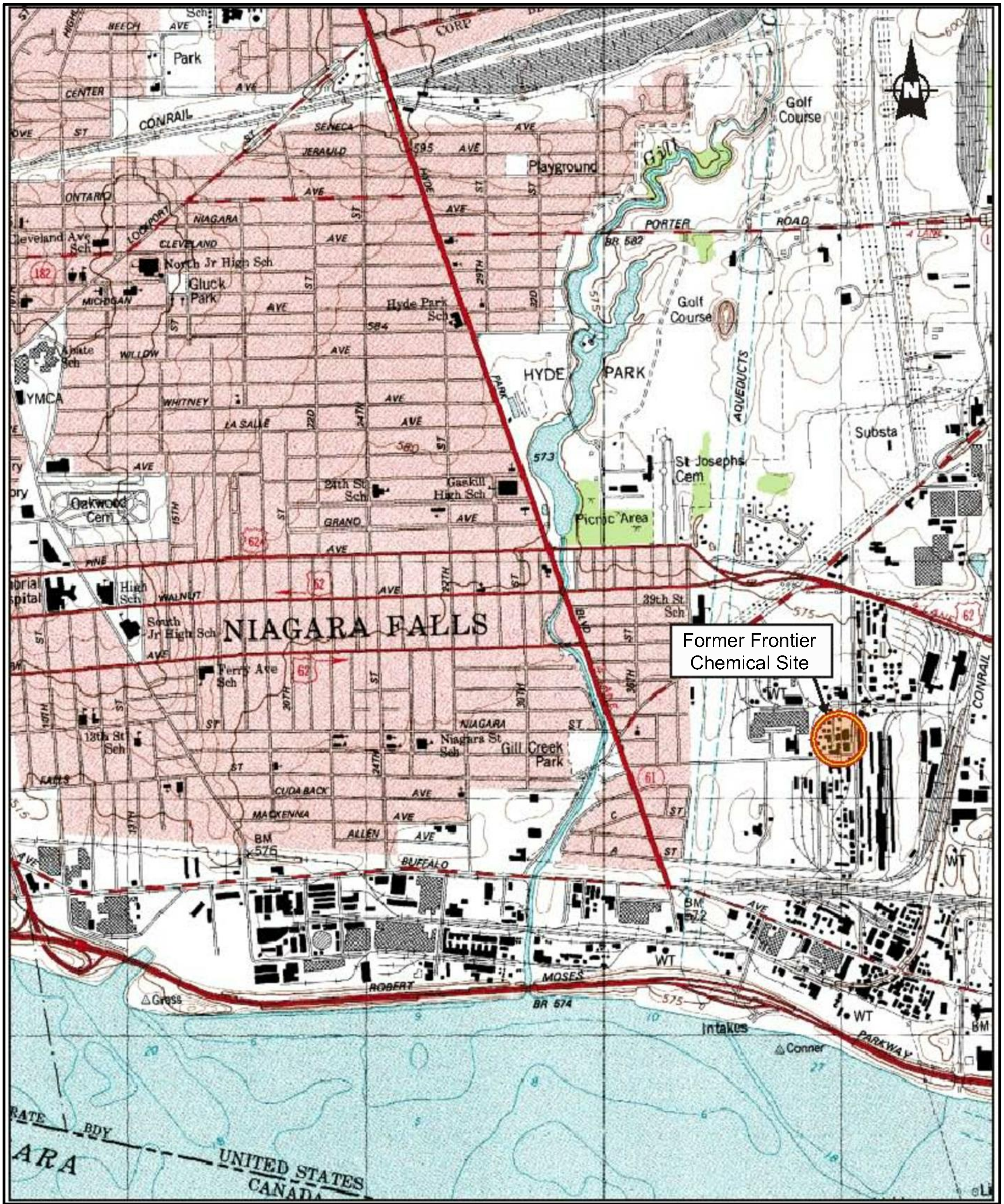
With higher groundwater elevations in the B Zone on the Frontier Site, there will be higher pressures exerted on the entry points where groundwater infiltrates into the 47th Street Tunnel. These higher pressures and elevations will likely result in some additional groundwater infiltration into the 47th Street Tunnel. The degree to which this occurs is fully dependent upon the fracture network in the bedrock as new flow paths develop.

In the end, it is expected that groundwater flow in the upper portion of the groundwater flow regime beneath the Site will continue to be captured. Upon entering the 47th Street Tunnel, the flow will be transported to the City of Niagara Falls WWTP via the Southside Interceptor Sewer. Although occasional overflow events may occur that direct water back to the Falls Street Tunnel and ultimately to the Niagara River, these events are not expected to contain Frontier Site chemicals. The reasons for this are that under high peak flows that occur during storm events, the infiltration from the Frontier Site into the 47th Street Tunnel will likely be halted or possibly even reversed. Furthermore, with 6,500,000 gallons per day of additional treatment capacity available to the WWTP, the number of overflow events will be reduced. Consequently, this potential element will have been eliminated or at least greatly reduced.

The 47th Street Tunnel should continue to work as an effective collector system for impacted groundwater from the Frontier Site and will still be an effective and efficient component of a comprehensive Site remedy encompassing both Operable Units 1 and 2.

9.0 CONCLUSION

The work required by the approved Supplemental Soil Characterization and Pilot Test Work Plan has been completed and the Report submitted to the NYSDEC in accordance with the Order on Consent and Administrative Settlement Agreement.

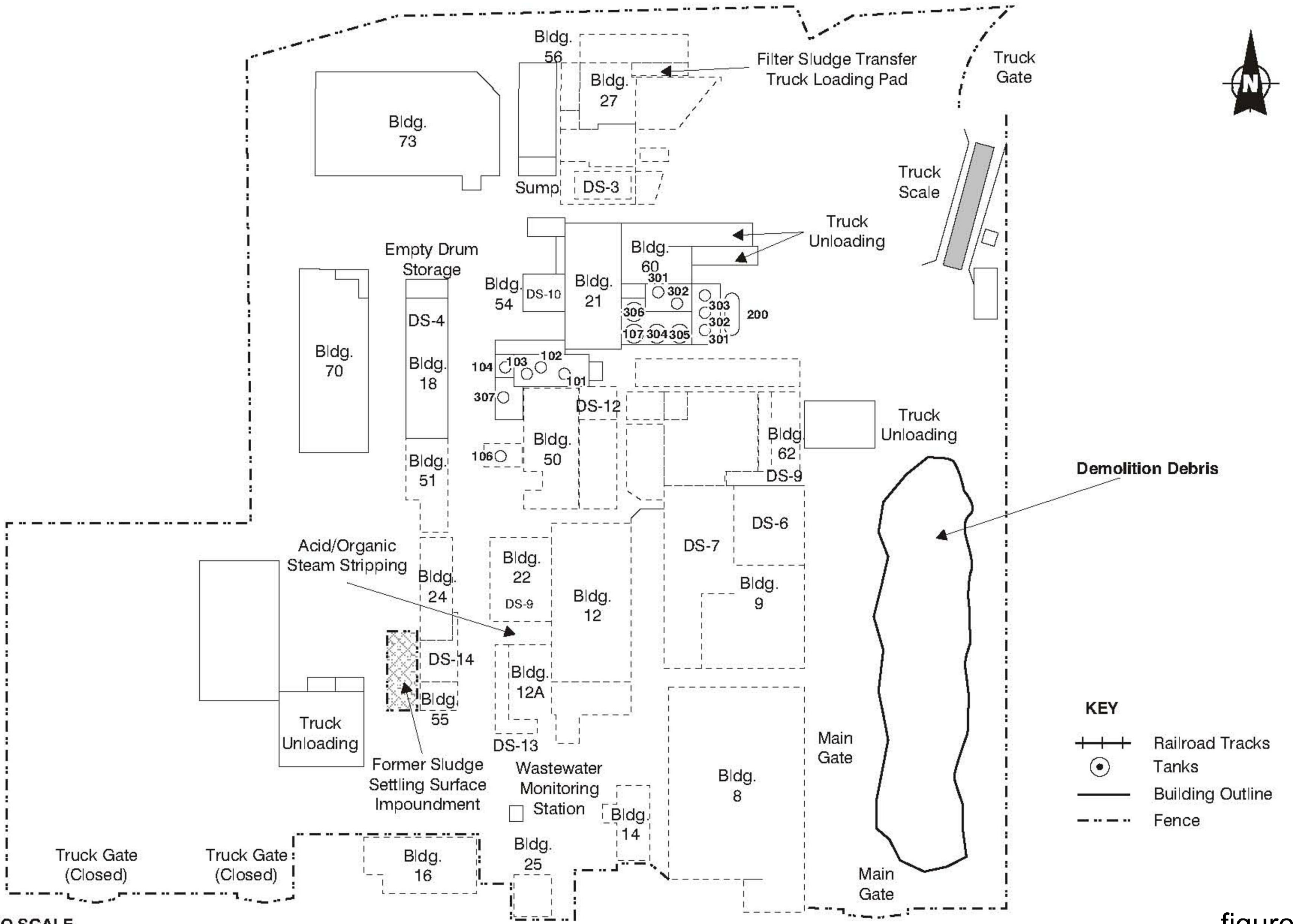


SOURCE: E & E, 2002

figure 3.1

SITE LOCATION MAP

Frontier Chemical Site - Niagara Falls, New York



NOT TO SCALE

figure 3.2

2001 SITE MAP

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

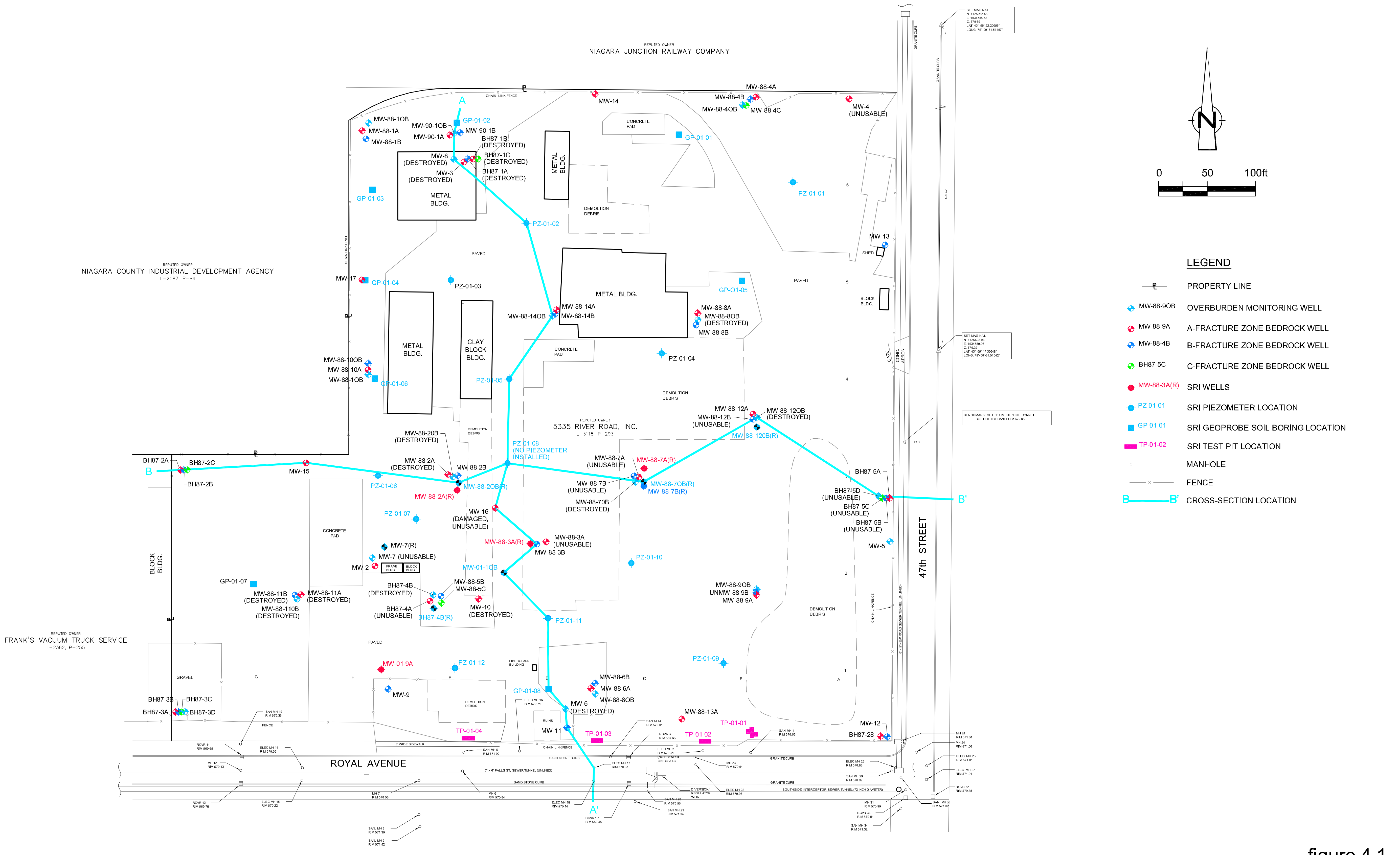


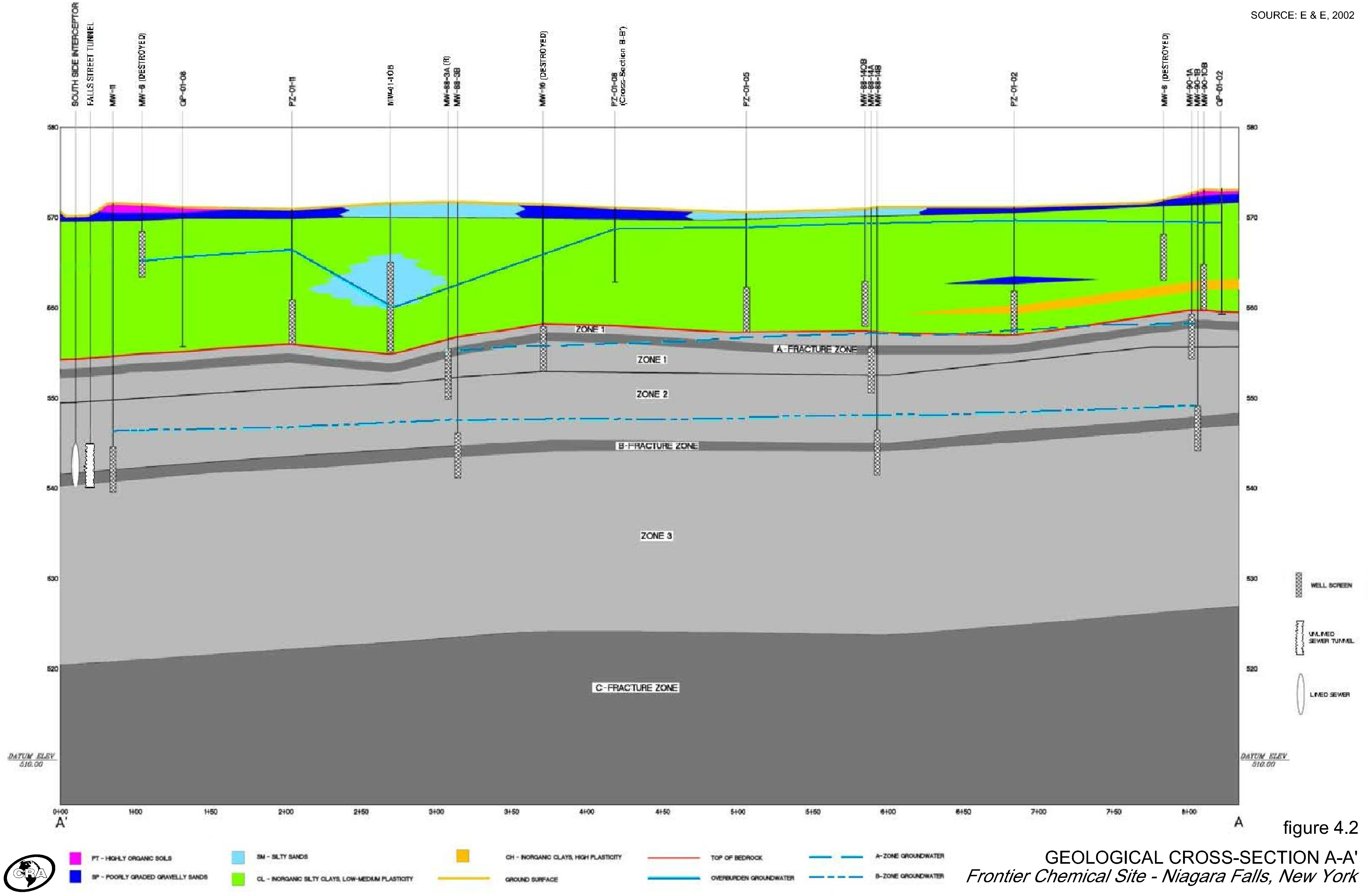
figure 4.1

GEOLOGIC CROSS-SECTION LOCATIONS

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

47392-00(007)GN-WA003 SEP 22/2009



SOURCE: E & E, 2002

figure 4.2

GEOLOGICAL CROSS-SECTION A-A'

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

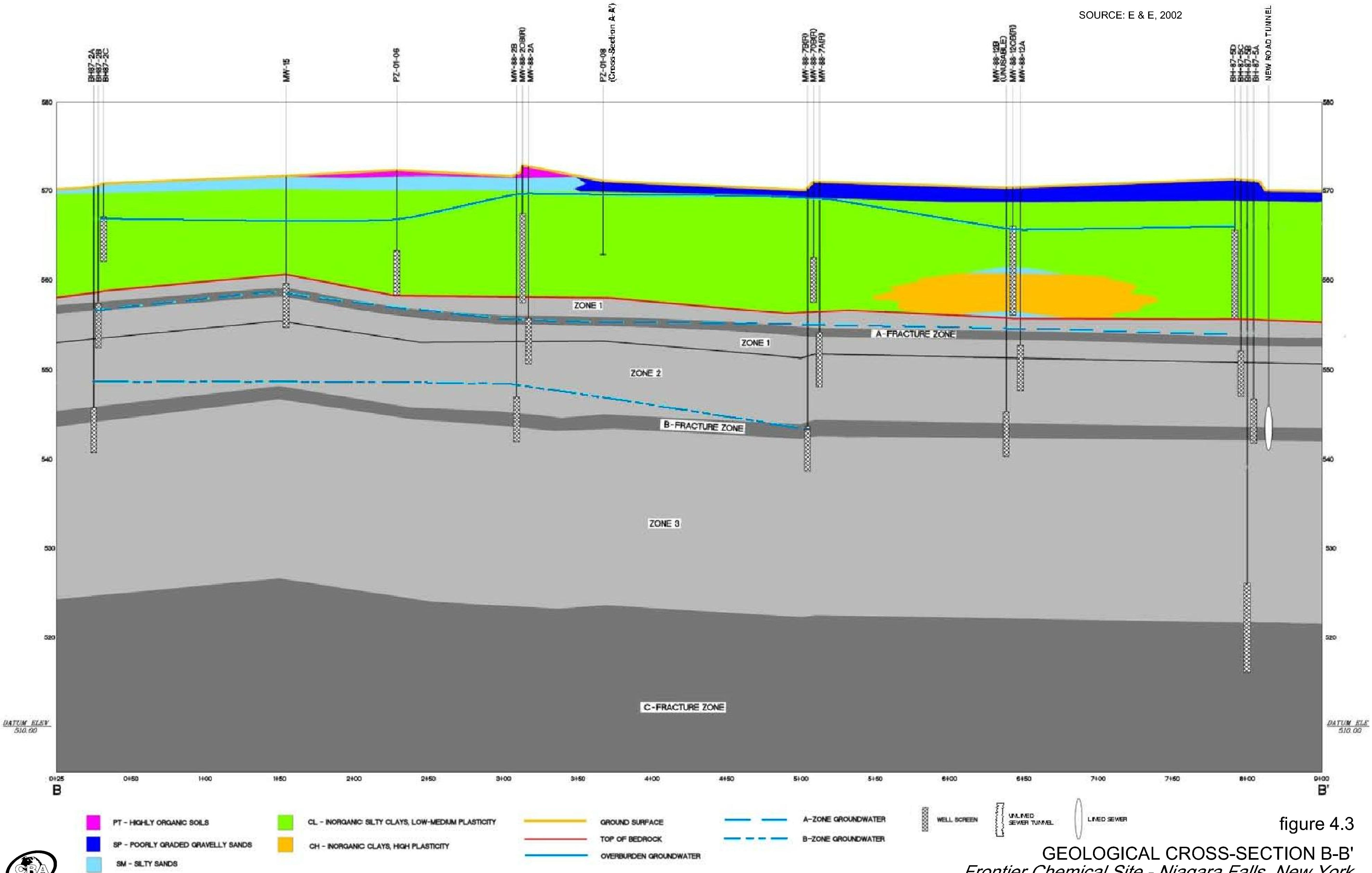
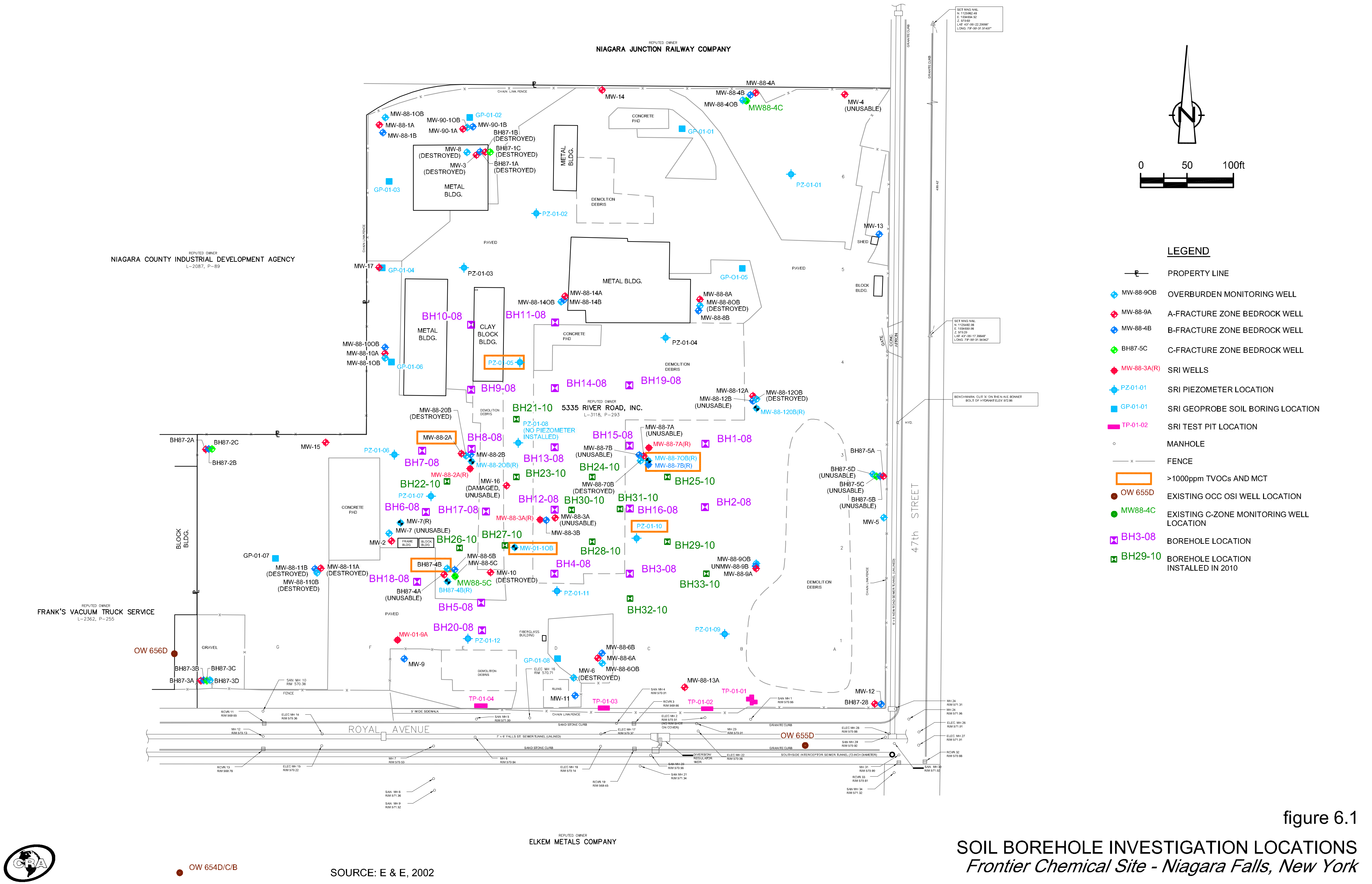


figure 4.3

GEOLOGICAL CROSS-SECTION B-B'

Frontier Chemical Site - Niagara Falls, New York

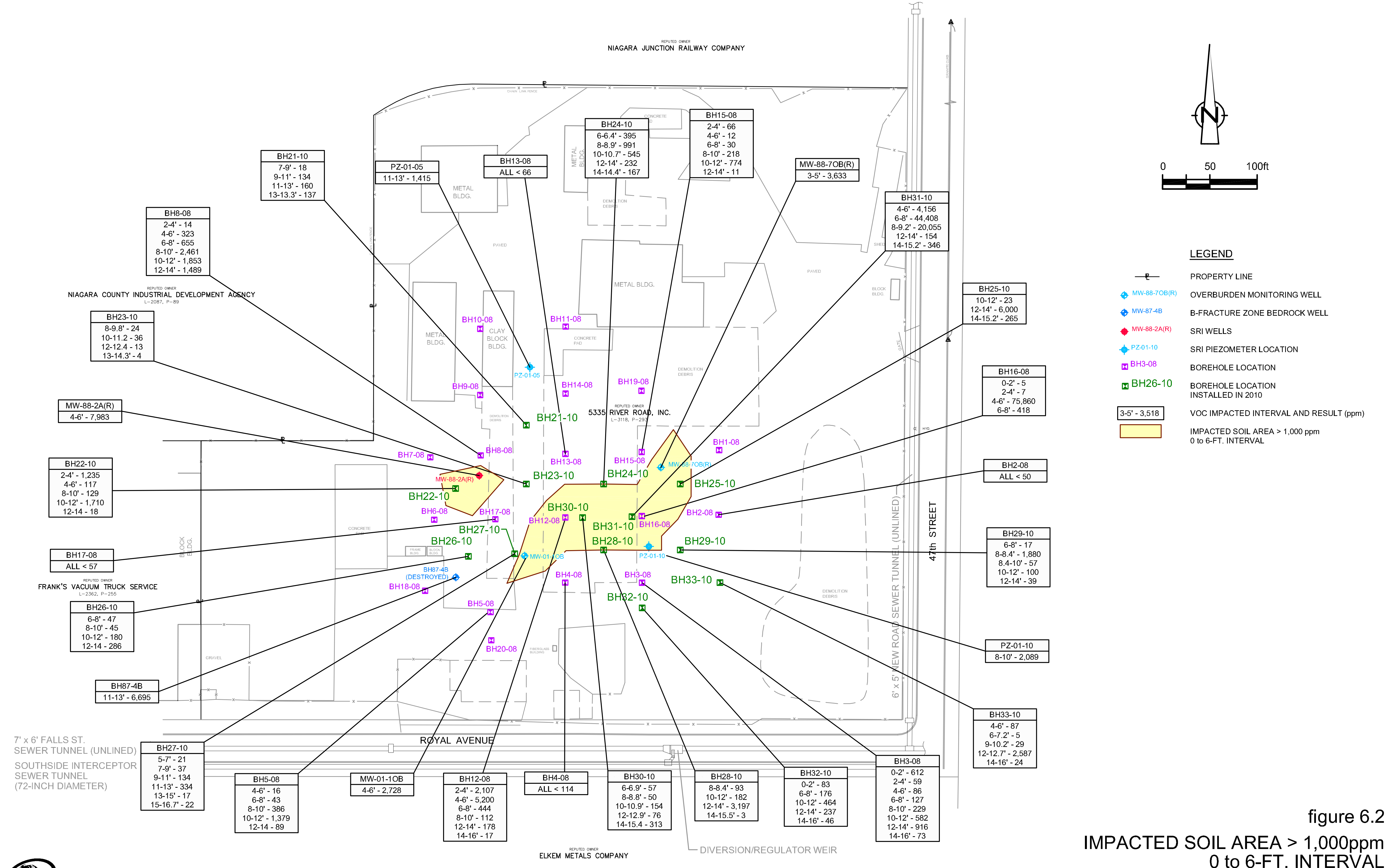


SOURCE: E & E, 2002

figure 6.1

SOIL BOREHOLE INVESTIGATION LOCATIONS

Frontier Chemical Site - Niagara Falls, New York

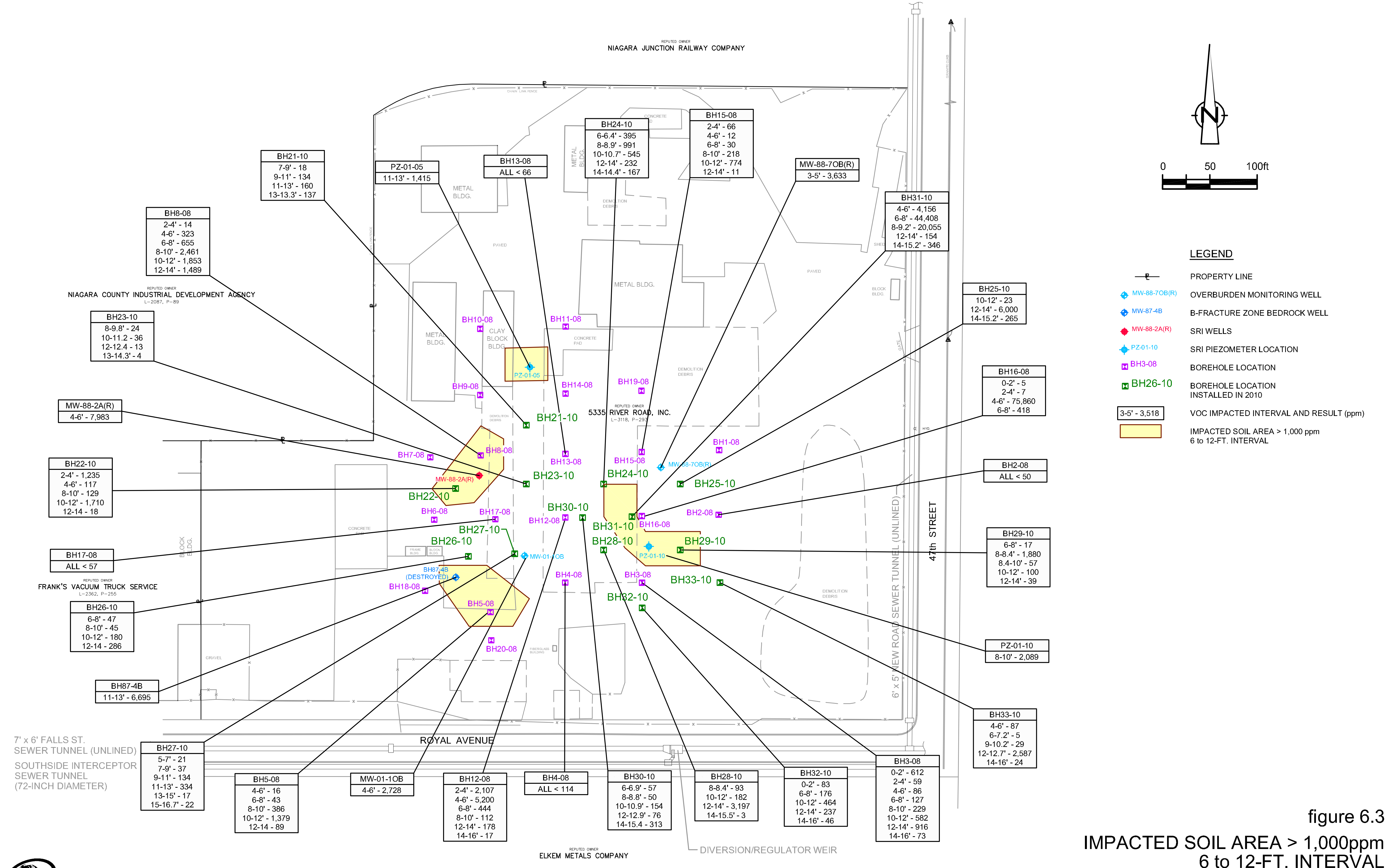


SOURCE: E & E, 2002

figure 6.2

IMPACTED SOIL AREA > 1,000ppm
0 to 6-FT. INTERVAL
Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA019 SEP 09/2010

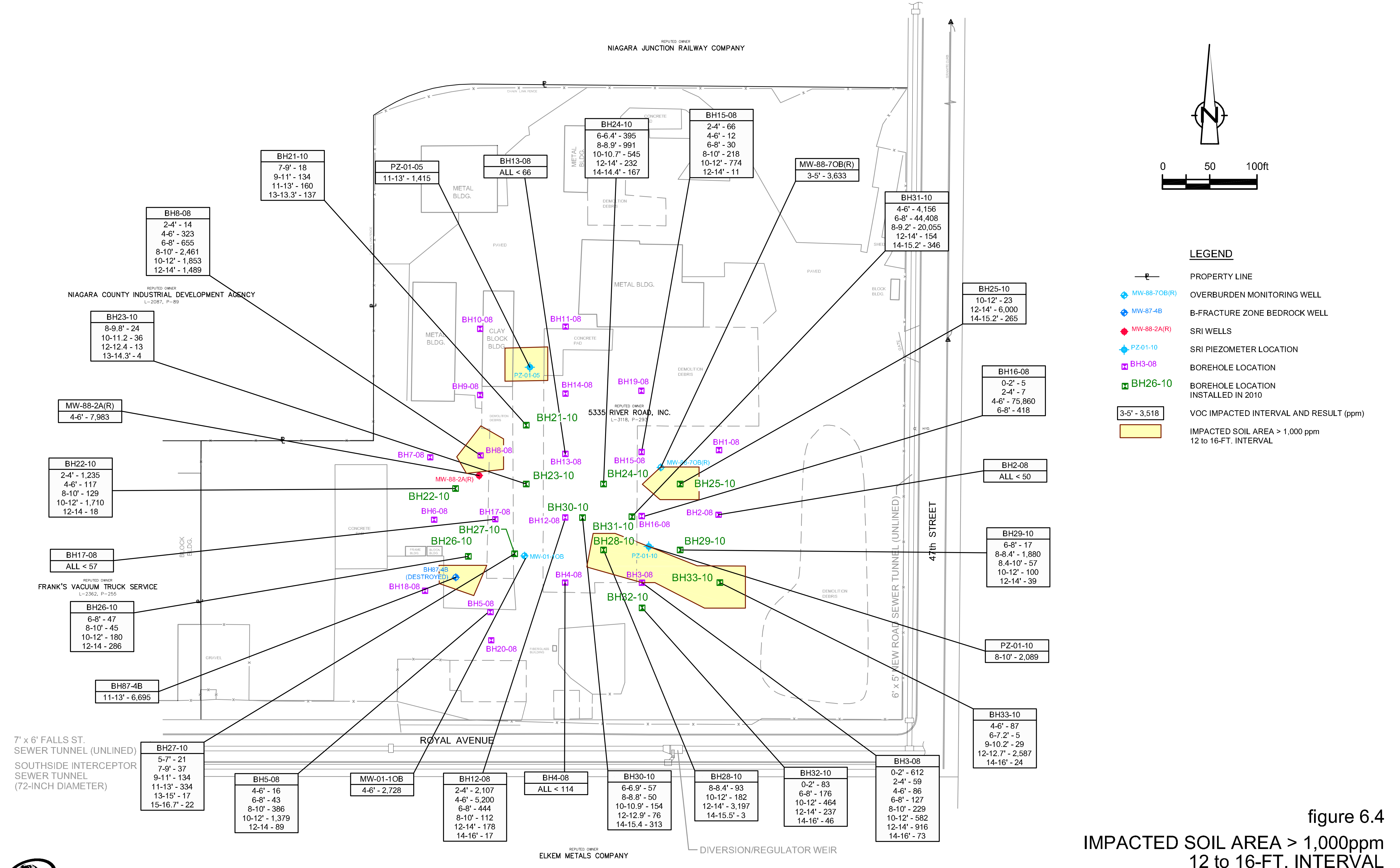


SOURCE: E & E, 2002

figure 6.3

IMPACTED SOIL AREA > 1,000ppm
6 to 12-FT. INTERVAL
Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA020 SEP 09/2010



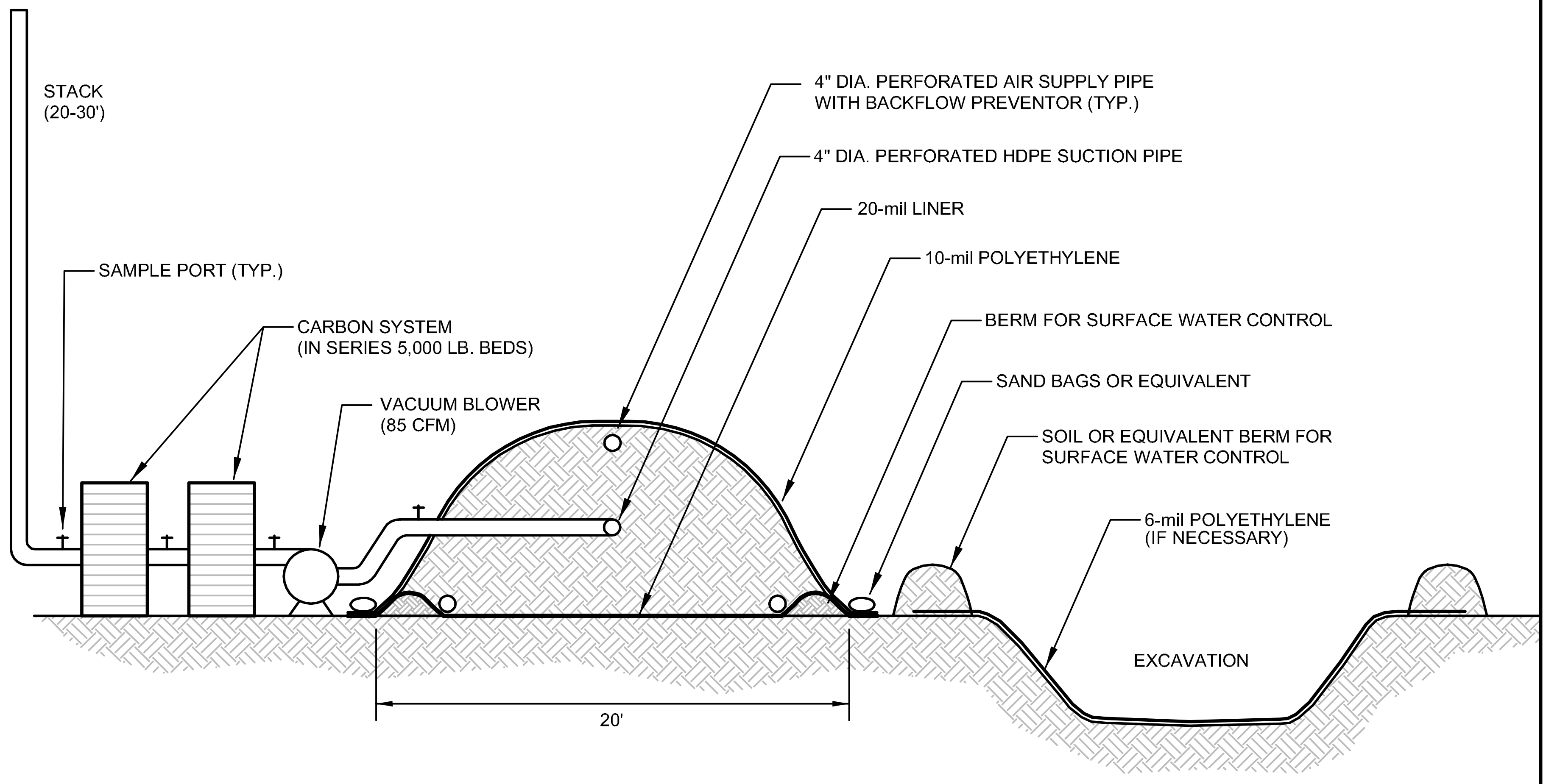
SOURCE: E & E, 2002

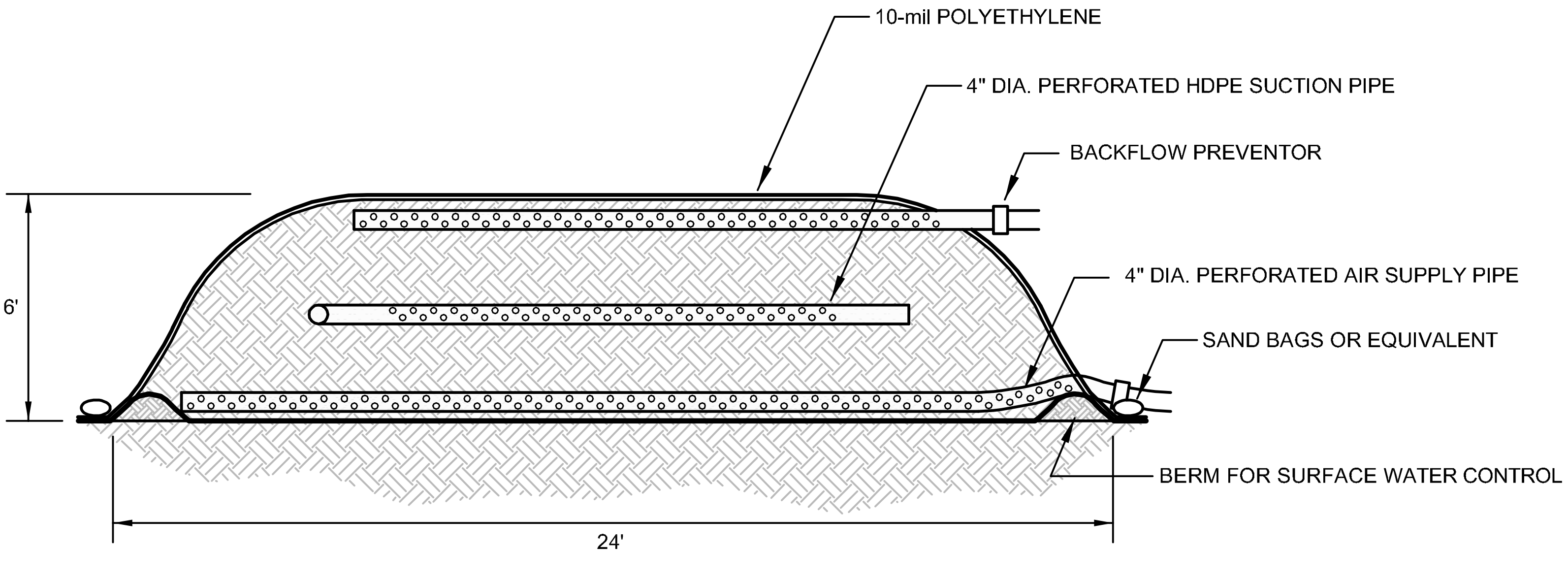
figure 6.4

IMPACTED SOIL AREA > 1,000ppm
12 to 16-FT. INTERVAL

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA021 SEP 09/2010





NOT TO SCALE

figure 6.5

ON-SITE SOIL PILOT TEST CELL

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA007 SEP 09/2010

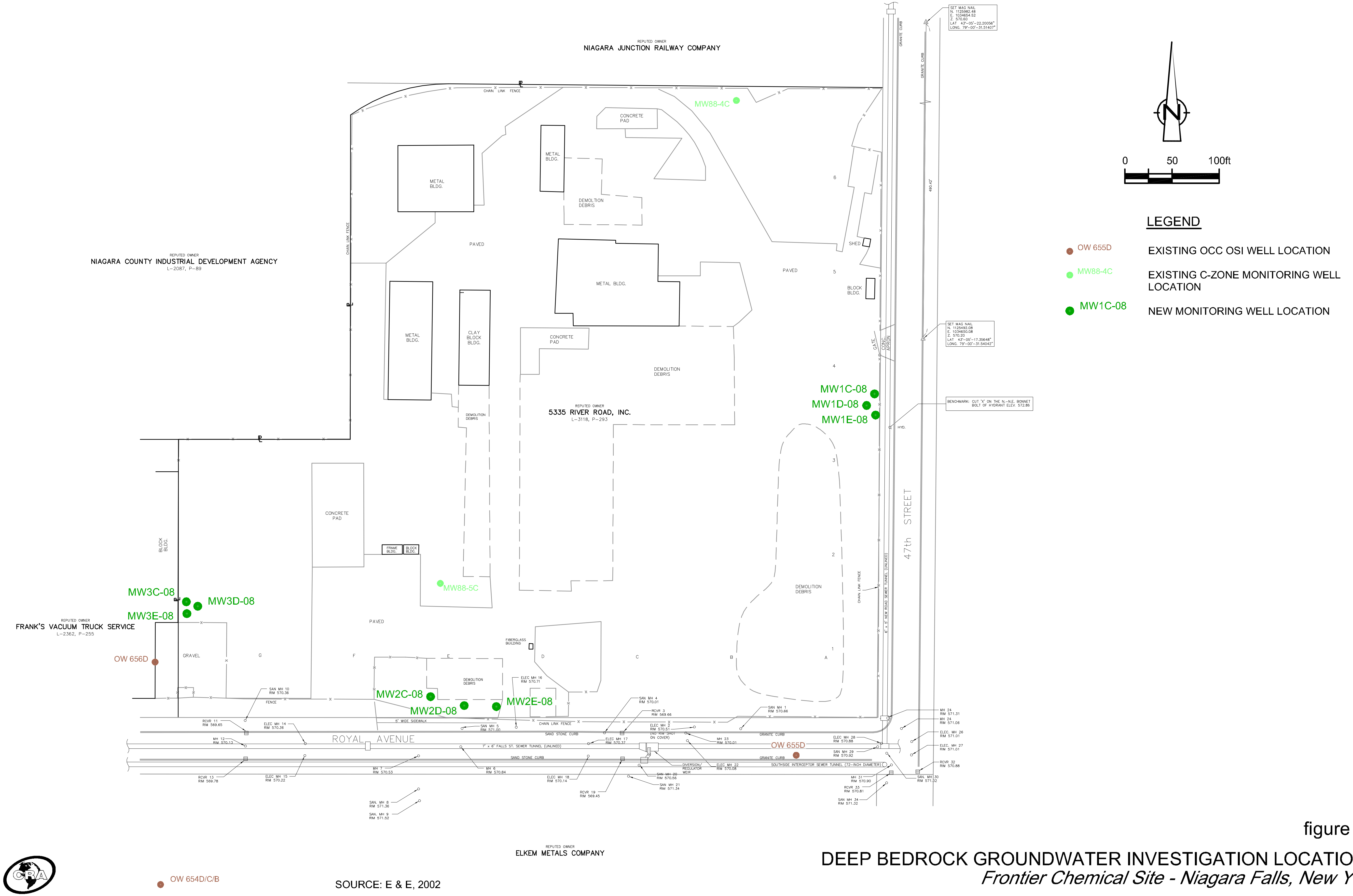


figure 6.6

DEEP BEDROCK GROUNDWATER INVESTIGATION LOCATIONS

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

47392-00(007)GN-WA008 SEP 09/2010

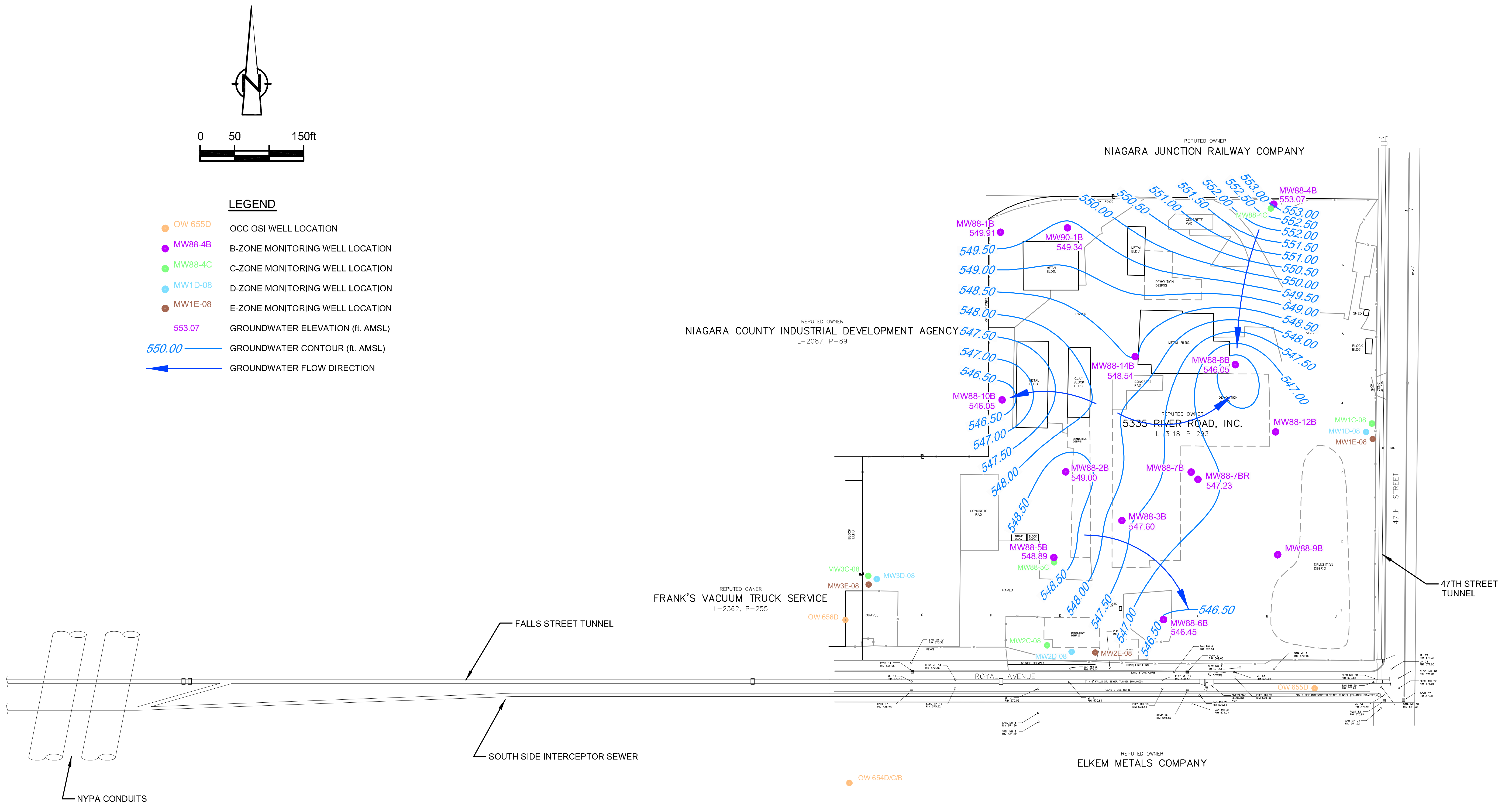


figure 6.7

GROUNDWATER CONTOURS - ZONE B
APRIL 24, 2009
Frontier Chemical Site - Niagara Falls, New York

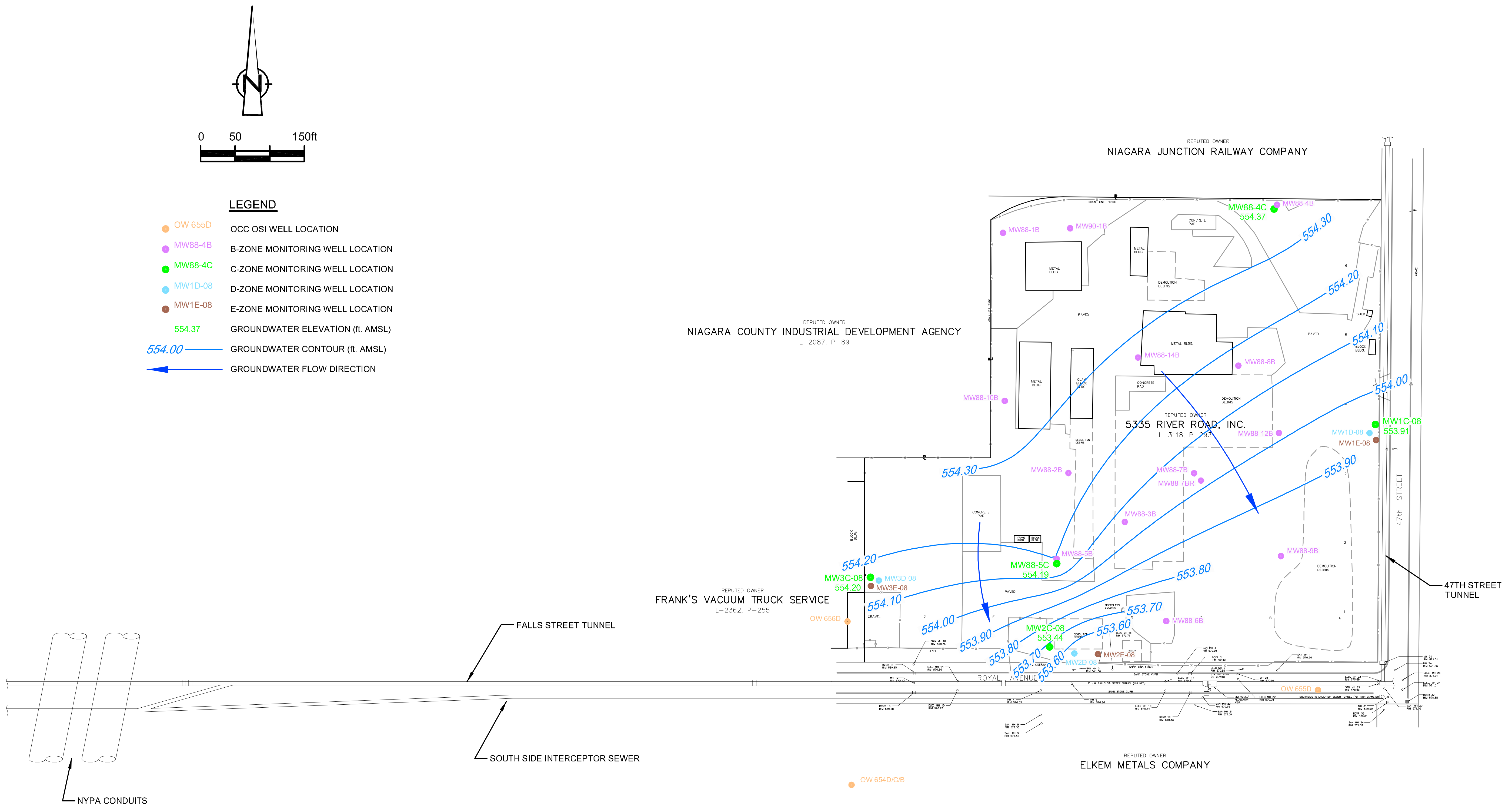


figure 6.8

GROUNDWATER CONTOURS - ZONE C
APRIL 24, 2009
Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA010 SEP 09/2010

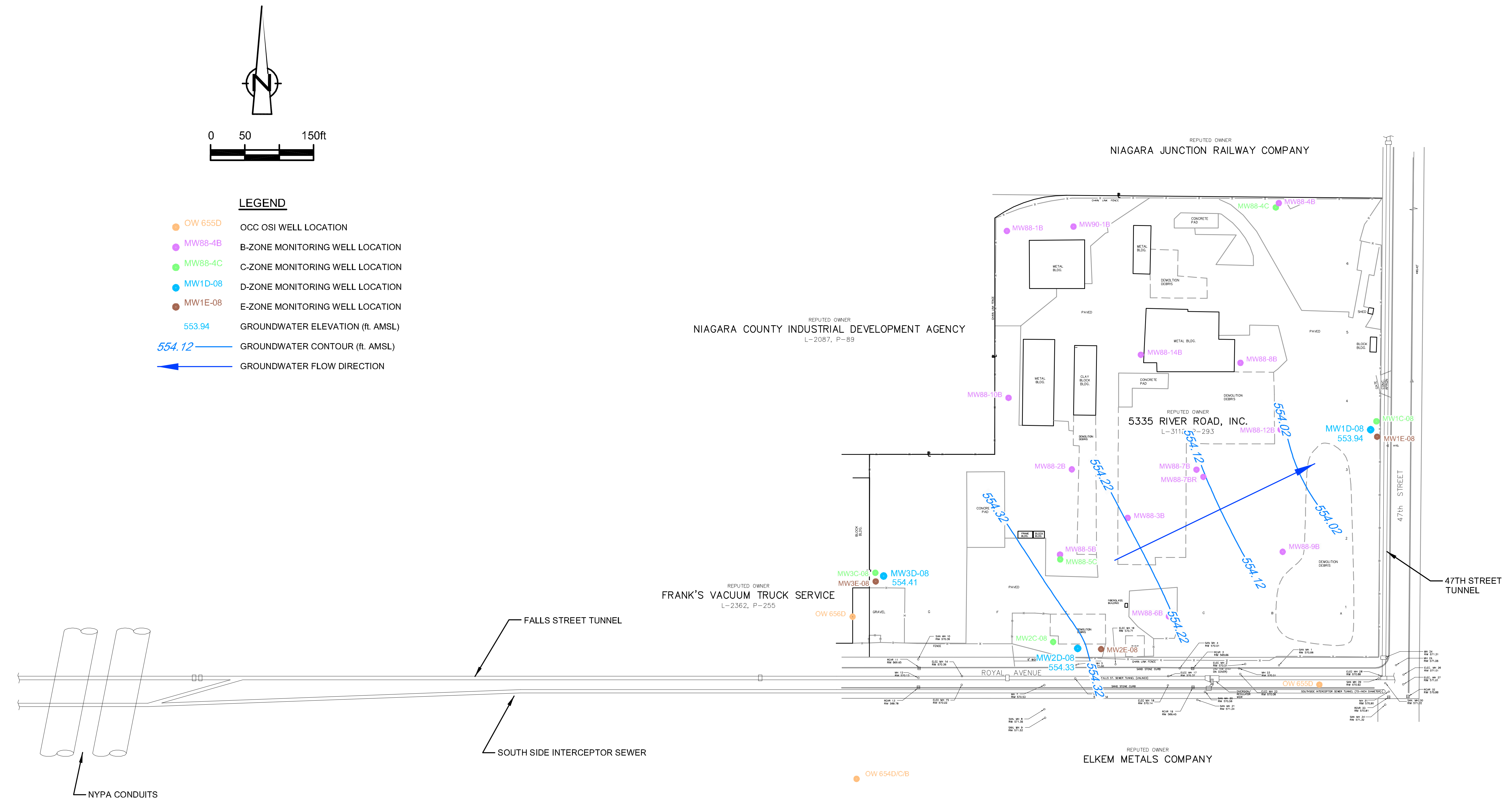


figure 6.9

GROUNDWATER CONTOURS - ZONE D
APRIL 24, 2009
Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA011 SEP 09/2010

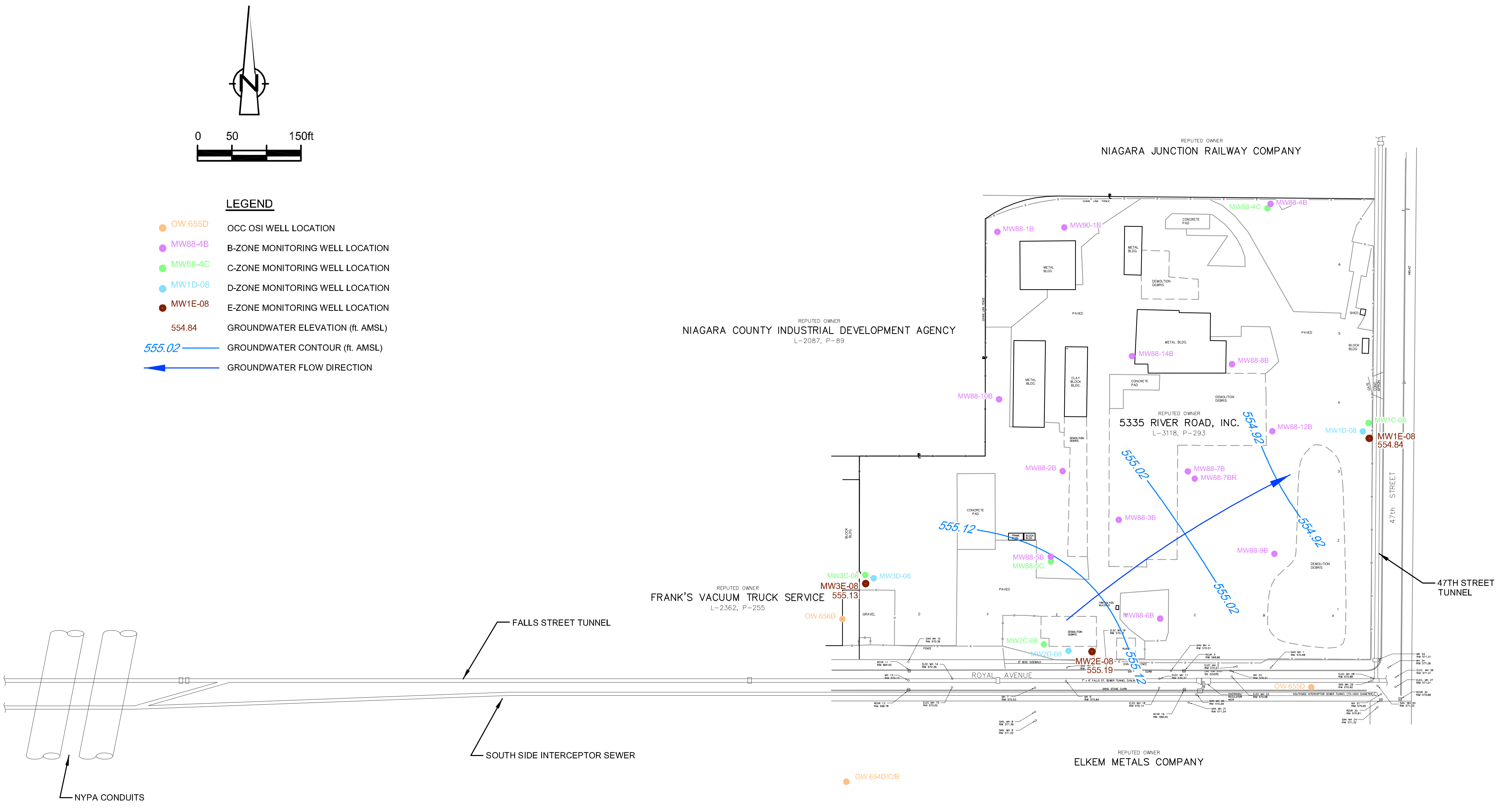
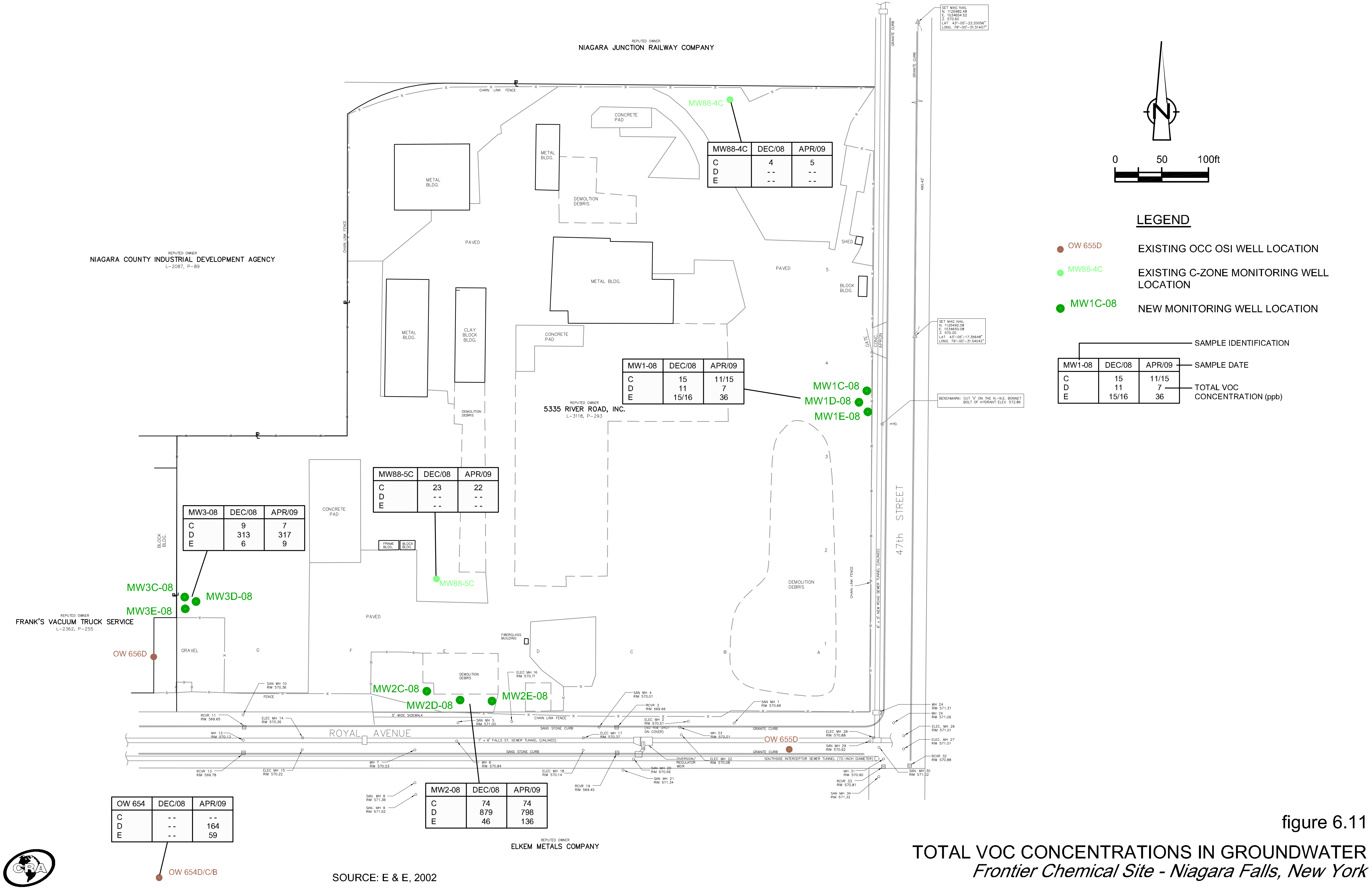


figure 6.10

GROUNDWATER CONTOURS - ZONE E
APRIL 24, 2009

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA012 SEP 09/2010



MW1-08	DEC/08	APR/09
C	15	11/15
D	11	7
E	15/16	36

MW88-4C	DEC/08	APR/09
C	4	5
D	- -	- -
E	- -	- -

MW1-08	DEC/08	APR/09
C	15	11/15
D	11	7
E	15/16	36

MW88-5C	DEC/08	APR/09
C	23	22
D	- -	- -
E	- -	- -

MW3-08	DEC/08	APR/09
C	9	7
D	313	317
E	6	9

MW2-08	DEC/08	APR/09
C	74	74
D	879	798
E	46	136

OW 654	DEC/08	APR/09
C	- -	- -
D	- -	164
E	- -	59

figure 6.11

TOTAL VOC CONCENTRATIONS IN GROUNDWATER

Frontier Chemical Site - Niagara Falls, New York

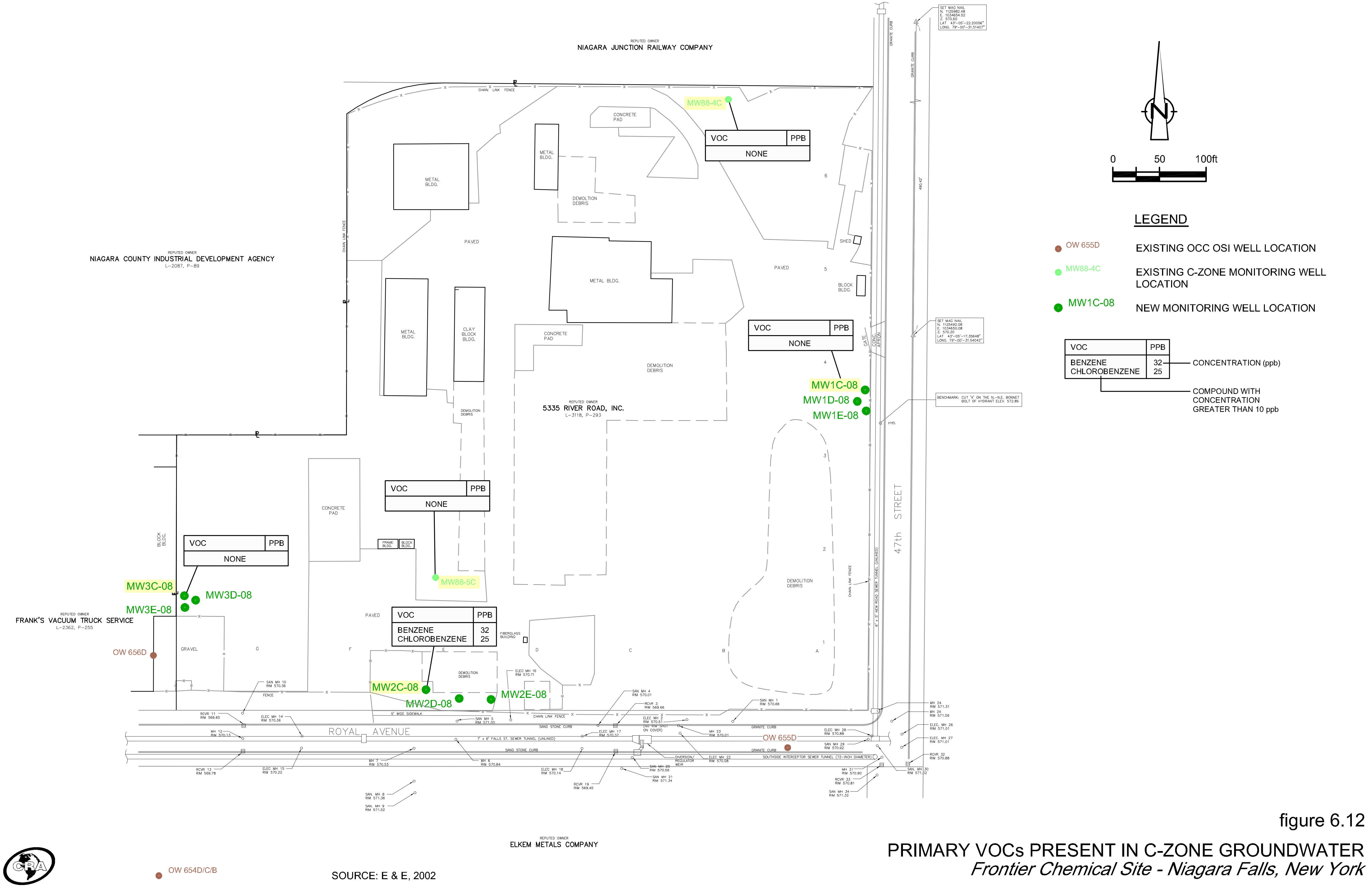


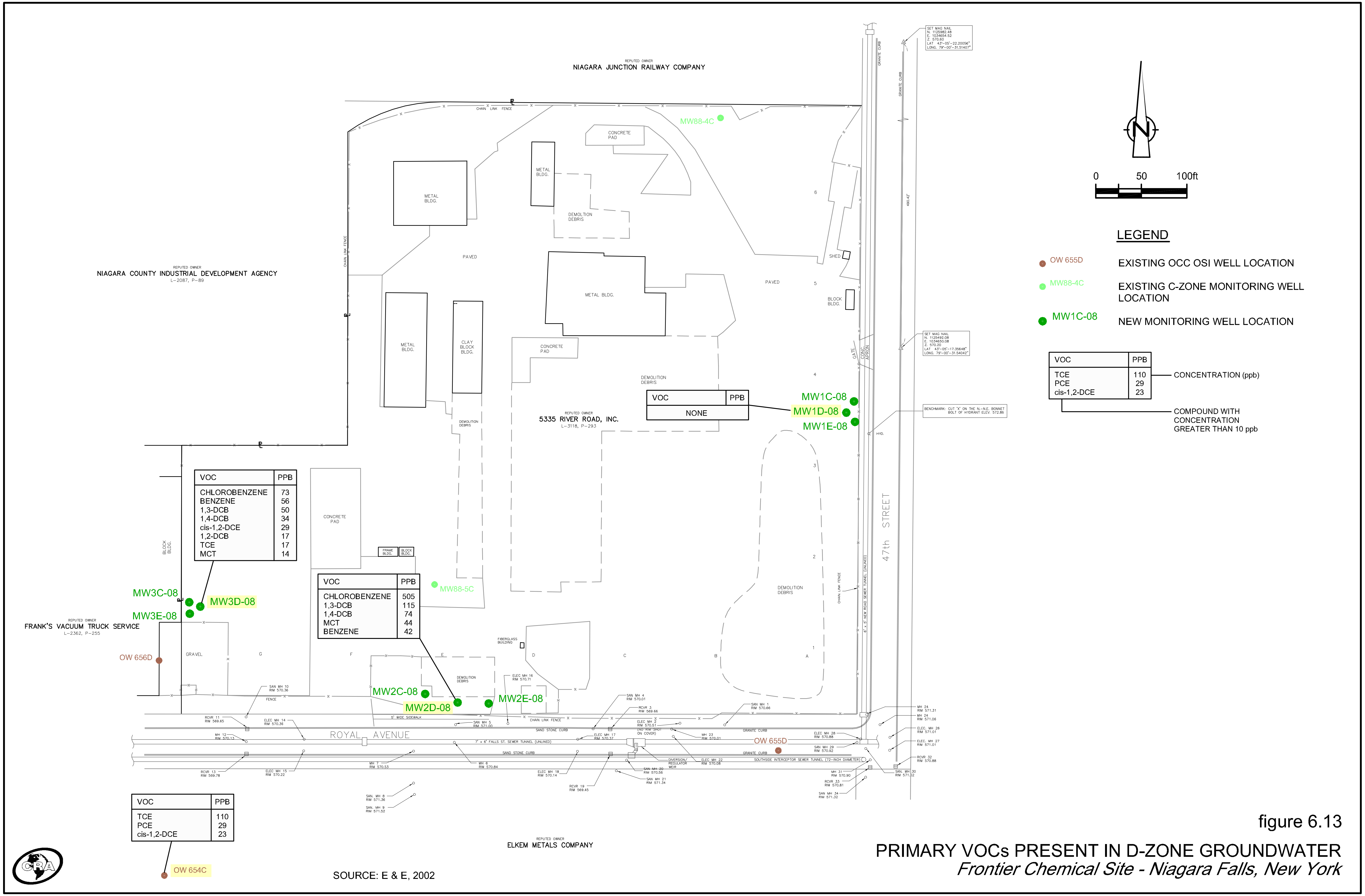
figure 6.12

PRIMARY VOCs PRESENT IN C-ZONE GROUNDWATER

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

47392-00(007)GN-WA014 SEP 09/2010



VOC	PPB
TCE	110
PCE	29
cis-1,2-DCE	23

VOC	PPB
NONE	

VOC	PPB
CHLOROBENZENE	73
BENZENE	56
1,3-DCB	50
1,4-DCB	34
cis-1,2-DCE	29
1,2-DCB	17
TCE	17
MCT	14

VOC	PPB
CHLOROBENZENE	505
1,3-DCB	115
1,4-DCB	74
MCT	44
BENZENE	42

VOC	PPB
TCE	110
PCE	29
cis-1,2-DCE	23

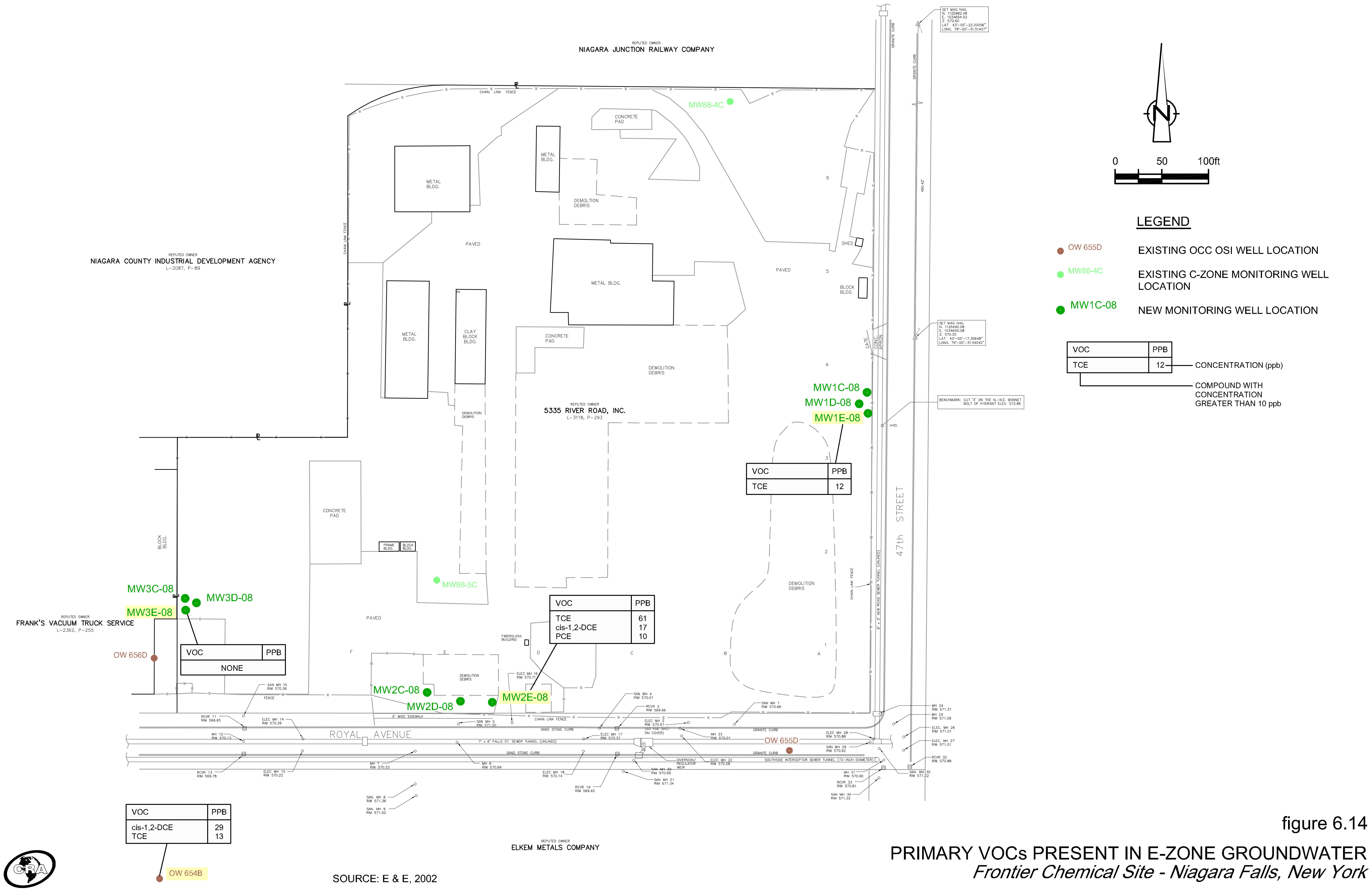
SOURCE: E & E, 2002

figure 6.13

PRIMARY VOCs PRESENT IN D-ZONE GROUNDWATER

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA015 SEP 09/2010



SOURCE: E & E, 2002

figure 6.14

PRIMARY VOCs PRESENT IN E-ZONE GROUNDWATER

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA016 SEP 09/2010

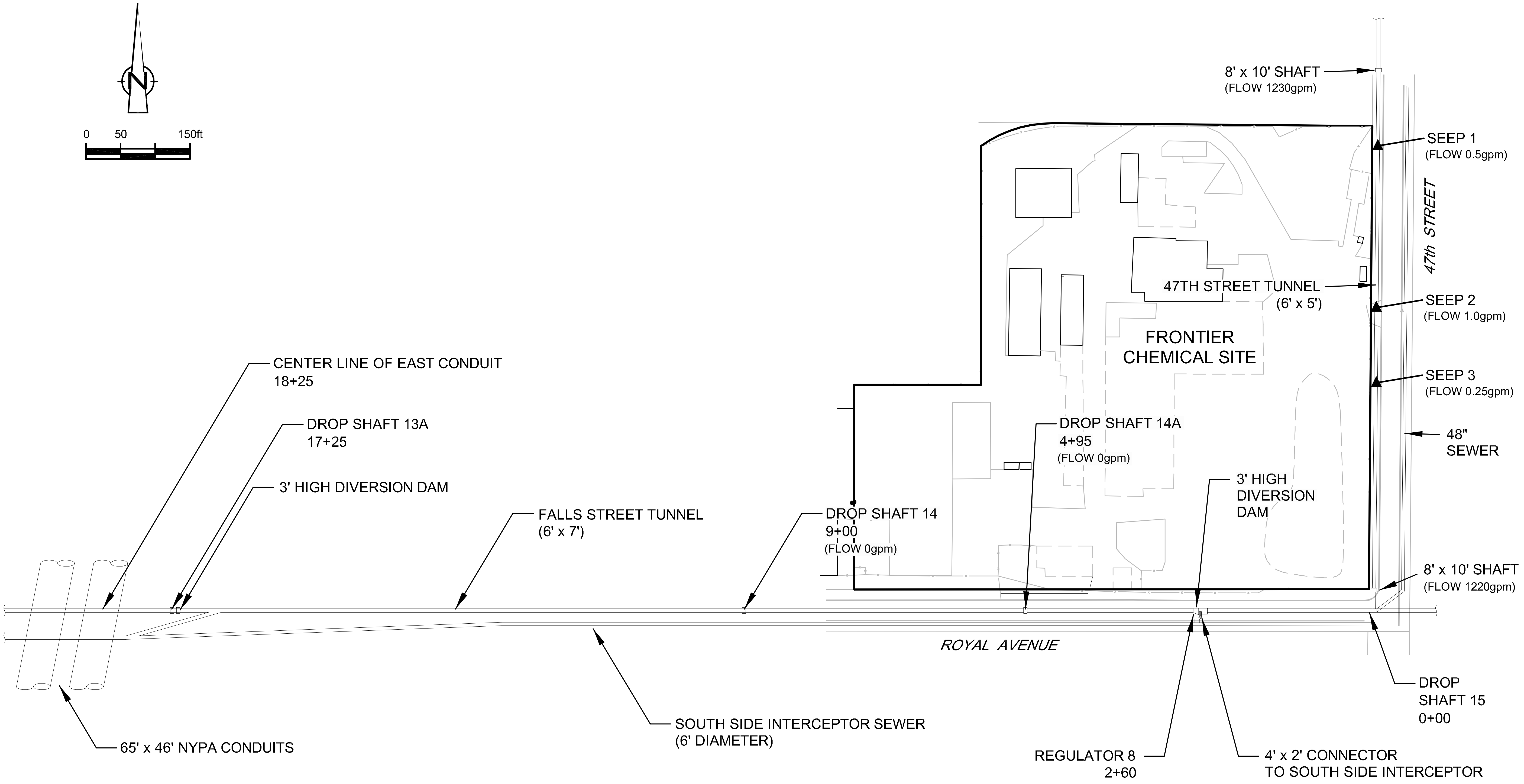


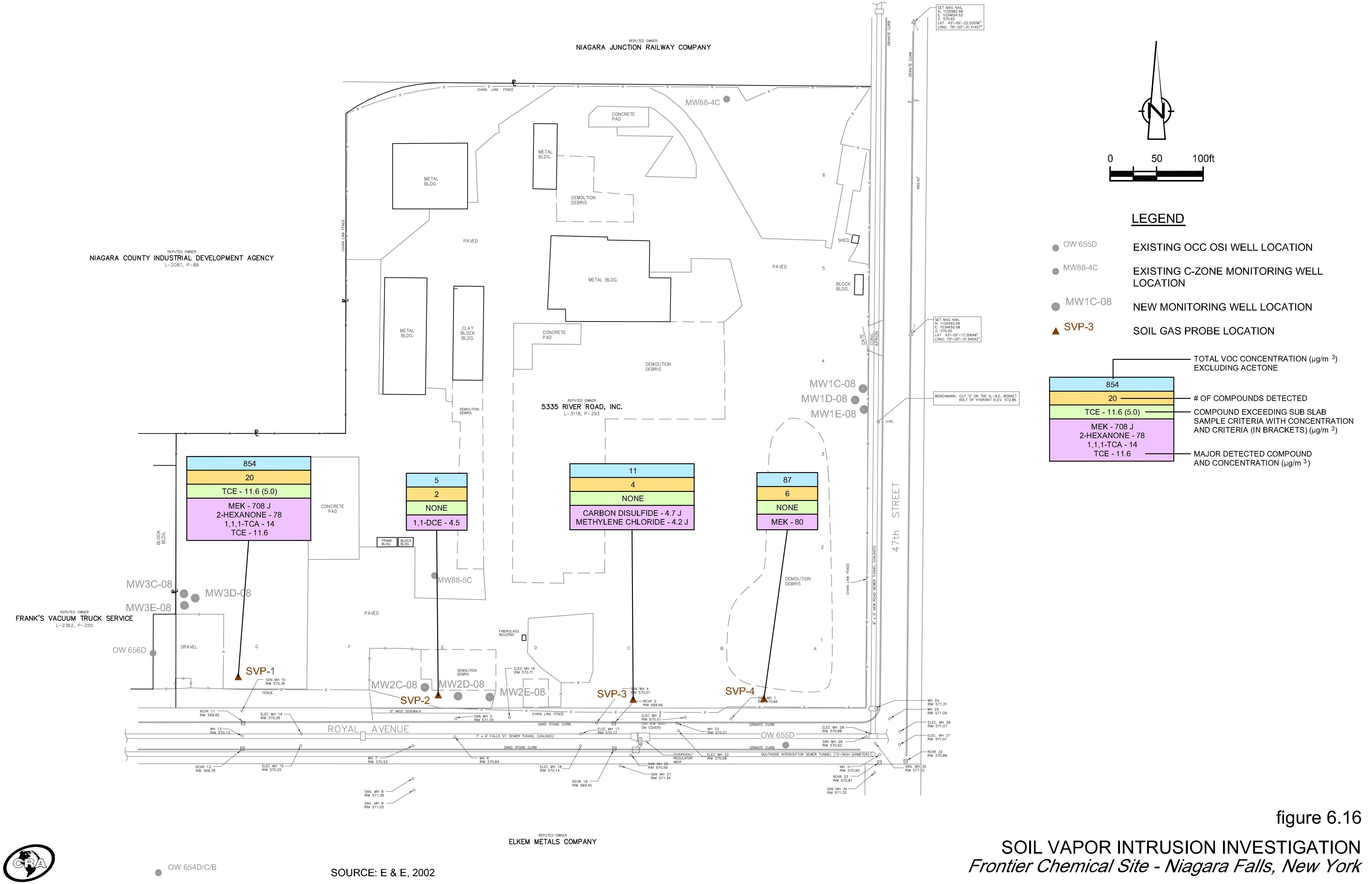
figure 6.15

TUNNEL INVESTIGATION RESULTS

Frontier Chemical Site - Niagara Falls, New York

SOURCE: E & E, 2002

47392-00(007)GN-WA017 SEP 09/2010



LEGEND

● OW 655D EXISTING OCC OSI WELL LOCATION

● MW88-4C EXISTING C-ZONE MONITORING WELL LOCATION

● MW1C-08 NEW MONITORING WELL LOCATION

▲ SVP-3 SOIL GAS PROBE LOCATION

854	TOTAL VOC CONCENTRATION ($\mu g/m^3$) EXCLUDING ACETONE
20	# OF COMPOUNDS DETECTED
TCE - 11.6 (5.0)	COMPOUND EXCEEDING SUB SLAB SAMPLE CRITERIA WITH CONCENTRATION AND CRITERIA (IN BRACKETS) ($\mu g/m^3$)
MEK - 708 J 2-HEXANONE - 78 1,1,1-TCA - 14 TCE - 11.6	MAJOR DETECTED COMPOUND AND CONCENTRATION ($\mu g/m^3$)

SOURCE: E & E, 2002

figure 6.16

SOIL VAPOR INTRUSION INVESTIGATION

Frontier Chemical Site - Niagara Falls, New York

47392-00(007)GN-WA018 SEP 09/2010

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*
		sampledate	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*
		Depth	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*6-8 ft BGS* *(Duplicate)*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	11 U	9 J	12	24 J	29 J	30	15	49 J	5 J
1,1,2,2-Tetrachloroethane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
1,1,2-Trichloroethane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	2 J	11 U	85 U	2 J
1,1-Dichloroethane	µg/kg	480000	11 U	3 J	3 J	46 U	55 U	7 J	7 J	17 J	3 J
1,1-Dichloroethene	µg/kg	1000000	11 U	12 U	11 U	46 U	55 U	3 J	11 U	85 U	11 U
1,2,4-Trichlorobenzene	µg/kg	NL	11 U	12 U	11 U	8 J	8 J	10 J	2600	810	1 J
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
1,2-Dichlorobenzene	µg/kg	1000000	11 U	12 U	3 J	71	79	120	170	470	1 J
1,2-Dichloroethane	µg/kg	60000	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
1,2-Dichloropropane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
1,3-Dichlorobenzene	µg/kg	560000	11 U	12 U	3 J	110	120	160	1000	680	11 U
1,4-Dichlorobenzene	µg/kg	250000	11 U	12 U	5 J	120	130	180	990	680	2 J
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	11 U	10 J	11 U	46 U	55 U	11 U	11 U	85 U	11 U
2-Chlorotoluene	µg/kg	1000000	11 U	22	110	2900	3100	7200	12000	7600	13
2-Hexanone	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
4-Chlorotoluene	µg/kg	1000000	11 U	5 J	3 J	46 U	55 U	25	190	570	1 J
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Acetone	µg/kg	1000000	780	3900	2000	6600	6300	210	440	34000	11 U
Benzene	µg/kg	89000	11 U	1 J	2 J	6 J	10 J	27	46	97	27
Bromodichloromethane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Bromoform	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Bromomethane (Methyl Bromide)	µg/kg	NL	11 U	12 UJ	11 UJ	46 U	55 U	11 UJ	11 UJ	85 U	11 U
Carbon disulfide	µg/kg	NL	11 U	12 UJ	11 UJ	46 U	55 U	11 UJ	11 UJ	13 J	2 J
Carbon tetrachloride	µg/kg	44000	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Chlorobenzene	µg/kg	1000000	11 U	12 U	6 J	22 J	25 J	49	85	180	1 J
Chloroethane	µg/kg	NL	11 U	12 UJ	11 UJ	46 U	55 U	11 UJ	11 UJ	85 U	11 U
Chloroform (Trichloromethane)	µg/kg	700000	2 J	20	11 U	46 U	55 U	2 J	11 U	85 U	11 U
Chloromethane (Methyl Chloride)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
cis-1,2-Dichloroethene	µg/kg	1000000	11 U	5 J	27	16 J	30 J	11	11 U	85 U	11 U
cis-1,3-Dichloropropene	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Cyclohexane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Dibromochloromethane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Ethylbenzene	µg/kg	780000	11 U	12 U	11 U	46 U	55 U	3 J	5 J	10 J	11 U
Isopropylbenzene	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*	*BH1-08*
		sampledate	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*
		Depth	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*6-8 ft BGS (Duplicate)*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	11 UJ	12 UJ	11 UJ	46 U	55 U	11 UJ	11 UJ	85 U	11 U
Methyl cyclohexane	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Methyl Tert Butyl Ether	µg/kg	1000000	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Methylene chloride	µg/kg	1000000	12	16 U	21 U	37 J	34 J	13 U	12 U	42 J	7 J
Styrene	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Tetrachloroethene	µg/kg	300000	10 J	10 J	60	58	76	50	1 J	85 U	4 J
Toluene	µg/kg	1000000	1 J	2 J	2 J	46 U	55 U	1 J	3 J	11 J	6 J
trans-1,2-Dichloroethene	µg/kg	1000000	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
trans-1,3-Dichloropropene	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Trichloroethene	µg/kg	400000	9 J	17	22	31 J	33 J	22	11 U	85 U	13
Trichlorofluoromethane (CFC-11)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	11 U	12 U	11 U	46 U	55 U	11 U	11 U	85 U	11 U
Vinyl chloride	µg/kg	27000	11 U	12 U	2 J	46 U	55 U	1 J	2 J	85 U	11 U
Xylene (total)	µg/kg	1000000	11 U	12 U	11 U	46 U	55 U	9 J	29	38 J	11 U
Total VOCs	µg/kg	>1000000	**814**	**4004**	**2260**	**10003**	**9974**	**8122**	**17583**	**45267**	**88**
PID	**ppm**		**18**	**5.7**	**20**	**70**	**--**	**11**	**20**	**42**	**59**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH2-08*	*BH2-08*	*BH2-08*	*BH2-08*	*BH2-08*	*BH2-08*	*BH2-08*	*BH3-08*	*BH3-08*
		sampledate	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/16/2008*	*9/17/2008*	*9/17/2008*
		Depth	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	3 J	3 J	1 J	51 U	9 J	51 U	6 J	42 J	51 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,1,2-Trichloroethane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,1-Dichloroethane	µg/kg	480000	11 U	1 J	1 J	51 U	56 U	51 U	55 U	9 J	51 U
1,1-Dichloroethene	µg/kg	1000000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,2,4-Trichlorobenzene	µg/kg	NL	11 U	11 U	3 J	7000	16 J	11 J	55 U	610000	26000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,2-Dichlorobenzene	µg/kg	1000000	11 U	2 J	150	10000	11000	70	94	440	18000
1,2-Dichloroethane	µg/kg	60000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,2-Dichloropropane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
1,3-Dichlorobenzene	µg/kg	560000	11 U	2 J	70	5100	7700	20 J	58	410	6000
1,4-Dichlorobenzene	µg/kg	250000	11 U	2 J	89	5600	9100	42 J	74	120	8200
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
2-Chlorotoluene	µg/kg	1000000	11 U	7 J	28	550	520	30 J	43 J	14 J	140
2-Hexanone	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
4-Chlorotoluene	µg/kg	1000000	11 U	1 J	11 U	4600	9200	72	78	59 U	320
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Acetone	µg/kg	1000000	35 U	11 U	780	1000	7800	2100	180	59 U	120
Benzene	µg/kg	89000	11 U	11 U	11 U	520	540	960	270	7 J	51 U
Bromodichloromethane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Bromoform	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Bromomethane (Methyl Bromide)	µg/kg	NL	11 U	11 UJ	11 UJ	51 U	56 U	51 U	55 U	59 U	51 U
Carbon disulfide	µg/kg	NL	11 U	11 UJ	11 UJ	51 U	7 J	51 U	55 U	7 J	7 J
Carbon tetrachloride	µg/kg	44000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Chlorobenzene	µg/kg	1000000	11 U	5 J	18	950	4300	3900	420	8 J	97
Chloroethane	µg/kg	NL	11 U	11 UJ	11 UJ	51 U	56 U	51 U	55 U	59 U	51 U
Chloroform (Trichloromethane)	µg/kg	700000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Chloromethane (Methyl Chloride)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
cis-1,2-Dichloroethene	µg/kg	1000000	11 U	2 J	2 J	20 J	6 J	18 J	55 U	59 U	51 U
cis-1,3-Dichloropropene	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Cyclohexane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Dibromochloromethane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Ethylbenzene	µg/kg	780000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Isopropylbenzene	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	***BH2-08***	***BH2-08***	***BH2-08***	***BH2-08***	***BH2-08***	***BH2-08***	***BH2-08***	***BH3-08***	***BH3-08***
		sampledate	***9/16/2008***	***9/16/2008***	***9/16/2008***	***9/16/2008***	***9/16/2008***	***9/16/2008***	***9/16/2008***	***9/17/2008***	***9/17/2008***
		Depth	***2-4 ft BGS***	***4-6 ft BGS***	***6-8 ft BGS***	***8-10 ft BGS***	***10-12 ft BGS***	***12-14 ft BGS***	***14-16 ft BGS***	***0-2 ft BGS***	***2-4 ft BGS***
	Units	***NYSDEC SCO (1)***									
VOAs											
Methyl acetate	µg/kg	NL	11 UJ	11 UJ	11 UJ	51 UJ	56 U	51 UJ	55 U	59 UJ	51 UJ
Methyl cyclohexane	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Methyl Tert Butyl Ether	µg/kg	1000000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Methylene chloride	µg/kg	1000000	12	15 U	11 U	40 J	49 J	37 J	12 J	120	49 J
Styrene	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Tetrachloroethene	µg/kg	300000	9 J	31	28	17 J	7 J	51 U	17 J	160	68
Toluene	µg/kg	1000000	11 U	11 U	11 U	51 U	6 J	61	64	12 J	51 U
trans-1,2-Dichloroethene	µg/kg	1000000	11 U	11 U	11 U	51 U	6 J	14 J	55 U	59 U	51 U
trans-1,3-Dichloropropene	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Trichloroethene	µg/kg	400000	11 U	9 J	6 J	51 U	56 U	51 U	31 J	120	51 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Vinyl chloride	µg/kg	27000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Xylene (total)	µg/kg	1000000	11 U	11 U	11 U	51 U	56 U	51 U	55 U	59 U	51 U
Total VOCs	µg/kg	>1000000	**24**	**65**	**1176**	**35397**	**50266**	**7335**	**1347**	**611469**	**59001**
PID	**ppm**		**4.3**	**1.2**	**8.3**	**24**	**123**	**92**	**50**	**10**	**28**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH4-08*	*BH4-08*	*BH4-08*
		sampledate	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*
		Depth	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	62	640 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,1,2-Trichloroethane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,1-Dichloroethane	µg/kg	480000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	19 J	640 U
1,1-Dichloroethene	µg/kg	1000000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,2,4-Trichlorobenzene	µg/kg	NL	37000	38000	140000	120000	140000	1300	380	83	340 J
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,2-Dichlorobenzene	µg/kg	1000000	22000	31000	48000	220000	360000	32000	2300	16000	18000
1,2-Dichloroethane	µg/kg	60000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,2-Dichloropropane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
1,3-Dichlorobenzene	µg/kg	560000	9600	14000	14000	79000	140000	12000	220 J	560	1800
1,4-Dichlorobenzene	µg/kg	250000	15000	22000	22000	140000	240000	22000	650	3600	4700
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	59 U	42 U	52 U	81	90	280 U	290 U	58 U	640 U
2-Chlorotoluene	µg/kg	1000000	410	680	360	1200	5800 J	440	290 U	28 J	640 U
2-Hexanone	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
4-Chlorotoluene	µg/kg	1000000	1800	3700	950	5700 J	11000 J	1000	290 U	19 J	640 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	59 U	42 U	52 U	49 J	65 U	280 U	290 U	58 U	640 U
Acetone	µg/kg	1000000	110	15000	2400	720	1500	1400	2800	58 U	3000
Benzene	µg/kg	89000	59 U	130	150	6500 J	5900	770	290 U	58 U	640 U
Bromodichloromethane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Bromoform	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Bromomethane (Methyl Bromide)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Carbon disulfide	µg/kg	NL	9 J	6 J	6 J	11 J	14 J	280 U	290 U	6 J	640 U
Carbon tetrachloride	µg/kg	44000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Chlorobenzene	µg/kg	1000000	99	370	860	7400 J	9200 J	1400	290 U	49 J	640 U
Chloroethane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Chloroform (Trichloromethane)	µg/kg	700000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Chloromethane (Methyl Chloride)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
cis-1,2-Dichloroethene	µg/kg	1000000	59 U	8 J	52 U	63 U	65 U	280 U	110 J	38 J	640 U
cis-1,3-Dichloropropene	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Cyclohexane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Dibromochloromethane	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Ethylbenzene	µg/kg	780000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Isopropylbenzene	µg/kg	NL	59 U	12 J	52 U	63 U	65 U	280 U	290 U	58 U	640 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH3-08*	*BH4-08*	*BH4-08*	*BH4-08*
		sampledate	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*
		Depth	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	59 UJ	42 UJ	52 UJ	63 U	65 U	370	170 J	58 U	290 J
Methyl cyclohexane	µg/kg	NL	59 U	42 U	52 U	63 U	7 J	280 U	290 U	58 U	640 U
Methyl Tert Butyl Ether	µg/kg	1000000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Methylene chloride	µg/kg	1000000	55 J	36 J	92	40 J	50 J	280 U	290 U	120	420 J
Styrene	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Tetrachloroethene	µg/kg	300000	280	1700	170	790	1200	150 J	2300	2900	5300
Toluene	µg/kg	1000000	59 U	33 J	38 J	650	800	110 J	290 U	35 J	640 U
trans-1,2-Dichloroethene	µg/kg	1000000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
trans-1,3-Dichloropropene	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Trichloroethene	µg/kg	400000	59 U	33 J	50 J	270	280	280 U	420	550	480 J
Trichlorofluoromethane (CFC-11)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Vinyl chloride	µg/kg	27000	59 U	42 U	52 U	63 U	65 U	280 U	290 U	58 U	640 U
Xylene (total)	µg/kg	1000000	59 U	19 J	15 J	63 U	25 J	280 U	290 U	58 U	640 U
Total VOCs	µg/kg	>1000000	**86363**	**126727**	**229091**	**582411**	**915866**	**72940**	**9350**	**24069**	**34330**
PID	**ppm**		**19**	**40**	**53**	**423**	**378**	**188**	**61**	**104**	**95**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH4-08*	*BH4-08*	*BH4-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*
		sampledate	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	4400	480	69	8 J	11 U	66 J	5500 U	2700 U	2 J
1,1,2,2-Tetrachloroethane	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
1,1,2-Trichloroethane	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
1,1-Dichloroethane	µg/kg	480000	200 J	10 J	69	23 J	35	270	5500 U	2700 U	6 J
1,1-Dichloroethene	µg/kg	1000000	320 U	9 J	50 U	56 U	11 U	15 J	5500 U	2700 U	10 U
1,2,4-Trichlorobenzene	µg/kg	NL	160 J	44 J	23 J	21 J	11 U	140	5500 U	2700 U	10 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
1,2-Dichlorobenzene	µg/kg	1000000	13000	46000	45 J	26 J	3 J	300	5500 U	2700 U	10 U
1,2-Dichloroethane	µg/kg	60000	320 U	29 J	29 J	56 U	11 U	70 U	5500 U	2700 U	10 U
1,2-Dichloropropane	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
1,3-Dichlorobenzene	µg/kg	560000	1000	280	8 J	14 J	5 J	320	5500 U	2700 U	10 U
1,4-Dichlorobenzene	µg/kg	250000	3300	9800	24 J	23 J	6 J	380	5500 U	2700 U	1 J
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	320 U	360	750	56 U	11 U	70 U	5500 U	2700 U	26
2-Chlorotoluene	µg/kg	1000000	320 U	17 J	12 J	9400	26000	250000	880000	58000	380
2-Hexanone	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
4-Chlorotoluene	µg/kg	1000000	320 U	9 J	50 U	3400	9800	120000	490000	27000	150
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	320 U	110	44 J	56 U	11 U	70 U	5500 U	2700 U	38
Acetone	µg/kg	1000000	2700	14000	4100	210	6600	390	5500 U	2700 U	770
Benzene	µg/kg	89000	320 U	62 U	50 U	30 J	7 J	100	5500 U	2700 U	1 J
Bromodichloromethane	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Bromoform	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Bromomethane (Methyl Bromide)	µg/kg	NL	320 U	62 U	50 U	56 U	11 UJ	70 U	5500 U	2700 U	10 UJ
Carbon disulfide	µg/kg	NL	320 U	12 J	14 J	8 J	2 J	9 J	5500 U	2700 U	3 J
Carbon tetrachloride	µg/kg	44000	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Chlorobenzene	µg/kg	1000000	85 J	26 J	24 J	6 J	3 J	130	5500 U	2700 U	12
Chloroethane	µg/kg	NL	320 U	62 U	50 U	56 U	11 UJ	70 U	5500 U	2700 U	10 UJ
Chloroform (Trichloromethane)	µg/kg	700000	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Chloromethane (Methyl Chloride)	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
cis-1,2-Dichloroethene	µg/kg	1000000	320 U	62 U	50 U	9 J	10 J	27 J	5500 U	2700 U	2 J
cis-1,3-Dichloropropene	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Cyclohexane	µg/kg	NL	320 U	62 U	50 U	110	31	130	5500 U	2700 U	10 U
Dibromochloromethane	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Ethylbenzene	µg/kg	780000	320 U	24 J	50 U	300	74	490	5500 U	2700 U	10 U
Isopropylbenzene	µg/kg	NL	320 U	62 U	50 U	17 J	6 J	35 J	5500 U	2700 U	10 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH4-08*	*BH4-08*	*BH4-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*	*BH5-08*
		sampledate	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	280 J	62 U	50 UJ	56 UJ	11 UJ	70 U	5500 U	2700 U	10 UJ
Methyl cyclohexane	µg/kg	NL	320 U	62 U	50 U	120	36	110	5500 U	2700 U	10 U
Methyl Tert Butyl Ether	µg/kg	1000000	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Methylene chloride	µg/kg	1000000	1900	340	370	94	11 U	170	5500 U	960 J	17 U
Styrene	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Tetrachloroethene	µg/kg	300000	11000	38000	28 J	6 J	6 J	140	5500 U	2700 U	4 J
Toluene	µg/kg	1000000	220 J	580	240	270	110	4400	6800	1200 J	210
trans-1,2-Dichloroethene	µg/kg	1000000	320 U	62 U	50 U	10 J	11 U	70 U	5500 U	2700 U	10 U
trans-1,3-Dichloropropene	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Trichloroethene	µg/kg	400000	4700	4100	4400	74	52	4600	2300 J	1400 J	56
Trichlorofluoromethane (CFC-11)	µg/kg	NL	320 U	62 U	50 U	56 U	11 U	70 U	5500 U	2700 U	10 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	320 U	62 U	15 J	56 U	11 U	70 U	5500 U	2700 U	10 U
Vinyl chloride	µg/kg	27000	320 U	62 U	50 U	56 U	2 J	70 U	5500 U	2700 U	10 U
Xylene (total)	µg/kg	1000000	320 U	120	50 U	2100	580	3300	5500 U	2700 U	6 J
Total VOCs	µg/kg	>1000000	**42945**	**114350**	**10264**	**16279**	**43368**	**385522**	**1379100**	**88560**	**1667**
PID	**ppm**		**136**	**53**	**5.4**	**51**	**64**	**566**	**174**	**66**	**35**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	***BH6-08***	***BH6-08***	***BH6-08***	***BH6-08***	***BH6-08***	***BH7-08***	***BH7-08***	***BH7-08***	***BH7-08***
		sampledate	***9/17/2008***	***9/17/2008***	***9/17/2008***	***9/17/2008***	***9/17/2008***	***9/18/2008***	***9/18/2008***	***9/18/2008***	***9/18/2008***
		Depth	***4-6 ft BGS***	***6-8 ft BGS***	***10-12 ft BGS***	***12-14 ft BGS***	***14-16 ft BGS***	***0-2 ft BGS***	***2-4 ft BGS***	***4-6 ft BGS***	***6-8 ft BGS***
	Units	***NYSDEC SCO (1)***									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	2 J	120	3700	5800 U	1500 J	280 U	290 U	290 U	490 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,1,2-Trichloroethane	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,1-Dichloroethane	µg/kg	480000	1 J	70	380	5800 U	5200 U	280 U	290 U	290 U	490 U
1,1-Dichloroethene	µg/kg	1000000	10 U	8 J	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,2,4-Trichlorobenzene	µg/kg	NL	10 U	1 J	15	5800 U	5200 U	86 J	100 J	120 J	2500
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,2-Dichlorobenzene	µg/kg	1000000	18	110	2900 J	5800 U	3100 J	280 U	290 U	1300	4600
1,2-Dichloroethane	µg/kg	60000	12	45	330	5800 U	5200 U	280 U	290 U	290 U	490 U
1,2-Dichloropropane	µg/kg	NL	10 U	4 J	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
1,3-Dichlorobenzene	µg/kg	560000	10 U	10 J	8 J	5800 U	5200 U	280 U	290 U	1300	7500
1,4-Dichlorobenzene	µg/kg	250000	2 J	10 J	48	5800 U	5200 U	280 U	290 U	1300	6200
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	24	12 U	450	5800 U	5200 U	280 U	290 U	290 U	490 U
2-Chlorotoluene	µg/kg	1000000	16000	46000	280000	150000	540000	2300	4800	1300	15000
2-Hexanone	µg/kg	NL	10 U	12 U	50	5800 U	5200 U	280 U	290 U	290 U	490 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
4-Chlorotoluene	µg/kg	1000000	2000	4700	26000	15000	49000	2300	4700	690	6800
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	21	28	460	5800 U	5200 U	280 U	290 U	290 U	490 U
Acetone	µg/kg	1000000	2000	1000	2200	5800 U	5200 U	280 U	290 U	440	1500
Benzene	µg/kg	89000	10 U	12 U	78	5800 U	5200 U	280 U	290 U	290 U	490 U
Bromodichloromethane	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Bromoform	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Bromomethane (Methyl Bromide)	µg/kg	NL	10 UJ	12 UJ	11 UJ	5800 U	5200 U	280 U	290 U	290 U	490 U
Carbon disulfide	µg/kg	NL	10 UJ	2 J	11 UJ	5800 U	5200 U	280 U	290 U	290 U	490 U
Carbon tetrachloride	µg/kg	44000	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Chlorobenzene	µg/kg	1000000	21	84	710	5800 U	5200 U	280 U	290 U	290 U	180 J
Chloroethane	µg/kg	NL	10 UJ	12 UJ	11 UJ	5800 U	5200 U	280 U	290 U	290 U	490 U
Chloroform (Trichloromethane)	µg/kg	700000	10 U	14	310	5800 U	5200 U	280 U	290 U	290 U	490 U
Chloromethane (Methyl Chloride)	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
cis-1,2-Dichloroethene	µg/kg	1000000	5 J	98	150	5800 U	5200 U	280 U	290 U	290 U	490 U
cis-1,3-Dichloropropene	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Cyclohexane	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Dibromochloromethane	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Ethylbenzene	µg/kg	780000	14	75	370	5800 U	5200 U	280 U	290 U	290 U	490 U
Isopropylbenzene	µg/kg	NL	10 U	2 J	10 J	5800 U	5200 U	280 U	290 U	290 U	260 J

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH6-08*	*BH6-08*	*BH6-08*	*BH6-08*	*BH6-08*	*BH7-08*	*BH7-08*	*BH7-08*	*BH7-08*
		sampledate	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/17/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*
		Depth	*4-6 ft BGS*	*6-8 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	10 UJ	12 UJ	11 UJ	5800 U	5200 U	280 U	110 J	160 J	180 J
Methyl cyclohexane	µg/kg	NL	10 U	2 J	24	5800 U	5200 U	280 U	290 U	290 U	490 U
Methyl Tert Butyl Ether	µg/kg	1000000	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Methylene chloride	µg/kg	1000000	49	840 J	3400	17000	5200 U	180 J	130 J	77 J	450 J
Styrene	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Tetrachloroethene	µg/kg	300000	73	1600	4800 J	5800 U	7700	3100	7000	290 U	490 U
Toluene	µg/kg	1000000	63	1200 J	6900	9200	9000	280 U	180 J	290 U	490 U
trans-1,2-Dichloroethene	µg/kg	1000000	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
trans-1,3-Dichloropropene	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Trichloroethene	µg/kg	400000	48	1600	7800	17000	6700	450	1000	290 U	490 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	10 U	12 U	600	5800 U	2800 J	280 U	290 U	290 U	490 U
Vinyl chloride	µg/kg	27000	10 U	12 U	11 U	5800 U	5200 U	280 U	290 U	290 U	490 U
Xylene (total)	µg/kg	1000000	74	340	3400 J	5800 U	5200 U	280 U	290 U	290 U	490 U
Total VOCs	µg/kg	>1000000	**20427**	**57963**	**345093**	**208200**	**619800**	**8416**	**18020**	**6687**	**45170**
PID	**ppm**		**215**	**87**	**315**	**315**	**131**	**61**	**15**	**11**	**27**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH7-08*	*BH7-08*	*BH7-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*
		sampledate	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*
		Depth	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,1,2-Trichloroethane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,1-Dichloroethane	µg/kg	480000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,1-Dichloroethene	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,2,4-Trichlorobenzene	µg/kg	NL	750	270 U	300 U	360 U	54000	19000	120000	100000	80000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,2-Dichlorobenzene	µg/kg	1000000	4400	7600	7200	99 J	33000	98000	340000	240000	190000
1,2-Dichloroethane	µg/kg	60000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,2-Dichloropropane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
1,3-Dichlorobenzene	µg/kg	560000	5600	8600	8000	320 J	54000	180000	580000	420000	330000
1,4-Dichlorobenzene	µg/kg	250000	4600	8200	8000	240 J	50000	150000	510000	370000	300000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
2-Chlorotoluene	µg/kg	1000000	6000	9700	11000	1800	46000	78000	330000	240000	190000
2-Hexanone	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
4-Chlorotoluene	µg/kg	1000000	3500	5600	5900	2700	54000	87000	370000	290000	240000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Acetone	µg/kg	1000000	390	380	2400	7900	6000	2500 U	2800 U	2700 U	2300 U
Benzene	µg/kg	89000	280 U	270 U	300 U	360 U	290 U	2500 U	14000	13000	13000
Bromodichloromethane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Bromoform	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Bromomethane (Methyl Bromide)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Carbon disulfide	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Carbon tetrachloride	µg/kg	44000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Chlorobenzene	µg/kg	1000000	280 U	260 J	290 J	350 J	5600	35000	130000	120000	100000
Chloroethane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Chloroform (Trichloromethane)	µg/kg	700000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Chloromethane (Methyl Chloride)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
cis-1,2-Dichloroethene	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
cis-1,3-Dichloropropene	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Cyclohexane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Dibromochloromethane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Ethylbenzene	µg/kg	780000	280 U	270 U	300 U	360 U	270 J	2500 U	1400 J	1500 J	1100 J
Isopropylbenzene	µg/kg	NL	81 J	270 U	300 U	360 U	17000	3800	45000	36000	27000

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH7-08*	*BH7-08*	*BH7-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*	*BH8-08*
		sampledate	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*	*9/18/2008*
		Depth	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	280 U	120 J	300 U	280 J	610	2500 U	2800 U	2700 U	2300 U
Methyl cyclohexane	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Methyl Tert Butyl Ether	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Methylene chloride	µg/kg	1000000	80 J	120 J	170 J	120 J	190 J	1400 J	1600 J	1700 J	1400 J
Styrene	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Tetrachloroethene	µg/kg	300000	280 U	110 J	210 J	360 U	100 J	2500 U	2800 U	2700 U	2300 U
Toluene	µg/kg	1000000	280 U	200 J	220 J	110 J	640	3200	12000	12000	10000
trans-1,2-Dichloroethene	µg/kg	1000000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
trans-1,3-Dichloropropene	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Trichloroethene	µg/kg	400000	280 U	94 J	130 J	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Vinyl chloride	µg/kg	27000	280 U	270 U	300 U	360 U	290 U	2500 U	2800 U	2700 U	2300 U
Xylene (total)	µg/kg	1000000	280 U	310	330	360 U	2000	2500 U	7800	8300	6000
Total VOCs	µg/kg	>1000000	**25401**	**41294**	**43850**	**13919**	**323410**	**655400**	**2461800**	**1852500**	**1488500**
PID	**ppm**		**18**	**17**	**37**	**83**	**18**	**136**	**299**	**349**	**114**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH9-08*	*BH9-08*	*BH9-08*	*BH10-08*	*BH10-08*	*BH10-08*	*BH11-08*	*BH11-08*	*BH11-08*
		sampledate	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*
		Depth	*4-6 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*0-2 ft BGS*	*6-8 ft BGS*	*10-12 ft BGS*	*2-4 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,1,2-Trichloroethane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,1-Dichloroethane	µg/kg	480000	300 U	300 U	300 U	90 J	290 U	320 U	260 U	300 U	300 U
1,1-Dichloroethene	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,2,4-Trichlorobenzene	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,2-Dichlorobenzene	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	650	2600
1,2-Dichloroethane	µg/kg	60000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,2-Dichloropropane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
1,3-Dichlorobenzene	µg/kg	560000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	1600	5700
1,4-Dichlorobenzene	µg/kg	250000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	310	1000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
2-Chlorotoluene	µg/kg	1000000	300 U	120 J	300 U	190000	6900	1400	260 U	920	6700
2-Hexanone	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
4-Chlorotoluene	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	470	5400
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Acetone	µg/kg	1000000	300 U	4200	3200	570	6200	1600	750	620	5500
Benzene	µg/kg	89000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Bromodichloromethane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Bromoform	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Bromomethane (Methyl Bromide)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Carbon disulfide	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Carbon tetrachloride	µg/kg	44000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Chlorobenzene	µg/kg	1000000	300 U	540	530	93 J	290 U	320 U	260 U	300 U	300 U
Chloroethane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Chloroform (Trichloromethane)	µg/kg	700000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Chloromethane (Methyl Chloride)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
cis-1,2-Dichloroethene	µg/kg	1000000	300 U	300 U	300 U	180 J	290 U	320 U	260 U	300 U	300 U
cis-1,3-Dichloropropene	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Cyclohexane	µg/kg	NL	300 U	300 U	300 U	77 J	290 U	320 U	260 U	300 U	300 U
Dibromochloromethane	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Ethylbenzene	µg/kg	780000	300 U	270 J	79 J	290 U	290 U	320 U	260 U	300 U	300 U
Isopropylbenzene	µg/kg	NL	300 U	480	390	290 U	290 U	320 U	260 U	300 U	300 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH9-08*	*BH9-08*	*BH9-08*	*BH10-08*	*BH10-08*	*BH10-08*	*BH11-08*	*BH11-08*	*BH11-08*
		sampledate	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*	*9/19/2008*
		Depth	*4-6 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*0-2 ft BGS*	*6-8 ft BGS*	*10-12 ft BGS*	*2-4 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	190 J	20000	190 J	290 UJ	290 UJ	320 UJ	260 UJ	300 UJ	90 J
Methyl cyclohexane	µg/kg	NL	300 U	300 U	300 U	240 J	290 U	320 U	260 U	300 U	300 U
Methyl Tert Butyl Ether	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Methylene chloride	µg/kg	1000000	370 J	300 U	350 J	280 J	290 U	290 J	200 J	230 J	300 U
Styrene	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Tetrachloroethene	µg/kg	300000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Toluene	µg/kg	1000000	300 U	340	210 J	120 J	290 U	320 U	260 U	300 U	300 U
trans-1,2-Dichloroethene	µg/kg	1000000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
trans-1,3-Dichloropropene	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Trichloroethene	µg/kg	400000	300 U	300 U	300 U	140 J	290 U	320 U	260 U	300 U	300 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Vinyl chloride	µg/kg	27000	300 U	300 U	300 U	290 U	290 U	320 U	260 U	300 U	300 U
Xylene (total)	µg/kg	1000000	300 U	2200	700	190 J	290 U	320 U	260 U	300 U	300 U
Total VOCs	µg/kg	>1000000	**560**	**28150**	**5649**	**191980**	**13100**	**3290**	**950**	**4800**	**26990**
PID	**ppm**		**2.3**	**55**	**29**	**16**	**38**	**14**	**24**	**14**	**79**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH11-08*	*BH11-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*
		sampledate	*9/19/2008*	*9/19/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*2-4 ft BGS*	*2-4 ft BGS (Duplicate)*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,1,2-Trichloroethane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,1-Dichloroethane	µg/kg	480000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	86 J
1,1-Dichloroethene	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,2,4-Trichlorobenzene	µg/kg	NL	100000	460000	1000000	540000	810000	36000	7700	4000	160 J
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,2-Dichlorobenzene	µg/kg	1000000	2800	15000	560000	220000	820000	50000	12000	24000	1300
1,2-Dichloroethane	µg/kg	60000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,2-Dichloropropane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
1,3-Dichlorobenzene	µg/kg	560000	4200	12000	460000	170000	580000	45000	13000	25000	1500
1,4-Dichlorobenzene	µg/kg	250000	1000	4400 J	400000	140000	1000000	59000	15000	29000	1600
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
2-Chlorotoluene	µg/kg	1000000	7100	14000	410000	150000	900000	150000	46000	44000	7800
2-Hexanone	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
4-Chlorotoluene	µg/kg	1000000	6400	12000	84000	28000	830000	82000	16000	23000	2900
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Acetone	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Benzene	µg/kg	89000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Bromodichloromethane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Bromoform	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Bromomethane (Methyl Bromide)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Carbon disulfide	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 UJ	1700 U	260 UJ
Carbon tetrachloride	µg/kg	44000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Chlorobenzene	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	140000	16000	2500	20000	1600
Chloroethane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Chloroform (Trichloromethane)	µg/kg	700000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Chloromethane (Methyl Chloride)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
cis-1,2-Dichloroethene	µg/kg	1000000	460	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
cis-1,3-Dichloropropene	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Cyclohexane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Dibromochloromethane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Ethylbenzene	µg/kg	780000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Isopropylbenzene	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH11-08*	*BH11-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*	*BH12-08*
		sampledate	*9/19/2008*	*9/19/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*	*9/22/2008*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*2-4 ft BGS*	*2-4 ft BGS (Duplicate)*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	310 UJ	10000 U	66000 UJ	26000 UJ	65000 UJ	3400 UJ	1200 U	1700 UJ	290
Methyl cyclohexane	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Methyl Tert Butyl Ether	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Methylene chloride	µg/kg	1000000	280 J	10000 U	66000 U	26000 U	65000 U	3400 U	1200 UJ	1700 U	260 UJ
Styrene	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Tetrachloroethene	µg/kg	300000	2100	29000	42000 J	9200 J	120000	5500	1200 U	4200	110 J
Toluene	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1200 J	85 J
trans-1,2-Dichloroethene	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
trans-1,3-Dichloropropene	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Trichloroethene	µg/kg	400000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	3200	260 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Vinyl chloride	µg/kg	27000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Xylene (total)	µg/kg	1000000	310 U	10000 U	66000 U	26000 U	65000 U	3400 U	1200 U	1700 U	260 U
Total VOCs	µg/kg	>1000000	**124340**	**546400**	**2956000**	**1257200**	**5200000**	**443500**	**112200**	**177600**	**17431**
PID	**ppm**		**6.7**	**718**	**216**	**216**	**690**	**385**	**1298**	**674**	**86**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH14-08*	*BH14-08*	*BH14-08*
		sampledate	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*
		Depth	*0-2 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,1,2-Trichloroethane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,1-Dichloroethane	µg/kg	480000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,1-Dichloroethene	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	R	R	310 U
1,2,4-Trichlorobenzene	µg/kg	NL	80 J	300 U	310 U	270 U	680 J	170 J	87 J	390 J	130 J
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,2-Dichlorobenzene	µg/kg	1000000	260 U	440	97 J	920	1600	620	290 U	400 J	340
1,2-Dichloroethane	µg/kg	60000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,2-Dichloropropane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
1,3-Dichlorobenzene	µg/kg	560000	260 U	300 U	310 U	380	2400	640	290 U	520 U	310 U
1,4-Dichlorobenzene	µg/kg	250000	260 U	120 J	310 U	510	2200	720	290 U	520 U	80 J
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
2-Chlorotoluene	µg/kg	1000000	260 U	3900	1200	5900	53000	18000	84 J	520 U	140 J
2-Hexanone	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
4-Chlorotoluene	µg/kg	1000000	260 U	500	150 J	870	5800	2200	290 U	520 U	310 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Acetone	µg/kg	1000000	260 U	300 U	1100 U	5100	1400 U	740 U	290 U	520 U	310 U
Benzene	µg/kg	89000	260 U	300 U	310 U	270 U	1400 U	560 U	R	R	310 U
Bromodichloromethane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Bromoform	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Bromomethane (Methyl Bromide)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Carbon disulfide	µg/kg	NL	260 U	300 U	310 U	270 UJ	1400 U	560 U	290 U	520 U	310 U
Carbon tetrachloride	µg/kg	44000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Chlorobenzene	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	150 J	R	R	310 U
Chloroethane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Chloroform (Trichloromethane)	µg/kg	700000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Chloromethane (Methyl Chloride)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
cis-1,2-Dichloroethene	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
cis-1,3-Dichloropropene	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Cyclohexane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Dibromochloromethane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Ethylbenzene	µg/kg	780000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	150 J
Isopropylbenzene	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	190 J	15000	9100

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH13-08*	*BH14-08*	*BH14-08*	*BH14-08*
		sampledate	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*
		Depth	*0-2 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	260 UJ	120 J	520 J	240 J	1400 U	560 U	290 U	520 U	310 UJ
Methyl cyclohexane	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Methyl Tert Butyl Ether	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Methylene chloride	µg/kg	1000000	260 U	300 U	310 U	270 UJ	1400 U	560 U	290 U	520 U	210 J
Styrene	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Tetrachloroethene	µg/kg	300000	150 J	300 U	310 U	270 U	1400 U	560 U	470	520 U	310 U
Toluene	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	R	R	310 U
trans-1,2-Dichloroethene	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
trans-1,3-Dichloropropene	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Trichloroethene	µg/kg	400000	260 U	300 U	310 U	270 U	1400 U	560 U	R	R	310 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Vinyl chloride	µg/kg	27000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	310 U
Xylene (total)	µg/kg	1000000	260 U	300 U	310 U	270 U	1400 U	560 U	290 U	520 U	520
Total VOCs	µg/kg	>1000000	**230**	**5080**	**1967**	**13920**	**65680**	**22500**	**831**	**15790**	**10670**
PID	**ppm**		**1.7**	**7.0**	**5.6**	**92**	**28**	**--**	**4.1**	**77**	**1291**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH14-08*	*BH14-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH16-08*
		sampledate	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*
		Depth	*6-8 ft BGS*	*6-8 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*0-2 ft BGS*
				(Duplicate)							
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,1,2-Trichloroethane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,1-Dichloroethane	µg/kg	480000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,1-Dichloroethene	µg/kg	1000000	610 U	320 U	1300 U	310 UJ	580 U	310 U	25000 U	270 U	280 U
1,2,4-Trichlorobenzene	µg/kg	NL	610 U	120 J	1300 U	310 U	580 U	14000	51000	170 J	1400
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,2-Dichlorobenzene	µg/kg	1000000	920	350	1300 U	310 U	320 J	8300	22000 J	270	880
1,2-Dichloroethane	µg/kg	60000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,2-Dichloropropane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
1,3-Dichlorobenzene	µg/kg	560000	610 U	320 U	1300 U	310 U	580 U	9000	30000	180 J	590
1,4-Dichlorobenzene	µg/kg	250000	610 U	320 U	1300 U	310 U	150 J	10000	33000	250 J	480
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
2-Chlorotoluene	µg/kg	1000000	610 U	110 J	27000	4600	13000	140000	570000	6400	540
2-Hexanone	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
4-Chlorotoluene	µg/kg	1000000	610 U	320 U	37000	6600	16000	30000	58000	650	300
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Acetone	µg/kg	1000000	1300	320 U	1300 U	310 U	580 U	620	25000 U	1200	280 U
Benzene	µg/kg	89000	610 U	320 U	1300 U	310 U	580 U	1300	25000 U	230 J	280 U
Bromodichloromethane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Bromoform	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Bromomethane (Methyl Bromide)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Carbon disulfide	µg/kg	NL	610 UJ	320 U	1300 U	310 U	580 U	310 U	25000 U	270 UJ	280 U
Carbon tetrachloride	µg/kg	44000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Chlorobenzene	µg/kg	1000000	180 J	320 U	2400	270 J	670	3600	10000 J	1300	160 J
Chloroethane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Chloroform (Trichloromethane)	µg/kg	700000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Chloromethane (Methyl Chloride)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
cis-1,2-Dichloroethene	µg/kg	1000000	160 J	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
cis-1,3-Dichloropropene	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Cyclohexane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Dibromochloromethane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Ethylbenzene	µg/kg	780000	930	160 J	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Isopropylbenzene	µg/kg	NL	36000	9500	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			*BH14-08*	*BH14-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH15-08*	*BH16-08*
sampledate			*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/23/2008*
Depth			*6-8 ft BGS*	*6-8 ft BGS (Duplicate)*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*0-2 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	610 U	320 UJ	1300 UJ	350 J	290 J	160 J	25000 UJ	180 J	280 UJ
Methyl cyclohexane	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Methyl Tert Butyl Ether	µg/kg	1000000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Methylene chloride	µg/kg	1000000	610 UJ	320 U	1300 U	310 U	580 U	310 U	25000 U	270 UJ	280 U
Styrene	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Tetrachloroethene	µg/kg	300000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	150 J
Toluene	µg/kg	1000000	610 U	320 U	1300 U	310 U	580 U	1100	25000 U	430	280 U
trans-1,2-Dichloroethene	µg/kg	1000000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
trans-1,3-Dichloropropene	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Trichloroethene	µg/kg	400000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	99 J
Trichlorofluoromethane (CFC-11)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Vinyl chloride	µg/kg	27000	610 U	320 U	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Xylene (total)	µg/kg	1000000	3100	550	1300 U	310 U	580 U	310 U	25000 U	270 U	280 U
Total VOCs	µg/kg	>1000000	**42590**	**10790**	**66400**	**11820**	**30430**	**218080**	**774000**	**11260**	**4599**
PID	**ppm**		**1291**	**77**	**68**	**219**	**68**	**70**	**181**	**225**	**3.9**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH16-08*	*BH16-08*	*BH16-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*
		sampledate	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*
		Depth	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,1,2-Trichloroethane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,1-Dichloroethane	µg/kg	480000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,1-Dichloroethene	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,2,4-Trichlorobenzene	µg/kg	NL	490	33000000	93000	1400 J	900	11 J	280 J	430 J	200 J
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,2-Dichlorobenzene	µg/kg	1000000	1500	23000000	120000	1500 U	260 J	8 J	270 J	410 J	530 U
1,2-Dichloroethane	µg/kg	60000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,2-Dichloropropane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
1,3-Dichlorobenzene	µg/kg	560000	390	960000	5300	1500 U	320 U	2 J	330	290 J	530 U
1,4-Dichlorobenzene	µg/kg	250000	650	3700000	20000	1500 U	320 U	2 J	340	350 J	530 U
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	370 U	590000 U	5000	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
2-Chlorotoluene	µg/kg	1000000	1200	3100000	16000	1500 U	110 J	9 J	6400	33000	21000
2-Hexanone	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
4-Chlorotoluene	µg/kg	1000000	790	11000000	98000	1500 U	320 U	4 J	3600	6900	4300
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
Acetone	µg/kg	1000000	1100	590000 U	2700 U	1500 U	10000	4400 J	590 J	1200 UJ	29000
Benzene	µg/kg	89000	430	620000	48000	1500 U	320 U	2 J	300 U	1200 U	530 U
Bromodichloromethane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Bromoform	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Bromomethane (Methyl Bromide)	µg/kg	NL	370 UJ	590000 UJ	2700 U	1500 UJ	320 UJ	12 U	300 U	1200 U	530 U
Carbon disulfide	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 UJ
Carbon tetrachloride	µg/kg	44000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Chlorobenzene	µg/kg	1000000	520	210000 J	5200	1500 U	320 U	2 J	300 U	1200 U	530 U
Chloroethane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Chloroform (Trichloromethane)	µg/kg	700000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Chloromethane (Methyl Chloride)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
cis-1,2-Dichloroethene	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
cis-1,3-Dichloropropene	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Cyclohexane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Dibromochloromethane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
Ethylbenzene	µg/kg	780000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Isopropylbenzene	µg/kg	NL	210 J	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH16-08*	*BH16-08*	*BH16-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*	*BH17-08*
		sampledate	*9/23/2008*	*9/23/2008*	*9/23/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*
		Depth	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 UJ	1200 UJ	530 U
Methyl cyclohexane	µg/kg	NL	370 U	590000 U	2700 U	1500 U	130 J	12 U	300 U	1200 U	530 U
Methyl Tert Butyl Ether	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Methylene chloride	µg/kg	1000000	370 UJ	590000 UJ	2700 U	1500 UJ	320 UJ	9 J	130 J	1200 U	530 UJ
Styrene	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Tetrachloroethene	µg/kg	300000	370 U	590000 U	2700 U	1500 U	320 U	2 J	200 J	4100	2200
Toluene	µg/kg	1000000	370 U	270000 J	7500	1500 U	130 J	2 J	300 U	1200 U	530 U
trans-1,2-Dichloroethene	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
trans-1,3-Dichloropropene	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Trichloroethene	µg/kg	400000	370 U	590000 U	2700 U	1500 U	100 J	12 U	65 J	420 J	260 J
Trichlorofluoromethane (CFC-11)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Vinyl chloride	µg/kg	27000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Xylene (total)	µg/kg	1000000	370 U	590000 U	2700 U	1500 U	320 U	12 U	300 U	1200 U	530 U
Total VOCs	µg/kg	>1000000	**7280**	**75860000**	**418000**	**1400**	**11630**	**4453**	**12205**	**45900**	**56960**
PID	**ppm**		**35**	**671**	**1690**	**1.7**	**112**	**112**	**68**	**128**	**164**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			*BH17-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH19-08*	*BH19-08*
sampledate			*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*
Depth			*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,1,2-Trichloroethane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,1-Dichloroethane	µg/kg	480000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,1-Dichloroethene	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,2,4-Trichlorobenzene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	130 J	280 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	240 UJ	280 UJ	310 UJ	590 UJ	300 U	2600 UJ	270 UJ	310 UJ	280 UJ
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,2-Dichlorobenzene	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310	240 J
1,2-Dichloroethane	µg/kg	60000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,2-Dichloropropane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
1,3-Dichlorobenzene	µg/kg	560000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	410	350
1,4-Dichlorobenzene	µg/kg	250000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	320	300
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	240 UJ	280 UJ	310 UJ	590 UJ	300 U	2600 UJ	270 UJ	310 UJ	280 UJ
2-Chlorotoluene	µg/kg	1000000	1700	4800	13000	16000	20000	79000	900	320	190 J
2-Hexanone	µg/kg	NL	240 UJ	280 UJ	310 UJ	590 UJ	300 U	2600 UJ	270 UJ	310 UJ	280 UJ
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
4-Chlorotoluene	µg/kg	1000000	260	120 J	370	550 J	560	13000	370	110 J	72 J
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	240 UJ	280 UJ	310 UJ	590 UJ	300 U	2600 UJ	270 UJ	310 UJ	280 UJ
Acetone	µg/kg	1000000	2400 J	280 UJ	1100 J	1600 J	970	2600 UJ	440 J	310 UJ	280 UJ
Benzene	µg/kg	89000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Bromodichloromethane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Bromoform	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Bromomethane (Methyl Bromide)	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Carbon disulfide	µg/kg	NL	240 U	280 U	310 U	590 U	300 UJ	2600 U	270 U	310 U	280 U
Carbon tetrachloride	µg/kg	44000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Chlorobenzene	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Chloroethane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Chloroform (Trichloromethane)	µg/kg	700000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Chloromethane (Methyl Chloride)	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
cis-1,2-Dichloroethene	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
cis-1,3-Dichloropropene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Cyclohexane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Dibromochloromethane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	240 UJ	280 UJ	310 UJ	590 UJ	300 U	2600 UJ	270 UJ	310 UJ	280 UJ
Ethylbenzene	µg/kg	780000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Isopropylbenzene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	4000	4200

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH17-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH18-08*	*BH19-08*	*BH19-08*
		sampledate	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*
		Depth	*14-16 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	240 UJ	190 J	310 UJ	590 UJ	170 J	2600 UJ	270 UJ	180 J	280 UJ
Methyl cyclohexane	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Methyl Tert Butyl Ether	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Methylene chloride	µg/kg	1000000	110 J	280 U	76 J	590 U	300 UJ	2600 U	270 U	310 U	280 U
Styrene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Tetrachloroethene	µg/kg	300000	1200	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Toluene	µg/kg	1000000	110 J	280 U	310 U	590 U	300 U	2600 U	330	310 U	280 U
trans-1,2-Dichloroethene	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
trans-1,3-Dichloropropene	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Trichloroethene	µg/kg	400000	830	280 U	310 U	590 U	300 U	2600 U	1300	310 U	280 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Vinyl chloride	µg/kg	27000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Xylene (total)	µg/kg	1000000	240 U	280 U	310 U	590 U	300 U	2600 U	270 U	310 U	280 U
Total VOCs	µg/kg	>1000000	**6610**	**5110**	**14546**	**18150**	**21700**	**92000**	**3340**	**5780**	**5352**
PID	**ppm**		**117**	**5.3**	**56**	**21**	**44**	**19**	**7.7**	**7.7**	**1.7**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH19-08*	*BH19-08*	*BH19-08*	*BH19-08*	*BH20-08*	*BH20-08*	*BH20-08*	*BH20-08*	*BH20-08*
		sampledate	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*
		Depth	*6-8 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	290 U	300 U	300 U	1600 U	3 J	12 U	12 U	12 U	13 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 UJ	12 UJ	12 UJ	12 UJ	13 U
1,1,2-Trichloroethane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
1,1-Dichloroethane	µg/kg	480000	290 U	300 U	300 U	1600 U	3 J	2 J	2 J	45	13 U
1,1-Dichloroethene	µg/kg	1000000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
1,2,4-Trichlorobenzene	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	4 J	13 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	290 UJ	300 U	300 U	1600 UJ	12 UJ	12 UJ	12 UJ	12 UJ	13 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
1,2-Dichlorobenzene	µg/kg	1000000	1600	2000	3300	23000	12 U	12 U	12 U	6 J	13 U
1,2-Dichloroethane	µg/kg	60000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
1,2-Dichloropropane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
1,3-Dichlorobenzene	µg/kg	560000	5500	5200	6400	45000	12 U	12 U	12 U	10 J	13 U
1,4-Dichlorobenzene	µg/kg	250000	4000	4100	5000	48000	12 U	12 U	12 U	10 J	13 U
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	290 UJ	300 U	300 U	1600 UJ	12 UJ	8 J	12 UJ	12 UJ	13 U
2-Chlorotoluene	µg/kg	1000000	350	260 J	280 J	2600	8 J	140	660	8400	90
2-Hexanone	µg/kg	NL	290 UJ	300 U	300 U	1600 UJ	12 UJ	12 UJ	12 UJ	12 UJ	13 U
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
4-Chlorotoluene	µg/kg	1000000	890	700	870	10000	4 J	18	540	7400	110
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	290 UJ	300 U	300 U	1600 UJ	12 UJ	12 UJ	12 UJ	12 UJ	13 U
Acetone	µg/kg	1000000	290 UJ	490	300 U	1600 UJ	26 UJ	77 J	60 UJ	45 UJ	86
Benzene	µg/kg	89000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Bromodichloromethane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Bromoform	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Bromomethane (Methyl Bromide)	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Carbon disulfide	µg/kg	NL	290 U	300 U	300 UJ	1600 U	12 U	2 J	2 J	4 J	13 U
Carbon tetrachloride	µg/kg	44000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Chlorobenzene	µg/kg	1000000	190 J	150 J	94 J	7300	12 U	12 U	12 U	1 J	13 U
Chloroethane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Chloroform (Trichloromethane)	µg/kg	700000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Chloromethane (Methyl Chloride)	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
cis-1,2-Dichloroethene	µg/kg	1000000	290 U	300 U	300 U	3500	12 U	12 U	12 U	6 J	13 U
cis-1,3-Dichloropropene	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Cyclohexane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Dibromochloromethane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	290 UJ	300 U	300 U	1600 UJ	12 U	12 U	12 U	12 U	13 U
Ethylbenzene	µg/kg	780000	96 J	82 J	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Isopropylbenzene	µg/kg	NL	2800	1700	630	750 J	12 U	12 U	12 U	12 U	13 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH19-08*	*BH19-08*	*BH19-08*	*BH19-08*	*BH20-08*	*BH20-08*	*BH20-08*	*BH20-08*	*BH20-08*
		sampledate	*9/24/2008*	*9/24/2008*	*9/24/2008*	*9/24/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*	*11/12/2008*
		Depth	*6-8 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*0-2 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	290 UJ	160 J	300 U	1600 UJ	12 UJ	12 UJ	12 UJ	12 UJ	13 U
Methyl cyclohexane	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Methyl Tert Butyl Ether	µg/kg	1000000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Methylene chloride	µg/kg	1000000	290 U	300 U	300 UJ	1600 U	22 U	16 U	17 U	13 U	21 U
Styrene	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Tetrachloroethene	µg/kg	300000	290 U	300 U	300 U	1600 U	5 J	12 U	12 U	3 J	13 U
Toluene	µg/kg	1000000	290 U	300 U	300 U	1000 J	12 U	12 U	12 U	23	13 U
trans-1,2-Dichloroethene	µg/kg	1000000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
trans-1,3-Dichloropropene	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Trichloroethene	µg/kg	400000	290 U	300 U	300 U	1600 U	110	12 U	12 U	20	13 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Vinyl chloride	µg/kg	27000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Xylene (total)	µg/kg	1000000	290 U	300 U	300 U	1600 U	12 U	12 U	12 U	12 U	13 U
Total VOCs	µg/kg	>1000000	**15426**	**14842**	**16574**	**141150**	**133**	**247**	**1204**	**15932**	**286**
PID	**ppm**		**6.7**	**6.7**	**7.7**	**6.3**	**0.1**	**0.5**	**0.3**	**11.6**	**0.5**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH20-08*	*BH20-08*	*BH21*	*BH21*	*BH21*	*BH21*	*BH22*	*BH22*	*BH22*
		sampledate	*11/12/2008*	*11/12/2008*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*7-9 ft BGS*	*9-11 ft BGS*	*11-13 ft BGS*	*13-13.3 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	13 UJ	11 UJ	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,1,2-Trichloroethane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,1-Dichloroethane	µg/kg	480000	190	7 J	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,1-Dichloroethene	µg/kg	1000000	12 J	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,2,4-Trichlorobenzene	µg/kg	NL	13 U	11 U	2700	19000	18000	10000	1200	140	590
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	13 UJ	11 UJ	120 UJ	120 UJ	110 UJ	110 UJ	120 UJ	120 UJ	120 UJ
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,2-Dichlorobenzene	µg/kg	1000000	13 U	11 U	2200	18000	25000	18000	600	74 J	1300
1,2-Dichloroethane	µg/kg	60000	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,2-Dichloropropane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
1,3-Dichlorobenzene	µg/kg	560000	13 U	11 U	4300	29000	40000	30000	890	88 J	1600
1,4-Dichlorobenzene	µg/kg	250000	13 U	11 U	3000	25000	35000	25000	940	98 J	1500
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	13 UJ	32 J	610 U	610 U	540 U	540 U	580 U	600 U	620 U
2-Chlorotoluene	µg/kg	1000000	10 J	13	2400	21000	17000	25000	820000	78000	67000
2-Hexanone	µg/kg	NL	13 UJ	11 UJ	610 U	610 U	690	540 U	580 U	600 U	620 U
2-Nitropropane	µg/kg	--	--	--	610 UJ	610 UJ	540 UJ	540 UJ	580 UJ	600 UJ	620 UJ
3-Chlorotoluene	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
4-Chlorotoluene	µg/kg	1000000	9 J	9 J	1500	21000	19000	25000	390000	36000	54000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	13 UJ	11 UJ	610 U	610 U	540 U	540 U	580 U	600 U	620 U
Acetone	µg/kg	1000000	94 J	370 J	610 U	610 U	540 U	540 U	620	1500	940
Benzene	µg/kg	89000	2 J	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Bromodichloromethane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Bromoform	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Bromomethane (Methyl Bromide)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Carbon disulfide	µg/kg	NL	2 J	2 J	120 UJ	120 UJ	110 UJ	110 UJ	120 UJ	120 UJ	120 UJ
Carbon tetrachloride	µg/kg	44000	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Chlorobenzene	µg/kg	1000000	13 U	11 U	76 J	500	4900	2600	120 U	120 U	500
Chloroethane	µg/kg	NL	13 U	11 U	120 UJ	120 UJ	110 UJ	110 UJ	120 UJ	120 UJ	120 UJ
Chloroform (Trichloromethane)	µg/kg	700000	13 U	11 U	120 U	120 U	110 U	110 U	110 J	120 U	120 U
Chloromethane (Methyl Chloride)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
cis-1,2-Dichloroethene	µg/kg	1000000	30	11 U	120 U	120 U	110 U	110 U	83 J	120 U	120 U
cis-1,3-Dichloropropene	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Cyclohexane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Dibromochloromethane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Ethylbenzene	µg/kg	780000	13 U	11 U	120 U	120 U	110 U	65 J	610	120 U	69 J
Isopropylbenzene	µg/kg	NL	13 U	11 U	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH20-08*	*BH20-08*	*BH21*	*BH21*	*BH21*	*BH21*	*BH22*	*BH22*	*BH22*
		sampledate	*11/12/2008*	*11/12/2008*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*7-9 ft BGS*	*9-11 ft BGS*	*11-13 ft BGS*	*13-13.3 ft BGS*	*2-4 ft BGS*	*4-6 ft BGS*	*8-10 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	13 UJ	11 UJ	120 UJ	160 J	110 UJ	80 J	130 J	170 J	91 J
Methyl cyclohexane	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	110 J	120 U	120 U
Methyl Tert Butyl Ether	µg/kg	1000000	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Methylene chloride	µg/kg	1000000	140	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Styrene	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Tetrachloroethene	µg/kg	300000	13 U	11 U	1400	130	110	300	8300	310	140
Toluene	µg/kg	1000000	13 U	11 U	120 U	120 U	400	340	1900	210	670
trans-1,2-Dichloroethene	µg/kg	1000000	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
trans-1,3-Dichloropropene	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Trichloroethene	µg/kg	400000	13 U	11 U	120 U	120 U	140	130	620	120 U	110 J
Trichlorofluoromethane (CFC-11)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	13 U	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Vinyl chloride	µg/kg	27000	4 J	11 U	120 U	120 U	110 U	110 U	120 U	120 U	120 U
Xylene (total)	µg/kg	1000000	13 U	11 U	240 U	100 J	63 J	320	8400	540	370
Total VOCs	µg/kg	>1000000	**493**	**433**	**17576**	**133890**	**160303**	**136835**	**1234513**	**117130**	**128880**
PID	**ppm**		**0.7**	**1.6**	**2.2**	**240**	**60**	**23**	**292**	**153**	**197**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH22*	*BH22*	*BH23*	*BH23*	*BH23*	*BH23*	*BH24*	*BH24*	*BH24*
		sampledate	*4/13/2010*	*4/13/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*8-9.8 ft BGS*	*10-11.2 ft BGS*	*12-12.4 ft BGS*	*13-14.3 ft BGS*	*6-6.4 ft BGS*	*8-8.9 ft BGS*	*10-10.7 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,1,2-Trichloroethane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,1-Dichloroethane	µg/kg	480000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,1-Dichloroethene	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,2,4-Trichlorobenzene	µg/kg	NL	12000 U	120 U	1000	870	120	110 U	20000	27000	29000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	12000 U	120 U	130 UJ	120 UJ	120 UJ	110 UJ	2600 UJ	1300 U	6600 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,2-Dichlorobenzene	µg/kg	1000000	12000 U	66 J	780	940	250	110 U	27000	26000	26000
1,2-Dichloroethane	µg/kg	60000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,2-Dichloropropane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
1,3-Dichlorobenzene	µg/kg	560000	12000 U	120 U	1100	1200	280	82 J	46000	40000	41000
1,4-Dichlorobenzene	µg/kg	250000	12000 U	70 J	960	1200	320	82 J	40000	38000	38000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	59000 U	590 U	650 U	610 U	600 U	550 U	13000 U	6500 U	33000 U
2-Chlorotoluene	µg/kg	1000000	**1200000 J**	11000	7500	7900	5100	940	210000	780000	340000
2-Hexanone	µg/kg	NL	59000 U	590 U	650 U	610 U	600 U	550 U	13000 UJ	6500 U	33000 U
2-Nitropropane	µg/kg	--	59000 UJ	590 UJ	650 UJ	610 UJ	600 UJ	550 UJ	13000 UJ	6500 UJ	33000 UJ
3-Chlorotoluene	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 UJ	1300 UJ	6600 UJ
4-Chlorotoluene	µg/kg	1000000	490000	5700	12000	23000	6500	560	45000	70000	65000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	59000 U	590 U	650 U	610 U	600 U	550 U	13000 U	6500 U	33000 U
Acetone	µg/kg	1000000	59000 U	720	650 U	610 U	600 U	550 U	13000 UJ	6500 U	33000 U
Benzene	µg/kg	89000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Bromodichloromethane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Bromoform	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 UJ	1300 U	6600 U
Bromomethane (Methyl Bromide)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 UJ	6600 UJ
Carbon disulfide	µg/kg	NL	12000 UJ	120 UJ	130 UJ	120 UJ	120 UJ	110 UJ	2600 UJ	1300 UJ	6600 UJ
Carbon tetrachloride	µg/kg	44000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Chlorobenzene	µg/kg	1000000	12000 U	120 U	260	230	200	450	3000	7900	5600 J
Chloroethane	µg/kg	NL	12000 U	120 U	130 UJ	120 UJ	120 UJ	110 UJ	2600 U	1300 UJ	6600 UJ
Chloroform (Trichloromethane)	µg/kg	700000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Chloromethane (Methyl Chloride)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
cis-1,2-Dichloroethene	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
cis-1,3-Dichloropropene	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Cyclohexane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 UJ	1300 U	6600 U
Dibromochloromethane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Ethylbenzene	µg/kg	780000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH22*	*BH22*	*BH23*	*BH23*	*BH23*	*BH23*	*BH24*	*BH24*	*BH24*
		sampledate	*4/13/2010*	*4/13/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*8-9.8 ft BGS*	*10-11.2 ft BGS*	*12-12.4 ft BGS*	*13-14.3 ft BGS*	*6-6.4 ft BGS*	*8-8.9 ft BGS*	*10-10.7 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	12000 UJ	130 J	130 UJ	360 J	120 UJ	190 J	2600 UJ	1300 UJ	6600 UJ
Methyl cyclohexane	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 UJ	1300 U	6600 U
Methyl Tert Butyl Ether	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 UJ	1300 U	6600 U
Methylene chloride	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Styrene	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Tetrachloroethene	µg/kg	300000	12000 U	120 U	130 U	120 U	120 U	450	3700	680 J	6600 U
Toluene	µg/kg	1000000	20000	100 J	130 U	120 U	120 U	680	2600 U	1800	6600 U
trans-1,2-Dichloroethene	µg/kg	1000000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
trans-1,3-Dichloropropene	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Trichloroethene	µg/kg	400000	12000 U	120 U	130 U	120 U	120 U	100 J	2600 U	1300 U	6600 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Vinyl chloride	µg/kg	27000	12000 U	120 U	130 U	120 U	120 U	110 U	2600 U	1300 U	6600 U
Xylene (total)	µg/kg	1000000	23000 U	230 U	260 U	250 U	240 U	220 U	5200 U	2600 U	13000 U
Total VOCs	µg/kg	>1000000	**1710000**	**17786**	**23600**	**35700**	**12770**	**3534**	**394700**	**991380**	**544600**
PID	**ppm**		**2533**	**90**	**24**	**28**	**12**	**5.2**	**234**	**5395**	**4174**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH24*	*BH24*	*BH25*	*BH25*	*BH25*	*BH26*	*BH26*	*BH26*	*BH26*
		sampledate	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*
		Depth	*12-14 ft BGS*	*14-14.4 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-15.2 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,1,2-Trichloroethane	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,1-Dichloroethane	µg/kg	480000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,1-Dichloroethene	µg/kg	1000000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,2,4-Trichlorobenzene	µg/kg	NL	17000	5900	760	3100000	120000	240 U	120 U	630 U	1300 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	2200 U	2100 U	250 UJ	11000 U	1100 U	240 UJ	120 U	630 U	1300 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,2-Dichlorobenzene	µg/kg	1000000	14000	7900	630	880000	48000	220 J	120 U	630 U	1300 U
1,2-Dichloroethane	µg/kg	60000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,2-Dichloropropane	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
1,3-Dichlorobenzene	µg/kg	560000	22000	12000	300	500000	27000	240 U	120 U	630 U	1300 U
1,4-Dichlorobenzene	µg/kg	250000	21000	12000	440	**560000**	29000	240 U	120 U	630 U	1300 U
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	11000 U	10000 U	1300 U	56000 U	5400 U	1200 U	620 U	3100 U	6700 U
2-Chlorotoluene	µg/kg	1000000	120000	99000	16000	140000	7200	21000	18000	72000	79000
2-Hexanone	µg/kg	NL	11000 U	10000 U	1300 UJ	56000 U	5400 U	1200 U	620 U	3100 U	6700 U
2-Nitropropane	µg/kg	--	11000 UJ	10000 UJ	1300 UJ	56000 U	5400 UJ	1200 UJ	620 UJ	3100 UJ	6700 UJ
3-Chlorotoluene	µg/kg	NL	2200 UJ	2100 UJ	250 UJ	11000 U	1100 UJ	240 U	120 U	630 U	1300 U
4-Chlorotoluene	µg/kg	1000000	34000	21000	4400	680000	31000	4900	4100	31000	46000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	11000 U	10000 U	1300 U	56000 U	5400 U	1200 U	620 U	3100 U	6700 U
Acetone	µg/kg	1000000	11000 U	10000 U	1300 UJ	56000 U	5400 U	1200 U	1800	3100 U	6700 U
Benzene	µg/kg	89000	2200 U	3200	250 U	33000	1100 U	240 U	120 U	630 U	1300 U
Bromodichloromethane	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Bromoform	µg/kg	NL	2200 U	2100 U	250 UJ	11000 U	1100 U	240 U	120 U	630 U	1300 U
Bromomethane (Methyl Bromide)	µg/kg	NL	2200 UJ	2100 UJ	250 U	11000 U	1100 UJ	240 U	120 U	630 U	1300 U
Carbon disulfide	µg/kg	NL	2200 UJ	2100 UJ	250 UJ	11000 UJ	1100 UJ	240 U	120 UJ	630 UJ	1300 UJ
Carbon tetrachloride	µg/kg	44000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Chlorobenzene	µg/kg	1000000	3900	4900	800	76000	2500	240 U	120 U	630 U	1300 U
Chloroethane	µg/kg	NL	2200 UJ	2100 UJ	250 U	11000 U	1100 UJ	240 U	120 U	630 U	1300 U
Chloroform (Trichloromethane)	µg/kg	700000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Chloromethane (Methyl Chloride)	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
cis-1,2-Dichloroethene	µg/kg	1000000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
cis-1,3-Dichloropropene	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Cyclohexane	µg/kg	NL	2200 U	2100 U	250 UJ	11000 U	1100 U	240 U	120 U	630 U	1300 U
Dibromochloromethane	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Ethylbenzene	µg/kg	780000	2200 U	2100 U	250 U	11000 U	1100 U	250	130	510 J	1000 J
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			*BH24*	*BH24*	*BH25*	*BH25*	*BH25*	*BH26*	*BH26*	*BH26*	*BH26*
sampledate			*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*	*4/13/2010*
Depth			*12-14 ft BGS*	*14-14.4 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*14-15.2 ft BGS*	*6-8 ft BGS*	*8-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	2200 UJ	2100 UJ	250 UJ	11000 UJ	1100 UJ	240 U	120 UJ	630 UJ	1300 UJ
Methyl cyclohexane	µg/kg	NL	2200 U	2100 U	250 UJ	11000 U	1100 U	240 U	120 U	630 U	1300 U
Methyl Tert Butyl Ether	µg/kg	1000000	2200 U	2100 U	250 UJ	11000 U	1100 U	240 U	120 U	630 U	1300 U
Methylene chloride	µg/kg	1000000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	200	540 J	2100
Styrene	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Tetrachloroethene	µg/kg	300000	2200 U	2100 U	250 U	11000 U	1100 U	19000	19000	69000	130000
Toluene	µg/kg	1000000	2200 U	1400 J	250 U	31000	630 J	170 J	230	1200	5600
trans-1,2-Dichloroethene	µg/kg	1000000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
trans-1,3-Dichloropropene	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Trichloroethene	µg/kg	400000	2200 U	2100 U	250 U	11000 U	1100 U	280	780	3600	18000
Trichlorofluoromethane (CFC-11)	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Vinyl chloride	µg/kg	27000	2200 U	2100 U	250 U	11000 U	1100 U	240 U	120 U	630 U	1300 U
Xylene (total)	µg/kg	1000000	4400 U	4200 U	510 U	22000 U	2200 U	1500	720	2600	4300
Total VOCs	µg/kg	>1000000	**231900**	**167300**	**23330**	**6000000**	**265330**	**47320**	**44960**	**180450**	**286000**
PID	**ppm**		**153**	**64**	**8.8**	**113**	**133**	**110**	**348**	**1310**	**121**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH27*	*BH27*	*BH27*	*BH27*	*BH27*	*BH27*	*BH28*	*BH28*	*BH28*
		sampledate	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*
		Depth	*5-7 ft BGS*	*7-9 ft BGS*	*9-11 ft BGS*	*11-13 ft BGS*	*13-15 ft BGS*	*15-16.7 ft BGS*	*8-8.4 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
VOAs	*Units*	*NYSDEC SCO (1)*									
1,1,1-Trichloroethane	µg/kg	1000000	98 J	140	96 J	200	150	99 U	280 U	250 U	11000
1,1,2,2-Tetrachloroethane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
1,1,2-Trichloroethane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
1,1-Dichloroethane	µg/kg	480000	110 U	70 J	130 U	200	150	99 U	280 U	250 U	590
1,1-Dichloroethene	µg/kg	1000000	110 U	120 U	130 U	120 U	66 J	99 U	280 U	250 U	250 U
1,2,4-Trichlorobenzene	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	3600	1700	11000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	110 UJ	120 UJ	130 UJ	120 UJ	100 UJ	99 UJ	280 U	250 U	250 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
1,2-Dichlorobenzene	µg/kg	1000000	110 U	120 U	70 J	92 J	100 U	590	76000	140000	2400000
1,2-Dichloroethane	µg/kg	60000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
1,2-Dichloropropane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
1,3-Dichlorobenzene	µg/kg	560000	110 U	120 U	76 J	140	100 U	670	1300	3300	29000
1,4-Dichlorobenzene	µg/kg	250000	110 U	120 U	86 J	150	100 U	600	10000	30000	480000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	570 U	590 U	630 U	610 U	520 U	490 U	1400 U	1300 U	1200 U
2-Chlorotoluene	µg/kg	1000000	8700	19000	82000	210000	1100	14000	1100	450	1000
2-Hexanone	µg/kg	NL	570 U	590 U	630 U	610 U	520 U	490 U	1400 U	1300 U	1200 U
2-Nitropropane	µg/kg	--	570 UJ	590 UJ	630 UJ	610 UJ	520 UJ	490 UJ	1400 U	1300 U	1200 U
3-Chlorotoluene	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
4-Chlorotoluene	µg/kg	1000000	3400	5300	36000	83000	460	5500	750	230 J	620
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	570 U	590 U	630 U	610 U	520 U	490 U	1400 U	1300 U	1200 U
Acetone	µg/kg	1000000	570 U	590 U	630 U	610 U	520 U	490 U	1400 U	1300 U	2100
Benzene	µg/kg	89000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	280
Bromodichloromethane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Bromoform	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 UJ	250 UJ	250 UJ
Bromomethane (Methyl Bromide)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Carbon disulfide	µg/kg	NL	110 UJ	120 UJ	130 UJ	120 UJ	100 UJ	99 UJ	280 UJ	250 UJ	250 UJ
Carbon tetrachloride	µg/kg	44000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Chlorobenzene	µg/kg	1000000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	310	3100
Chloroethane	µg/kg	NL	110 UJ	120 UJ	130 UJ	120 UJ	100 UJ	99 UJ	280 U	250 U	250 U
Chloroform (Trichloromethane)	µg/kg	700000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Chloromethane (Methyl Chloride)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
cis-1,2-Dichloroethene	µg/kg	1000000	190	380	260	440	100 U	99 U	280 U	250 U	250 U
cis-1,3-Dichloropropene	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Cyclohexane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Dibromochloromethane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Ethylbenzene	µg/kg	780000	120	180	270	690	100 U	99 U	280 U	250 U	130 J
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH27*	*BH27*	*BH27*	*BH27*	*BH27*	*BH27*	*BH28*	*BH28*	*BH28*
		sampledate	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/12/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*
		Depth	*5-7 ft BGS*	*7-9 ft BGS*	*9-11 ft BGS*	*11-13 ft BGS*	*13-15 ft BGS*	*15-16.7 ft BGS*	*8-8.4 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	110 UJ	120 UJ	130 UJ	120 UJ	100 UJ	99 UJ	280 U	250 U	220 J
Methyl cyclohexane	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Methyl Tert Butyl Ether	µg/kg	1000000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Methylene chloride	µg/kg	1000000	110 U	120 U	97 J	150	65 J	99 U	280 U	250 U	400
Styrene	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Tetrachloroethene	µg/kg	300000	6800	9400	11000	25000	190	580	340	5200	180000
Toluene	µg/kg	1000000	190	350	500	1800	1200	99 U	280 U	250 U	1500
trans-1,2-Dichloroethene	µg/kg	1000000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
trans-1,3-Dichloropropene	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Trichloroethene	µg/kg	400000	940	1800	2300	9600	14000	330	140 J	910	75000
Trichlorofluoromethane (CFC-11)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	420
Vinyl chloride	µg/kg	27000	110 U	120 U	130 U	120 U	100 U	99 U	280 U	250 U	250 U
Xylene (total)	µg/kg	1000000	420	650	950	2200	210 U	200 U	560 U	510 U	600
Total VOCs	µg/kg	>1000000	**20858**	**37270**	**133705**	**333662**	**17381**	**22270**	**93230**	**182100**	**3196960**
PID	**ppm**		**11**	**25**	**228**	**29**	**6.5**	**--**	**33**	**160**	**239**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH28*	*BH29*	*BH29*	*BH29*	*BH29*	*BH29*	*BH30*	*BH30*	*BH30*
		sampledate	*4/16/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*
		Depth	*14-15.5 ft BGS*	*6-8 ft BGS*	*8-8.4 ft BGS*	*8.4-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*6-6.9 ft BGS*	*8-8.8 ft BGS*	*10-10.9 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	110 U	120 U	9600 U	650 U	600 U	110 U	160 J	250 U	260 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,1,2-Trichloroethane	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,1-Dichloroethane	µg/kg	480000	1300	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,1-Dichloroethene	µg/kg	1000000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,2,4-Trichlorobenzene	µg/kg	NL	63 J	1400	850000	25000	28000	3900	12000	10000	12000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	110 U	120 UJ	9600 U	650 UJ	600 UJ	110 UJ	230 U	250 U	260 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,2-Dichlorobenzene	µg/kg	1000000	480	8900	580000	19000	43000	23000	14000	5800	15000
1,2-Dichloroethane	µg/kg	60000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,2-Dichloropropane	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
1,3-Dichlorobenzene	µg/kg	560000	110 U	2300	130000	3800	6000	2400	7000	5800	15000
1,4-Dichlorobenzene	µg/kg	250000	140	3900	250000	7600	14000	5900	10000	5300	15000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	550 U	590 U	48000 U	3200 U	3000 U	570 U	1100 U	1300 U	1300 U
2-Chlorotoluene	µg/kg	1000000	110 U	200	8600 J	350 J	970	480	7200	15000	75000
2-Hexanone	µg/kg	NL	550 U	590 U	48000 U	3200 UJ	3000 UJ	570 UJ	1100 U	1300 U	1300 U
2-Nitropropane	µg/kg	--	550 U	590 U	48000 UJ	3200 UJ	3000 UJ	570 UJ	1100 U	1300 U	1300 U
3-Chlorotoluene	µg/kg	NL	110 U	120 U	9600 UJ	650 UJ	600 UJ	110 UJ	230 U	250 U	260 U
4-Chlorotoluene	µg/kg	1000000	110 U	120	6000 J	650 U	3200	1600	3400	6700	20000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	550 U	590 U	48000 U	3200 U	3000 U	570 U	1100 U	1300 U	1300 U
Acetone	µg/kg	1000000	550 U	590 U	48000 U	3200 UJ	3000 UJ	570 UJ	1100 U	1300 U	1300 U
Benzene	µg/kg	89000	110 U	120 U	9600 U	650 U	920	74 J	200 J	250 U	260 U
Bromodichloromethane	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Bromoform	µg/kg	NL	110 U	120 U	9600 U	650 UJ	600 UJ	110 UJ	230 U	250 U	260 UJ
Bromomethane (Methyl Bromide)	µg/kg	NL	110 U	120 U	9600 UJ	650 U	600 U	110 U	230 U	250 U	260 U
Carbon disulfide	µg/kg	NL	110 UJ	120 U	9600 UJ	650 UJ	600 UJ	110 UJ	230 UJ	250 UJ	260 UJ
Carbon tetrachloride	µg/kg	44000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Chlorobenzene	µg/kg	1000000	110 U	380	18000	500 J	1800	630	890	160 J	380
Chloroethane	µg/kg	NL	110 U	120 UJ	9600 UJ	650 U	600 U	110 U	230 U	250 U	260 U
Chloroform (Trichloromethane)	µg/kg	700000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Chloromethane (Methyl Chloride)	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
cis-1,2-Dichloroethene	µg/kg	1000000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
cis-1,3-Dichloropropene	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Cyclohexane	µg/kg	NL	110 U	120 U	9600 U	650 UJ	600 UJ	110 UJ	230 U	250 U	260 U
Dibromochloromethane	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Ethylbenzene	µg/kg	780000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH28*	*BH29*	*BH29*	*BH29*	*BH29*	*BH29*	*BH30*	*BH30*	*BH30*
		sampledate	*4/16/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/14/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*
		Depth	*14-15.5 ft BGS*	*6-8 ft BGS*	*8-8.4 ft BGS*	*8.4-10 ft BGS*	*10-12 ft BGS*	*12-14 ft BGS*	*6-6.9 ft BGS*	*8-8.8 ft BGS*	*10-10.9 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	100 J	190 J	9600 UJ	650 UJ	600 UJ	240 J	460 J	310 J	260 U
Methyl cyclohexane	µg/kg	NL	110 U	120 U	9600 U	650 UJ	600 UJ	110 UJ	230 U	250 U	260 U
Methyl Tert Butyl Ether	µg/kg	1000000	110 U	120 U	9600 U	650 UJ	600 UJ	110 UJ	230 U	250 U	260 U
Methylene chloride	µg/kg	1000000	770	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Styrene	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Tetrachloroethene	µg/kg	300000	110 U	120 U	37000	480 J	1300	810	1600	1200	2000
Toluene	µg/kg	1000000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
trans-1,2-Dichloroethene	µg/kg	1000000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
trans-1,3-Dichloropropene	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Trichloroethene	µg/kg	400000	210	120 U	9600 U	650 U	700	120	130 J	140 J	260 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Vinyl chloride	µg/kg	27000	110 U	120 U	9600 U	650 U	600 U	110 U	230 U	250 U	260 U
Xylene (total)	µg/kg	1000000	220 U	230 U	19000 U	1300 U	1200 U	230 U	130 J	510 U	520 U
Total VOCs	µg/kg	>1000000	**3063**	**17390**	**1879600**	**56730**	**99890**	**39154**	**57170**	**50410**	**154380**
PID	**ppm**		**8.3**	**5.1**	**842**	**107**	**41**	**20**	**1357**	**114**	**161**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH30*	*BH30*	*BH31*	*BH31*	*BH31*	*BH31*	*BH31*	*BH32*	*BH32*
		sampledate	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/16/2010*	*4/16/2010*
		Depth	*12-12.9 ft BGS*	*14-15.4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-9.2 ft BGS*	*12-14 ft BGS*	*14-15.2 ft BGS*	*0-2 ft BGS*	*6-8 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	260 U	520	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,1,2-Trichloroethane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,1-Dichloroethane	µg/kg	480000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,1-Dichloroethene	µg/kg	1000000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,2,4-Trichlorobenzene	µg/kg	NL	5600	7400	1300000	11000000	3400000	30000	110000	30000	62000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,2-Dichlorobenzene	µg/kg	1000000	9500	21000	**1200000**	**15000000**	**7300000**	54000	110000	26000	63000
1,2-Dichloroethane	µg/kg	60000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,2-Dichloropropane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
1,3-Dichlorobenzene	µg/kg	560000	8700	25000	240000	**2300000**	**720000**	18000	28000	8600	16000
1,4-Dichlorobenzene	µg/kg	250000	10000	25000	**380000**	**4600000**	**1900000**	32000	52000	15000	30000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	1300 U	1100 U	10000	91000	530000 U	1100 U	2700 U	1300 U	1300 U
2-Chlorotoluene	µg/kg	1000000	25000	150000	97000	820000	450000	2600	6000	2500	4000
2-Hexanone	µg/kg	NL	1300 U	1100 U	1600 U	2400 U	1300 U	1100 U	2700 U	1300 U	1300 U
2-Nitropropane	µg/kg	--	1300 U	1100 U	1600 U	2400 U	1300 U	1100 U	2700 U	1300 U	1300 U
3-Chlorotoluene	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
4-Chlorotoluene	µg/kg	1000000	11000	46000	300000	**4400000**	**2700000**	10000	25000	150 J	240 J
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	1300 U	1100 U	2200	49000	56000	1100 U	2700 U	1300 U	1300 U
Acetone	µg/kg	1000000	1300 U	1100 U	1600 U	4100	3900	1100 U	2700 U	1300 U	1300 U
Benzene	µg/kg	89000	200 J	210 U	**430000**	**4500000**	**2800000**	2700	7400	230 J	260 U
Bromodichloromethane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Bromoform	µg/kg	NL	260 UJ	210 UJ	320 UJ	480 UJ	270 UJ	210 U	540 U	260 UJ	260 UJ
Bromomethane (Methyl Bromide)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Carbon disulfide	µg/kg	NL	260 UJ	210 UJ	320 UJ	480 UJ	270 UJ	210 UJ	540 UJ	260 UJ	260 UJ
Carbon tetrachloride	µg/kg	44000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Chlorobenzene	µg/kg	1000000	2600	16000	110000	950000	380000	3900	5900	470	350
Chloroethane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Chloroform (Trichloromethane)	µg/kg	700000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Chloromethane (Methyl Chloride)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
cis-1,2-Dichloroethene	µg/kg	1000000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
cis-1,3-Dichloropropene	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Cyclohexane	µg/kg	NL	260 U	180 J	800	5200	4000	210 U	540 U	260 U	260 U
Dibromochloromethane	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Ethylbenzene	µg/kg	780000	260 U	110 J	980	6600	4800	210 U	540 U	260 U	260 U
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	--

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH30*	*BH30*	*BH31*	*BH31*	*BH31*	*BH31*	*BH31*	*BH32*	*BH32*
		sampledate	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/15/2010*	*4/16/2010*	*4/16/2010*
		Depth	*12-12.9 ft BGS*	*14-15.4 ft BGS*	*4-6 ft BGS*	*6-8 ft BGS*	*8-9.2 ft BGS*	*12-14 ft BGS*	*14-15.2 ft BGS*	*0-2 ft BGS*	*6-8 ft BGS*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	150 J	460 J	220 J	260 U
Methyl cyclohexane	µg/kg	NL	260 U	490	1700	17000	14000	210 U	540 U	260 U	260 U
Methyl Tert Butyl Ether	µg/kg	1000000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Methylene chloride	µg/kg	1000000	260 U	210 U	320 U	360 J	270 U	210 U	540 U	260 U	260 U
Styrene	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Tetrachloroethene	µg/kg	300000	2800	18000	4100	26000	8800	210 U	540 U	260 U	260 U
Toluene	µg/kg	1000000	130 J	980	74000	600000	290000	710	1600	260 U	260 U
trans-1,2-Dichloroethene	µg/kg	1000000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
trans-1,3-Dichloropropene	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Trichloroethene	µg/kg	400000	300	1400	1200	8800	3000	210 U	540 U	260 U	260 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	260 U	420	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Vinyl chloride	µg/kg	27000	260 U	210 U	320 U	480 U	270 U	210 U	540 U	260 U	260 U
Xylene (total)	µg/kg	1000000	530 U	410 J	4400	30000	20000	420 U	1100 U	520 U	510 U
Total VOCs	µg/kg	>1000000	**75830**	**312910**	**4156380**	**44408060**	**20054500**	**154060**	**346360**	**83170**	**175590**
PID	**ppm**		**210**	**127**	**174**	**1379**	**7081**	**183**	**115**	**182**	**117**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			*BH32*	*BH32*	*BH32*	*BH33*	*BH33*	*BH33*	*BH33*	*BH33*	*Soilpile*
sampledate			*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*11/4/2008*
Depth			*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-7.2 ft BGS*	*9-10.2 ft BGS*	*12-12.7 ft BGS*	*14-16 ft BGS*	*--*
	Units	*NYSDEC SCO (1)*									
VOAs											
1,1,1-Trichloroethane	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,1,2,2-Tetrachloroethane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 UJ	140 U	12000 U	1100 U	2900 U
1,1,2-Trichloroethane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,1-Dichloroethane	µg/kg	480000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,1-Dichloroethene	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,2,4-Trichlorobenzene	µg/kg	NL	100000	70000	26000	30000	1300	8800	1100000	9300	34000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	2200 U	1100 UJ	430 UJ	450 UJ	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,2-Dichlorobenzene	µg/kg	1000000	180000	79000	11000	29000	900	8300	750000	5900	56000
1,2-Dichloroethane	µg/kg	60000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,2-Dichloropropane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
1,3-Dichlorobenzene	µg/kg	560000	59000	27000	3100	8800	280	3200	210000	1800	88000
1,4-Dichlorobenzene	µg/kg	250000	110000	50000	5400	16000	520	4400	310000	2900	75000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	11000 U	5600 U	2200 U	2300 U	600 U	700 U	61000 U	5400 U	2900 U
2-Chlorotoluene	µg/kg	1000000	13000	7800	630	2700	94 J	2300	150000	1300	55000
2-Hexanone	µg/kg	NL	11000 U	5600 U	2200 U	2300 U	600 UJ	700 UJ	61000 U	5400 UJ	2900 U
2-Nitropropane	µg/kg	--	11000 U	5600 U	2200 U	2300 U	600 UJ	700 UJ	61000 U	5400 UJ	--
3-Chlorotoluene	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
4-Chlorotoluene	µg/kg	1000000	2200 U	1100 U	430 U	570	1300	480	19000	1100 U	64000
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	11000 U	5600 U	2200 U	2300 U	600 U	700 U	61000 U	5400 U	2900 U
Acetone	µg/kg	1000000	11000 U	5600 U	2200 U	2300 U	600 UJ	700 UJ	61000 U	5400 UJ	2900 UJ
Benzene	µg/kg	89000	2200 U	620 J	240 J	450 U	120 U	140 U	12000 U	1100 U	2900 U
Bromodichloromethane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Bromoform	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
Bromomethane (Methyl Bromide)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Carbon disulfide	µg/kg	NL	2200 UJ	1100 U	430 U	450 U	120 UJ	140 UJ	12000 UJ	1100 UJ	2900 U
Carbon tetrachloride	µg/kg	44000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Chlorobenzene	µg/kg	1000000	3900	2100	430 U	250 J	120 U	200	16000	950 J	11000
Chloroethane	µg/kg	NL	2200 U	1100 UJ	430 UJ	450 UJ	120 U	140 U	12000 U	1100 U	2900 U
Chloroform (Trichloromethane)	µg/kg	700000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Chloromethane (Methyl Chloride)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
cis-1,2-Dichloroethene	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
cis-1,3-Dichloropropene	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Cyclohexane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
Dibromochloromethane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Ethylbenzene	µg/kg	780000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Isopropylbenzene	µg/kg	NL	--	--	--	--	--	--	--	--	2900 U

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	*BH32*	*BH32*	*BH32*	*BH33*	*BH33*	*BH33*	*BH33*	*BH33*	*Soilpile*
		sampledate	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*4/16/2010*	*11/4/2008*
		Depth	*10-12 ft BGS*	*12-14 ft BGS*	*14-16 ft BGS*	*4-6 ft BGS*	*6-7.2 ft BGS*	*9-10.2 ft BGS*	*12-12.7 ft BGS*	*14-16 ft BGS*	*--*
	Units	*NYSDEC SCO (1)*									
VOAs											
Methyl acetate	µg/kg	NL	2200 UJ	1100 UJ	430 UJ	450 UJ	120 UJ	140 UJ	12000 UJ	1100 UJ	2900 U
Methyl cyclohexane	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
Methyl Tert Butyl Ether	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 UJ	140 UJ	12000 U	1100 UJ	2900 U
Methylene chloride	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Styrene	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Tetrachloroethene	µg/kg	300000	2200 U	1100 U	430 U	450 U	160	800	32000	1100 U	2900 U
Toluene	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	650 J
trans-1,2-Dichloroethene	µg/kg	1000000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
trans-1,3-Dichloropropene	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Trichloroethene	µg/kg	400000	2200 U	1100 U	430 U	450 U	150	120 J	12000 U	1900	2900 U
Trichlorofluoromethane (CFC-11)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Vinyl chloride	µg/kg	27000	2200 U	1100 U	430 U	450 U	120 U	140 U	12000 U	1100 U	2900 U
Xylene (total)	µg/kg	1000000	4300 U	2300 U	870 U	900 U	240 U	280 U	24000 U	2100 U	2900 U
Total VOCs	µg/kg	>1000000	**465900**	**236520**	**46370**	**87320**	**4704**	**28600**	**2587000**	**24050**	**383650**
PID	**ppm**		**230**	**140**	**125**	**--**	**--**	**38**	**6445**	**27**	**--**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

			loc_name	*Soilpile*	*Soilpile*	*Soilpile*	GP-01-0	GP-01-02	GP-01-03	GP-01-04	GP-01-05	GP-01-06	GP-01-07	GP-01-08	PZ-01-01
			sampledate	*11/4/2008*	*12/22/2008*	*12/22/2008*	10/26/01	10/26/01	10/29/01	10/29/01	10/29/01	10/29/01	10/30/01	10/30/01	10/26/01
			Depth	*--*	*--*	*--*	9-11	11-13	12-13	12-13.5	4-5.5	11-12.5	14-16	12-14	12-14
				(Duplicate)		*(Duplicate)*									
	Units	*NYSDEC SCO (1)*													
VOAs															
1,1,1-Trichloroethane	µg/kg	1000000		1200 U	11 U	5700 U	16	ND	6	2	ND	3	ND	ND	ND
1,1,2,2-Tetrachloroethane	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	480000		1200 U	11 U	5700 U	ND	ND	37	4	ND	ND	ND	ND	6
1,1-Dichloroethene	µg/kg	1000000		1200 U	11 U	5700 U	ND	ND	5	ND	ND	ND	ND	ND	3
1,2,4-Trichlorobenzene	µg/kg	NL		17000	2400 E	52000	ND	ND	ND	4	2	ND	ND	18000	8
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	1000000		21000	3600 E	78000	3	2	2	8	ND	ND	ND	450000	640
1,2-Dichloroethane	µg/kg	60000		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	560000		33000	4700 E	120000	2	ND	ND	9	ND	ND	ND	71000	980
1,4-Dichlorobenzene	µg/kg	250000		29000	3900 E	110000	2	ND	ND	9	ND	ND	ND	220000	700
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000		1200 U	11 U	5700 U	ND	ND	ND	ND	9	ND	ND	ND	ND
2-Chlorotoluene	µg/kg	1000000		27000	7000 E	110000	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
2-Nitropropane	µg/kg	--		--	--	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
4-Chlorotoluene	µg/kg	1000000		33000	7000 E	130000	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL		1200 U	11 U	5700 U	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/kg	1000000		1200 UJ	14	14	ND	8	ND	ND	47	ND	ND	ND	ND
Benzene	µg/kg	89000		1200 U	18	18	ND	ND	12	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/kg	NL		1200 U	11 U	5700 U	ND	ND	0	ND	ND	ND	ND	ND	36
Bromoform	µg/kg	NL		1200 U	11 U	5700 U	82	ND	ND	ND	ND	ND	ND	ND	14
Bromomethane (Methyl Bromide)	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	NL		1200 U	1 J	1 J	ND	ND	2	ND	5	ND	ND	ND	ND
Carbon tetrachloride	µg/kg	44000		1200 U	11 U	5700 U	18	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	µg/kg	1000000		3900	1700E	21000	4	3	2	270	ND	28	ND	6600	3
Chloroethane	µg/kg	NL		1200 U	11 U	5700 U	ND	ND	12	ND	ND	ND	ND	ND	ND
Chloroform (Trichloromethane)	µg/kg	700000		1200 U	11 U	5700 U	39	ND	20	35	160	52	4	ND	960
Chloromethane (Methyl Chloride)	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	1000000		1200 U	11 U	5700 U	90	4	91	5	ND	7	5	ND	65
cis-1,3-Dichloropropene	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	NL		1200 U	1 J	5700 U	--	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	NL		1200 U	11 U	5700 U	12	ND	ND	ND	ND	ND	ND	ND	23
Dichlorodifluoromethane (CFC-12)	µg/kg	NL		1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	780000		1200 U	6 J	5700 U	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	µg/kg	NL		370 J	110	5700 U	9	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			***Soilpile***	***Soilpile***	***Soilpile***	GP-01-0	GP-01-02	GP-01-03	GP-01-04	GP-01-05	GP-01-06	GP-01-07	GP-01-08	PZ-01-01
sampledate			***11/4/2008***	***12/22/2008***	***12/22/2008***	10/26/01	10/26/01	10/29/01	10/29/01	10/29/01	10/29/01	10/30/01	10/30/01	10/26/01
Depth			**--**	**--**	**--**	9-11	11-13	12-13	12-13.5	4-5.5	11-12.5	14-16	12-14	12-14
			(Duplicate)		***(Duplicate)***									
	Units	*NYSDEC SCO (1)*												
VOAs														
Methyl acetate	µg/kg	NL	330 J	11 U	5700 U	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	NL	1200 U	5 J	5700 U	ND	ND	ND	ND	5	4	1	ND	ND
Methyl Tert Butyl Ether	µg/kg	1000000	1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	1000000	1200 U	10 J	5700 U	ND	ND	ND	ND	21	3	ND	ND	3
Styrene	µg/kg	NL	1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	300000	1200 U	18	5700 U	810	ND	ND	ND	58	520	24	ND	560
Toluene	µg/kg	1000000	260 J	270 E	1600 J	ND	ND	3	14	4	24	1	ND	ND
trans-1,2-Dichloroethene	µg/kg	1000000	1200 U	11 U	5700 U	ND	ND	6	2	ND	ND	5	ND	ND
trans-1,3-Dichloropropene	µg/kg	NL	1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	400000	1200 U	11 U	5700 U	99	4	17	17	12	130	2	ND	160
Trichlorofluoromethane (CFC-11)	µg/kg	NL	1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	1200 U	11 U	5700 U	--	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	27000	1200 U	11 U	5700 U	2	ND	ND	ND	ND	ND	3	ND	ND
Xylene (total)	µg/kg	1000000	1200 U	37	5700 U	2	ND	3	1	2	6	ND	ND	15
Total VOCs	µg/kg	>1000000	**164860**	**30790**	**622633**	**1190**	**21**	**218**	**380**	**325**	**777**	**45**	**765600**	**4176**
PID	**ppm**		**--**			**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Notes:

☐ Concentration exceeds NYSDEC SCO.

ND Not Detected

(1) New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.

(2) NYSDEC SCO not available, therefore substituted Total VOC SCO.

NL Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

	Units	*NYSDEC SCO (1)*	PZ-01-02	PZ-01-03	PZ-01-04	PZ-01-05	PZ-01-05/D	PZ-01-06	PZ-01-07	PZ-01-08	PZ-01-09	PZ-01-10	PZ-01-11	PZ-01-12
loc_name			PZ-01-02	PZ-01-03	PZ-01-04	PZ-01-05	PZ-01-05/D	PZ-01-06	PZ-01-07	PZ-01-08	PZ-01-09	PZ-01-10	PZ-01-11	PZ-01-12
sampledate			10/26/01	10/29/01	10/29/01	10/29/01	10/29/01	10/29/01	10/30/01	10/30/01	10/30/01	10/30/01	10/30/01	10/30/01
Depth			2.5-4	4-5.5	8-10	11-13	11-13	11-13	12-14	4-6	5-7	8-10	9-13	5-7
VOAs														
1,1,1-Trichloroethane	µg/kg	1000000	ND	ND	ND	30000	510000	ND	950	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	480000	3	ND	ND	3000	45000	ND	ND	ND	ND	ND	ND	2700
1,1-Dichloroethene	µg/kg	1000000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/kg	NL	ND	ND	ND	5300	ND	42000	ND	140000	ND	19000	ND	ND
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	1000000	ND	ND	ND	2800	ND	79000	ND	15000	12	680000	160000	ND
1,2-Dichloroethane	µg/kg	60000	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	560000	ND	ND	ND	1900	ND	89000	ND	25000	4	130000	3500	ND
1,4-Dichlorobenzene	µg/kg	250000	ND	ND	ND	1900	ND	87000	ND	20000	6	430000	32000	ND
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorotoluene	µg/kg	1000000	ND	ND	ND	2700	2700	240000	975000	240000	4500	ND	ND	330000
2-Hexanone	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
4-Chlorotoluene	µg/kg	1000000	--	--	--	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	ND	ND	ND	ND	6500	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/kg	1000000	84	33	ND	ND	48000	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/kg	89000	ND	ND	ND	ND	ND	1100	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane (Methyl Bromide)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	NL	ND	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/kg	44000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	µg/kg	1000000	ND	ND	ND	ND	ND	24000	160	7200	5	830000	ND	ND
Chloroethane	µg/kg	NL	ND	ND	ND	ND	5300	ND	ND	ND	ND	ND	ND	ND
Chloroform (Trichloromethane)	µg/kg	700000	ND	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane (Methyl Chloride)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	1000000	ND	2	24000	3100	19000	ND	480	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	780000	210	ND	ND	ND	7300	ND	ND	19000	ND	ND	ND	ND
Isopropylbenzene	µg/kg	NL	3	ND	ND	ND	ND	ND	ND	17000	ND	ND	ND	ND

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			PZ-01-02	PZ-01-03	PZ-01-04	PZ-01-05	PZ-01-05/D	PZ-01-06	PZ-01-07	PZ-01-08	PZ-01-09	PZ-01-10	PZ-01-11	PZ-01-12
sampledate			10/26/01	10/29/01	10/29/01	10/29/01	10/29/01	10/29/01	10/30/01	10/30/01	10/30/01	10/30/01	10/30/01	10/30/01
Depth			2.5-4	4-5.5	8-10	11-13	11-13	11-13	12-14	4-6	5-7	8-10	9-13	5-7
	Units	*NYSDEC SCO (1)*												
VOAs														
Methyl acetate	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	NL	3	2	ND	ND	ND	ND	ND	ND	3	ND	ND	ND
Methyl Tert Butyl Ether	µg/kg	1000000	--	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	1000000	ND	ND	ND	ND	3400	ND	500	ND	ND	ND	ND	ND
Styrene	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	300000	ND	ND	6600	1300000	2700000	ND	210	2000	200	ND	10000	1300
Toluene	µg/kg	1000000	6	2	ND	2700	56000	1200	6500	ND	ND	ND	ND	1100
trans-1,2-Dichloroethene	µg/kg	1000000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	400000	2	ND	47000	64000	150000	ND	4500	ND	ND	ND	5800	ND
Trichlorofluoromethane (CFC-11)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	27000	ND	ND	1800	ND	4900	ND	ND	ND	ND	ND	ND	ND
Xylene (total)	µg/kg	1000000	28	ND	1500	ND	12000	ND	ND	40000	11	ND	ND	ND
Total VOCs	µg/kg	>1000000	**358**	**50**	**80900**	**1417400**	**3570100**	**563300**	**988300**	**525200**	**4741**	**2089000**	**211300**	**335100**
PID	**ppm**		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		loc_name	MW-01-1OB	MW-01-1OB	MW-01-9A	BH87-4B	BH87-4B	MW-88-2OB	MW-88-7OB	MW-88-7OB/D
		sampledate	10/16/01	10/16/01	10/18/01	10/17/01	10/17/01	10/17/01	10/16/01	10/16/01
		Depth	10-12	4-6	16-17	11-13	1-4	4-6	3-5	3-5
	Units	*NYSDEC SCO (1)*								
VOAs										
1,1,1-Trichloroethane	µg/kg	1000000	ND	7800	ND	ND	ND	1200	ND	ND
1,1,2,2-Tetrachloroethane	µg/kg	NL	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	µg/kg	NL	--	--	--	--	--	--	--	--
1,1-Dichloroethane	µg/kg	480000	170	840	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	µg/kg	1000000	ND	500	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/kg	NL	ND	ND	ND	910	ND	4100	7900	110000
1,2-Dibromo-3-chloropropane (DBCP)	µg/kg	NL	--	--	--	--	--	--	--	--
1,2-Dibromoethane (Ethylene Dibromide)	µg/kg	NL	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	µg/kg	1000000	ND	ND	ND	2500	1300	10000	28000	110000
1,2-Dichloroethane	µg/kg	60000	--	--	--	--	--	--	--	--
1,2-Dichloropropane	µg/kg	NL	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	µg/kg	560000	ND	ND	ND	4800	3200	15000	57000	210000
1,4-Dichlorobenzene	µg/kg	250000	ND	ND	ND	4300	2600	14000	44000	170000
2-Butanone (Methyl Ethyl Ketone)	µg/kg	1000000	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorotoluene	µg/kg	1000000	--	2646000	21	6630000	--	7884000	3000000	3000000
2-Hexanone	µg/kg	NL	--	--	--	--	--	--	--	--
2-Nitropropane	µg/kg	--	--	--	--	--	--	--	--	--
3-Chlorotoluene	µg/kg	NL	--	--	--	--	--	--	--	--
4-Chlorotoluene	µg/kg	1000000	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/kg	1000000	ND	2000	5	ND	ND	ND	ND	ND
Benzene	µg/kg	89000	ND	ND	ND	ND	ND	2500	1900	9800
Bromodichloromethane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane (Methyl Bromide)	µg/kg	NL	--	--	--	--	--	--	--	--
Carbon disulfide	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/kg	44000	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	µg/kg	1000000	ND	ND	ND	ND	ND	27000	2800	14000
Chloroethane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform (Trichloromethane)	µg/kg	700000	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane (Methyl Chloride)	µg/kg	NL	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	µg/kg	1000000	240	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	µg/kg	NL	--	--	--	--	--	--	--	--
Cyclohexane	µg/kg	NL	--	--	--	--	--	--	--	--
Dibromochloromethane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane (CFC-12)	µg/kg	NL	--	--	--	--	--	--	--	--
Ethylbenzene	µg/kg	780000	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	µg/kg	NL	ND	ND	ND	ND	ND	ND	1400	3200

TABLE 6.1

SCREENING OF SOIL ANALYTICAL RESULTS TO NYSDEC SCOs - INDUSTRIAL
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

loc_name			MW-01-1OB	MW-01-1OB	MW-01-9A	BH87-4B	BH87-4B	MW-88-2OB	MW-88-7OB	MW-88-7OB/D
sampledate			10/16/01	10/16/01	10/18/01	10/17/01	10/17/01	10/17/01	10/16/01	10/16/01
Depth			10-12	4-6	16-17	11-13	1-4	4-6	3-5	3-5
	Units	*NYSDEC SCO (1)*								
VOAs										
Methyl acetate	µg/kg	NL	--	--	--	--	--	--	--	--
Methyl cyclohexane	µg/kg	NL	ND	ND	ND	ND	ND	ND	ND	ND
Methyl Tert Butyl Ether	µg/kg	1000000	--	--	--	--	--	--	--	--
Methylene chloride	µg/kg	1000000	ND	1300	ND	ND	ND	ND	ND	ND
Styrene	µg/kg	NL	--	--	--	--	--	--	--	--
Tetrachloroethene	µg/kg	300000	3000	4700	3	2300	ND	9700	ND	ND
Toluene	µg/kg	1000000	160	8300	1	9500	ND	13000	780	5600
trans-1,2-Dichloroethene	µg/kg	1000000	ND	ND	11	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	µg/kg	NL	--	--	--	--	--	--	--	--
Trichloroethene	µg/kg	400000	1100	56000	ND	41000	ND	1300	ND	ND
Trichlorofluoromethane (CFC-11)	µg/kg	NL	--	--	--	--	--	--	--	--
Trifluorotrichloroethane (Freon 113)	µg/kg	NL	--	--	--	--	--	--	--	--
Vinyl chloride	µg/kg	27000	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (total)	µg/kg	1000000	200	430	1	ND	ND	1300	ND	ND
Total VOCs	µg/kg	>1000000	**4870**	**2727870**	**42**	**6695310**	**7100**	**7983100**	**3143780**	**3632600**
PID	**ppm**		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

Notes:

☐	Concentration exceeds NYSDEC SCO.
ND	Not Detected
(1)	New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, New York State Department of Environmental Conservation (NYSDEC), Table 11-2, Final Restricted Use of SCOs as Presented in 6 NYCRR Part 375, Protection of Public Health - Industrial, September 2006.
(2)	NYSDEC SCO not available, therefore substituted Total VOC SCO.
NL	Not Listed

TABLE 6.2

EXCEEDANCES OF INDIVIDUAL COMPOUND INDUSTRIAL CRITERIA
FRONTIER CHEMICAL SITE

Location	*Depth*	*Chemicals Exceeding Criteria*
BH5-08	10-12'	Monochlorotoluene
BH8-08	8-10'	1,3-DCB
		1,4-DCB
	10-12'	1,4-DCB
	12-14'	1,4-DCB
BH12-08	2-4'	1,4-DCB
	4-6'	1,3-DCB
		1,4-DCB
		Monochlorotoluene
BH16-08	4-6'	1,2-DCB
		1,3-DCB
		1,4-DCB
		Benzene
		Monochlorotoluene
BH22-10	10-12'	Monochlorotoluene
BH25-10	12-14'	1,4-DCB
BH28-10	12-14'	1,2-DCB
		1,4-DCB
BH31-10	4-6'	1,2-DCB
		1,4-DCB
		Benzene
BH31-10	6-8'	1,2-DCB
		1,3-DCB
		1,4-DCB
		Benzene
		Monochlorotoluene
BH31-10	8-9.2'	1,2-DCB
		1,3-DCB
		1,4-DCB
		Benzene
		Monochlorotoluene

TABLE 6.2

EXCEEDANCES OF INDIVIDUAL COMPOUND INDUSTRIAL CRITERIA
FRONTIER CHEMICAL SITE

Location	*Depth*	*Chemicals Exceeding Criteria*
BH33-10	12-12.7'	1,4-DCB
PZ-01-05	11-13'	PCE
PZ-01-10	8-10'	1,4-DCB
MW-01-1 OB	4-6'	Monochlorotoluene
BH87-4B	11-13'	Monochlorotoluene
MW-88-2 OB	4-6'	Monochlorotoluene
MW-88-7 OB	3-5'	Monochlorotoluene

TABLE 6.3

WASTE CHARACTERIZATION RESULTS SUMMARY
FRONTIER CHEMICAL SITE
APRIL 2010

	Sample Location:		*BH22*	*BH24*	*BH26*	*BH29*	*BH30*	*BH31*	*BH32*
	Sample Date:		*4/13/2010*	*4/14/2010*	*4/13/2010*	*4/14/2010*	*4/15/2010*	*4/15/2010*	*4/16/2010*
	Sample Depth:		*10-12 ft BGS*	*8-8.9 ft BGS*	*12-14 ft BGS*	*8-8.4 ft BGS*	*6-6.9 ft BGS*	*8-9.2 ft BGS*	*0-2 ft BGS*
Parameters	*Units*	*TCLP Criteria*							
Herbicides									
2,4,5-TP (Silvex)	µg/L	1,000	-	2.0 U Dup 2.0 U	-	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U
2,4-Dichlorophenoxyacetic acid (2,4-D)	µg/L	10,000	-	2.0 U Dup 2.0 U	-	4.8 Dup 1.8 J	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U
Metals									
Arsenic	mg/L	5.0	0.0100 U	0.0100 U	0.0100 U	0.0100 U	0.0100 U	0.0100 U	0.0062 J
Barium	mg/L	100	1.49 B	0.695 B	1.46 B	0.434 B	0.282 B	0.526 B	1.32 B
Cadmium	mg/L	1.0	0.0070	0.0010 U	0.0065	0.0005 J	0.0034	0.0054	0.0183
Chromium	mg/L	5.0	0.0009 J	0.0014 JB	0.0012 J	0.0040 U	0.0073 B	0.0106 B	0.0233 B
Lead	mg/L	5.0	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050	0.0032 J	0.954
Mercury	mg/L	0.2	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Selenium	mg/L	1.0	0.0150 U	0.0150 U	0.0150 U	0.0150 U	0.0150 U	0.0150 U	0.0150 U
Silver	mg/L	5.0	0.0030 U	0.0030 U	0.0030 U	0.0030 U	0.0030 U	0.0030 U	0.0030 U
PCBs									
Aroclor-1016 (PCB-1016)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1221 (PCB-1221)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1232 (PCB-1232)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1242 (PCB-1242)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1248 (PCB-1248)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1254 (PCB-1254)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1260 (PCB-1260)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1262 (PCB-1262)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Aroclor-1268 (PCB-1268)	µg/kg	NL	-	220 U	-	21 U	190 U	310 U	110 U
Pesticides									
Chlordane	µg/L	30	-	2.0 U Dup 2.0 U	-	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U
Endrin	µg/L	20	-	0.20 U Dup 0.20 U	-	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U
gamma-BHC (lindane)	µg/L	400	-	0.20 U Dup 0.20 U	-	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U
Heptachlor	µg/L	8	-	0.20 U Dup 0.20 U	-	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.084 J Dup 0.11 J
Heptachlor epoxide	µg/L	8	-	0.20 U Dup 0.20 U	-	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U
Methoxychlor	µg/L	10,000	-	0.20 U Dup 0.20 U	-	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U	0.20 U Dup 0.20 U
Toxaphene	µg/L	500	-	2.0 U Dup 2.0 U	-	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U	2.0 U Dup 2.0 U

TABLE 6.3

WASTE CHARACTERIZATION RESULTS SUMMARY
FRONTIER CHEMICAL SITE
APRIL 2010

Parameters	*Units*	*TCLP Criteria*	***Sample Location:*** ***BH22***	***BH24***	***BH26***	***BH29***	***BH30***	***BH31***	***BH32***
		Sample Date:	***4/13/2010***	***4/14/2010***	***4/13/2010***	***4/14/2010***	***4/15/2010***	***4/15/2010***	***4/16/2010***
		Sample Depth:	***10-12 ft BGS***	***8-8.9 ft BGS***	***12-14 ft BGS***	***8-8.4 ft BGS***	***6-6.9 ft BGS***	***8-9.2 ft BGS***	***0-2 ft BGS***
SVOAs									
1,4-Dichlorobenzene	µg/L	7500	40 U	980 D	40 U	3800 D	69	1600 D	1700 D
2,4,5-Trichlorophenol	µg/L	400000	20 U	20 U	20 U	20 U	20 U	20 U	20 U
2,4,6-Trichlorophenol	µg/L	2000	4.2 J	20 U	20 U	20 U	20 U	8.4 J	20 U
2,4-Dinitrotoluene	µg/L	130	20 U	20 U	20 U	20 U	20 U	20 U	20 U
2-Methylphenol	µg/L	200000	1.6 J	20 U	1.6 J	20 U	20 U	4.2 J	20 U
3&4-Methylphenol	µg/L	200000	7.6 J	40 U	40 U	40 U	40 U	6.1 J	40 U
Hexachlorobenzene	µg/L	130	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Hexachlorobutadiene	µg/L	500	20 U	20 U	20 U	17 J	20 U	20 U	20 U
Hexachloroethane	µg/L	3000	20 U	20 U	20 U	5.2 J	20 U	20 U	20 U
Nitrobenzene	µg/L	2000	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Pentachlorophenol	µg/L	100000	40 U	40 U	40 U	40 U	40 U	40 U	40 U
Pyridine	µg/L	5000	3.0 JB	100 U	100 U	100 U	100 U	3.7 JB	100 U
VOAs									
1,1-Dichloroethene	µg/L	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	µg/L	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Butanone (Methyl ethyl ketone) (MEK)	µg/L	200000	50 U	50 U	50 U	50 U	50 U	2000 D	50 U
Benzene	µg/L	500	10 U	320 D	10 U	110 D	28 D	26000 D	23 D
Carbon tetrachloride	µg/L	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	µg/L	100000	10 U	2000 D	10 U	1700 D	50 D	1800 D	350 D
Chloroform (Trichloromethane)	µg/L	6000	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	µg/L	700	10 U	110 D	1700 D	1900 D	210 D	36 D	37 D
Trichloroethene	µg/L	500	10 U	24 D	92 D	180 D	29 D	25 D	12 D
Vinyl chloride	µg/L	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Wet									
Flash point (closed cup)	Deg F	140	> 176	> 176	> 176	176	> 176	176	> 176
pH, lab	s.u.	< 2.5; >12.5	11.1	12.2	9.37	9.50	11.3	12.7	8.57
Reactive cyanide	mg/kg		10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	0.680 J	10.0 U
Reactive sulfide	mg/kg		10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Solids @ 180 C	%		84	74	79	79	85	53	73

Note:

☐ Exceeds Criteria

TABLE 6.4

SUMMARY OF DETECTED COMPOUNDS
SOIL SAMPLING RESULTS - SOIL TREATMENT PILE
FRONTIER CHEMICAL SITE

			Initial						*Final*				
	Date:		***4-Nov***		***4-Nov***		***4-Nov***	***22-Dec***		***22-Dec***		***22-Dec***
Parameter	***Sample No.:***		***S-114***		***S-115***		***Avg.***	***S-123***		***S123D***		***Avg.***
	Units:											
Tetrachloroethylene	µg/Kg		<2900		<1200		<2050	18		<5,700		<2859
Trichloroethylene	µg/Kg		<2900		<1200		<2050	<11		<5,700		<2856
Trichloroethane	µg/Kg		<2900		<1200		<2050	<11		<5,700		<2856
Chlorobenzene	µg/Kg		11,000		3,900		7,450	1,700	E	21,000	D	11,350
Toluene	µg/Kg	J	650	J	260	J	455	270	E	1,600	DJ	935
chlorotoluene	µg/Kg											
2-chlorotoluene	µg/Kg		55,000		27,000		41,000	7,000	E	110000	D	58,500
1,3-dichlorobenzene	µg/Kg		88,000		33,000		60,500	4,700	E	120,000	D	62,350
1,4-dichlorobenzene	µg/Kg		75,000		29,000		52,000	3,900	E	110,000	D	56,950
1,2-dichlorobenzene	µg/Kg		56,000		21,000		38,500	3,600	E	78,000	D	40,800
1,2,4-trichlorobenzene	µg/Kg		34,000		17,000		25,500	2,400	E	52,000	D	27,200
Isopropylbenzene	µg/Kg		<2900	J	370	<J	<1635	110		<5700		<2905
Methyl Acetate	µg/Kg		<2900	J	330	<J	<1615	<11		<5700		<2856
4 chlorotoluene	µg/Kg		64,000		33000		48,500	7,000	E	130000	D	68,500
Total	µg/Kg		383,650		164,860		273,905	30,698		622,600		326,585

TABLE 6.5

SVE FIELD MEASURED VAPOR READINGS AND MASS REMOVAL
FRONTIER CHEMICAL SITE

Date	*Units*	*20-Nov*	*21-Nov*	*24-Nov*	*26-Nov*	*2-Dec*	*4-Dec*	*15-Dec*	*22-Dec*
Photoionization Detector									
Before Blower	PPM	841	184	65.3	39.1	21.1	23	9	27.1
Before Carbon	PPM	980	160	51.8	34.2	20.9	12.2	12.2	21.8
In-Between Carbon	PPM	27	5.5	14.2	2.2	1.5	1.1	0.7	0.6
After Carbon	PPM	10.5	4.2	2.1	0.8	0.9	0.7	0.4	0.2
Draeger Tubes									
Halogenated Hydrocarbons	PPM	0	0	0	0	0	0	nm	0
Tetrachloroethylene	PPM	15	3	5	2	2	1	nm	1
Trichloroethylene	PPM	2	1	1	0	0	0	nm	0
1,1,1-Trichloroethane	PPM	20	3.5	5	1	1	trace	nm	1
Chlorobenzene	PPM	20	5	2	2	1	1.25	nm	1
Air Sample Collected	Canister No.	115	117	--	--	--	138		136
Flow	CFM	85	87	85	85	85	85	85	85
Vacuum	In. Water	4.4	4.3	4.2	4.5	4.1	4.5	4.5	4.2
Temp.	Deg. F	42	41	40.5	40	39	39	38.5	33
Run Time	Hours	14070.49	14091.15	14164.17	14211.48	14356.56	14406.14	14673.16	14839.29
Knockout water removed	Gallons	--	--	--	--	--	9	--	--
Mass Removal									
Days since last readings		1	1	3	2	6	2	11	7
Cumulative Days	Running	1	2	5	7	13	15	26	33
Hourly	Pounds/hour	0.84	0.18	0.07	0.04	0.02	0.02	0.01	0.03
Daily	Pounds	20.2	4.4	1.6	0.9	0.5	0.6	0.2	0.7
Cumulative	Pounds	20.2	24.6	29.3	31.2	34.2	35.3	37.7	42.2
daily average	Pounds/day	20.2	12.3	5.9	4.5	2.6	2.4	1.4	1.3
									shut down

TABLE 6.6

SUMMARY OF DETECTED COMPOUNDS
SUMMA CANISTER SAMPLING
FRONTIER CHEMICAL SITE

Parameter	*Date* *Sample No.*	*20-Nov* *SV-001*	*21-Nov* *SV-002*	*4-Dec* *A-003*	*22-Dec* *SV-004*
	Units:				
Tetrachloroethylene	µg/M3	< 20,300	1,020	291	184
Trichloroethylene	µg/M3	< 16,100	< 1,610	< 40	< 27
Trichloroethane	µg/M3	< 16,400	< 1,640	< 41	< 27
Chlorobenzene	µg/M3	177,000	11,700	691	553
Toluene	µg/M3	11,800	716	68	81
chlorotoluene isomer	µg/M3		15,600	J 2743	1,589
2-chlorotoluene	µg/M3	652,000	61,100	2,250	1,630
m-dichlorobenzene	µg/M3	477,000	72,700	2,370	1,230
p-dichlorobenzene	µg/M3	420,000	67,300	2,140	1,060
o-dichlorobenzene	µg/M3	250,000	46,200	1,410	566
1,2,4-trichlorobenzene	µg/M3	< 22,300	21,000	802	261
Total	µg/M3	2,062,900	300,586	12,932	7,291
	mg/M3	2062.9	300.6	12.9	7.3
Average	mg/M3		1181.7	156.8	10.1
Other compounds					
Methylene Chloride	µg/M3			< 26.1	J 9.03
Acetone	µg/M3			J 16.2	15
Benzene	µg/M3			43.4	59.4

		Average	12/22 as % of initial
Tetrachloroethylene	µg/M3	5,449	0.0091
Trichloroethylene	µg/M3	4,444	0.0017
Trichloroethane	µg/M3	4,527	0.0017
Chlorobenzene	µg/M3	47,486	0.0031
Toluene	µg/M3	3,166	0.0068
chlorotoluene	µg/M3	6,644	0.1019
2-chlorotoluene	µg/M3	179,245	0.0025
m-dichlorobenzene	µg/M3	138,325	0.0026
p-dichlorobenzene	µg/M3	122,625	0.0025
o-dichlorobenzene	µg/M3	74,544	0.0023
1,2,4-trichlorobenzene	µg/M3	11,091	0.0117

Reduction in VOCS:	days	0	1	13	18	
	Lbs/Hour	--	0.38	0.05	0.0032	
	Total hours	0	24	312	432	
	Total pounds VOCs	0	9.02	15.55	1.39	25.95

TABLE 6.7

GROUNDWATER ELEVATIONS
FRONTIER CHEMICAL SITE

Well ID	*Top of Casing (ft)*	*Depth to Water (ft)*	*GW Elevation*
		4/24/2009	
BH87-A		7.52	
BH87-B		14.25	
BH87-C		7.46	
BH87-D		7.59	
BH87-2B	573.23	25.22	548.01
MW-01-1OB	573.26	6.08	567.18
MW-01-8A		21.82	
MW-1C-08	572.22	18.31	553.91
MW-1D-08	572.67	18.73	553.94
MW-1E-08	572.40	17.56	554.84
MW-2C-08	572.76	19.32	553.44
MW-2D-08	572.70	18.37	554.33
MW-2E-08	573.29	18.10	555.19
MW-3C-08	572.60	18.40	554.20
MW-3D-08	572.83	18.42	554.41
MW-3E-08	572.74	17.61	555.13
MW-5	573.53	6.79	566.74
MW-7 R	574.42	5.97	568.45
MW-11	574.14	26.78	547.36
MW-12	573.82	27.44	546.38
MW-17	572.73	15.02	557.71
MW-88-1A	572.9	15.19	557.71
MW-88-1B	572.88	22.97	549.91
MW-88-1OB	573.15	4.04	569.11
MW-88-2A R	574.62	18.75	555.87
MW-88-2B	573.66	24.66	549.00
MW-88-2OB	574.81	5.35	569.46
MW-88-3A	573.44	DRY	<556.74
MW-88-3A R	573.72	18.35	555.37
MW-88-3B	575.08	27.48	547.60
MW-88-4A	573.37	14.23	559.14
MW-88-4B	573.32	20.25	553.07
MW-88-4C	573.22	18.26	554.96
MW-88-4OB	573.14	4.26	568.88
MW-88-5B	573.80	24.91	548.89
MW-88-5C	575.05	20.25	554.80
MW-88-5OB R		4.81	
MW-88-6A	574.04	21.77	552.27
MW-88-6B	574.58	28.13	546.45
MW-88-6OB	573.75	9.69	564.06
MW-88-7A	572.45	DRY	<556.85
MW-88-7A R	573.43	18.02	555.41

TABLE 6.7

GROUNDWATER ELEVATIONS
FRONTIER CHEMICAL SITE

Well ID	*Top of Casing (ft)*	*Depth to Water (ft)*	*GW Elevation*
		4/24/2009	
MW-88-7B	572.58	DRY	<554.68
MW-88-7B R	571.54	24.31	547.23
MW-88-7OB R	573.21	3.16	570.05
MW-88-8A	574.02	18.19	555.83
MW-88-8B	574.04	27.99	546.05
MW-88-8OB	574.30	4.00	570.30
MW-88-9A	573.67	19.99	553.68
MW-88-9B	572.98	DRY	<548.38
MW-88-9-OB	573.63	10.03	563.60
MW-88-10OB	574.78	16.75	558.03
MW-88-10A	574.28	16.67	557.61
MW-88-10B	574.46	4.98	569.48
MW-88-12A	573.35	18.44	554.91
MW-88-12B	572.79	DRY	<548.49
MW-88-12OB	573.39	6.82	566.57
MW-88-13A	573.84	22.30	551.54
MW-88-14A	573.88	16.72	557.16
MW-88-14B	573.83	25.29	548.54
MW-88-14OB		2.86	
MW-90-1A	574.78	17.02	557.76
MW-90-1B	574.46	25.12	549.34
MW-90-1OB	574.96	5.56	569.40

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW1-C-08*	*MW1-C-08*	*MW1-C-08*	*MW1-D-08*
			Sample Name:	*GW-47392-120308-JJW-001*	*GW-47392-033109-JJW-014*	*GW-47392-033109-JJW-015*	*GW-47392-120308-JJW-002*
			Sample Date:	*12/3/2008*	*3/31/2009*	*3/31/2009*	*12/3/2008*
						Duplicate	
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	µg/L	NC	1	0.84 J	**3.1**	**2.6**	**4.0**
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	**10**	1.0 U	0.65 J	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 UJ	1.0 UJ	1.0 U
cis-1,2-Dichloroethene	µg/L	NC	5	1.0 U	1.6	1.2	1.6
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.1	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	--	1.0 U	1.0 U	--
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	1.0 U	--	--	1.0 U

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW1-C-08*	*MW1-C-08*	*MW1-C-08*	*MW1-D-08*
			Sample Name:	*GW-47392-120308-JJW-001*	*GW-47392-033109-JJW-014*	*GW-47392-033109-JJW-015*	*GW-47392-120308-JJW-002*
			Sample Date:	*12/3/2008*	*3/31/2009*	*3/31/2009*	*12/3/2008*
						Duplicate	
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methyl cyclohexane	µg/L	NC	NC	1.8	1.0 U	1.0 U	1.9
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	µg/L	NC	5	1.6	4.7 J	**9.8 J**	1.2
Total Monochlorotoluenes	µg/L	NC	NC	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	0.89 J
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	1.0 U	1.5	0.97 J	1.8
Xylene (total)	µg/L	NC	NC	3.0 U	2.0 U	2.0 U	3.0 U
Total VOCs	µg/L	NC	NC	15.34	10.9	15.22	11.39

Notes:

6.24 Concentration exceed NYS TOGS.
U - Not present at or above the associated MDL.
J - Estimated concentration between the MDL and Reporting Limit.
MDL - Method detection limit
NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW1-D-08*	*MW1-E-08*	*MW1-E-08*	*MW1-E-08*
			Sample Name:	*GW-47392-033109-JJW-013*	*GW-47392-120308-JJW-003*	*GW-47392-120308-JJW-004*	*GW-47392-040109-JJW-016*
			Sample Date:	*3/31/2009*	*12/3/2008*	*12/3/2008*	*4/1/2009*
						Duplicate	
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	µg/L	NC	1	**3.4**	1.0 U	1.0 U	1.0 U
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	0.44 J
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	1.0 U	0.90 J	0.89 J	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 UJ	1.0 U	1.0 U	1.0 UJ
cis-1,2-Dichloroethene	µg/L	NC	5	2.1	**5.6**	**5.8**	**11**
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	1.0 U	--	--	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	--	1.0 U	1.0 U	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW1-D-08*	*MW1-E-08*	*MW1-E-08*	*MW1-E-08*
			Sample Name:	*GW-47392-033109-JJW-013*	*GW-47392-120308-JJW-003*	*GW-47392-120308-JJW-004*	*GW-47392-040109-JJW-016*
			Sample Date:	*3/31/2009*	*12/3/2008*	*12/3/2008*	*4/1/2009*
						Duplicate	
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 UJ	1.0 U	1.0 U	1.0 U
Methyl cyclohexane	µg/L	NC	NC	1.0 U	0.84 J	0.97 J	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	1.0 U	1.4	1.6	2.9
Toluene	µg/L	NC	5	1.0	1.4	1.5	2.1
Total Monochlorotoluenes	µg/L	NC	NC	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	µg/L	NC	5	0.97 J	1.0 U	1.0 U	1.0 U
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	1.0 U	4.5	4.9	**20**
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 UJ	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	1.0 U	1.0 U	1.0 U	1.0 U
Xylene (total)	µg/L	NC	NC	2.0 U	3.0 U	3.0 U	2.0 U
Total VOCs	µg/L	NC	NC	7.47	14.64	15.66	36.44

Notes:

6.24 Concentration exceed NYS TOGS.

U - Not present at or above the associated MDL.

J - Estimated concentration between the MDL and Reporting Limit.

MDL - Method detection limit

NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW2-C-08*	*MW2-C-08*	*MW2-D-08*	*MW2-D-08*
			Sample Name:	*GW-47392-120508-JJW-011*	*GW-47392-040309-JJW-023*	*GW-47392-120508-JJW-009*	*GW-47392-040309-JJW-022*
			Sample Date:	*12/5/2008*	*4/3/2009*	*12/5/2008*	*4/3/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 UJ	1.0 U	1.9 J	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.5	1.5	**8.8**	**8.9**
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	2.3	**3.1**	**120**	**110**
1,4-Dichlorobenzene	µg/L	NC	3	**3.6**	**4.0**	**70**	**78**
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 UJ	5.0 U	5.0 UJ	5.0 U
Benzene	µg/L	NC	1	**33**	**30**	**38**	**46**
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	0.57 J	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	**24**	**26**	**550**	**460**
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	1.0 U	1.0 U	1.0 U	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	µg/L	NC	5	2.8	2.6	0.90 J	0.81 J
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	--	1.0 U	--	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	1.0 U	--	1.0 U	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW2-C-08*	*MW2-C-08*	*MW2-D-08*	*MW2-D-08*
			Sample Name:	*GW-47392-120508-JJW-011*	*GW-47392-040309-JJW-023*	*GW-47392-120508-JJW-009*	*GW-47392-040309-JJW-022*
			Sample Date:	*12/5/2008*	*4/3/2009*	*12/5/2008*	*4/3/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ
Methyl cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	µg/L	NC	5	1.0	1.0 U	1.0	0.86 J
Total Monochlorotoluenes	µg/L	NC	NC	2	2.3	87	92
trans-1,2-Dichloroethene	µg/L	NC	5	0.80 J	0.61 J	1.0 U	1.0 U
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	0.63 J	0.52 J	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	2.0	**3.0**	1.5	1.7
Xylene (total)	µg/L	NC	NC	3.0 U	2.0 U	3.0 U	2.0 U
Total VOCs	µg/L	NC	NC	74.2	73.63	879.1	798.27

Notes:

6.24 Concentration exceed NYS TOGS.
U - Not present at or above the associated MDL.
J - Estimated concentration between the MDL and Reporting Limit.
MDL - Method detection limit
NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW2-E-08*	*MW2-E-08*	*MW3-C-08*	*MW3-C-08*
			Sample Name:	*GW-47392-120508-JJW-010*	*GW-47392-040309-JJW-024*	*GW-47392-120408-JJW-006*	*GW-47392-040109-JJW-019*
			Sample Date:	*12/5/2008*	*4/3/2009*	*12/4/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	0.46 J	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 UJ	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	0.54 J	0.58 J
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	0.62 J	0.58 J	0.50 J	0.47 J
1,4-Dichlorobenzene	µg/L	NC	3	0.51 J	0.62 J	1.0	1.2
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	µg/L	NC	1	1.0 U	1.0 U	0.83 J	1.0 U
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	1.4	1.6	1.3	1.1
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	0.89 J	1.0 U	0.60 J	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 UJ
cis-1,2-Dichloroethene	µg/L	NC	5	**13 J**	**20**	1.8	1.9
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	--	1.0 U	--	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	1.0 U	--	1.0 U	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW2-E-08*	*MW2-E-08*	*MW3-C-08*	*MW3-C-08*
			Sample Name:	*GW-47392-120508-JJW-010*	*GW-47392-040309-JJW-024*	*GW-47392-120408-JJW-006*	*GW-47392-040109-JJW-019*
			Sample Date:	*12/5/2008*	*4/3/2009*	*12/4/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 U	1.0 UJ	1.0 U	1.0 U
Methyl cyclohexane	µg/L	NC	NC	0.76 J	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	**6.7**	**14**	1.0 U	1.0 U
Toluene	µg/L	NC	5	0.57 J	1.0 U	1.0 U	1.0 U
Total Monochlorotoluenes	µg/L	NC	NC	1 UJ	1 U	0.67 J	0.56 J
trans-1,2-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	0.54 J	0.73 J
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	**22**	**99**	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	1.0 U	1.0 U	1.5	1.0 U
Xylene (total)	µg/L	NC	NC	3.0 U	2.0 U	3.0 U	2.0 U
Total VOCs	µg/L	NC	NC	46.45	136.26	9.28	6.54

Notes:

6.24 Concentration exceed NYS TOGS.
U - Not present at or above the associated MDL.
J - Estimated concentration between the MDL and Reporting Limit.
MDL - Method detection limit
NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW3-D-08*	*MW3-D-08*	*MW3-E-08*	*MW3-E-08*
			Sample Name:	*GW-47392-120408-JJW-008*	*GW-47392-040109-JJW-021*	*GW-47392-120408-JJW-007*	*GW-47392-040109-JJW-020*
			Sample Date:	*12/4/2008*	*4/1/2009*	*12/4/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	0.91 J	1.8	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	**16**	**18**	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	**48**	**52**	1.0 U	1.0 U
1,4-Dichlorobenzene	µg/L	NC	3	**32**	**35**	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	µg/L	NC	1	**55**	**57**	**2.0**	**3.0**
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	**74**	**71**	1.0 U	3.0
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	1.0 U	1.0 U	1.0 U	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 UJ	1.0 U	1.0 UJ
cis-1,2-Dichloroethene	µg/L	NC	5	**26**	**31**	1.8	1.1
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	--	1.0 U	--	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	1.0 U	--	1.0 U	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW3-D-08*	*MW3-D-08*	*MW3-E-08*	*MW3-E-08*
			Sample Name:	*GW-47392-120408-JJW-008*	*GW-47392-040109-JJW-021*	*GW-47392-120408-JJW-007*	*GW-47392-040109-JJW-020*
			Sample Date:	*12/4/2008*	*4/1/2009*	*12/4/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methyl cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	**6.0**	**5.1**	1.0 U	1.0 U
Toluene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Total Monochlorotoluenes	µg/L	NC	NC	28	29	1 U	1 U
trans-1,2-Dichloroethene	µg/L	NC	5	1.3	0.88 J	0.89 J	0.75 J
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	**22**	**12**	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	**3.9**	**4.3**	1.5	1.0 U
Xylene (total)	µg/L	NC	NC	3.0 U	2.0 U	3.0 U	2.0 U
Total VOCs	µg/L	NC	NC	313.11	317.08	6.19	7.85

Notes:

6.24 Concentration exceed NYS TOGS.

U - Not present at or above the associated MDL.

J - Estimated concentration between the MDL and Reporting Limit.

MDL - Method detection limit

NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW88-4C*	*MW88-4C*	*MW88-5C*	*MW88-5C*
			Sample Name:	*GW-47392-120408-JJW-005*	*GW-47392-040109-JJW-018*	*GW-47392-120508-JJW-012*	*GW-47392-040109-JJW-017*
			Sample Date:	*12/4/2008*	*4/1/2009*	*12/5/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 UJ	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	0.70 J	0.53 J
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.1	0.42 J
1,4-Dichlorobenzene	µg/L	NC	3	1.0 U	1.0 U	1.5	0.97 J
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U	5.0 UJ	5.0 U
Benzene	µg/L	NC	1	**2.1**	**2.5**	**2.5**	**2.4**
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	0.45 J	1.0 U	0.51 J
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	1.0 U	1.0 U	3.5	2.0
Chloroethane	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	1.0 U	1.0 U	1.0 U	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 UJ	1.0 U	1.0 UJ
cis-1,2-Dichloroethene	µg/L	NC	5	0.51 J	0.62 J	4.0	4.5
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	--	1.0 U	--	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	1.0 U	--	1.0 U	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*MW88-4C*	*MW88-4C*	*MW88-5C*	*MW88-5C*
			Sample Name:	*GW-47392-120408-JJW-005*	*GW-47392-040109-JJW-018*	*GW-47392-120508-JJW-012*	*GW-47392-040109-JJW-017*
			Sample Date:	*12/4/2008*	*4/1/2009*	*12/5/2008*	*4/1/2009*
		New York State TOGs					
Parameter	*Units*	*Guidance Value*	*Standard*				
Volatile Organic Compounds							
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 U	1.0 U	1.0 UJ	1.0 U
Methyl cyclohexane	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	µg/L	NC	5	1.0 U	0.51 J	1.0 U	1.9
Total Monochlorotoluenes	µg/L	NC	NC	1 U	1 U	1.5	0.57 J
trans-1,2-Dichloroethene	µg/L	NC	5	0.50 J	0.47 J	2.1	2.5
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	1.0 U	1.0 U	0.90 J	1.3
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	1.2	1.0 U	**4.8**	**4.1**
Xylene (total)	µg/L	NC	NC	3.0 U	2.0 U	3.0 U	2.0 U
Total VOCs	µg/L	NC	NC	4.31	4.55	22.6	21.7

Notes:

6.24 Concentration exceed NYS TOGS.

U - Not present at or above the associated MDL.

J - Estimated concentration between the MDL and Reporting Limit.

MDL - Method detection limit

NC - No criteria.

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*OXY 654B*	*OXY 654C*
			Sample Name:	*GW-47392-040309-JJW-025*	*GW-47392-040309-JJW-026*
			Sample Date:	*4/3/2009*	*4/3/2009*
		New York State TOGs			
Parameter	*Units*	*Guidance Value*	*Standard*		
Volatile Organic Compounds					
1,1,1-Trichloroethane	µg/L	NC	5	1.0 U	0.52 J
1,1,2,2-Tetrachloroethane	µg/L	NC	5	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	NC	1	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	NC	5	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	NC	5	1.0 U	0.70 J
1,2,4-Trichlorobenzene	µg/L	NC	5	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	NC	0.04	1.0 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	NC	0.0006	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	NC	3	1.4	1.0 U
1,2-Dichloroethane	µg/L	NC	0.6	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	NC	1	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	NC	3	1.0	1.0 U
1,4-Dichlorobenzene	µg/L	NC	3	2.7	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	50	NC	5.0 U	5.0 U
2-Hexanone	µg/L	50	NC	5.0 U	5.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	NC	NC	5.0 U	5.0 U
Acetone	µg/L	50	NC	5.0 U	5.0 U
Benzene	µg/L	NC	1	1.0 U	1.0 U
Bromodichloromethane	µg/L	50	NC	1.0 U	1.0 U
Bromoform	µg/L	50	NC	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	NC	5	1.0 U	1.0 U
Carbon disulfide	µg/L	60	NC	1.0 U	1.0 U
Carbon tetrachloride	µg/L	NC	5	1.0 U	1.0 U
Chlorobenzene	µg/L	NC	5	**5.4**	0.49 J
Chloroethane	µg/L	NC	5	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	NC	7	1.0 U	1.0 U
Chloromethane (Methyl Chloride)	µg/L	NC	5	1.0 U	1.0 U
cis-1,2-Dichloroethene	µg/L	NC	5	**29**	**23**
cis-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U
Cyclohexane	µg/L	NC	NC	1.0 U	1.0 U
Dibromochloromethane	µg/L	50	NC	1.0 U	1.0 U
Dibromodifluoromethane	µg/L	NC	NC	1.0 U	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	NC	5	--	--

TABLE 6.8

SUMMARY OF DEEP GROUNDWATER ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

			Location ID:	*OXY 654B*	*OXY 654C*
			Sample Name:	*GW-47392-040309-JJW-025*	*GW-47392-040309-JJW-026*
			Sample Date:	*4/3/2009*	*4/3/2009*
		New York State TOGs			
Parameter	*Units*	*Guidance Value*	*Standard*		
Volatile Organic Compounds					
Ethylbenzene	µg/L	NC	5	1.0 U	1.0 U
Isopropylbenzene	µg/L	NC	5	1.0 U	1.0 U
Methyl acetate	µg/L	NC	NC	1.0 UJ	1.0 UJ
Methyl cyclohexane	µg/L	NC	NC	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	10	NC	1.0 U	1.0 U
Methylene chloride	µg/L	NC	5	1.0 U	1.0 U
Styrene	µg/L	NC	5	1.0 U	1.0 U
Tetrachloroethene	µg/L	NC	5	2.4	**29**
Toluene	µg/L	NC	5	1.0 U	1.0 U
Total Monochlorotoluenes	µg/L	NC	NC	1.4	1 U
trans-1,2-Dichloroethene	µg/L	NC	5	1.0 U	1.0 U
trans-1,3-Dichloropropene	µg/L	NC	NC	1.0 U	1.0 U
Trichloroethene	µg/L	NC	5	**13**	**110**
Trichlorofluoromethane (CFC-11)	µg/L	NC	5	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	NC	5	1.0 U	1.0 U
Vinyl chloride	µg/L	NC	2	**2.3**	1.0 U
Xylene (total)	µg/L	NC	NC	2.0 U	2.0 U
Total VOCs	µg/L	NC	NC	58.6	163.71

Notes:

6.24 Concentration exceed NYS TOGS.
U - Not present at or above the associated MDL.
J - Estimated concentration between the MDL and Reporting Limit.
MDL - Method detection limit
NC - No criteria.

TABLE 6.9

FREQUENCY OF DETECTION
C ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Frequency of Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
December 2008					
VOCs by Method OLM04.2					
1,1,1-Trichloroethane	0/5	0	-	-	5
1,1,2,2-Tetrachloroethane	0/5	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/5	0	-	-	1
1,1-Dichloroethane	0/5	0	-	-	5
1,1-Dichloroethene	0/5	0	-	-	5
1,2,4-Trichlorobenzene	0/5	0	-	-	5
1,2-Dibromo-3-chloropropane (DBCP)	0/5	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/5	0	-	-	0.0006
1,2-Dichlorobenzene	3/5	0	0.54	1.5	3
1,2-Dichloroethane	0/5	0	-	-	0.6
1,2-Dichloropropane	0/5	0	-	-	1
1,3-Dichlorobenzene	3/5	0	0.5	2.3	3
1,4-Dichlorobenzene	3/5	1	1	3.6	3
2-Butanone	0/5	0	-	-	50
2-Hexanone	0/5	0	-	-	50*
4-Methyl-2-pentanone	0/5	0	-	-	50*
Acetone	0/5	0	-	-	50
Benzene	5/5	3	0.83	33	1
Bromodichloromethane	0/5	0	-	-	50
Bromoform	0/5	0	-	-	50
Bromomethane (Methyl Bromide)	0/5	0	-	-	5
Carbon disulfide	1/5	0	0.57	0.57	60
Carbon tetrachloride	0/5	0	-	-	5
Chlorobenzene	3/5	1	1.3	24	5
Chloroethane	0/5	0	-	-	5
Chloroform	2/5	1	0.6	10	7
Chloromethane (Methyl Chloride)	0/5	0	-	-	5
cis-1,2-Dichloroethene	4/5	0	0.51	4	5
cis-1,3-Dichloropropene	0/5	0	-	-	0.4**
Cyclohexane	1/5	0	1.1	1.1	50*
Dibromochloromethane	0/5	0	-	-	50
Dibromodifluoromethane	-	-	-	-	-
Dichlorodifluoromethane (CFC-12)	0/5	0	-	-	5
Ethylbenzene	0/5	0	-	-	5
Isopropylbenzene	0/5	0	-	-	5
Methyl acetate	0/5	0	-	-	50*
Methyl cyclohexane	1/5	0	1.8	1.8	50*
Methyl Tert Butyl Ether	0/5	0	-	-	10
Methylene chloride	0/5	0	-	-	5
Styrene	0/5	0	-	-	5
Tetrachloroethene	0/5	0	-	-	5
Toluene	2/5	0	1	1.6	5
Total Monochlorotoluenes	3/5	0	0.67	2	5
trans-1,2-Dichloroethene	4/5	0	0.5	2.1	5
trans-1,3-Dichloropropene	0/5	0	-	-	0.4**
Trichloroethene	2/5	0	0.63	0.9	5
Trichlorofluoromethane (CFC-11)	0/5	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/5	0	-	-	-
Vinyl chloride	4/5	1	1.2	4.8	2
Xylenes, total	0/5	0	-	-	5

TABLE 6.9

FREQUENCY OF DETECTION
C ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Frequency of Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
<u>March/April 2009</u>					
<u>VOCs by Method OLM04.2</u>					
1,1,1-Trichloroethane	1/6	0	0.52	0.52	5
1,1,2,2-Tetrachloroethane	0/6	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/6	0	-	-	1
1,1-Dichloroethane	0/6	0	-	-	5
1,1-Dichloroethene	1/6	0	0.7	0.7	5
1,2,4-Trichlorobenzene	0/6	0	-	-	5
1,2-Dibromo-3-chloropropane (DBCP)	0/6	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/6	0	-	-	0.0006
1,2-Dichlorobenzene	3/6	0	0.53	1.5	3
1,2-Dichloroethane	0/6	0	-	-	0.6
1,2-Dichloropropane	0/6	0	-	-	1
1,3-Dichlorobenzene	3/6	1	0.42	3.1	3
1,4-Dichlorobenzene	3/6	1	0.97	4	3
2-Butanone	0/6	0	-	-	50
2-Hexanone	0/6	0	-	-	50*
4-Methyl-2-pentanone	0/6	0	-	-	50*
Acetone	0/6	0	-	-	50
Benzene	4/6	5	2.9	30	1
Bromodichloromethane	0/6	0	-	-	50
Bromoform	0/6	0	-	-	50
Bromomethane (Methyl Bromide)	0/6	0	-	-	5
Carbon disulfide	2/6	0	0.45	0.51	60
Carbon tetrachloride	0/6	0	-	-	5
Chlorobenzene	4/6	1	0.49	26	5
Chloroethane	0/6	0	-	-	5
Chloroform	1/6	0	0.65	0.65	7
Chloromethane (Methyl Chloride)	0/6	0	-	-	5
cis-1,2-Dichloroethene	6/6	1	0.62	23	5
cis-1,3-Dichloropropene	0/6	0	-	-	0.4**
Cyclohexane	0/6	0	-	-	50*
Dibromochloromethane	0/6	0	-	-	50
Dibromodifluoromethane	0/6	0	-	-	-
Dichlorodifluoromethane (CFC-12)	-	-	-	-	5
Ethylbenzene	0/6	0	-	-	5
Isopropylbenzene	0/6	0	-	-	5
Methyl acetate	0/6	0	-	-	50*
Methyl cyclohexane	0/6	0	-	-	50*
Methyl Tert Butyl Ether	0/6	0	-	-	10
Methylene chloride	0/6	0	-	-	5
Styrene	0/6	0	-	-	5
Tetrachloroethene	1/6	1	29	29	5
Toluene	3/6	1	0.51	7.3	5
Total Monochlorotoluenes	3/6	0	0.56	2.3	5
trans-1,2-Dichloroethene	4/6	0	0.47	2.5	5
trans-1,3-Dichloropropene	0/6	0	-	-	0.4**
Trichloroethene	3/7	1	0.52	110	5
Trichlorofluoromethane (CFC-11)	0/6	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/6	0	-	-	-
Vinyl chloride	4/7	2	0.97	4.1	2
Xylenes, total	0/6	0	-	-	5

TABLE 6.10

FREQUENCY OF DETECTION
D ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Frequency of Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
<u>*December 2008*</u>					
<u>VOCs by Method OLM04.2</u>					
1,1,1-Trichloroethane	0/3	0	-	-	5
1,1,2,2-Tetrachloroethane	0/3	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/3	0	-	-	1
1,1-Dichloroethane	0/3	0	-	-	5
1,1-Dichloroethene	0/3	0	-	-	5
1,2,4-Trichlorobenzene	2/3	0	0.91	1.9	5
1,2-Dibromo-3-chloropropane (DBCP)	0/3	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/3	0	-	-	0.0006
1,2-Dichlorobenzene	2/3	2	8.8	16	3
1,2-Dichloroethane	0/3	0	-	-	0.6
1,2-Dichloropropane	0/3	0	-	-	1
1,3-Dichlorobenzene	2/3	2	48	120	3
1,4-Dichlorobenzene	2/3	2	32	70	3
2-Butanone	0/3	0	-	-	50
2-Hexanone	0/3	0	-	-	50*
4-Methyl-2-pentanone	0/3	0	-	-	50*
Acetone	0/3	0	-	-	50
Benzene	3/3	3	4	55	1
Bromodichloromethane	0/3	0	-	-	50
Bromoform	0/3	0	-	-	50
Bromomethane (Methyl Bromide)	0/3	0	-	-	5
Carbon disulfide	0/3	0	-	-	60
Carbon tetrachloride	0/3	0	-	-	5
Chlorobenzene	2/3	2	74	550	5
Chloroethane	0/3	0	-	-	5
Chloroform	0/3	0	-	-	7
Chloromethane (Methyl Chloride)	0/3	0	-	-	5
cis-1,2-Dichloroethene	3/3	1	0.9	26	5
cis-1,3-Dichloropropene	0/3	0	-	-	0.4**
Cyclohexane	0/3	0	-	-	50*
Dibromochloromethane	0/3	0	-	-	50
Dibromodifluoromethane	-	-	-	-	-
Dichlorodifluoromethane (CFC-12)	0/3	0	-	-	5
Ethylbenzene	0/3	0	-	-	5
Isopropylbenzene	0/3	0	-	-	5
Methyl acetate	0/3	0	-	-	50*
Methyl cyclohexane	1/3	0	1.9	1.9	50*
Methyl Tert Butyl Ether	0/3	0	-	-	10
Methylene chloride	0/3	0	-	-	5
Styrene	0/3	0	-	-	5
Tetrachloroethene	1/3	1	6	6	5
Toluene	2/3	0	1	1.2	5
Total Monochlorotoluenes	2/3	2	28	87	5
trans-1,2-Dichloroethene	2/3	0	0.89	1.3	5
trans-1,3-Dichloropropene	0/3	0	-	-	0.4**
Trichloroethene	1/3	1	22	22	5
Trichlorofluoromethane (CFC-11)	0/3	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/3	0	-	-	-
Vinyl chloride	3/3	1	1.5	3.9	2
Xylenes, total	0/3	0	-	-	5

TABLE 6.10

FREQUENCY OF DETECTION
D ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Frequency of Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
<u>March/April 2009</u>					
<u>VOCs by Method OLM04.2</u>					
1,1,1-Trichloroethane	0/3	0	-	-	5
1,1,2,2-Tetrachloroethane	0/3	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/3	0	-	-	1
1,1-Dichloroethane	0/3	0	-	-	5
1,1-Dichloroethene	0/3	0	-	-	5
1,2,4-Trichlorobenzene	1/3	0	1.8	1.8	5
1,2-Dibromo-3-chloropropane (DBCP)	0/3	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/3	0	-	-	0.0006
1,2-Dichlorobenzene	2/3	2	8.9	18	3
1,2-Dichloroethane	0/3	0	-	-	0.6
1,2-Dichloropropane	0/3	0	-	-	1
1,3-Dichlorobenzene	2/3	2	52	110	3
1,4-Dichlorobenzene	2/3	2	32	70	3
2-Butanone	0/3	0	-	-	50
2-Hexanone	0/3	0	-	-	50*
4-Methyl-2-pentanone	0/3	0	-	-	50*
Acetone	0/3	0	-	-	50
Benzene	3/3	3	3.4	57	1
Bromodichloromethane	0/3	0	-	-	50
Bromoform	0/3	0	-	-	50
Bromomethane (Methyl Bromide)	0/3	0	-	-	5
Carbon disulfide	0/3	0	-	-	60
Carbon tetrachloride	0/3	0	-	-	5
Chlorobenzene	2/3	2	71	460	5
Chloroethane	0/3	0	-	-	5
Chloroform	0/3	0	-	-	7
Chloromethane (Methyl Chloride)	0/3	0	-	-	5
cis-1,2-Dichloroethene	3/3	1	0.81	31	5
cis-1,3-Dichloropropene	0/3	0	-	-	0.4**
Cyclohexane	0/3	0	-	-	50*
Dibromochloromethane	0/3	0	-	-	50
Dibromodifluoromethane	0/3	0	-	-	-
Dichlorodifluoromethane (CFC-12)	-	-	-	-	5
Ethylbenzene	0/3	0	-	-	5
Isopropylbenzene	0/3	0	-	-	5
Methyl acetate	0/3	0	-	-	50*
Methyl cyclohexane	0/3	0	-	-	50*
Methyl Tert Butyl Ether	0/3	0	-	-	10
Methylene chloride	0/3	0	-	-	5
Styrene	0/3	0	-	-	5
Tetrachloroethene	1/3	1	5.1	5.1	5
Toluene	2/3	0	0.86	1	5
Total Monochlorotoluenes	2/3	2	29	92	5
trans-1,2-Dichloroethene	2/3	0	0.88	0.97	5
trans-1,3-Dichloropropene	0/3	0	-	-	0.4**
Trichloroethene	1/3	1	12	12	5
Trichlorofluoromethane (CFC-11)	0/3	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/3	0	-	-	-
Vinyl chloride	2/3	1	1.7	4.3	2
Xylenes, total	0/3	0	-	-	5

TABLE 6.11

FREQUENCY OF DETECTION
E ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
December 2008					
VOCs by Method OLM04.2					
1,1,1-Trichloroethane	0/3	0	-	-	5
1,1,2,2-Tetrachloroethane	0/3	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/3	0	-	-	1
1,1-Dichloroethane	0/3	0	-	-	5
1,1-Dichloroethene	0/3	0	-	-	5
1,2,4-Trichlorobenzene	0/3	0	-	-	5
1,2-Dibromo-3-chloropropane (DBCP)	0/3	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/3	0	-	-	0.0006
1,2-Dichlorobenzene	0/3	0	-	-	3
1,2-Dichloroethane	0/3	0	-	-	0.6
1,2-Dichloropropane	0/3	0	-	-	1
1,3-Dichlorobenzene	1/3	0	0.62	0.62	3
1,4-Dichlorobenzene	1/3	0	0.51	0.51	3
2-Butanone	0/3	0	-	-	50
2-Hexanone	0/3	0	-	-	50*
4-Methyl-2-pentanone	0/3	0	-	-	50*
Acetone	0/3	0	-	-	50
Benzene	1/3	1	2	2	1
Bromodichloromethane	0/3	0	-	-	50
Bromoform	0/3	0	-	-	50
Bromomethane (Methyl Bromide)	0/3	0	-	-	5
Carbon disulfide	0/3	0	-	-	60
Carbon tetrachloride	0/3	0	-	-	5
Chlorobenzene	1/3	0	1.4	1.4	5
Chloroethane	0/3	0	-	-	5
Chloroform	2/3	0	0.89	0.9	7
Chloromethane (Methyl Chloride)	0/3	0	-	-	5
cis-1,2-Dichloroethene	3/3	3	1.8	13	5
cis-1,3-Dichloropropene	0/3	0	-	-	0.4**
Cyclohexane	0/3	0	-	-	50*
Dibromochloromethane	0/3	0	-	-	50
Dibromodifluoromethane	-	-	-	-	-
Dichlorodifluoromethane (CFC-12)	0/3	0	-	-	5
Ethylbenzene	0/3	0	-	-	5
Isopropylbenzene	0/3	0	-	-	5
Methyl acetate	0/3	0	-	-	50*
Methyl cyclohexane	2/3	0	0.76	0.91	50*
Methyl Tert Butyl Ether	0/3	0	-	-	10
Methylene chloride	0/3	0	-	-	5
Styrene	0/3	0	-	-	5
Tetrachloroethene	2/3	1	1.5	6.7	5
Toluene	2/3	0	0.57	1.5	5
Total Monochlorotoluenes	0/3	0	-	-	5
trans-1,2-Dichloroethene	1/3	0	0.89	0.89	5
trans-1,3-Dichloropropene	0/3	0	-	-	0.4**
Trichloroethene	2/3	1	4.7	22	5
Trichlorofluoromethane (CFC-11)	0/3	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/3	0	-	-	-
Vinyl chloride	1/3	0	1.5	1.5	2
Xylenes, total	0/3	0	-	-	5

TABLE 6.11

FREQUENCY OF DETECTION
E ZONE
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Analyte	*Frequency of Detection*	*Detection Above Screening Criteria*	*Minimum*	*Maximum*	*Screening Criteria*
<u>March/April 2009</u>					
<u>VOCs by Method OLM04.2</u>					
1,1,1-Trichloroethane	1/3	0	0.46	0.46	5
1,1,2,2-Tetrachloroethane	0/3	0	-	-	5
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	5
1,1,2-Trichlooethane	0/3	0	-	-	1
1,1-Dichloroethane	0/3	0	-	-	5
1,1-Dichloroethene	0/3	0	-	-	5
1,2,4-Trichlorobenzene	0/3	0	-	-	5
1,2-Dibromo-3-chloropropane (DBCP)	0/3	0	-	-	0.04
1,2-Dibromoethane (Ehtylene Dibromide)	0/3	0	-	-	0.0006
1,2-Dichlorobenzene	0/3	0	-	-	3
1,2-Dichloroethane	0/3	0	-	-	0.6
1,2-Dichloropropane	0/3	0	-	-	1
1,3-Dichlorobenzene	1/3	0	0.58	0.58	3
1,4-Dichlorobenzene	1/3	0	0.62	0.62	3
2-Butanone	0/3	0	-	-	50
2-Hexanone	0/3	0	-	-	50*
4-Methyl-2-pentanone	0/3	0	-	-	50*
Acetone	0/3	0	-	-	50
Benzene	1/3	1	3	3	1
Bromodichloromethane	0/3	0	-	-	50
Bromoform	0/3	0	-	-	50
Bromomethane (Methyl Bromide)	0/3	0	-	-	5
Carbon disulfide	0/3	0	-	-	60
Carbon tetrachloride	0/3	0	-	-	5
Chlorobenzene	3/3	0	0.44	3	5
Chloroethane	0/3	0	-	-	5
Chloroform	0/3	0	-	-	7
Chloromethane (Methyl Chloride)	0/3	0	-	-	5
cis-1,2-Dichloroethene	3/3	2	1.1	20	5
cis-1,3-Dichloropropene	0/3	0	-	-	0.4**
Cyclohexane	0/3	0	-	-	50*
Dibromochloromethane	0/3	0	-	-	50
Dibromodifluoromethane	0/3	0	-	-	-
Dichlorodifluoromethane (CFC-12)	-	-	-	-	5
Ethylbenzene	0/3	0	-	-	5
Isopropylbenzene	0/3	0	-	-	5
Methyl acetate	0/3	0	-	-	50*
Methyl cyclohexane	0/3	0	-	-	50*
Methyl Tert Butyl Ether	0/3	0	-	-	10
Methylene chloride	0/3	0	-	-	5
Styrene	0/3	0	-	-	5
Tetrachloroethene	2/3	1	2.9	14	5
Toluene	1/3	0	2.1	2.1	5
Total Monochlorotoluenes	0/3	0	-	-	5
trans-1,2-Dichloroethene	1/3	0	0.75	0.75	5
trans-1,3-Dichloropropene	0/3	0	-	-	0.4**
Trichloroethene	2/3	2	20	99	5
Trichlorofluoromethane (CFC-11)	0/3	0	-	-	5
Trifluorotrichloromethane (Freon 113)	0/3	0	-	-	-
Vinyl chloride	0/3	0	-	-	2
Xylenes, total	0/3	0	-	-	5

TABLE 6.12

ESTIMATED TOTAL VOC FLUX
C, D, AND E-ZONES
FRONTIER CHEMICAL SITE, NIAGARA FALLS, NY

Zone	*Property Boundary*	*Boundary Length (ft)*	*Zone Thickness (ft)*	*Zone Gradient*	*Flow Angle*	*Factored Gradient*	*Geometric Mean Hydraulic Conductivity (ft/day)*	*Average TVOC Concentration (µg/L)*	*Mass Flux (lb/day)*
C	East	665	10	0.0013	36°	0.00076	0.96	14	4.3E-06
	South	735	10.5	0.0013	54°	0.0011	0.96	74	3.6E-05
D	East	665	9	0.00075	65°	0.00068	0.71	9	1.6E-06
	North	560	No Well (1)	0.00075	25°	0.00032	0.71	No Well (2)	6.4E-07
E	East	665	8	0.00061	58°	0.00052	6.2	2.6	2.8E-05
	North	560	No Well (1)	0.00061	32°	0.00032	6.2	No Well (2)	1.4E-05

Notes:

(1) - Assume same zone thickness as east well.
(2) - Assume same concentration as east well.

TABLE 6.13

TUNNEL SAMPLE ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

	Location ID:	*Dropshaft 14A*	*MH 47th and Royal*	*MH 47th and Simmons*	*Seep 120*	*Seep 340*	*Seep 450*
	Sample Name:	*SAN-ROYAL-47392-061109*	*SAN-DS-47392-061109*	*SAN-US-47392-061109*	*SEEP120-47392-061009*	*SEEP340-47392-061009*	*SEEP450-47392-061009*
	Sample Date:	*6/11/2009*	*6/11/2009*	*6/11/2009*	*6/10/2009*	*6/10/2009*	*6/10/2009*
Parameters	*Units*						
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	2800	1.0 U	2.0 U	20 U	12 J	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	20 U	25	47	20 U	20 U	0.99 J
1,1,2-Trichloroethane	µg/L	20 U	14	24	20 U	20 U	0.84 J
1,1-Dichloroethane	µg/L	2000	1.0 U	2.0 U	20 U	24	1.0 U
1,1-Dichloroethene	µg/L	60	1.0 U	2.0 U	20 U	24	1.0 U
1,2,4-Trichlorobenzene	µg/L	440	0.95 J	2.0 U	20 U	20 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
1,2-Dichlorobenzene	µg/L	3900	3.0	2.0 U	20 U	270	1.5
1,2-Dichloroethane	µg/L	22	1.0	1.4 J	20 U	20 U	1.0 U
1,2-Dichloropropane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
1,3-Dichlorobenzene	µg/L	2500	3.2	2.0 U	20 U	390	1.7
1,4-Dichlorobenzene	µg/L	3800	3.3	2.0 U	20 U	270	1.5
2-Butanone (Methyl Ethyl Ketone)	µg/L	98 J	63	110	100 U	100 U	5.0 U
2-Chlorotoluene	µg/L	20 U	1.0 U	2.0 U	40 U	200 U	1.0 U
2-Hexanone	µg/L	100 U	5.0 U	10 U	100 U	100 U	5.0 U
3-Chlorotoluene	µg/L	9200	64	2.0 U	3700	14000	1.7
4-Chlorotoluene	µg/L	5900	2.0	2.0 U	40 U	220	1.0 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	110	4.8 J	6.9 J	100 U	100 U	5.0 U
Acetone	µg/L	1200	620	490	100 U	100 U	2.2 J
Benzene	µg/L	2300	2.1	2.0 U	20 U	20 U	1.0 U
Bromodichloromethane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Bromoform	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Carbon disulfide	µg/L	24	1.0	1.2 J	20 U	20 U	0.51 J
Carbon tetrachloride	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Chlorobenzene	µg/L	6800	2.8	2.0 U	20 U	14 J	1.5
Chloroethane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Chloroform (Trichloromethane)	µg/L	20 U	2.8	4.3	20 U	20 U	0.73 J
Chloromethane (Methyl Chloride)	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
cis-1,2-Dichloroethene	µg/L	800	36	5.0	4.2 J	5400	3.1
cis-1,3-Dichloropropene	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Cyclohexane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Dibromochloromethane	µg/L	20 U	2.4	2.0 U	20 U	20 U	1.0 U
Dibromodifluoromethane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U

TABLE 6.13

TUNNEL SAMPLE ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

	Location ID:	*Dropshaft 14A*	*MH 47th and Royal*	*MH 47th and Simmons*	*Seep 120*	*Seep 340*	*Seep 450*
	Sample Name:	*SAN-ROYAL-47392-061109*	*SAN-DS-47392-061109*	*SAN-US-47392-061109*	*SEEP120-47392-061009*	*SEEP340-47392-061009*	*SEEP450-47392-061009*
	Sample Date:	*6/11/2009*	*6/11/2009*	*6/11/2009*	*6/10/2009*	*6/10/2009*	*6/10/2009*
Parameters	*Units*						
Volatile Organic Compounds							
Ethylbenzene	µg/L	24	0.26 J	2.0 U	20 U	20 U	1.0 U
Isopropylbenzene	µg/L	6.4 J	1.0 U	2.0 U	20 U	20 U	1.0 U
Methyl acetate	µg/L	20 U	3.8	4.7	20 U	20 U	1.0 U
Methyl cyclohexane	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Methyl Tert Butyl Ether	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Methylene chloride	µg/L	1400	1.0 U	2.3 J	20 U	20 U	1.0 UJ
Styrene	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Tetrachloroethene	µg/L	1000	1.9	2.0 U	20 U	20 U	1.0 U
Toluene	µg/L	1400	1.0 U	2.0 U	20 U	20 U	1.0 U
Total Monochlorotoluenes	µg/L	15100	66	2 U	3700	14220	1.7
trans-1,2-Dichloroethene	µg/L	43	0.71 J	2.0 U	20 U	44	1.0 U
trans-1,3-Dichloropropene	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Trichloroethene	µg/L	4900	4.0	1.3 J	20 U	4.6 J	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	20 U	1.0 U	2.0 U	20 U	20 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	77	1.0 U	2.0 U	20 U	20 U	1.0 U
Vinyl chloride	µg/L	86	19	2.0 U	20 U	1600	2.3
Xylene (total)	µg/L	120	1.1 J	1.5 J	40 U	40 U	2.0 U

TABLE 6.14

SOIL VAPOR ANALYTICAL RESULTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		Location ID:	*SVP-1*	*SVP-2*	*SVP-3*	*SVP-4*
		Sample Date:	*2/12/2009*	*2/12/2009*	*2/12/2009*	*2/12/2009*
Parameters	*Units*	*NYS Air* (1)				
Volatile Organic Compounds						
1,1,1-Trichloroethane	µg/m^3	--	14.3	4.36 U	10.9 U	2.73 U
1,1,2,2-Tetrachloroethane	µg/m^3	--	3.43 U	5.49 U	13.7 U	3.43 U
1,1,2-Trichloroethane	µg/m^3	--	2.73 U	4.36 U	10.9 U	2.73 U
1,1-Dichloroethane	µg/m^3	--	1.21 J	4.53	8.09 U	2.02 U
1,1-Dichloroethene	µg/m^3	--	1.98 U	3.17 U	7.93 U	1.98 U
1,2,4-Trichlorobenzene	µg/m^3	--	3.71 U	5.94 U	14.8 U	3.71 U
1,2,4-Trimethylbenzene	µg/m^3	--	0.98 J	3.93 U	9.83 U	2.46 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/m^3	--	3.84 U	6.15 U	15.4 U	3.84 U
1,2-Dichlorobenzene	µg/m^3	--	3.01 U	4.81 U	12.0 U	3.01 U
1,2-Dichloroethane	µg/m^3	--	1.98 U	3.17 U	7.93 U	1.98 U
1,2-Dichloropropane	µg/m^3	--	1.16 J	3.70 U	9.24 U	2.31 U
1,2-Dichlorotetrafluoroethane (CFC 114)	µg/m^3	--	3.49 U	5.59 U	14.0 U	3.49 U
1,3,5-Trimethylbenzene	µg/m^3	--	2.46 U	3.93 U	9.83 U	2.46 U
1,3-Dichlorobenzene	µg/m^3	--	3.01 U	4.81 U	12.0 U	3.01 U
1,4-Dichlorobenzene	µg/m^3	--	3.01 U	4.81 U	12.0 U	3.01 U
2-Butanone (Methyl Ethyl Ketone)	µg/m^3	--	708 J	0.88 J	5.90 U	79.6
2-Chlorotoluene	µg/m^3	--	2.59 U	4.14 U	10.4 U	2.59 U
2-Hexanone	µg/m^3	--	77.8	3.28 U	8.19 U	2.87
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/m^3	--	2.05 U	3.28 U	8.20 U	2.05 U
Acetone	µg/m^3	--	4320	47.7	46.3	2050
Benzene	µg/m^3	--	2.40	2.56 U	6.39 U	1.60 U
Bromodichloromethane	µg/m^3	--	3.35 U	5.36 U	13.4 U	3.35 U
Bromoform	µg/m^3	--	5.17 U	8.27 U	20.7 U	5.17 U
Bromomethane (Methyl Bromide)	µg/m^3	--	1.94 U	3.11 U	7.77 U	1.94 U
Carbon disulfide	µg/m^3	--	8.07	2.49 U	4.67 J	1.56 U
Carbon tetrachloride	µg/m^3	--	3.15 U	5.03 U	12.6 U	3.15 U
Chlorobenzene	µg/m^3	--	2.30 U	3.68 U	9.21 U	2.30 U
Chloroethane	µg/m^3	--	1.32 U	2.11 U	5.28 U	1.32 U
Chloroform (Trichloromethane)	µg/m^3	--	1.37 J	3.91 U	9.77 U	2.44 U
Chloromethane (Methyl Chloride)	µg/m^3	--	0.56 J	1.65 U	1.65 J	1.14
cis-1,2-Dichloroethene	µg/m^3	--	1.98 U	3.17 U	7.93 U	1.98 U
cis-1,3-Dichloropropene	µg/m^3	--	2.27 U	3.63 U	9.08 U	2.27 U
Dibromochloromethane	µg/m^3	--	4.26 U	6.82 U	17.0 U	4.26 U
Dichlorodifluoromethane (CFC-12)	µg/m^3	--	1.73 J	3.96 U	9.89 U	1.93 J
Ethylbenzene	µg/m^3	--	1.13 J	3.47 U	8.69 U	2.17 U
Hexachlorobutadiene	µg/m^3	--	5.33 U	8.53 U	21.3 U	5.33 U
m&p-Xylene	µg/m^3	--	2.91	3.47 U	8.69 U	2.17 U
Methyl Tert Butyl Ether	µg/m^3	--	1.80 U	2.88 U	7.21 U	1.80 U
Methylene chloride	µg/m^3	60	2.19	1.60 J	4.17 J	1.29 J
o-Xylene	µg/m^3	--	1.04 J	3.47 U	8.69 U	2.17 U
Styrene	µg/m^3	--	2.13 U	3.41 U	8.52 U	2.13 U
Tetrachloroethene	µg/m^3	100	6.10	5.42 U	13.6 U	3.39 U
Toluene	µg/m^3	--	5.39	3.01 U	7.54 U	2.00
trans-1,2-Dichloroethene	µg/m^3	--	1.98 U	3.17 U	7.93 U	1.98 U
trans-1,3-Dichloropropene	µg/m^3	--	2.27 U	3.63 U	9.08 U	2.27 U
Trichloroethene	µg/m^3	5	11.6	4.30 U	10.7 U	2.69 U
Trichlorofluoromethane (CFC-11)	µg/m^3	--	2.81 U	4.50 U	11.2 U	2.81 U
Trifluorotrichloroethane (Freon 113)	µg/m^3	--	5.44	6.13 U	15.3 U	3.83 U
Vinyl acetate	µg/m^3	--	1.76 U	2.82 U	7.04 U	1.76 U
Vinyl chloride	µg/m^3	--	1.28 U	2.04 U	5.11 U	1.28 U

Notes:

U Not detected at the associated value.

(1) Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final Soil Vapor Intrusion Guidance,
Table 3.1: Air Guideline Values derived by the NYSDOH, New York State Department of Health (NYSDOH), October 2006.
(http://www.health.state.ny.us/environmental/investigations/soil_gas/svi_guidance/)

TABLE 6.15

SOIL VAPOR MATRIX
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

		SVP-1		*SVP-2*		*SVP-3*		*SVP-4*	
		2/12/2009		*2/12/2009*		*2/12/2009*		*2/12/2009*	
Parameters	*Units*		*NYSDOH Matrix (1)*		*NYSDOH Matrix (1)*		*NYSDOH Matrix (1)*		*NYSDOH Matrix (1)*
Volatile Organic Compounds									
1,1,1-Trichloroethane	µg/m^3	**14.3**	a	4.36 U	a	10.9 U	a	2.73 U	a
Carbon tetrachloride	µg/m^3	3.15 U	a	5.03 U	a	12.6 U	a	3.15 U	a
Tetrachloroethene	µg/m^3	**6.1**	a	5.42 U	a	13.6 U	a	3.39 U	a
Trichloroethene	µg/m^3	**11.6**	a	4.30 U	a	10.7 U	a	2.69 U	a

Notes:

U Not detected at the associated value.

(1) Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final Soil Vapor Intrusion Guidance,
New York State Department of Health (NYSDOH), October 2006.
(http://www.health.state.ny.us/environmental/investigations/soil_gas/svi_guidance/)
Note: Matrix is an estimate based solely on available soil vapor concentration.

a no further action

b take reasonable and practical actions to identify source(s) and reduce exposures

c monitor

d mitigate

APPENDIX A

STRATIGRAPHIC LOGS AND FIELD DATA

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.S.)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF OF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES, < 5% FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, < 5% FINES
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, > 12% FINES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, > 12% FINES
	SANDS MORE THAN HALF OF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS	SW	WELL GRADED SANDS, GRAVELLY SANDS, < 5% FINES
			SP	POORLY GRADED SANDS, OR GRAVELLY SAND, < 5% FINES
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES > 12% FINES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES > 12% FINES
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML	INORGANIC SILTS AND VERY FINE SAND, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			OH	ORGANIC CLAYS OF HIGH PLASTICITY

CONVENTIONAL SOIL DESCRIPTIONS

NON-COHESIVE (GRANULAR) SOIL

RELATIVE DENSITY	BLOWS PER FOOT (N-VALUE)
Very loose	less than 5
Loose	5 to 9
Compact	10 to 29
Dense	30 to 50
Very Dense	greater than 50

COHESIVE (CLAYEY) SOIL

CONSISTENCY	BLOWS PER FOOT (N-VALUE)
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	greater than 30

GRAIN SIZE CLASSIFICATION

COBBLES	Greater than 3 inches (76 mm)
GRAVEL	3 in. to No. 4 (4.76 mm)
Coarse Gravel	3 in. to 3/4 in.
Fine Gravel	3/4 in. to No. 4 (4.76 mm)
SAND	No. 4 (4.76 mm) to No. 200 (0.074 mm)
Coarse Sand	No. 4 (4.76 mm) to No. 10 (2.0 mm)
Medium Sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine Sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
SILT	No. 200 (0.074 mm) to 0.002 mm
CLAY	Less than 0.002 mm

NOTE: The "No. __ " refers to the standard sieve sizes.

COMPONENT PERCENTAGE DESCRIPTORS

Noun(s) (e.g. SAND and GRAVEL)	35 to 50%
Adjective (e.g. SANDY)	20 to 35%
With	10 to 20%
Trace	Less than 10%

SOIL STRUCTURE TERMS

Stratified
Laminated
Fissured

Blocky
Lenses/Seams
Homogeneous

DRILLING METHOD: TYPE AND DIAMETER, CORING (NQ, HQ, PQ, ETC), AIR, WATER OR MUD (AND TYPE OF MUD) ROTARY.

DRILLING RATE/CORE RUN: DRILLED RATE FOR EACH DRILLED INTERVAL OR CORE RETRIEVED. LIST START/END TIMES FOR EACH DRILLED INTERVAL OR CORE RUN. DETERMINE RQD AND FRACTURE INDEX FOR CORE. A NEW RQD/FRACTURE INDEX SHOULD BE LISTED IF THE ROCK TYPE CHANGES WITHIN A SINGLE RETRIEVED CORE RUN.

WATER USAGE: RECORD VOLUME OF WATER LOST TO THE FORMATION DURING EACH DRILLED INTERVAL OR CORE RUN.
IF DRILLING WITH AIR, RECORD VOLUME OF WATER RETURNED IN EACH DRILLED INTERVAL.

ROCK DESCRIPTION

FORMATION NAME: TYPICALLY UNIQUE TO AREA AND AGE OF THE ROCK UNIT. SEE LOCAL BEDROCK GEOLOGY MAPS FOR FORMATION NAMES.

ROCK TYPE: SUCH AS DOLOMITE, LIMESTONE, SANDSTONE, SILTSTONE, MUDSTONE, SHALE, PHYLLITE, SCHIST, GABBRO, ETC (THERE ARE MANY OTHER ROCK TYPE NAMES).

BEDDING:

THICK BEDDED	>60 cm (>2 feet)	THICK LAMINATED	0.5 to 1 cm (1/4 to 1/2 inch)
THIN BEDDED	1 cm to 60 cm (0.5 inches to 2 feet)	THIN LAMINATED	<0.5 cm (<1/4 inch)

GRAIN SIZE: SIZE AND SHAPE OF GRAINS AND CRYSTALS, SUCH AS COARSE, MEDIUM, FINE, MICROCRYSTALLINE, AMORPHOUS

TEXTURE/FABRIC: ARENACEOUS, ARGILLACEOUS, FISSILE, INTERBEDDED, MICACEOUS, EQUIGRANULAR, SACCHAROIDAL, NODULAR, CROSS-BEDDED, LAMINATED, BIOCLASTIC, BURROWED, OOLITIC, FOLIATION, CLEAVAGE, ETC.

CEMENTATION: TYPE (SUCH AS SILICA, CALCITE, ETC) AND DEGREE OF CEMENTATION.

FOSSILS: TYPE OF FOSSIL PRESENT, SUCH AS HORN CORAL, COLONIAL CORAL, BRACHIOPOD, GASTROPOD, BRYOZOAN, CRINOID, ETC.

POROSITY: SUCH AS INTERGRANULAR, INTERCRYSTALLINE, INTERFRAGMENTAL, VUGS/VOIDS (SIZE), FOSSIL MOLDS, ETC.

SUPPLEMENTARY DESCRIPTORS: PARTINGS, CRYSTAL VOID INFILLINGS (SIZE OF CRYSTALS AND TYPE, IF KNOWN), STYLOLITES, STRINGERS, MICROFRACTURES (SHORT LENGTH CLOSED FRACTURES), ETC.

THE FOLLOWING ONLY APPLIES TO NATURAL FRACTURES. MECHANICAL FRACTURES CAUSED BY THE DRILLING METHOD ARE COMMON AND CAN BE DETECTED AS THE MECHANICALLY FRACTURED SURFACE WILL BE CLEAN AND THE TWO ADJACENT PIECES WILL FIT BACK TOGETHER VERY CLOSELY. NATURAL FRACTURES OFTEN HAVE WEATHERING/MINERALIZATION ON THE FRACTURE SURFACE OR A ROUGH SURFACE CAUSED BY DISSOLUTION.

FRACTURE DESCRIPTION

FRACTURE TYPE: BEDDING PLANE, CROSS-CUTTING, JOINT (NO MOVEMENT), FAULT (MOVEMENT), PLANAR, ARCUATE.

ORIENTATION: HORIZONTAL, DIPPING (AND DEGREE OF DIP FROM HORIZONTAL), NEAR-VERTICAL, VERTICAL.

SPACING:

VERY CLOSE	<5 cm (<2 inches)
CLOSE	5 to 30 cm (2 inches to 12 inches)
MODERATE	0.3 to 1 metre (1 foot to 3 feet)
WIDE	1 to 3 metres (3 feet to 10 feet)
VERY WIDE	>3 metres (>10 feet)

ROUGHNESS: ROUGH, SMOOTH, SLICKENSIDED, WAVY.

APERTURE: PERPENDICULAR DISTANCE BETWEEN ADJACENT WALLS, TYPICALLY TIGHT (<0.25 mm), OPEN (>0.25 mm), CLOSED (ZERO APERTURE). DRILL CORE PIECES CANNOT BE FIT TOGETHER TO GET AN ACCURATE MEASURE OF APERTURE. APERTURE WIDTH STRONGLY AFFECTED BY DRILLING (WASHING, PLUCKING OF FRACTURE SURFACE).

WEATHERING:
UNWEATHERED - NO VISIBLE WEATHERING
SLIGHTLY WEATHERED - OXIDIZED
MODERATELY WEATHERED - DISCOLOURED INTO ROCK MATRIX
HIGHLY WEATHERED - ROCK MATRIX IS FRIABLE
COMPLETELY WEATHERED - ROCK MATRIX IS SOIL-LIKE

INFILLING: SUCH AS CALCITE, GYPSUM, PYRITE, OR OTHER MINERALIZATION, SANDY, SILTY, CLAYEY, ETC.

RQD: ROCK QUALITY DESIGNATION. CALCULATED AS THE RATIO OF THE SUM OF THE LENGTH OF ALL PIECES OF CORE GREATER THAN 10 cm (4 inches) IN LENGTH (MEASURED ALONG THE CENTERLINE) DIVIDED BY THE TOTAL LENGTH OF THE CORE RUN (NOT THE LENGTH OF THE CORE RECOVERED). NOTE THAT MECHANICAL FRACTURES CAUSED BY THE DRILLING METHOD OR LONG VERTICAL FRACTURES DO NOT COUNT FOR THIS CALCULATION.

FRACTURE INDEX: NUMBER OF FRACTURES PER FOOT OF DRILL CORE , LISTED AS #FRACTURES/FOOT. FOR FRAGMENTED CORE USE "NON-INTACT" (NI).

Note: FOAM PIPE WRAP OR SIMILAR ITEMS ARE USEFUL SPACERS FOR MISSING OR REMOVED CORE.
A NOTE SHOULD BE INCLUDED TO INDICATE THE DEPTH INTERVAL OF CORE REMOVED.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE i OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH1-08
DATE/TIME STARTED 9/16/08
DATE/TIME COMPLETED 9/16/08
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
FROM	AT	TO				6"	6"	6"	6"		(ppm)		
0		0.3	Concrete - auger w/o sampling	1	SS	X	2	3	1	0 /	19.8	-001	
						R=	8"	N=	5	/ 2			
0.3		0.6	SP- medium grained SAND, some gravel, little silt,	2	SS	2	3	3	3	2 /	5.7	-002	
			black and gray, dry (FILL)			R=	10"	N=	6	/ 4			
				3	SS	3	3	3	4	4 /	20.4	-003	
0.6		11.0	ML- SILT, some fine sand, tan, moist			R=	2.0	N=	6	/ 6			
				4	SS	WH	WH	1	1	6 /	70.1	-004/	-009
	6.0		Same with little to some clay			R=	2.0'	N=	1	/ 8			
				5	SS	WH	WH	1	1	8 /	10.8	-005	
	6.2		wet			R=	2.0'	N=	1	/ 10			
				6	SS	WH	4	5	7	10 /	20.2	-006	
11.0		11.4	SP- fine grained SAND, little silt, gray, wet			R=	2.0'	N=	9	/ 12			
				7	SS	6	9	15	17	12 /	41.8	-007	
11.4		13.4	GP- GRAVEL, some medium to coarse grained			R=	1.6'	N=	24	/ 14			
			sand, black stained, wet	8	SS	15	22	50/0	-	14 /	58.6	-008	
						R=	1.0'	N=	>50	/ 16			
13.4			ML- SILT, some clay and gravel, ~~stiff~~, soft										
			red brown with some black staining, moist (TILL)										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH1-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
	14.0		becoming hard, no staining										
	15.0		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH2-08
DATE/TIME STARTED 9/16/08
DATE/TIME COMPLETED 9/16/08
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		0.5	Concrete - auger w/o sampling	1	SS	X	3	4	3	0	NA		
						R=	0	N=	7	2			
0.5		2.0	no recovery	2	SS	4	5	3	2	2	4.3	-010	
						R=	0.5'	N=	8	4			
2.0		6.0	ML-SILT, little fine sand, tan, dry	3	SS	4	5	3	2	4	1.2	-011	
						R=	1.5'	N=	8	6			
6.0		10.9	ML-SILT, some clay, trace sand, tan, dry	4	SS	2	2	2	2	6	8.3	-012	
						R=	2.0'	N=	4	8			
10.9		15.3	ML-SILT, some fine grained sand, little gravel,	5	SS	1	1	1	1	8	24.2	-013	
			red brown, wet (TILL)			R=	2.0'	N=	2	10			
				6	SS	1	2	1	2	10	123	-014	
	14.0		Same with some clay and trace sand			R=	1.2'	N=	3	12			
				7	SS	3	2	1	1	12	91.5	-015	
	15.3		Spoon refusal			R=	2.0	N=	3	14			
				8	SS	17	22	5/4"	X	14	50.0	-016	
						R=		N=		16			

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH3-08
DATE/TIME STARTED 9/17/08
DATE/TIME COMPLETED 9/17/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		1.1	GP-GRAVEL, some medium to coarse grained sand	1	SS	10	10	4	5	0/	10.1	-017	
			and silt, gray to black, moist (Fill)			R=	1.3'	N=	14	/2			
				2	SS	3	5	6	9	2/	27.7	-018	
1.1		4.0	CI-CLAY, little silt, stiff, brown, dry to moist			R=	1.5'	N=	11	/4			
				3	SS	8	5	7	9	4/	18.8	-019	
	2.0	4.0	brown to gray, chemical odor			R=	1.5	N=	12	/6			
				4	SS	7	7	10	11	6/	39.9	-020	
4.0		8.1	ML-SILT, some fine sand, trace clay, stiff,			R=	0.6'	N=	17	/8			
			gray, moist, chemical odor	5	SS	3	4	8	10	8/	53.0	-021	
						R=	0.3	N=	12	/10			
	6.0		wet	6	SS	3	4	3	5	10/	423	-022	
						R=	2.0	N=	7	/12			
8.1		12.0	CI-CLAY, little silt, medium soft, red brown,	7	SS	11	27	25	24	12/	378	-023	
			moist, chemical odor			R=	2.0	N=	52	/14			
				8	SS	27	32	50/1"	x	14/	188	-024	
	11.4	11.8	Sand lens - SP- fine to medium grained sand, some			R=	2.0'	N=	>50	/16			
			silt, gray, moist										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ____________
PROJECT NUMBER ____________
CLIENT ____________
LOCATION ____________

DRILLING CONTRACTOR ____________
DRILLER ____________
SURFACE ELEVATION ____________
WEATHER (A.M.) ____________
(P.M.) ____________

HOLE DESIGNATION BH3-08
DATE/TIME STARTED ____________
DATE/TIME COMPLETED ____________
DRILLING METHOD ____________
CRA SUPERVISOR ____________

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
12.0		14.9	Cl-CLAY, some rounded gravel, chemical odor										
			(TILL)										
14.9		15.1	weathered rock fragments										
	15.1		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____________ TOPSOIL THICKNESS ____________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____________, AFTER _____ HOURS _____
COMPLETION DETAILS: ____________

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

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STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier chemical site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH4-08
DATE/TIME STARTED 9/17/08
DATE/TIME COMPLETED 9/17/08
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO				6"	6"	6"	6"				
0		0.3	Concrete - auger w/o sampling	1	SS	X	3	4	8	0/	21.6		
						R=	0.1'	N=	7	/2			
0.3		2.0	SP- medium grained SAND, trace silt and brick	2	SS	3	2	2	3	2/	33.0		
			fragments, brown and gray, wet (FILL)			R=	2.0'	N=	4	/4			
				3	SS	3	4	6	9	4/	61.3	-025	
2.0		4.3	Cl- CLAY, little silt, stiff, gray, moist			R=	2.0'	N=	10	/6			
				4	SS	9	6	9	8	6/	104	-026	
4.3		12.0	ML- SILT, little clay and fine grained sand,			R=	2.0'	N=	15	/8			
			stiff, gray, moist	5	SS	26	38	40	50/4"	8/	95.1	-027	
						R=	2.0	N=	78	/10			
	8.0		dry, hard	6	SS	8	18	24	25	10/	136	-028	
						R=	2.0'	N=	42	/12			
	10.0		becoming moist	7	SS	32	50/4"	-	-	12/	52.9	-029	
						R=	0.9'	N=	>50	/14			
12.0		14.7	Cl- CLAY, little silt and gravel, stiff, red brown,	8	SS	29	17	36	50/4"	14/	5.4*	-030	
			dry (TILL)			R=	1.0	N=	>50	/16			
14.7		15.0	Weathered bedrock fragments										
	15.8		spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____________ TOPSOIL THICKNESS ____________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____________, AFTER _____ HOURS _____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH5-08
DATE/TIME STARTED 9/17/08
DATE/TIME COMPLETED 9/17/03
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		0.3	Asphalt - auger w/o sampling	1	SS	X	3	6	8	0	26		
						R=	1.0'	N=	9	2			
0.3		2.1	SP/GP - medium to coarse grained SAND and	2	SS	7	1	2	3	2	4.3		
			GRAVEL, little silt and cinders, loose, black,			R=	1.5	N=	3	4			
			dry, (FILL)	3	SS	4	2	4	8	4	51.3	-031	
						R=	2.0'	N=	6	6			
2.1		3.9	Cl - ClAY, trace silt, firm, med. soft, gray,	4	SS	7	8	7	7	6	64.0	-032	
			moist			R=	2.0	N=	15	8			
				5	SS	WH	2	2	2	8	566	-033	
3.9		9.5	ML - SILT, some fine grained sand, gray, moist			R=	2.0'	N=	4	10			
				6	SS	3	3	4	3	10	174	-034	
	4.0		some tan mottling			R=	2.0	N=	7	12			
				7	SS	2	3	2	2	12	65.8	-035	
	6.0		wet, with some clay, NAPL present on core surface			R=	2.0	N=	5	14			
				8	SS	17	15	50	50/4"	14	35.4	-036	
9.5		15.3	Cl-ClAY, little gravel, trace silt, soft, medium			R=	1.5	N=	>50	16			
			plasticity, red brown, moist to wet (TILL)										
	13.0		with little to some silt										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ______
PROJECT NUMBER ______
CLIENT ______
LOCATION ______

DRILLING CONTRACTOR ______
DRILLER ______
SURFACE ELEVATION ______
WEATHER (A.M.) ______
(P.M.) ______

HOLE DESIGNATION BH5-08
DATE/TIME STARTED ______
DATE/TIME COMPLETED ______
DRILLING METHOD ______
CRA SUPERVISOR ______

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
15.3		15.5	weathered bedrock fragments										
	15.5		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS: ______

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH6-08
DATE/TIME STARTED 9/17/08
DATE/TIME COMPLETED 9/17/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
0		2.9	GM- GRAVEL and SILT, some sand and cinders,	1	SS	7	7	10	7	0/	23.2		
			gray and black, loose (FILL)			R=	1.0'	N=	17	/2			
				2	SS	8	10	9	7	2/	21.2		
2.9		8.0	ML-SILT, little fine grained sand and clay, stiff,			R=	1.0'	N=	19	/4			
			gray, dry	3	SS	7	10	9	8	4/	215	-036	
						R=	2.0'	N=	19	/6			
8.0		10.0	No recovery	4	SS	10	15	16	22	6/	87	-037	
						R=	2.0'	N=	31	/8			
10.0		13.5	ML-SILT, some clay, trace sand, stiff, gray,	5	SS	16	22	12	12	8/	NA	-038	
			dry, chemical odor			R=	0.1'	N=	33	/10			
				6	SS	4	6	7	6	10/	315	-039	
13.5		15.0	CI- CLAY, little gravel, trace silt, soft, medium			R=	2.0'	N=	13	/12			
			plasticity, wet, red-brown (TILL)	7	SS	4	4	2	2	12/	315	-040	
						R=	2.0	N=	6	/14			
15.0		15.5	GP- GRAVEL, some clay and silt, hard, red brown,	8	SS	22	36	38	50/0	14/	131	-041	
			wet, chemical odor			R=	2.0	N=	74	/16			
	15.5		spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

01001-00(029)GN-WA023 SEP 13/99 (SP-17) REVISION 3

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH7-08
DATE/TIME STARTED 9/18/08
DATE/TIME COMPLETED 9/18/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
0		0.2	ML-SILT, trace sand and clay, brown, moist	1	SS	5	7	15	19	0 /	60.6	-042	
						R=	1.8'	N=	22	/ 2			
0.2		1.6	GP- angular GRAVEL, some medium to coarse	2	SS	25	15	5	4	2 /	14.7	-043	
			grained sand, loose, gray, dry (FILL)			R=	1.0'	N=	20	/ 4			
				3	SS	7	6	6	9	4 /	11.1	-044	
1.6		4.7	SP/ML- fine to medium grained SAND and			R=	1.9'	N=	12	/ 6			
			SILT, firm, brown, moist	4	SS	8	10	11	15	6 /	26.6	-045	
						R=	2.0'	N=	21	/ 8			
	1.8	4.7	same with some gravel and green slag, loose, dry	5	SS	22	19	21	15	8 /	17.8	-046	
						R=	1.5	N=	40	/ 10			
4.7		8.0	ML-SILT, little fine grained sand, trace clay,	6	SS	6	15	12	12	10 /	17.0	-047	
			firm, no plasticity, gray and tan mottled,			R=	1.3'	N=	27	/ 12			
			dry to moist, slight chemical odor	7	SS	10	10	50/4"	—	12 /	36.9	-048	
						R=	1.0	N=	>50	/ 14			
8.0		13.3	CI- CLAY, some gravel, little silt, red brown,										
			dry, no plasticity, moderate chemical odor										
	9.5		becoming moist, low plasticity										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

01001-00(029)GN-WA023 SEP 13/99 (SP-17) REVISION 3

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ____
PROJECT NUMBER ____
CLIENT ____
LOCATION ____

DRILLING CONTRACTOR ____
DRILLER ____
SURFACE ELEVATION ____
WEATHER (A.M.) ____
(P.M.) ____

HOLE DESIGNATION BH7-08
DATE/TIME STARTED ____
DATE/TIME COMPLETED ____
DRILLING METHOD ____
CRA SUPERVISOR ____

SAMPLE DESCRIPTION

ORDER OF DESCRIPTORS:
SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS

NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
						PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)								
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL				
10.0		13.3	becoming wet, trace silt, medium soft,											
			high plasticity, no chemical odor											
	13.3		spoon refusal											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____
COMPLETION DETAILS: ____
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH8-08
DATE/TIME STARTED 9/18/08
DATE/TIME COMPLETED 9/18/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS) FROM	AT	TO	SAMPLE DESCRIPTION: ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS. NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		3.0	SP/GP- SAND and GRAVEL, some silt, little clay and	1	SS	7	7	10	40	0/	41.4		
			crushed red brick, loose, red and gray, moist (FILL)			R=	1.5	N=	17	/2			
				2	SS	19	6	3	5	2/	83.1	-049	
3.0		4.0	CL-CLAY, little silt, firm, low plasticity, tan-			R=	1.5	N=	9	/4			
			brown with black staining, moist, slight	3	SS	6	7	8	10	4/	18.4		
			chemical odor			R=	2.0	N=	15	/6			
				4	SS	9	9	10	20	6/	136	-050	
4.0		8.2	ML-SILT, little clay, trace fine grained sand,			R=	2.0	N=	19	/8			
			firm, low plasticity, gray and tan mottled,	5	SS	12	25	27	21	8/	299	-051	
			dry to moist, slight chemical odor			R=	1.0	N=	52	/10			
				6	SS	9	11	9	5	10/	549	-052	
	6.0	8.0	strong chemical odor			R=	1.5	N=	20	/12			
				7	SS	8	11	13	15	12/	114	-053	
8.2		14.2	CL-CLAY, some angular gravel, little silt, firm,			R=	2.0	N=	24	/14			
			very low plasticity, red brown, dry to moist,	8	SS	50/3"	–	–	–	14/	96.5	-054	
			strong chemical odor			R=	1.0	N=	>50	/16			
	11.5		wet, soft, medium plasticity, strong chemical odor										
	14.2		spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH9-08
DATE/TIME STARTED 9/19/08
DATE/TIME COMPLETED 9/19/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
0		2.0	No Recovery - large gravel in Spoon shoe	1	SS	3	3	2	2	0/	NA		
						R=	0	N=	5	/2			
2.0		12.0	ML- SILT, some clay, stiff, low plasticity,	2	SS	3	1	3	5	2/	1.6		
			gray and tan mottled, moist			R=	1.0	N=	4	/4			
				3	SS	7	5	8	8	4/	2.3	-055	
	4.0	6.0	with little clay, very moist			R=	0.5	N=	13	/6			
				4	SS	5	5	6	8	6/	2.7		
	6.0		with trace fine grained sand			R=	2.0	N=	11	/8			
				5	SS	7	10	12	18	8/	7.4	~~-056~~	
	8.0		becoming dry to moist, hard			R=	2.0	N=	22	/10			
				6	SS	5	8	8	14	10/	55.2	-056	
	11.0		with some gravel			R=	2.0	N=	16	/12			
				7	SS	25	36	50/0	—	12/	28.7	-057	
	11.7	11.8	medium grained sand seam <1/2" tan gray to brown			R=	1.0	N=	>50	/14			
	~~11.8~~		moist										
12.0		13.0	GP- angular GRAVEL, some silt, clay, and fine										
			grained sand, dense, hard, red brown, dry to										
			moist (TILL)										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ______
PROJECT NUMBER ______
CLIENT ______
LOCATION ______

DRILLING CONTRACTOR ______
DRILLER ______
SURFACE ELEVATION ______
WEATHER (A.M.) ______
(P.M.) ______

HOLE DESIGNATION BH9-08
DATE/TIME STARTED ______
DATE/TIME COMPLETED ______
DRILLING METHOD ______
CRA SUPERVISOR ______

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
FROM	AT	TO				6"	6"	6"	6"				
	13.0		weathered bedrock fragment, spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS: ______
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH10-08
DATE/TIME STARTED 9/19/08
DATE/TIME COMPLETED 9/19/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		0.1	Asphalt	1	SS	–	5	11	13	0/	16.2	-058	
						R=	1.0	N=	16	/2			
0.1		2.0	GP/SP- angular GRAVEL and medium to coarse	2	SS	5	3	3	6	2/	NA		
			grained SAND, trace silt, hard, gray to black,			R=	0	N=	6	/4			
			dry to moist (FILL)	3	SS	7	7	7	7	4/	4.2		
						R=	0.8	N=	14	/6			
2.0		4.0	no recovery	4	SS	3	3	2	2	6/	37.6	-059	
						R=	1.7	N=	5	/8			
4.0		11.8	ML-SILT, little clay, trace fine grained sand,	5	SS	1	1	1	1	8/	2.4		
			stiff, gray and tan mottled, moist			R=	2.0	N=	2	/10			
				6	SS	1	1	3	2	10/	13.8	-060	
	8.0		with little fine grained sand and clay, soft,			R=	2.0	N=	4	/12			
			very moist	7	SS	2	50	–	–	12/	5.6		
						R=	1.0	N=	>50	/14			
11.8		13.0	CI-CLAY, some gravel, little silt, soft, low										
			plasticity, red brown, wet (TILL)										
	13.0		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH11-08
DATE/TIME STARTED 9/19/08
DATE/TIME COMPLETED 9/19/08
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).			PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)							
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		0.1	Asphalt	1	SS	-	3	4	4	0/	7.0		
						R=	0.5	N=	7	/2			
0.1		4.1	GP-angular GRAVEL, trace silt, loose, gray, wet	2	SS	3	2	2	2	2/	24.0	-061	
			(FILL)			R=	1.0	N=	4	/4			
				3	SS	3	5	3	2	4/	7.9		
4.1		11.0	ML/SP- SILT and fine grained SAND, trace clay,			R=	1.5	N=	8	/6			
			firm, gray and tan mottled, moist	4	SS	3	5	3	3	6/	14.4	-062	
						R=	1.5	N=	8	/8			
	5.7		becoming little clay and trace fine grained sand	5	SS	2	1	1	1	8/	79.2	-063	
						R=	1.5	N=	2	/10			
	8.0		becoming soft, wet	6	SS	1	1	1	1	10/	6.7	-064	
						R=	2.0	N=	2	/12			
11.0		13.0	CL-CLAY, some angular gravel, little silt, very	7	SS	10	15	50/0	-	12/	718	-065	
			soft, high plasticity, red brown, wet, moderate			R=	1.0	N=	>50	/14			
			to strong chemical odor										
	12.0	13.0	Strong chemical odor, visible NAPL presence										
	13.0		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER _____ HOURS _____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH12-08
DATE/TIME STARTED 9/21/08
DATE/TIME COMPLETED 9/21/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS			PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)							
FROM	AT	TO	NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
0		2.0	Concrete - auger w/o sampling	1	SS	—	—	—	—	0	NA		
						R=	0	N=	NA	2			
2.0		2.5	SP- medium grained SAND, some cinders + slag,	2	SS	14	12	3	4	2	216	-066/	-073
			little gravel, black, strong chemical odor, moist			R=	1.5	N=	15	4			
			(FILL)	3	SS	12	12	24	50	4	690	-067	
						R=	2.0	N=	36	6			
2.5		14.1	ML- SILT, little to some fine grained sand,	4	SS	50/4"	—	—	—	6	385*	-068	
			firm, tan to brown, moist			R=	0.1	N=	>50	8			
				5	SS	37	50/4"	—	—	8	1298	-069	
	3.5		becoming gray			R=	0.9	N=	>50	10			
				6	SS	30	50/3"	—	—	10	715		
	4.0	6.0	tan and gray mottled			R=	0.8	N=	>50	12			
				7	SS	33	50	50/3"	—	12	674	-071	
	5.8	14.0	becoming very hard, dry			R=	1.2	N=	>100	14			
				8	SS	43	50/4"	—	—	14	86.1	-072	
	8.0	14.0	very strong chemical odor			R=	1.0	N=	>50	16			
14.1		14.8	Cl- ClAY, some gravel, fine grained sand and silt,										
			hard, red brown, moist (TILL)										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ____________________
PROJECT NUMBER ____________________
CLIENT ____________________
LOCATION ____________________

DRILLING CONTRACTOR ____________________
DRILLER ____________________
SURFACE ELEVATION ____________________
WEATHER (A.M.) ____________________
(P.M.) ____________________

HOLE DESIGNATION BH12-08
DATE/TIME STARTED ____________________
DATE/TIME COMPLETED ____________________
DRILLING METHOD ____________________
CRA SUPERVISOR ____________________

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
						6"	6"	6"	6"				
	14.8		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING __________ DEPTH OF FIRST GROUNDWATER ENCOUNTER __________ TOPSOIL THICKNESS __________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION __________, AFTER ______ HOURS ______
COMPLETION DETAILS: ____________________
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH13-08
DATE/TIME STARTED 9/23/08
DATE/TIME COMPLETED 9/23/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		2.1	GP/SP- angular GRAVEL and medium grained	1	SS	4	8	11	11	0/2	1.7	-074	
			SAND, little silt, loose, gray, brown, and black,			R=	1.2	N=	19				
			dry (FILL)	2	SS	6	9	8	6	2/4	3.1		
						R=	1.5	N=	17				
2.1		7.7	ML- SILT, little fine grained sand and ~~clay~~ gravel,	3	SS	50/3"	-	-	-	4/6	NA		
			~~very hard~~, gray ~~to tan~~, ~~dry~~ moist, firm			R=	0	N=	>50				
				4	SS	28	35	50	50	6/8	7.0	-075	
	6.0	7.7	with little clay, no gravel, very hard, gray to			R=	2.0	N=	85				
			tan, dry	5	SS	27	30	50/3"	-	8/10	5.6	-076	
						R=	2.0	N>	>50				
7.7			Cl/ML- CLAY and SILT, some fine grained sand	6	SS	22	47	50	25	10/12	92.4	-077	
			and gravel, hard, red brown, moist			R=	2.0	N=	97				
				7	SS	19	27	19	15	12/14	27.5	-078	
	10.0	12.0	moderate chemical odor			R=	1.5	N=	46				
				8	SS	22	50/0	-	-	14/16	NA	-079	
	12.0		becoming soft, low plasticity; wet			R=	0.2	N=	>50				
	14.7		weathered bedrock fragments										
	15.0		Spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH14-08
DATE/TIME STARTED 9/23/08
DATE/TIME COMPLETED 9/23/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

ORDER OF DESCRIPTORS:
SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS

NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
						PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)							
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL			
0		0.7	Concrete - auger w/o sampling	1	SS	-	2	7	8	0/2	4.1	-080	
						R=	1.0	N=	9				
0.7		4.4	GM- GRAVEL, SAND, and SILT, loose, brown	2	SS	6	5	6	8	2/4	77	-081	
			and gray, dry to moist			R=	1.0	N=	11				
				3	SS	8	3	4	6	4/6	1291	-082/	-084
	2.0		moist to wet, moderate chemical odor			R=	2.0	N=	7				
				4	SS	12	19	20	20	6/8	77	-083	
4.4		8.0	ML-SILT, little fine grained sand and clay,			R=	2.0	N=	39				
			stiff, gray and tan, moist, strong chemical										
			odor, no visible NAPL										
	6.0	8.0	augered following sample collection, upon										
			removal of drill rods abundant NAPL encountered,										
			abandoned hole to prevent downward migration.										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH15-08
DATE/TIME STARTED 9/23/08
DATE/TIME COMPLETED 9/23/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).			6"	6"	6"	6"				
0		2.0	No recovery	1	SS	1	1	2	1	0/	NA		
						R=	0	N=	3	/2			
2.0		2.4	GP- angular GRAVEL, some silt and sand, loose,	2	SS	4	9	13	10	2/	68	-085	
			gray, moist			R=	1.8	N=	22	/4			
				3	SS	8	5	5	7	4/	219	-086	
2.4		10.5	ML-SILT, little to some fine grained sand, trace			R=	2.0	N=	10	/6			
			clay, firm, gray, moist, slight chemical odor	4	SS	8	7	7	7	6/	68.1	-087	
						R=	2.0	N=	14	/8			
	5.4		with some sand, becoming very moist	5	SS	8	12	15	19	8/	70.2	-088	
						R=	2.0	N=	27	/10			
	8.0	10.5	with some clay, trace sand, very moist, tan	6	SS	12	50/0	–	–	10/	181	-089	
			and gray mottled, chemical odor			R=	0.8	N=	>50	/12			
				7	SS	NM	NM	NM	NM	12/	225	-090	
10.5		12.0	GM - SILT and angular GRAVEL, some fine grained			R=	0.6	N=	–	/14			
			sand and clay, medium stiff, gray, wet										
12.0		12.8	ML- SILT, some gravel, little clay, stiff, red-										
			brown, moist (TILL)										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME ______
PROJECT NUMBER ______
CLIENT ______
LOCATION ______

DRILLING CONTRACTOR ______
DRILLER ______
SURFACE ELEVATION ______
WEATHER (A.M.) ______
(P.M.) ______

HOLE DESIGNATION BH15-08
DATE/TIME STARTED ______
DATE/TIME COMPLETED ______
DRILLING METHOD ______
CRA SUPERVISOR ______

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
						6"	6"	6"	6"				
	12.0	14.0	augered following sample collection, upon removal of drilling rods, visible NAPL observed on rods, borehole abandoned to prevent migration to bedrock.										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS: ______

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH16-08
DATE/TIME STARTED 9/23/08
DATE/TIME COMPLETED 9/23/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS) FROM	AT	TO	SAMPLE DESCRIPTION: ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS. NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		2.2	GM-angular GRAVEL and SILT, some sand, brown	1	SS	9	11	11	10	0	3.9	-091	
			and gray, moist (FILL)			R=	1.5	N=	22	2			
				2	SS	3	4	4	5	2	34.5	-092	
2.2		3.3	decayed wood, wet			R=	1.5	N=	8	4			
				3	SS	1	WH	WH	WH	4	671	-093	
3.3		4.2	slag and metal debris			R=	2.0	N=	<1	6			
				4	SS	1	WH	WH	WH	6	1690	-094	
4.2		9.0	Cl-ClAY, trace silt, very soft (pudding like),			R=	2.0	N=	<1	8			
			brownish red, no plasticity, strong chemical odor,	5	SS	WH	WH	50/0	—	8	NA		
			wet			R=	0	N=	>50	10			
	6.0	8.0	sheen present in core										
	9.0		spoon/auger refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER _____ HOURS _____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH17-08
DATE/TIME STARTED 9/24/08
DATE/TIME COMPLETED 9/24/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
0		0.8	Concrete- auger w/o sampling	1	SS	-	2	4	1	0	0.5		
						R=	0.5	N=	6	2			
0.8		12.0	ML-SILT, some fine grained sand, trace clay,	2	SS	1	2	2	3	2	0		
			firm, tan and gray mottled with black staining,			R=	1.0	N=	4	4			
			moist	3	SS	3	4	7	20	4	1.7	-095	
						R=	2.0	N=	11	6			
	2.0	4.5	Same with some clay, low plasticity, very moist	4	SS	42	50/4"	-	-	6	112	-096/	-101
						R=	2.0	N=	>50	8			
	4.5		moist	5	SS	7	13	13	27	8	68	-097	
						R=	2.0	N=	26	10			
	5.5		becoming dry, hard	6	SS	12	13	15	25	10	128	-098	
						R=	2.0	N=	28	12			
	6.0	8.0	dry, very hard, chemical odor	7	SS	50/4"	-	-	-	12	164	-099	
						R=	0.4	N=	>50	14			
	6.3	6.5	Sand seam - fine to medium grained	8	SS	28	32	50/6"	-	14	117	-100	
						R=	0.3	N=	>50	16			
	8.0	12.0	slightly moist										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____

COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME

PROJECT NUMBER

CLIENT

LOCATION

DRILLING CONTRACTOR

DRILLER

SURFACE ELEVATION

WEATHER (A.M.)

(P.M.)

HOLE DESIGNATION BH17-08

DATE/TIME STARTED

DATE/TIME COMPLETED

DRILLING METHOD

CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
12.0		14.0	ML-SILT, some gravel, little fine grained sand and clay, hard, red brown, dry, moderate chemical odor										
14.0		15.5	weathered bedrock and sand, hard, gray, dry to moist, moderate chemical odor										
	15.5		spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING

DEPTH OF FIRST GROUNDWATER ENCOUNTER

TOPSOIL THICKNESS

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH18-08
DATE/TIME STARTED 9/24/08
DATE/TIME COMPLETED 9/24/08
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL				
FROM	AT	TO				6"	6"	6"	6"					
0		0.3	Asphalt- auger w/o sampling	1	SS	-	5	8	9	0/		0.2		
						R=	1.0	N=	13	/2				
0.3		3.0	GM- GRAVEL and SILT, black and gray,	2	SS	7	5	3	2	2/		0.5		
			moist (FILL)			R=	1.0	N=	8	/4				
				3	SS	2	3	3	3	4/		5.3	-102	
3.0		4.0	CL- CLAY, very soft, gray with black staining,			R=	1.7	N=	6	/6				
			wet	4	SS	6	7	7	7	6/		55.6	-103	
						R=	2.0	N=	14	/8				
4.0		13.8	ML- SILT, some fine grained sand, little clay,	5	SS	3	3	3	3	8/		20.8	-104	
			stiff, gray and tan mottled, moist			R=	2.0	N=	6	/10				
				6	SS	3	6	6	4	10/		43.7	-105	
	7.0		with some clay			R=	2.0	N=	12	/12				
				7	SS	3	3	2	1	12/		19.0	-106	
	9.0		with some fine grained sand, trace clay			R=	1.2	N=	5	/14				
				8	SS	14	14	24	45	14/		7.7	-107	
	9.8		wet			R=	1.7	N=	38	/16				
	10.0	11.8	moist											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH18-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) - MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
	11.8	13.8	wet										
13.8		14.4	GP-GRAVEL, little sand and silt, loose, dark gray, wet										
14.4		15.8	CI-CLAY, some gravel and silt, little fine grained sand, hard, red brown, moist (TILL)										
15.8		16.0	weathered bedrock fragments										
	16.0		spoon refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH19-08
DATE/TIME STARTED 9/24/08
DATE/TIME COMPLETED 9/24/08
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
FROM	AT	TO				6"	6"	6"	6"					
0		0.5	Concrete - auger w/o sampling	1	SS	-	4	4	3	0/		2.3		
						R=	0.2	N=	8	/2				
0.5		2.2	SP - medium grained SAND, loose, brown, wet	2	SS	2	2	2	2	2/		7.7	-108	
			(FILL)			R=	0.4	N=	4	/4				
				3	SS	2	2	3	3	4/		1.7	-109	
2.2		10.2	ML - SILT, some fine grained sand and clay,			R=	2.0	N=	5	/6				
			firm, gray and tan mottled, moist	4	SS	4	4	5	5	6/		6.7	-110/	-113
						R=	2.0	N=	9	/8				
	8.0	9.0	with some clay	5	SS	3	3	3	3	8/		7.7	-111	
						R=	2.0	N=	6	/10				
10.2		13.3	CI - CLAY, trace silt, medium soft, medium	6	SS	3	2	2	2	10/		6.3	-112	
			plasticity, red brown, moist			R=	2.0	N=	4	/12				
				7	SS	WH	WH	50	-	12/		1.1		
	11.0		wet, high plasticity			R=	1.5	N=	>50	/14				
13.3		13.5	weathered bedrock fragments											
	13.5		spoon refusal											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

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STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH20-08
DATE/TIME STARTED 11/11/08
DATE/TIME COMPLETED 11/11/08
DRILLING METHOD Geoprobe
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
0		2.0	GP/SP - angular GRAVEL and fine to medium SAND,	1	MC					0	0.1	0.1	-116
			tan and gray with black staining, loose, moist			R=	3.4'			4		0.5	-117
			(FILL)	2	MC					4	2.2	0.3	-118
						R=	4.0'			8		11.6	-119
2.0		7.9	ML - SILT, little fine sand, trace clay, gray, dense,	3	MC					8	0	0.5	-120
			firm, moist (NATIVE)			R=	4.0'			12		0.7	-121
				4	MC					12	2.1	1.6	-122
	6.0		with some fine sand, no clay, very moist			R=	1.4'			16			
7.9		10.4	CL - CLAY, little gravel, dense, hard, red brown, moist										
10.4		12.5	CL - CLAY, soft, high plasticity, red brown, moist										
12.5		14.3	GM/SM - CLAY, SAND, and GRAVEL, red brown, hard,										
			wet, slight chemical odor (TILL)										
	14.3		end of hole - refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

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STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH21-10
DATE/TIME STARTED 4/12/10
DATE/TIME COMPLETED 4/12/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO				6"	6"	6"	6"				
0		1.0	CONCRETE & ASPHALT - AUGER W/O SAMPLING.	1	SS	8	12	5	4	1-3	1.7		
1.0		2.3	SP- MEDIUM SAND, SOME GRAVEL, LITTLE SILT,	2	SS	6	6	5	4	3-5	2.8		
			BLACK AND GRAY, MOIST, (FILL)										
				3	SS	5	8	6	5	5-7	1.8		
2.3		9.3	ML- SILT, SOME FINE SAND, GRAY, MOIST										
				4	SS	7	5	5	8	7-9	2.2	X	
	5.0		MOTTLED GRAY - SAME										
				5	SS	15	25	39	33	9-11	240	X	
	9.0												
				6	SS	25	23	50	35	11-13	60	X	
9.3		13.3	ML- SILT, SOME CLAY AND GRAVEL, STIFF,										
			RED-BROWN, MOIST TO WET (TILL),	7	SS	50/0.3				13-13.3	23	X	
	13.3		SPOON REFUSAL										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS: TREMMIE GROUT TO SURFACE

CRA

NOTE: FOR EACH SPLIT–SPOON SAMPLE, RECORD BLOW COUNTS, N–VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH22-10
DATE/TIME STARTED 4/13/10
DATE/TIME COMPLETED 4/13/10
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)

SAMPLE DESCRIPTION
ORDER OF DESCRIPTORS:
SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS
NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).

SAMPLE DETAILS

FROM	AT	TO	SAMPLE DESCRIPTION	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		4.6	ML- SILT, SOME FINE SAND, LITTLE GRAVEL,	1	SS	1	3	5	9	0-2	12.9		
			BROWN, MOIST (FILL)										
				2	SS	9	11	13	10	2-4	292	X	
2		4	SAME SOME GRAVEL AND ROCK FRAGMENTS,										
				3	SS	14	10	10	12	4-6	153	X	
4.6		5.1	CL- CLAY, SOME SILT AND FINE SAND, GRAY,	4	SS	13	12	15	15	6-8	94		
			MOIST										
				5	SS	11	10	16	17	8-10	197	X	
5.1		10.3	ML- SILT, SOME FINE SAND, SOME TO LITTLE										
			CLAY, GRAY, MOIST	6	SS	5	13	25	28	10-12	2533	X	
10.3		14.3	ML- SILT, SOME CLAY AND GRAVEL, STIFF,	7	SS	27	25	26	20	12-14	90	X	
			RED- BROWN, MOIST (TILL)										
				8	SS	50/0.3				14-14.3	21		
11.2		12	NAPL IS VISIBLE										
	14.3		SAME WITH WEATHERED ROCK FRAGMENTS, WET,										
			SPOON REFUSAL										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS: TREMMIE GROUTED TO THE SURFACE

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH23-10
DATE/TIME STARTED 4/12/10
DATE/TIME COMPLETED 4/12/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		1.0	ASPHALT & GRAVEL, AUGER w/o SAMPLING	1	SS	19	11	48	9	1-3	1.1		
1.0		1.7	SP- MEDIUM SAND, SOME GRAVEL, SOME TO LITTLE SILT, TRACE CLAY, BLACK, WET, (FILL)	2	SS	4	5	9	11	3-5	1.4		
				3	SS	3	5	7	13	5-7	4.6		
1.7		10.8	ML- SILT, SOME FINE SAND, GRAY, MOIST	4	SS	33	50			7-8	5.2		
	5.5		SAME, MOTTLED GRAY, MOIST TO WET.	5	SS	15	28	42	50/0.3	8-9.8	24	X	
	8.0		DENSE	6	SS	13	65	50/0.2		10-11.2	28	X	
10.8		14.3	ML- SILT, SOME CLAY AND GRAVEL, STIFF, RED-BROWN, MOIST, (TILL), SLIGHT	7	SS	100/0.4				12-12.4	12	X	
				8	SS	12	17	100		13-14.5	5.2	X	
14.3		14.5	SAME WITH WEATHERED ROCK FRAGMENTS										
	14.5		SPOON AND AUGER REFUSAL										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS: TREMMIE GROUTED TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

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STRATIGRAPHY LOG (OVERBURDEN)

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PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH24-10
DATE/TIME STARTED 4/13/10
DATE/TIME COMPLETED 4/14/10
DRILLING METHOD 7 1/4" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).			PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)								
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		0.5	AUGER THROUGH CONCRETE WITHOUT SAMPLING.	1	SS	6	4	6		0.5-2	5.9		
0.5		2.4	ML- SILT, SOME FINE TO MEDIUM SAND AND	2	SS	3	2	12	38	2-4	62		
			FINE TO MEDIUM GRAVEL, RED-BROWN, WET, (FILL)										
				3	SS	15	25	50/0.2		4-5.2	214		
2.4		3.0	ML- SILT, LITTLE CLAY, TRACE FINE SAND,										
			GRAY-BROWN, WET.	4	SS	50/0.4				6-6.4	234	X	
3.0		12.0	ML- SILT, SOME FINE SAND, TRACE GRAVEL,	5	SS	34	57	50/0.4		8-9.4	5395	X	
			GRAY, MOIST.										
				6	SS	13	50/0.2			10-10.7	4174	X	
	6.0		SAME, SOME GRAVEL, HARD	7	SS	21	39	41	38	12-14	153	X	
	8.0		SAME	8	SS	50/0.4				14-14.4	64	X	
	10.0		SAME										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER _____ HOURS _____

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47393
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH24-10 CONT
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS		GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL				
FROM	AT	TO				6"	6"	6"	6"					
12.0		14.4	ML-SILT, SOME CLAY AND GRAVEL, HARD,											
			RED-BROWN, MOIST [illegible]											
	12.4		SAME WITH WEATHERED ROCK FRAGMENTS,											
	14.4		SPLIT SPOON REFUSAL											
			NOTE: EXTREMELY DIFFICULT DRILLING											
			AND SAMPLING AT THIS LOCATION.											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER ____ HOURS ____

COMPLETION DETAILS: TREMMIE GROUTED BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH25-10
DATE/TIME STARTED 4/14/10
DATE/TIME COMPLETED 4/14/10
DRILLING METHOD 4 1/4 ID HSA
CRA SUPERVISOR ED. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) -- MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
0		1.0	AUGER THROUGH 5" OF CONCRETE AND GRAVEL	1	SS	1	1	2	4	1-3	<1		
			WITHOUT SAMPLING.										
				2	SS	4	5	6	6	3-5	<1		
1.0		10.3	SL- SILT, SOME FINE SAND, LITTLE TO TRACE										
			CLAY, GRAY, MOIST	3	SS	2	3	5	6	5-7	1		
	3.8		SAME, TRACE CLAY	4	SS	5	4	3	3	7-9	1.2		
10.3		11.5	SP- FINE SAND, LITTLE SILT, GRAY, MOIST	5	SS	1	1	4	6	10-12	8.8	X	
			TO WET										
				6	SS	2	2	2	4	12-14	113	X	
11.5		15.2	SL- SILT, SOME CLAY AND GRAVEL, RED-BROWN,										
			WET, (TILL)	7	SS	8	9	5/0.2		14-15.2	133	X	
	12.6		SAME WITH LITTLE FINE SAND.										
	15.2		SPLIT SPOON REFUSAL										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER _____ HOURS _____
COMPLETION DETAILS: TREMMIE GROUTED BOREHOLE TO THE SURFACE

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH26-10
DATE/TIME STARTED 4/13/10
DATE/TIME COMPLETED 4/13/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL				
0		4.8	ML- SILT, SOME FINE SAND, TRACE	1	SS	5	5	7	8	6-2	1.1		
			VEGETATION, FINE GRAVEL, BROWN, MOIST										
			(FILL)	2	SS	8	7	7	7	2-4	1.4		
	0.4		SAME, BROWN AND GRAY, LITTLE CLAY, SOME	3	SS	7	5	4	4	4-6	31.6		
			FINE TO MEDIUM GRAVEL										
				4	SS	8	7	6	8	6-8	110	X	
	2.0		SAME, TRACE SLAG										
				5	SS	4	4	6	7	8-10	348	X	
4.8		11.4	ML- SILT, SOME FINE SAND AND CLAY,										
			MOTTLED GRAY, MOIST	6	SS	4	3	5	4	10-12	1310	X	
	6.0		SAME, SOME TO LITTLE CLAY	7	SS	WH	1	15	14	12-14	121	X	
				8	SS	50/0.2				14-14.2	—		
	7.0		SOME, LITTLE TO TRACE CLAY										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION AFTER HOURS
COMPLETION DETAILS: TREMMIE GROUTED TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH26-10 CONT
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
FROM	AT	TO				6"	6"	6"	6"		(ppm)			
	8.0		SAME, SOME TO LITTLE CLAY											
	10.0		SAME, NAPL PRESENT											
11.4		12.8	ML-SILT, SOME CLAY AND FINE SAND, GRAY, MOIST											
	12.0		SAME, SOFT, WET											
12.8		13.8	SAME, LITTLE FINE SAND, TRACE CLAY, GRAY, SOFT, WET											
13.8		14.2	ML-SILT, SOME CLAY AND GRAVEL, STIFF, RED-BROWN, MOIST											
	14.0		SAME WITH WEATHERED ROCK FRAGMENTS											
	14.2		SPILT SPOON REFUSAL											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS: TREMMIE GROUT BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE ~~2~~ 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH27-10
DATE/TIME STARTED 4/12/10
DATE/TIME COMPLETED 4/12/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).			PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)							
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		1.0	ASPHALT & GRAVEL, AUGER w/o SAMPLING	1	SS	8	7	4	7	1-3	1.4		
1.0		2.2	SP- MEDIUM SAND, SOME GRAVEL, SOME TO	2	SS	5	7	7	8	3-5	3.7		
			LITTLE SILT, BLACK TO GRAY, MOIST, (FILL)										
				3	SS	3	7	12	17	5-7	10.5	X	
2.2		10.3	ML- SILT, SOME FINE SAND, GRAY, MOIST										
				4	SS	7	7	5	7	7-9	25.1	X	
5		7											
				5	SS	3	3	4	4	9-11	228	X	
	7		SAME, SOME TO LITTLE CLAY, TRACE GRAVEL										
				6	SS	2	1	2	4	11-13	29.2	X	
10.3		11.6	SP- FINE SAND, LITTLE SILT, SOFT, GRAY,										
			MOIST TO WET	7	SS	2	6	14	22	13-15	6.5	X	
11.6		12.3	ML- SILT, LITTLE FINE SAND, GRAY, SOFT, WET,	8	SS	14	13	43	50/.2	14-15.7	—	X	
12.3		14.7	ML- SILT, SOME CLAY AND GRAVEL, SOFT TO										
			STIFF, RED-BROWN, WET TO MOIST, (TILL)										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH27-10 CONT
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL				
14.7		15.7	SAME WITH WEATHERED ROCK FRAGMENTS,											
			GRAY, MOIST											
	15.7		SPOON REFUSAL											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______

COMPLETION DETAILS: TREMMIE GROUTED TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH28-10
DATE/TIME STARTED 4/15/10
DATE/TIME COMPLETED 4/16/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR ED. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		2.0	SAND/SILT/GRAVEL, SOME TO LITTLE CLAY, TRACE	1	SS	1	3	6	5	0-2	7.9		
			YELLOW BRICK, BROWN AND RED-BROWN, WET (FILL)										
				2	SS	3	3	5	12	2-4	9.4		
2.0		2.7	CL - CLAY, SOME SILT AND FINE SAND, GRAY,										
			MOIST	3	SS	17	31	50/0.4		4-5.4	12		
2.7		11.3	SL - SILT, SOME FINE SAND, LITTLE CLAY, GRAY,	4	SS	50/0.4				6-6.4	7.7		
			MOIST TO WET										
				5	SS	50/0.4				8-8.4	33	X	
	4.0		SAME WITHOUT CLAY, DRY										
				6	SS	36	47	44	32	10-12	160	X	
	6.0		SAME										
				7	SS	25	23	15	16	12-14	239	X	
	8.0		SAME										
				8	SS	16	14	15	50/0	14-15.5	8.3	X	
	10.0		SAME										
	10.7		SAME, LITTLE TO TRACE CLAY										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH28-10 CON'T
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
11.3		13.8	SP - FINE SAND, LITTLE SILT, GRAY, MOIST,										
13.8		15.5	SL- SILT, SOME CLAY AND GRAVEL, RED-BROWN										
			MOIST (TILL)										
	15.5		SPLIT SPOON REFUSAL										
			NOTE: DIFFICULT DRILLING AND SAMPLING										
			FROM 5 TO 10' AT THIS LOCATION										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS: TREMMIE GROUT BOREHOLE TO THE SURFACE

CRA

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH29-10
DATE/TIME STARTED 4/14/10
DATE/TIME COMPLETED 4/14/10
DRILLING METHOD 7¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		2.4	ML- SILT- SOME FINE TO MEDIUM SAND AND	1	SS	3	3	3	3	0-2	3.0		
			FINE TO MEDIUM GRAVEL, TRACE VEGETATION,										
			BROWN AND BLACK, MOIST. (FILL)	2	SS	3	3	4	4	2-4	3.4		
2.4		4.0	CL- CLAY- SOME SILT, SAND AND GRAVEL, RED-	3	SS	50/.4				4-4.4	2.9		
			BROWN, BLACK AND GRAY, MOIST (FILL)										
				4	SS	4	2	3	4	6-8	5.1	X	
4.0		4.4	SP- SAND, MEDIUM AND MEDIUM GRAVEL,										
			BROWN AND GRAY, DRY (FILL)	5a	SS	6	4	7	8	8-10	842	X	
				5b							107	X	
4.4		5.0	AUGER THROUGH CONCRETE WITHOUT SAMPLING	6	SS	6	5	4	5	10-12	41	X	
5.0		6.0	AUGER THROUGH GRAVEL AND SOIL WITHOUT	7	SS	9	6	6	7	12-14	20	X	
			SAMPLING.										
				8	SS	9	10	19	50/.2	14-15.7	28		
6.0		8.4	SL- SILT, SOME FINE SAND, LITTLE TO TRACE										
			CLAY, GRAY, MOIST										
8.0		8.4	SAME, NAPL PRESENT.										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH29-10 CON'T
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
8.4		12.0	CL- CLAY, SOME SILT, TRACE FINE SAND AND FINE GRAVEL, RED-BROWN, MOIST,										
12.0		15.7	SL- SILT, SOME CLAY AND GRAVEL RED-BROWN, MOIST (TILL)										
	14.0		SAME WITH WEATHERED ROCK FRAGMENTS.										
	15.7		SPOON REFUSAL										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH30-10
DATE/TIME STARTED 4/15/10
DATE/TIME COMPLETED 4/15/10
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL	PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO				6"	6"	6"	6"				
0		4.0	AUGER THROUGH CONCRETE AND RUBBLE WITHOUT	1	SS	10	25	33	50/0.4	4-5.9	70		
			SAMPLING.										
				2	SS	33	50/0.4			6-6.9	1357	X	
4.0		4.4	SL- SILT, BROWN, DRY (FILL)										
				3	SS	9	50/0.3			8-8.8	114	X	
4.4		12.9	SL- SILT, SOME FINE SAND, LITTLE TO										
			TRACE CLAY, TRACE GRAVEL, GRAY, MOIST	4	SS	33	50/0.4			10-10.9	161	X	
				5	SS	36	50/0.4			12-12.9	210	X	
			(NOTE: NUMEROUS SPLIT SPOON REFUSALS)										
				7	SS	16	19	50/0.4		14-15.4	127	X	
14.0		15.4	SL- SILT, SOME CLAY AND GRAVEL, RED										
			BROWN, MOIST										
			NOTE: VERY DIFFICULT DRILLING AND										
			SAMPLING AT THIS LOCATION										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS: TREMMIE GROUT BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH31-10
DATE/TIME STARTED 4/15/10
DATE/TIME COMPLETED 4/15/10
DRILLING METHOD 4 1/4" ID HSA
CRA SUPERVISOR D. ASCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL				
FROM	AT	TO				6"	6"	6"	6"					
0		4.5	SP- FINE TO MEDIUM SAND, LITTLE TO TRACE	1	SS	8	9	7	8	0-2	2.8			
			CLAY, SOME FINE TO MEDIUM GRAVEL, BROWN											
			AND GRAY, MOIST (FILL)	2	SS	5	4	4	2	2-4	5.0			
4.5		8.0	SL- SILT, SOME FINE SAND, DARK BROWN,	3	SS	3	1	1	1	4-6	174	X		
			MOIST TO WET, NAPL PRESENT											
				4	SS	WH	WH	1	1	6-8	1379	X		
8.0		9.2	GRAVEL/SLAG, BLACK, WET, NAPL PRESENT,	5	SS	4	2	50/0.2		8-9.2	7081	X		
			CHEMICAL ODOR											
				6	SS	3	4	6	23	12-14	183	X		
9.2		11.5	AUGER THROUGH CONCRETE WITHOUT SAMPLING											
				7	SS	9	29	50/0.2		14-15.2	115	X		
11.5		12.0	AUGER WITHOUT SAMPLING											
12.0		15.2	SL- SILT, SOME CLAY AND FINE SAND, RED											
			BROWN, MOIST.											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS: TREMMIE GROUTED BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH32-10
DATE/TIME STARTED 4/16/10
DATE/TIME COMPLETED 4/16/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR D. OSCAR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL				
0		0.3	SP- SAND, SOME SILT, TRACE CLAY, BROWN, WET (FILL)	1	SS	1	13	6	7	0-2		182	X	
0.3		0.9	WOOD	2	SS	3	2	7	7	2-4		31		
0.9		2.0	SAND/SILT/GRAVEL, BLACK, MOIST TO WET,	3	SS	5	7	7	5	4-6		33		
				4	SS	6	7	11	12	6-8		117	X	
2.0		4.0	SL- SILT, SOME CLAY AND FINE SAND, LITTLE GRAVEL, BROWN, GRAY AND RED-BROWN, MOIST (FILL)	5	SS	11	12	13	16	8-10		87		
				6	SS	3	4	6	6	10-12		230	X	
4.0		7.2	SL- SILT, SOME FINE SAND, SOME TO LITTLE CLAY, DARK BROWN TO GRAY, MOIST	7	SS	3	4	9	18	12-14		140	X	
7.2		8.7	SL- SILT, SOME CLAY, LITTLE FINE SAND, TRACE GRAVEL, GRAY, MOIST.	8	SS	4	9	13	10	14-16		125	X	
				9	SS	50/0.4				16-16.4		22		
8.7		10.7	CL- CLAY, SOME SILT, RED-BROWN, MOIST											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH32-10 CON'T
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE	
10.7		16.4	SL- SILT, SOME CLAY, GRAVEL AND FINE											
			SAND, RED-BROWN, MOIST (TILL).											
	16.0		SAME											
	16.4		SPLIT SPOON REFUSAL											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS: TREMMIE GROUT BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

01001-00(029)GN-WA023 SEP 13/99 (SP-17) REVISION 3

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH33-10
DATE/TIME STARTED 4/16/10
DATE/TIME COMPLETED 4/16/10
DRILLING METHOD 4¼" ID HSA
CRA SUPERVISOR RD:OSCAR

ORDER OF DESCRIPTORS:
SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS

NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS									
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
0		1.0	AUGER THROUGH CONCRETE & GRAVEL WITHOUT	1	SS	2	3	5	6	1-3	1.2		
			SAMPLING										
				2	SS	1	2	2	3	3-5	—		
1.0		3.0	SP- SAND AND GRAVEL, FINE TO MEDIUM,										
			LITTLE SILT, BROWN, WET (FILL)	3	SS	2	3	5	12	5-7	20	X	
3.0		5.0	NO RECOVERY	4	SS	33	18	50/.2		7-8.2	3.0	X	
5.0		5.3	SAME, BROWN AND BLACK, MOIST (FILL)	5	SS	13	28	50/.2		9-10.2	38	X	
5.3		7.0	SLAG / HIGHLY WEATHERED CONCRETE, SOME	6	SS	23	50/.2			12-12.7	6445	X	
			SILT AND FINE SAND, GRAY, BROWN AND GREEN,										
			MOIST (FILL)	7	SS	15	10	22	23	14-16	27	X	
7.0		8.2	WEATHERED ROCK FRAGMENTS, LITTLE SILT AND	8	SS	50/.2				16-16.2	—		
			FINE SAND, WET (FILL)										
9.0		9.8	SL- SILT, LITTLE CLAY, FINE TO MEDIUM SAND										
			RED-GRAY, MOIST										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME FRONTIER
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR SJB
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION BH33-10 CONT
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL	ANALYSIS	GRAIN SIZE
9.8		10.2	SL- SILT, SOME FINE SAND, GRAY, MOIST.											
12.0		12.7	SL- SILT, SOME FINE SAND, LITTLE GRAVEL, RED-BROWN, MOIST (TILL).											
14.0		16.0	SAME											
16.0		16.2	NO RECOVERY											
	16.2		SPLIT SPOON REFUSAL											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______ AFTER ____ HOURS ____

COMPLETION DETAILS: TREMMIE GROUT BOREHOLE TO THE SURFACE

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION SVP-1
DATE/TIME STARTED 11/11/08
DATE/TIME COMPLETED 11/11/08
DRILLING METHOD Geoprobe
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
						6"	6"	6"	6"				
0		1.1	SP/GP - SAND and GRAVEL, gray, tan, and black,	1	MC					0/	0		
			moist (FILL)			R=	4.0			/4			
				2	MC					4/	0		
1.1		7.5	ML - SILT, little clay, trace fine sand, firm,			R=	4.0			/8			
			tan, moist (NATIVE)										
7.5		8.0	CL - CLAY, medium plasticity, red brown, moist										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION SVP-2
DATE/TIME STARTED 11/11/08
DATE/TIME COMPLETED 11/11/08
DRILLING METHOD Geoprobe
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL			
			For stratigraphy refer to overburden stratigraphy										
			log for MW2-08										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION SVP-3
DATE/TIME STARTED 11/11/08
DATE/TIME COMPLETED 11/11/08
DRILLING METHOD Geoprobe
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
0		0.3	Asphalt	1	MC					0/	0		
						R=	4.0			/4			
0.3		4.0	GP/SP - angular GRAVEL and fine to coarse SAND,										
			gray and brown, dry (FILL)										
	1.0	1.5	greenish coloration										
	2.1		wet										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ____ HOURS ____
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION SVP-4
DATE/TIME STARTED 11/11/08
DATE/TIME COMPLETED 11/11/08
DRILLING METHOD Geoprobe
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
FROM	AT	TO				6"	6"	6"	6"				
0		0.2	Asphalt	1	MC					0 /	0		
						R=	1.7			/ 4			
0.2		2.6	Concrete	2	MC					4 /	0		
						R=	4.0			/ 8			
2.6		3.0	GP/SP - SAND and GRAVEL, brown and gray, dry										
			(FILL)										
3.0		7.8	ML - SILT, little to some fine sand, trace to										
			little clay, firm, tan and gray mottled, moist										
			(NATIVE)										
7.8		8.0	CL - CLAY, trace silt, stiff, medium plasticity,										
			moist, red brown										
	8.0		end of hole										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ______ DEPTH OF FIRST GROUNDWATER ENCOUNTER ______ TOPSOIL THICKNESS ______
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ______, AFTER ______ HOURS ______
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW1-08
DATE/TIME STARTED 9/16/08
DATE/TIME COMPLETED 9/16/08
DRILLING METHOD 8¼" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID/FID	CHEMICAL ANALYSIS	GRAIN SIZE
			ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).			PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)							
FROM	AT	TO		SAMPLE #	SAMPLING METHOD	6"	6"	6"	6"	SAMPLE INTERVAL	(ppm)		
0		0.2	Asphalt	1	SS	1	3	3	3	2/4	0		
						R=	1.5'	N=	6				
0.2		1.8	GM - SILT and angular GRAVEL, some fine to	2	SS	3	2	3	3	4/6	0		
			Coarse sand, dark brown to black, dry (FILL)			R=	2.0'	N=	5				
				3	SS	3	3	3	4	6/8	0		
1.8		2.0	Concrete			R=	1.7'	N=	6				
				4	SS	1	1	wr	1	8/10	0.1		
2.0		2.2	GP - GRAVEL, some silt and fine to medium			R=	2.0	N=	2				
			sand, some white slag, gray, soft, moist	5	SS	WH	1	1	1	10/12	0		
						R=	2.0	N=	2				
2.2		9.5	ML - SILT, little clay, trace fine sand, tan	6	SS	3	3	4	4	12/14	0		
			and brown mottled, moist (NATIVE)			R=	2.0	N=	7				
				7	SS	2	11	50/4"	—	14/16	0		
	4.0		with little fine sand, no clay, tan and gray mottled			R=	0.7'	N=	>50				
	6.0		with some fine sand										
	6.2		wet										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 2 OF 2

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MWI-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS										
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL	PID/FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
9.5		11.8	ML-SILT, some clay, trace fine sand, tan and brown mottled, moist										
11.8		14.0	ML-SILT, some clay and fine to medium sand and angular gravel, red brown, soft, wet (TILL)										
14.0		14.5	GP-GRAVEL, some silt, sand, and clay, gray, wet										
	14.5	14.7	Bedrock fragments										
	15.3		Spoon refusal										
	16.0		Auger refusal										

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING
DEPTH OF FIRST GROUNDWATER ENCOUNTER
TOPSOIL THICKNESS
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION , AFTER HOURS
COMPLETION DETAILS:
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 1 OF 2

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW1-D-08
DATE/TIME STARTED 9/30/08
DATE/TIME COMPLETED 10/9/08
DRILLING METHOD HQ Core
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING) DRILLING RATE/CORE DRILLING RECORD						WATER USAGE
FROM	AT	TO	BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
16.0		78.2	Lockport Formation- Oak Orchard Member,	1	16.0	24.8	79.5	45		100% loss @ 20.2'
			Dolomite, brownish gray to dark gray,	2	24.8	34.8	98	94		
			medium crystalline, thick bedded,	3	34.8	44.8	96	93		
			massive, sacharoidal, bituminous;	4	44.8	54.8	103	100		
			vugs present but not common,	5	54.8	64.8	100	100		
			sphalerite and anhydrite present in	6	65.0	75.0	97	95		100% loss @ 69.5'
			vugs and veinlets, occasional favosites	7	75.0	80.0	99	90		
			coral present	8	80.0	90.0	102	100		
				9	90.0	100.0	101	95		
	20.0	21.0	very fractured and broken highly	10	100.0	107.0	100	89		
			weathered, staining on surfaces							
	30.1		Fracture, moderately weathered, approximate							
			1/2-inch aperture							
	62.3		Fracture, moderately weathered, approximate							

NOTES AND COMMENTS 1/2-inch aperture

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BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 2 OF 2

PROJECT NAME

PROJECT NUMBER

CLIENT

LOCATION

DRILLING CONTRACTOR

DRILLER

SURFACE ELEVATION

WEATHER (A.M.)

(P.M.)

HOLE DESIGNATION MW1-D-08

DATE/TIME STARTED

DATE/TIME COMPLETED

DRILLING METHOD

CRA SUPERVISOR

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING) DRILLING RATE/CORE DRILLING RECORD						WATER USAGE
FROM	AT	TO		RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
	69.8		Fracture, moderately weathered, approximate							
			1/4-1/2-inch aperature							
	67	77	Occasional small (1/4-inch) vugs							
78.2		107.0	Lockport Formation - Eramosa Member							
			Dolomite, medium to dark-gray, fine							
			grained, argillaceous, bituminous,							
			carbonceous shaly partings, medium							
			bedded becoming thin bedded with							
			depth.							
	105.2		Fracture, slight to moderately weathered,							
			approximate 1/4-inch aperature							
	107.0		End of hole							

NOTES AND COMMENTS

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47342
CLIENT Frontier PRP Group
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW2-08
DATE/TIME STARTED 9/29/08
DATE/TIME COMPLETED 9/29/08
DRILLING METHOD 8 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS								PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL				
						6"	6"	6"	6"					
0		3.4	GM - angular GRAVEL and SILT, brown and gray,	1	SS	4	4	5	1	0/		0		
			firm, moist (FILL)			R-	4"	N:	9	/2				
				2	SS	1	2	2	4	2/		0		
3.9		7.8	ML-SILT, some fine sand, trace clay, soft,			R-	6"	N:	4	/4				
			tan and gray mottled, moist (NATIVE)	3	SS	4	3	3	4	4/		0		
						R=	2.0'	N:	6	/6				
	7.0		with some clay, low plasticity	4	SS	2	3	3	5	6/		0.4		
						R=	2.0'	N=	6	/8				
7.8		13.6	CI- CLAY, little silt, stiff, red brown, moist	5	SS	5	7	8	11	8/		0.3		
						R=	2.0	N=	15	/10				
	11.0		high plasticity, very moist	6	SS	4	5	6	6	10/		0		
						R=	2.0'	N=	11	/12				
13.8		15.6	ML- SILT, some clay and gravel, little fine sand,	7	SS	5	4	4	5	12/		0		
			low plasticity, red brown, moist (TILL)			R=	2.0'	N=	8	/14				
				8	SS	18	25	25	40	14/		0		
	15.6		Top of weathered bedrock			R=	1.5	N=	50	/16				
	16.0		End of hole											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____
COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 1 OF 3

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT Frontier PRP Group
LOCATION
DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)
HOLE DESIGNATION MW2-D-08
DATE/TIME STARTED 10/30/08
DATE/TIME COMPLETED 11/5/08
DRILLING METHOD HQ Core
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING)						WATER USAGE
			BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR.	DRILLING RATE/CORE DRILLING RECORD						
FROM	AT	TO	FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
18.0		77.9	Lockport Formation-Oak Orchard Member,	1	18.0	25.0	99	81		100% to 20.5 ft, then 0
			Dolomite, brownish gray to dark gray,	2	25.0	35.0	95	70		0
			medium crystalline, thick bedded,	3	35.0	45.0	100	100		0
			massive, sacharoidal, bituminous;	4	45.0	55.0	95	91		0
			vugs present but not common, sphalerite	5	55.0	65.0	90	87		0
			and anhydrite present in vugs and	6	65.0	68.0	117	100		0
			veinlets, occasional favosites coral	7	68.0	76.0	100	99		100% to 70.5' then 0
			present.	8	76.0	86.0	99	89		0
				9	86.0	96.0	100	96		0
	22.2		Fracture, moderately weathered	10	96.0	106.0	100	55		0
	22.7		Fracture, moderately weathered							
	26.1		Fracture, highly weathered, approximate							
			1/2-inch aperature, surrounding rock							
			very porous							

NOTES AND COMMENTS

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 2 OF 3

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW2-D-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING) DRILLING RATE/CORE DRILLING RECORD						WATER USAGE
FROM	AT	TO	BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
	36.5		Fracture, moderately weathered							
	55.0	55.4	Very broken and Fractured, moderately							
			weathered							
	63.9	64.1	Very broken and Fractured, moderately							
			weathered							
77.9		106.0	Lockport Formation - Eramosa Member,							
			Dolomite, medium to dark gray, fine							
			grained, argillaceous, bituminous,							
			carbonaceous shaly partings, medium							
			bedded becoming thin bedded with depth							
	78.1	79.0	Very broken and Fractured, moderately							
			weathered							

NOTES AND COMMENTS

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 3 OF 3

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION
DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)
HOLE DESIGNATION MW2-D-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING)						WATER USAGE
			BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	DRILLING RATE/CORE DRILLING RECORD						
FROM	AT	TO		RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
	83.5	85.4	mineral infilled near vertical fracture							
	90	106	numerous shaly partings							
	97.8		Fracture, moderately weathered							
	99.4	99.6	Very broken and Fractured, moderately							
			weathered							
	101.1		Fracture, moderately weathered							
	106.0		Bottom of corehole							

NOTES AND COMMENTS

STRATIGRAPHY LOG (OVERBURDEN)

PAGE 1 OF 1

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT Frontier PRP Group
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW3-08
DATE/TIME STARTED 9/25/08
DATE/TIME COMPLETED 9/25/08
DRILLING METHOD 8 1/4" ID HSA
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS		GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	SAMPLE INTERVAL		CHEMICAL	ANALYSIS	
0		0.2	Red brick fragments, dry (FILL)	1	SS	5	12	11	12	0 /	0.3			
						R=	1.0'	N=	23	/ 2				
0.2		0.4	GP- angular GRAVEL, gray, dry	2	SS	5	3	5	5	2 /	NA			
						R=	NR	N=	8	/ 4				
0.4		4.0	ML- SILT, some sand, trace clay, loose, brown,	3	SS	42	50	–	–	4 /	174			
			dry			R=	1.0'	N=	>50	/ 6				
				4	SS	28	38	43	53	6 /	866			
4.0		11.4	ML- SILT, some fine sand, hard, tan, dry,			R=	2,0'	N=	81	/ 8				
			slight chemical odor (NATIVE)	5	SS	17	22	20	35	8 /	99			
						R=	2.0'	N=	42	/ 10				
	6.0	8.0	strong chemical odor	6	SS	3	4	8	12	10 /	108			
						R=	2.0	N=	12	/ 12				
11.4		13.8	CI- CLAY, some silt, little gravel, firm, red brown,	7	SS	10	12	14	25	12 /	28			
			moist (TILL)			R=	2.0	N=	26	/ 14				
				8	SS	50/3"	–	–	–	14 /	NA			
	12.5		with some gravel			R=	1"	N=	>50	/ 16				
	13.8		shattered bedrock fragments											
	14.2		Spoon refusal 15.0 Auger refusal											

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ____ DEPTH OF FIRST GROUNDWATER ENCOUNTER ____ TOPSOIL THICKNESS ____

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ____, AFTER ____ HOURS ____

COMPLETION DETAILS:

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 1 OF 3

PROJECT NAME Frontier Chemical Site
PROJECT NUMBER 47392
CLIENT Frontier PRP Group
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW3-D-08
DATE/TIME STARTED 10/15/08
DATE/TIME COMPLETED 10/20/08
DRILLING METHOD HQ Core
CRA SUPERVISOR J. Williams

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING) DRILLING RATE/CORE DRILLING RECORD						WATER USAGE
FROM	AT	TO	BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
14.5		75.0	Lockport Formation Oak Orchard Member,	1	14.5	18.5	70	25		100 to 75% at 17.0'
			Dolostone, brownish gray to dark gray,	2	18.5	25.9	95	69		75 to 0% at 19.0'
			medium crystalline, thick bedded,	3	25.9	35.9	99	85		0
			massive, sacharoidal, bituminous; vugs	4	35.9	45.9	99	100		0
			present but not common, sphalerite	5	45.9	55.9	80	76		0
			and anhydrite present in vugs and	6	55.9	65.9	100	98		0
			veinlets, occasional favosites coral	7	66.0	76.0	97	95		0
			present.	8	76.0	86.0	99	94		0
				9	86.0	96.0	101	96		0
	17.0	19.0	Very fractured and broken, highly	10	96.0	106.0	101	76		0
			weathered							
	30.0	31.0	Very fractured and broken, highly							
			weathered							
	52.3		Fracture, moderately weathered ~1/2-inch							

NOTES AND COMMENTS

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 2 OF 3

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW3-D-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING)						WATER USAGE
			BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	DRILLING RATE/CORE DRILLING RECORD						
FROM	AT	TO		RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
	65.7		Fracture, moderately weathered							
	66.0	74.0	numerous small vugs							
	72.0		Fracture, moderately weathered							
	73.5	74.6	very broken							
75.0		106.0	Lockport Formation, Eramosa Member, Dolostone, medium to dark gray, fine grained, argillaceous, bituminous, carbonaceous shaly partings, medium bedded becoming thin bedded with depth.							
	92.0	106.0	numerous shaly partings							

NOTES AND COMMENTS

BEDROCK CORING AND DRILLING STRATIGRAPHIC LOG

PAGE 3 OF 3

PROJECT NAME
PROJECT NUMBER
CLIENT
LOCATION

DRILLING CONTRACTOR
DRILLER
SURFACE ELEVATION
WEATHER (A.M.)
(P.M.)

HOLE DESIGNATION MW3-D-08
DATE/TIME STARTED
DATE/TIME COMPLETED
DRILLING METHOD
CRA SUPERVISOR

STRATIGRAPHIC INTERVALS DEPTHS IN FEET/METRES BGS			SAMPLE DESCRIPTION	NOTE: USE THESE COLUMNS FOR RECORDING DRILLING RATE AND CORE RECORD (IF CORING) DRILLING RATE/CORE DRILLING RECORD						WATER USAGE
FROM	AT	TO	BEDROCK DESCRIPTION: FORMATION NAME, ROCK TYPE, COLOUR, BEDDING, GRAIN SIZE, TEXTURE, WEATHERING, CEMENTATION, POROSITY, FOSSILS, SUPPL. DESCR. FRACTURE DESCRIPTION: TYPE, ORIENTATION, SPACING, ROUGHNESS, APERTURE, WEATHERING, INFILLING, SUPPLEMENTARY DESCRIPTORS	RUN NO.	DEPTH FROM START TIME	DEPTH TO END TIME	CORE REC% DRILL RATE	RQD %	FRACTURE INDEX	VOL. WATER LOST PER RUN
	101.5		Fracture, Moderately weathered							
	106.0		End of corehole							

NOTES AND COMMENTS

CONESTOGA-ROVERS & ASSOCIATES

PROJECT No.: 47392

PROJECT NAME: Frontier Chemical Site

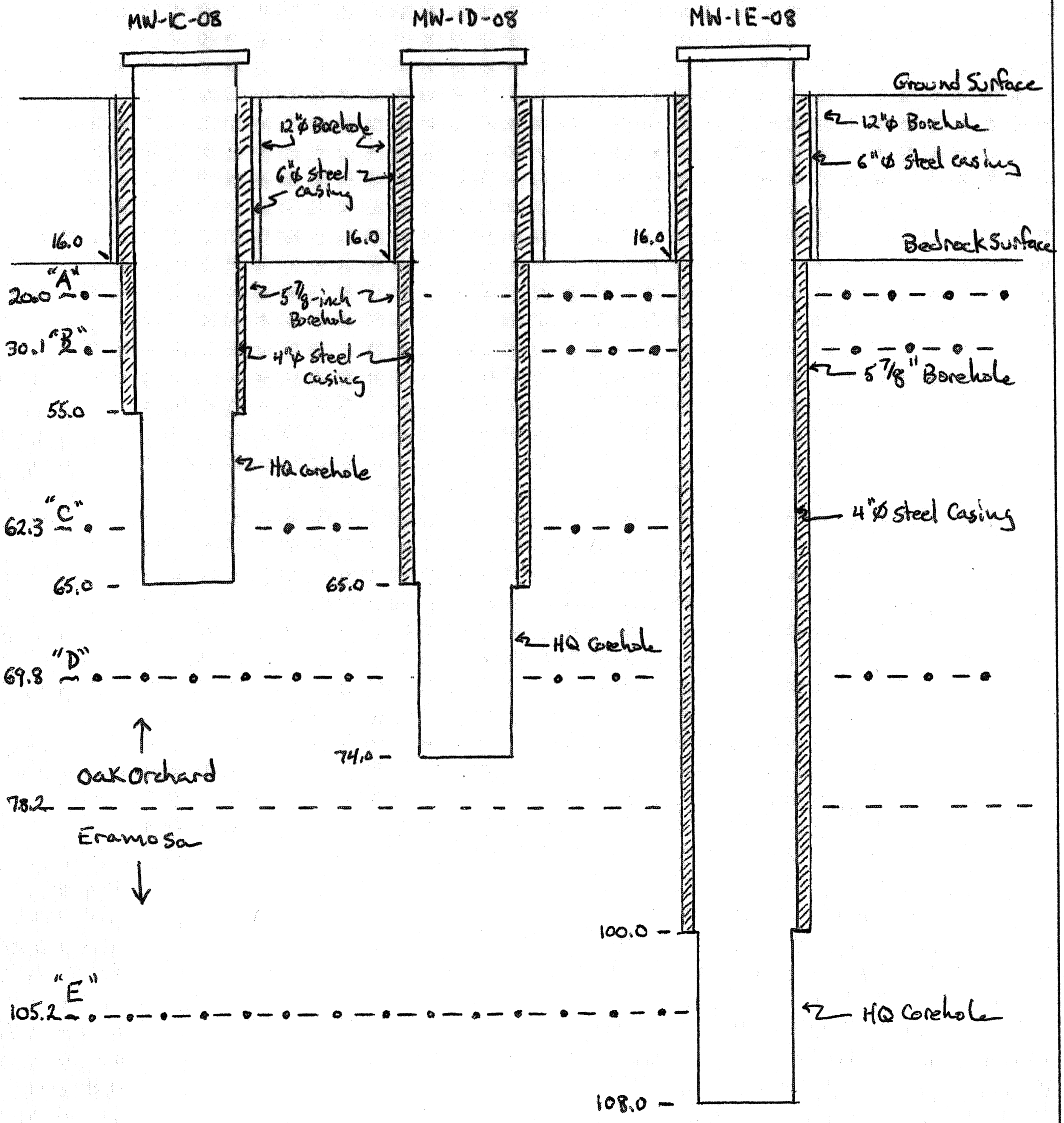
DESIGNED BY: J. Williams

DATE:

CHECKED BY:

PAGE ____ OF ____

Monitoring Well MW-1 Well Cluster Construction Details



CONESTOGA-ROVERS & ASSOCIATES

PROJECT No.: 47392

PROJECT NAME: Frontier Chemical Site

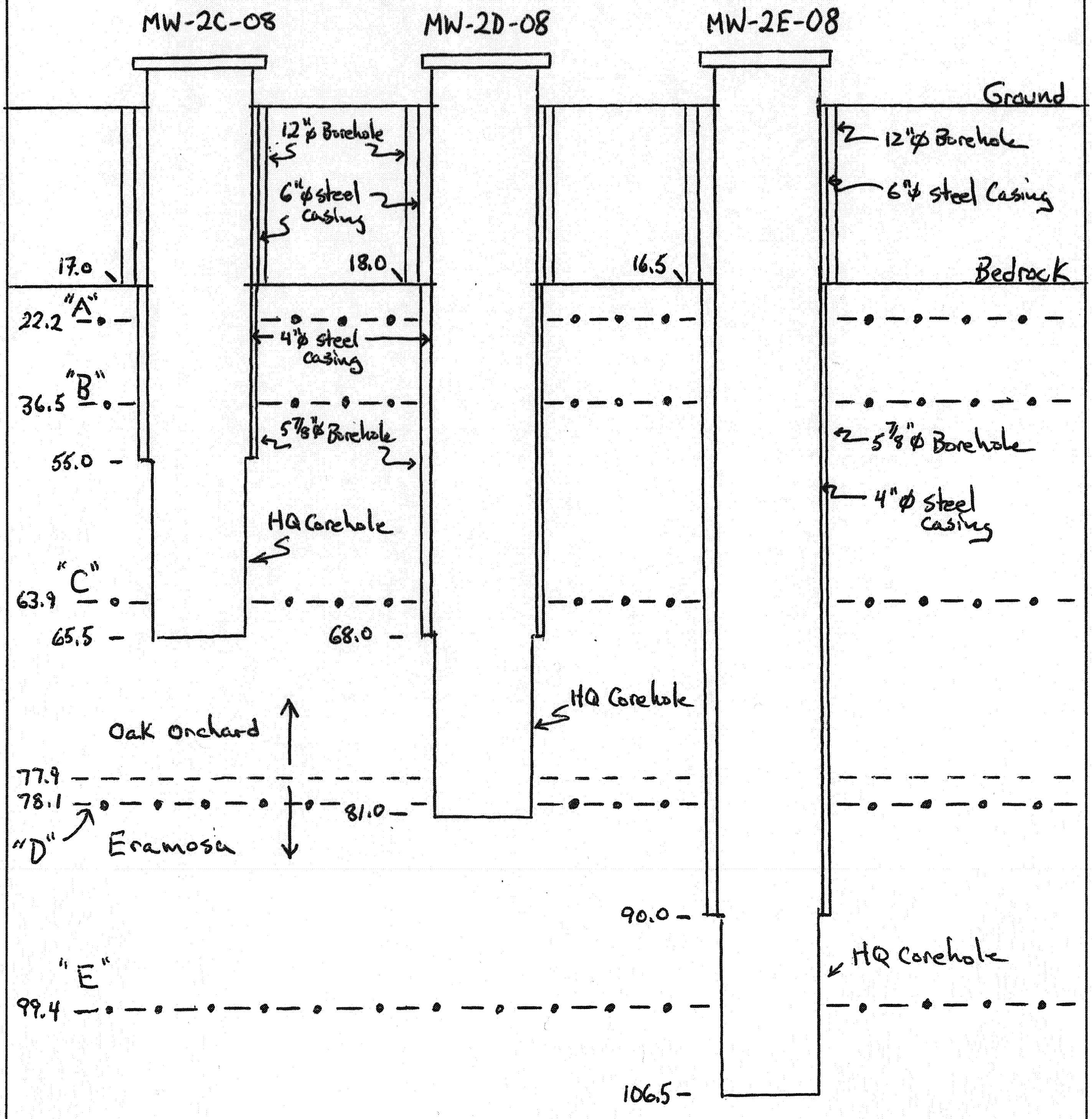
DESIGNED BY: J. Williams

DATE:

CHECKED BY:

PAGE ____ OF ____

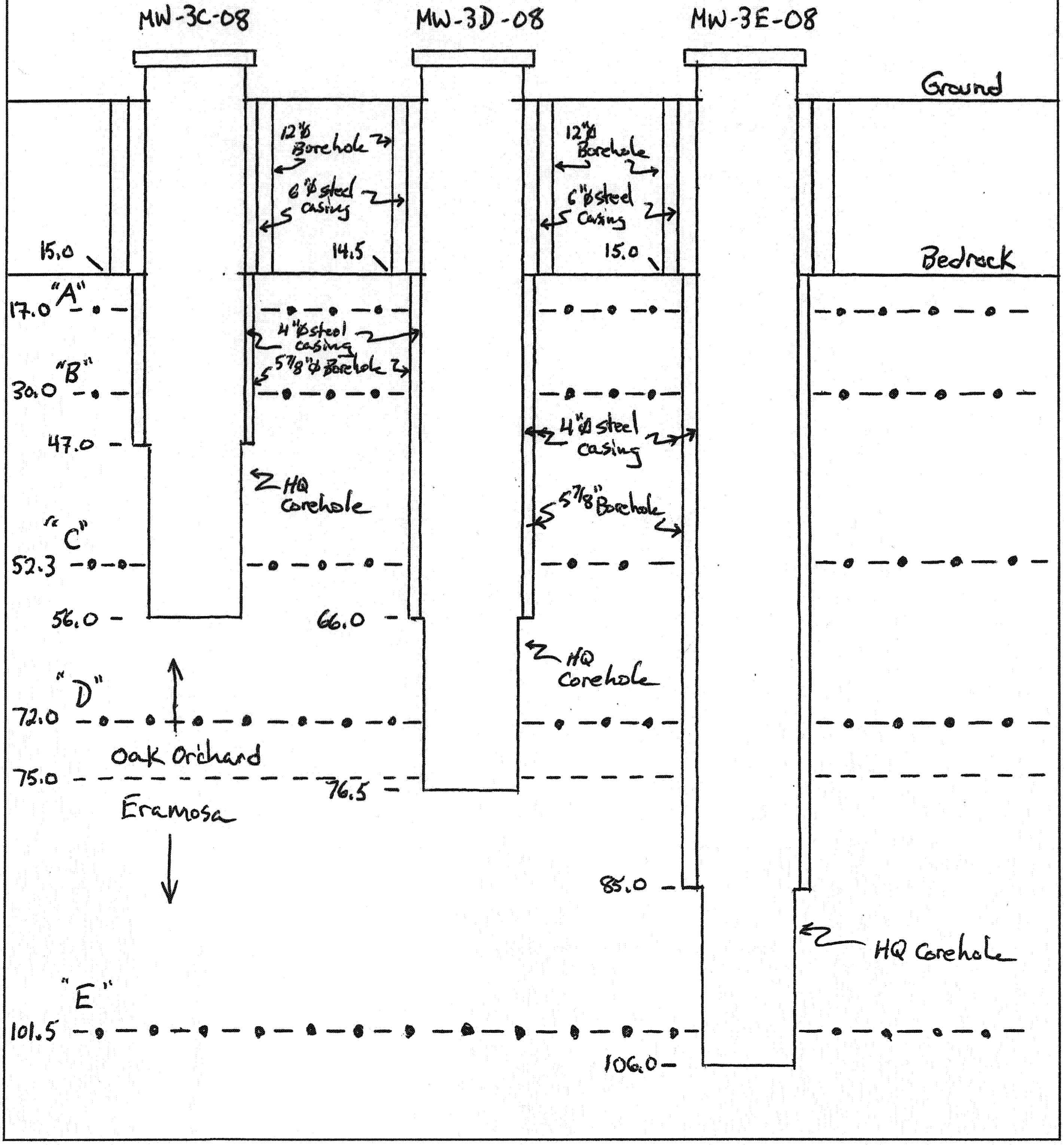
Monitoring Well MW-2 Well Cluster Construction Details



CONESTOGA-ROVERS & ASSOCIATES

PROJECT No.: 47392
PROJECT NAME: Frontier Chemical Site
DESIGNED BY: J. Williams
DATE:
CHECKED BY:
PAGE ____ OF ____

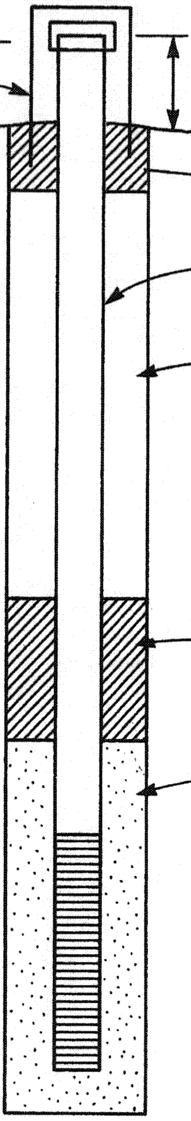
Monitoring Well MW-3 Well Cluster Construction Details



WELL INSTRUMENTATION LOG

PROJECT NAME: Frontier Chemical Site
PROJECT №: 47392
CLIENT: Frontier PRP Group
LOCATION: As per plan

HOLE DESIGNATION: SVP-1
DATE COMPLETED: 11/11/08
DRILLING METHOD: Geoprobe
CRA SUPERVISOR: J. Williams



CAP TYPE:
PROTECTIVE CASING
GROUND SURFACE
STICK UP = ~2.5 [✓ ft.] m.
SURFACE SEAL TYPE:
WELL CASING
ANNULUS BACKFILL TYPE: native soil
TOP OF SEAL* AT 0.5 ft/m
SEAL TYPE hydrated bentonite
BOTTOM OF SEAL* AT 5.5 ft/m
PACK TYPE: [✓ - SAND], SIZE Coarse
- GRAVEL
- NATURAL
TOP OF SCREEN* AT 6.5 ft/m
BOTTOM OF SCREEN* AT 7.5 ft/m
BOTTOM OF HOLE* AT 8.0 [✓ ft]/m

*NOTE:
ALL DIMENSIONS ARE
BELOW GROUND SURFACE (BGS)

SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☒ other: Mesh
SCREEN MATERIAL: ☒ stainless steel ☐ plastic ☐ other:
SCREEN LENGTH: 1.0 [✓ ft]/m SCREEN DIAMETER: 1.0 [✓ in]/cm SCREEN SLOT SIZE:
WELL CASING MATERIAL: polyethylene WELL CASING DIAMETER: 0.5 [✓ in]/cm
HOLE DIAMETER: 2.0 in.
DEVELOPMENT: METHOD: DURATION:

WELL INSTRUMENTATION LOG

PROJECT NAME: Frontier Chemical Site

PROJECT Nº: 47392

CLIENT: Frontier PRP Group

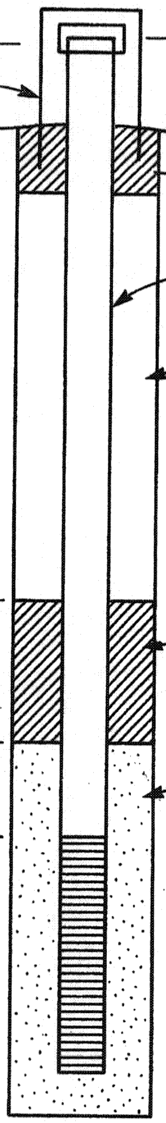
LOCATION: As per plan

HOLE DESIGNATION: SVP-2

DATE COMPLETED: 11/11/08

DRILLING METHOD: Geoprobe

CRA SUPERVISOR: J. Williams



CAP TYPE

PROTECTIVE CASING

GROUND SURFACE

STICK UP = ~2.5 [✓ ft]/m.

SURFACE SEAL TYPE

WELL CASING

ANNULUS BACKFILL TYPE: Native Soil

TOP OF SEAL* AT 0.5 [✓ ft]/m

SEAL TYPE Hydrated Bentonite

BOTTOM OF SEAL* AT 5.8 [✓ ft]/m

TOP OF SCREEN* AT 6.8 [✓ ft]/m

PACK TYPE:
- [✓ SAND], [✓ SIZE] coarse
- GRAVEL
- NATURAL

BOTTOM OF SCREEN* AT 7.8 [✓ ft]/m

BOTTOM OF HOLE* AT 7.8 [✓ ft]/m

*NOTE: ALL DIMENSIONS ARE BELOW GROUND SURFACE (BGS)

SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☒ other: Mesh

SCREEN MATERIAL: ☒ stainless steel ☐ plastic ☐ other:

SCREEN LENGTH: 1.0 [✓ ft]/m SCREEN DIAMETER: 1.0 [✓ in]/cm SCREEN SLOT SIZE:

WELL CASING MATERIAL: Polyethylene WELL CASING DIAMETER: 0.5 [✓ in]/cm

HOLE DIAMETER: 2.0 in.

DEVELOPMENT: METHOD: DURATION:

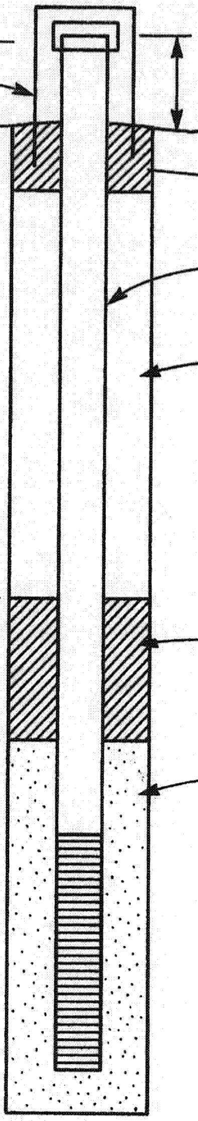
2/05/85

CRA

WELL INSTRUMENTATION LOG

PROJECT NAME: Frontier Chemical Site
PROJECT Nº: 47392
CLIENT: Frontier PRP Group
LOCATION: As per plan

HOLE DESIGNATION: SVP-3
DATE COMPLETED: 11/11/08
DRILLING METHOD: Geoprobe
CRA SUPERVISOR: J. Williams



CAP TYPE

PROTECTIVE CASING

GROUND SURFACE

STICK UP = 0 [✓ ft]/m.

SURFACE SEAL TYPE

WELL CASING

ANNULUS BACKFILL TYPE: Native Soil

TOP OF SEAL* AT 0.1 ft/m

SEAL TYPE Hydrated Bentonite

BOTTOM OF SEAL* AT 0.5 ft/m

PACK TYPE: [✓ SAND], SIZE Coarse
- GRAVEL
- NATURAL

TOP OF SCREEN* AT 0.7 ft/m

BOTTOM OF SCREEN* AT 1.7 ft/m

BOTTOM OF HOLE* AT 4.0 [✓ ft]/m

* NOTE:
ALL DIMENSIONS ARE
BELOW GROUND SURFACE (BGS)

SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☒ other: Mesh

SCREEN MATERIAL: ☒ stainless steel ☐ plastic ☐ other:

SCREEN LENGTH: 1.0 [✓ ft]/m SCREEN DIAMETER: in/cm SCREEN SLOT SIZE:

WELL CASING MATERIAL: Polyethylene WELL CASING DIAMETER: 0.5 [✓ in]/cm

HOLE DIAMETER: 2.0 in.

DEVELOPMENT: METHOD: DURATION:

WELL INSTRUMENTATION LOG

PROJECT NAME: Frontier Chemical Site

PROJECT Nº: 47392

CLIENT: Frontier PRP Group

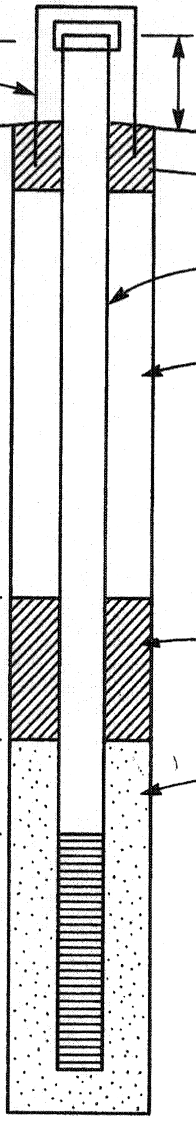
LOCATION: As per Plan

HOLE DESIGNATION: SVP-4

DATE COMPLETED: 11/11/08

DRILLING METHOD: Geoprobe

CRA SUPERVISOR: J. Williams



CAP TYPE

STICK UP = 0 [✓ ft]/m.

SURFACE SEAL TYPE

ANNULUS BACKFILL TYPE: Native Soil

TOP OF SEAL* AT 0.5 [✓ ft]/m

SEAL TYPE Hydrated Bentonite

BOTTOM OF SEAL* AT 5.8 [✓ ft]/m

PACK TYPE: - [✓ SAND] SIZE Coarse
- GRAVEL
- NATURAL

TOP OF SCREEN* AT 6.8 [✓ ft]/m

BOTTOM OF SCREEN* AT 7.8 [✓ ft]/m

BOTTOM OF HOLE* AT 8.0 [✓ ft]/m

* NOTE:
ALL DIMENSIONS ARE
BELOW GROUND SURFACE (BGS)

SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☒ other: Mesh

SCREEN MATERIAL: ☒ stainless steel ☐ plastic ☐ other:

SCREEN LENGTH: 1.0 [✓ ft]/m SCREEN DIAMETER: 1.0 [✓ in]/cm SCREEN SLOT SIZE:

WELL CASING MATERIAL: Polyethylene WELL CASING DIAMETER: 0.5 [✓ in]/cm

HOLE DIAMETER: 2.0 in.

DEVELOPMENT: METHOD: DURATION:

2/05/85

CRA

SUMMARY OF PACKER PUMPING TESTS
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

Location	Interval Tested Top (ft. BGS)	 Bottom (ft. BGS)	Test Duration (min.)	Volume Pumped (gallons)	Effective Flow Rate (GPM)	Waterbearing? (yes/no)
MW-1D-08	64.5	79.6	60	192	3.2	Yes
	79.6	94.7	10	<1	<0.1	No
	88.3	103.4	12	<1	<0.1	No
	88.3	107	31	291.5	9.4	Yes
MW-2D-08	67.5	82.6	62	142.6	2.3	Yes
	82.6	97.7	8	<1	<0.1	No
	87.1	102.2	60	288	4.8	Yes
	82.1	106	60	288.2	4.8	Yes
MW-3D-08	65.5	80.6	60	84	1.4	Yes
	80.6	95.7	10	<1	<0.1	No
	87.3	102.4	30	294	9.8	Yes
	87.3	106	20	202.3	10.1	Yes

Notes:
ft. BGS - feet below ground surface.
GPM - gallons per minute.
Waterbearing - defined as >0.1 GPM per inch diameter of borehole.

Former Frontier Chemical Site
Royal Avenue
Niagara Falls, NY

10/16/2009

Well Identification	Northing	Easting	Ground Elevation	Top of Outer Casing Elevation	Riser Elevation	Notes
MW1-08 C	1125406.93	1034595.38	570.26		572.22	4" Steel
MW1-08 D	1125398.90	1034582.34	570.70		572.67	4" Steel
MW1-08 E	1125387.23	1034594.95	570.43		572.40	4" Steel
MW2-08 C	1125101.39	1034191.05	570.86		572.76	4" Steel
MW2-08 D	1125101.90	1034161.00	570.66		572.70	4" Steel
MW2-08 E	1125114.21	1034128.06	571.05		573.29	4" Steel
MW3-08 C	1125237.28	1033874.71	570.72		572.60	4" Steel
MW3-08 D	1125227.87	1033889.31	570.84		572.83	4" Steel
MW3-08 E	1125216.59	1033874.99	570.63		572.74	4" Steel
MW-88-4C	1125744.97	1034452.50	570.62	572.61	572.63	2" Steel
MW-88-5C	1125233.31	1034138.47	571.05	574.51	574.44	3" Steel
OW-654 B	1124784.79	1033571.17	569.81	569.82	569.43	4" Steel
OW-654 C	1124808.12	1033569.24	570.23	570.40	570.05	4" Steel
OW-654 D	1124831.63	1033568.19	570.28	570.35	570.06	6" Steel
OW-655 D	1124995.84	1034445.80	571.45	571.45	571.13	6" Steel
OW-656 D	1125134.92	1033540.95	569.84	569.66	569.32	6" Steel
BH1-08	1125361.17	1034412.87	570.32			
BH2-08	1125295.08	1034413.53	570.23			
BH3-08	1125237.96	1034334.22	569.74			
BH4-08	1125239.65	1034243.03	570.68			
BH5-08	1125206.36	1034177.50	570.34			
BH6-08	1125304.05	1034110.64	571.22			
BH7-08	1125383.25	1034161.33	571.16			
BH8-08	1125386.45	1034110.71	571.28			
BH9-08	1125456.01	1034151.38	569.96			
BH10-08	1125525.61	1034148.14	570.88			
BH11-08	1125510.01	1034230.55	570.40			
BH12-08	1125302.71	1034242.12	571.35			
BH13-08	1125378.85	1034240.87	571.56			
BH14-08	1125441.30	1034243.14	570.89			
BH15-08	1125358.74	1034328.69	569.76			
BH16-08	1125295.92	1034333.99	570.02			
BH17-08	1125304.08	1034174.63	570.58			
BH18-08	1125207.79	1034080.74	571.32			
BH19-08	1125429.27	1034337.24	569.43			
BH20-08	1125171.98	1034174.35	570.31			
SVP-1	1125128.84	1033935.87	570.06			
SVP-2	1125102.22	1034135.66	570.50			
SVP-3	1125094.09	1034334.69	570.63			
SVP-4	1125102.31	1034500.34	570.97			
Excav Corner NE	1125392.53	1034176.49	570.70			
Excav Corner SE	1125375.63	1034175.78	570.57			
Excav Corner SW	1125376.78	1034141.40	571.44			
Excav Corner NW	1125393.78	1034142.71	571.53			
Baseline Benchmark	1125041.95	1034317.15	570.66			
Property Corners						
NE	1125758.62	1034608.18				
NW	1125758.63	1034147.98				
Angle (PC)	1125750.75	1034110.45				
NW	1125729.61	1034045.80				
Angle	1125385.41	1034044.63				
Angle	1125385.46	1033862.19				
SW	1125090.33	1033861.18				
SE	1125090.13	1034602.33				

APPENDIX B

DERIVATION OF CLEANUP CRITERIA FOR MONOCHLOROTOLUENE

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LIST OF TABLES

CALCULATION OF SOIL CLEANUP OBJECTIVES FOR 2-CHLOROTOLUENE AND 4-CHLOROTOLUENE

1.0 INTRODUCTION

In the "Supplemental Soil Characterization and Pilot Test Work Plan", it was noted that 6 NYCRR Part 375-6 does not have Soil Cleanup Objectives (SCOs) for monochlorotoluene (MCT). Since MCT is a Chemical of Concern for the Frontier Site, it was proposed in the Work Plan and approved that the Frontier Chemical Group develop the MCT criteria specifically for the protection of human health in an industrial setting. The SCO calculated for MCT was presented in Section 6.1.4 and Appendix B of the "Remedial Pre-Design Investigation Report." Based upon the December 31, 2009 comments from the NYSDEC, the Frontier Chemical Group has:

- Refined the SCO calculation required in the approved Work Plan for MCT as it applies to the protection of human health in an industrial setting
- Further expanded upon the derivation of the SCO
- Provided additional SCOs applicable to other land-use categories (although not a requirement of the Work Plan)
- Developed an SCO for protection of groundwater (although not a requirement of the Work Plan)

The following analyses derive SCOs for MCT, specifically 2-chlorotoluene and 4-chlorotoluene, using methods recommended by NYSDEC guidance (2006) and NYSDEC's December 31, 2009 comment letter. SCOs have not been developed for 3-chlorotoluene as it was not detected in the soil samples analyzed as part of the Pre-Design Investigation and therefore is not a Site Chemical of Concern.

2.0 REVIEW OF TOXICOLOGICAL INFORMATION FOR 2- AND 4-CHLOROTOLUENE

As recommended in the New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives Technical Support Document (NYSDEC, 2006), chemical specific toxicological information was sought in authoritative health and environmental agency documents including: USEPA, ATSDR, World Health Organization, Health Canada, NYSDOH, NYSDEC, and California Environmental Protection Agency.

As a first step, information from New York State was searched. NYSDEC has groundwater criteria of 5 µg/L for all three chlorotoluene isomers (2, 3, and 4-chlorotoluene). However, these groundwater criteria are not based on toxicological information specific to the chlorotoluene isomers (NYDEC, 1996). Instead, they are based on the generic definition as a principal organic contaminant (New York has classified a number of organic chemicals (halogenated alkanes, benzene, alkyl substituted benzenes, etc.) as principal organic contaminants for which groundwater criteria have been established at 5 µg/L, irrespective of the specific toxicological data.)

NYSDEC's air quality standards (NYSDEC 2007) present an Annual Guideline Concentration of 620 µg/m^3 for 2-chlorotoluene, which appears to be based on chemical-specific toxicological information. Annual Guideline Concentrations are similar in intent to a reference concentration (RfC), although the derivations are different. That is, the Annual Guideline Concentration values are intended as concentrations to which more sensitive members of the population can be exposed, chronically, without adverse effects.[1] Following NYSDEC guidance and applying a route-to-route extrapolation of this de facto RfC would produce a reference dose (RfD) of 0.18 mg/kg-day[2].

---

[1] According to NYSDEC (2007), the 2-chlorotoluene standard is based on
"*ACGIH TLV-TWA values published in the 2000 TLVs and BEIs handbook. These values are published annually and represent occupational exposure values to which it is believed nearly all workers may be repeatedly exposed, day after day, without adverse effect based on a 8 hour workday and 40 hour workweek. AGCs are derived from TLVs by dividing them by a factor of 420. This represents a dosimetric adjustment of 4.2 (40 hour workweek adjusted to 168 hours per week) with an additional safety/uncertainty factor adjustment of one-hundred (100) for the general population.*"
Note that the original reference for the ACGIH value could not be found; hence, the toxicological basis of this value could not be evaluated.

[2] NYSDEC (2006) guidance suggests that a route-to-route extrapolation could be done when
"*three conditions were met: (1) adequate toxicity data for one exposure route were available, but adequate data for another route (usually inhalation) were not available; (2) the toxicity data indicated that the critical effects were systemic; and (3) the structural orpharmacokinetic data (i.e., data on its absorption, distribution, metabolism, and excretion) suggested that it was likely to be absorbed by both exposure routes.*"
The available toxicological data for 2-chlorotoluene satisfies these three conditions, such that the route-to-route conversion can be done.

$$RfD = \frac{RfC\,(20m^3/d)}{(70\,kg)(1000\,ug/mg)}$$

$$RfD = \frac{620\,ug/m^3\,(20m^3/d)}{(70\,kg)(1000\,ug/mg)}$$

$$RfD = 0.18\,mg/(kg*d)$$

USEPA's review of oral toxicity information for 2-chlorotoluene generated a lower oral RfD of 0.02 mg/kg-day. This RfD is based on a subchronic (103-day) rat no observed adverse effects level (NOAEL) of 20 mg/kg-day, modified by a 1000-fold uncertainty factor. The uncertainty factor is the product of 10 to account for interspecies extrapolation, 10 for differences in individual human sensitivity, and 10 for use of a subchronic study. Although there are some limited experimental data with inhalation toxicity, USEPA did not attempt to calculate an RfC. Using NYSDEC (2006) recommended methods for route-to-route extrapolation, the RfD yields an RfC of 0.07 mg/m^3. This is based on the following equation, from NYSDEC guidance:

$$RfC = \frac{RfD\,(70\,kg)(1000\,ug/mg)}{20m^3/d}$$

$$RfC = \frac{0.02mg/kg-d\,(70\,kg)(1000\,ug/mg)}{20m^3/d}$$

$$RfC = 70\,ug/m^3$$

The Integrated Risk Information System (IRIS) report also details several in vitro and in vivo tests of potential carcinogenic potency, all of which were negative. That is, 2-chlorotoluene showed no mutagenic, clastogenic, or carcinogenic effects in a series of bioassays. In an acute whole animal test, no evidence of mutations in bone marrow cells was found. However, there are apparently no long-term cancer bioassays with animals. Therefore, no attempt has been made to classify this chemical's carcinogenic status. Other agencies, such as the International Agency for Research on Cancer, have also not determined the carcinogenic potential of 2-chlorotoluene.

The California Office of Environmental Health Hazard Assessment (OEHHA) obtained the same RfD, 0.02 mg/kg-day as the USEPA using the same toxicological data and same set of uncertainty/safety factors (OEHHA, 2000).

A search of World Health Organization sources yielded no information specific to 2-chlorotoluene. However, an allied agency, the United Nations Environmental Program, published a toxicological review of 2-chlorotoluene. This screening information data set (SIDS) was conducted by the Organization for Economic Co-operation and Development (2000). This toxicological review is similar to that presented in IRIS. It proposes a NOAEL of 20 mg/kg-day, and also concludes that 2-chlorotoluene shows no evidence of mutagenic, clastogenic, or carcinogenic effects in a series of short-term *in vitro* and *in vivo* tests.

A review of chlorotoluene toxicity by the Dutch Environmental Agency (van Herwijnen and van Leeuwen 2009) reports that the Netherlands has generated RfD-like and RfC-like values of 0.02 mg/kg-day and 0.775 mg/m^3, respectively. In the Dutch regulatory vernacular, these are called Tolerable Daily Intake and Tolerable Concentration in Air, respectively. However, the original sources for these health based values could not be located, so the toxicological bases could not be evaluated. It can, however, be assumed that the Tolerable Daily Intake was generated using the same data and NOAEL as the USEPA and California RfDs.

No Health Canada reviews or health based values could be found for 2-chlorotouene. Similarly, no toxicological summaries for chlorotoluene were found at the Agency for Toxic Substances Disease Registry.

In summary, there is general agreement that a NOAEL of 20 mg/kg-day is valid for 2-chlorotouene. In turn, this consensus NOAEL has been translated to RfD or RfD-like values of 0.02 mg/kg-day with a 1000 fold uncertainty factor. Although no RfC values have been calculated by the USEPA, RfC-like values of 0.775 mg/m^3 and 0.62 mg/m^3 have been generated by other health agencies. The latter value, 0.62 mg/m^3, is found in current NYSDEC regulation (NYSDEC, 2007). However, the source documents for these RfC-like values could not be located, so their toxicological bases could not be evaluated. Using route-to-route extrapolation of the USEPA RfD for 2-chlorotoluene produces a lower RfC value of 0.07 mg/m^3. To be conservative, the latter RfC value will be used in the generation of SCO values for 2-chlorotoluene.

With respect to potential carcinogenic effects of 2-chlorotoluene, information from authoritative health and environmental agencies indicates that there is evidence, albeit limited, that the compound is **not** carcinogenic. That is, the compound does not cause mutations or disrupt DNA in Ames tests, mammalian cell preps, or in limited whole organism bioassays. However, no long-term carcinogenic bioassays have been conducted. Thus, these authoritative sources generally conclude that information is insufficient to make a final judgment about the carcinogenic potential. Based upon the current weight of evidence, it is only necessary to consider non-cancer toxicity.

The same authoritative sources were also searched for toxicological information concerning 4-chlorotoluene. Information on 4-chlorotoluene is more limited than that for 2-chlorotoluene. For example, no Annual Guideline Concentration exists in NYSDEC (2007), nor is this isomer discussed in IRIS. However, specific discussions of 4-chlorotouene toxicity can be found in the Organization for Economic Cooperation and Development (2005) and van Herwijnen and van Leeuwen (2009). In general, these reviews indicate that toxicological data on 4-chlorotoluene is more limited than for 2-chlorotoluene. Thus, they either propose no RfD values for 4-chlorotoluene or they assume that 4-chlorotoluene is as toxic as 2-chlorotoluene and apply the same health related values. In contrast, USEPA has generated a 4-chlorotoluene specific RfD of 0.07 mg/kg-day (USEPA 2009), which is now used in its RBCs and reported in other toxicity references (e.g., see Risk Assessment Information System 2010). An equivalent RfC value, 0.245 mg/m^3, can be generated with the route-to-route extrapolation method suggested by NYSDEC guidance using the equations described above. Both values will be used in the discussion below.

As with 2-chlorotoluene, a limited number of *in vitro* and *in vivo* analyses indicate that 4-chlorotoluene is not mutagenic, but no long term carcinogenic bioassays have been conducted. Hence, available health based values for 4-chlorotoluene (e.g., USEPA 2009, Risk Assessment Information System 2010, and van Herwijnen and van Leeuwen 2009) are based on non-cancer toxicity.

3.0 CALCULATION OF SCOS FOR 2- AND 4-CHLOROTOLUENE

As requested in the NYSDEC's December 31, 2009 letter, SCO values were calculated for each of the receptors and each of the land-use types found in the original guidance, in addition to those applicable to human health in an industrial setting as originally proposed in the approved Work Plan. The SCO values were calculated as recommended in the guidance and NYDEC letter. That is, SCOs were calculated for each of the five land-use categories included in 6 NYCRR Part 375: unrestricted, residential, restricted residential, commercial, and industrial. For each land use category, exposures for each relevant receptor were evaluated (i.e., children, adolescents, and adults). Calculation of SCOs accounted for all of the exposure pathways that were considered in developing the 6 NYCRR Part 375 SCOs and using the equations and assumptions found in NYSDEC guidance (2006). The toxicity reference values for non-cancer endpoints were also adjusted to account for non-site exposures.

The resulting SCO values for 2-chlorotoluene and 4-chlorotoluene are presented in Table 1 and the detailed calculations are provided in Attachment 1. SCO values for chlorobenzene, taken from Table 5.3.6-2 of NYSDEC (2006), are also provided on Table 1 for comparison to demonstrate that the calculations for 2-chlorotoluene are reasonable. That is, the SCOs for 2-chlorotoluene should be only slightly higher than those of chlorobenzene since the two chemicals have the same RfD (0.02 mg/kg-day) and about the same RfCs. The RfC for 2-chlorotoluene, 0.07 mg/m^3, is slightly higher than that for chlorobenzene, 0.06 mg/m^3. Thus, the SCOs for 2-chlorotoluene should be about equal to those for chlorobenzene. The data on Table 1 show that this expectation is met.

Since the land is zoned industrial, the approved Work Plan only required the calculation of the MCT SCOs for the protection of human health in an industrial setting. Nonetheless, in order to comply with the NYSDEC comment letter of December 31, 2009, SCOs for each of the five land-use categories have been calculated and included in Table 1. The pertinent SCOs are those for industrial land-use scenario. As shown in Table 1, the most restrictive industrial SCO for 2-chlorotoluene is 3,900 mg/kg pertaining to the exposure to adults in an industrial setting. Based on the USEPA's RfD for 4-chlorotoluene, its most restrictive SCO is 14,000 mg/kg for the same receptor.

Although the approved Work Plan did not include the need to develop an SCO for the protection of groundwater, such calculations have been made to respond to comments received from the NYSDEC during the various meetings with the Frontier Chemical Group since the time the Remedial Pre-Design Investigation Report was submitted. The SCO protective of groundwater was estimated to be about 1.9 mg/kg for both chlorotoluene isomers. This value is based on the groundwater criteria of 0.005 mg/l, a

Koc of 387, and a Dilution Attenuation Factor of 100. The Koc value is the geometric mean of the range of observed Koc values, 170 to 880, reported in the Hazardous Substances Database (2004).

4.0 ADJUSTMENTS TO THE SCOS FOR 2- AND 4-CHLOROTOLUENE

According to NYSDEC guidance and its December 31, 2009 letter, final SCOs must also consider potential acute effects and effects of dermal irritation. With respect to any of the chlorotoluene isomers, no acute oral RfDs or toxicity values pertaining to skin irritation could be found. However, this is not considered a significant data gap. The acute oral dose pertains to instances of very high soil ingestion by small children. This scenario is not applicable to the Frontier Site because:

1. High concentrations of chlorotoluene are not found in surface soils
2. Exposure to soils is limited since most of the Site is covered with asphalt or concrete
3. The Site is secured with a perimeter fence and small children will not have access to this industrial site

Similarly, potential uncertainty about skin irritation is not a significant data gap. Except during excavation, dermal exposure to industrial workers will not be possible due to the subsurface distribution of the chemicals and therefore the lack of exposure potential. If excavation occurs at the Site, potential dermal contact would be managed by use of the protective clothing specified in typical health and safety plans.

Final SCOs must also consider background concentrations, detection limits, and regulatory caps. Although no information concerning background concentrations of 2- or 4-chlorotoluene could be found, the calculated SCOs are almost certainly well above background values. Thus, consideration of background concentrations should not affect the SCOs. The SCOs are also well above typical analytical detection limits, so they do not need to be adjusted. However, NYSDEC guidance recommends that the cap, or maximum SCO, for any organic chemical at an industrial site should be 1,000 mg/kg (Table 9.3-1 of NYSDEC 2006). As this value is less than both SCOs, they should both be adjusted down to this maximum concentration. Consequently, the SCOs for 2-chlorotoluene and 4-chlorotoluene should be set at the cap of 1,000 mg/kg, even though the risk-based SCOs are considerably higher.

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TABLE 1

SCO VALUES FOR NON-CANCER TOXICITY AND DIFFERENT LAND-USES AND RECEPTORS THE APPLICABLE LAND-USE IS INDUSTRIAL

		Unrestricted		*Residential*		*Restricted Residential*		*Commercial*		*Industrial*	
Compound	*CAS #*	*Adult*	*Child*	*Adult*	*Child*	*Adult*	*Child*	*Adult*	*Child*	*Adult*	*Juvenile*
2-Chlorotoluene	95-49-8	460	65	530	120	610	340	1900	4900	**3900**	14000
4-Chlorotoluene	106-43-4	1600	230	1800	410	2100	1200	6800	17000	**14000**	49000
Chlorobenzene	108-90-7	410	63	460	110	520	310	1700	4700	3400	13000

APPENDIX C

HISTORIC DATA – OTHER REPORTS

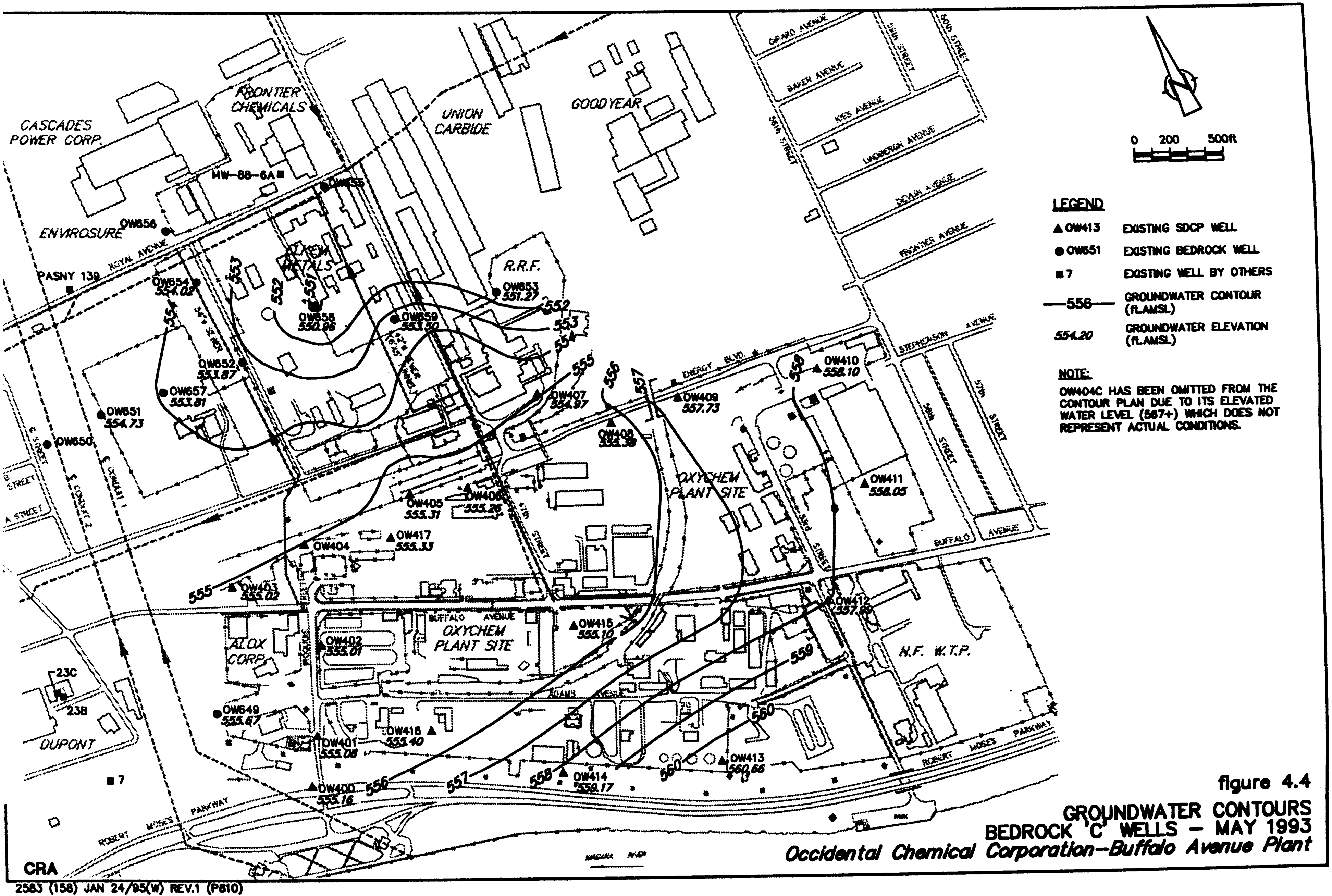

figure 4.4

GROUNDWATER CONTOURS
BEDROCK 'C' WELLS – MAY 1993
Occidental Chemical Corporation–Buffalo Avenue Plant

2583 (158) JAN 24/95(W) REV.1 (P810)

Table 5-12B
Comparison of Historical and Recent Analytical Results for C-Fracture Zone Bedrock Groundwater Samples
SRI Frontier Chemical Site

Analyte	Screening Criteria Sample ID: Date:	MW-88-4C 11/01/88	MW-88-4C 11/06/01	MW-88-5C 11/01/88	MW-88-5C 11/12/01
VOCs by Method OLM04.2 (µg/L)					
1,1,1-Trichloroethane	5	[illegible]	10 U	4 U	**910**
1,1,2,2-Tetrachloroethane	5	[illegible]	10 U	4 U	100 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	[illegible]	10 U	[illegible]	100 UJ
1,1,2-Trichloroethane	1	[illegible]	10 U	4 U	100 U
1,1-Dichloroethane	5	[illegible]	10 U	[illegible]	**77 J**
1,1-Dichloroethene	5	[illegible]	10 U	[illegible]	100 U
1,2,4-Trichlorobenzene	5	[illegible]	10 U	4 U	**57 J**
1,2-Dichlorobenzene^2	3	[illegible]	10 U	[illegible]	**210**
1,2-Dichloroethane	0.6	[illegible]	10 U	4 U	100 U
1,3-Dichlorobenzene^2	3	[illegible]	10 U	[illegible]	**210**
1,4-Dichlorobenzene^2	3	[illegible]	10 U	4 U	**210**
2-Butanone	50 ^{G}	[illegible]	10 U	[illegible]	100 U
2-Hexanone	50 ^{G}	[illegible]	10 U	4 U	100 U
4-Methyl-2-pentanone	N/A	[illegible]	10 U	[illegible]	100 U
Acetone	50 ^{G}	[illegible]	10 U	[illegible]	100 U
Benzene	1	[illegible]	**4 J**	4 U	**440**
Carbon disulfide	60 ^{G}	[illegible]	10 U	[illegible]	100 U
Chlorobenzene	5	[illegible]	10 U	4 U	**680**
Chloroethane	5	[illegible]	10 U	[illegible]	100 U
Chloroform	7	[illegible]	10 U	[illegible]	**11 J**
cis-1,2-Dichloroethene	5	[illegible]	10 U	4 U	100 U
Cyclohexane	N/A	[illegible]	10 U	4 U	100 U
Ethylbenzene	5	[illegible]	10 U	4 U	100 U
Isopropylbenzene	5	[illegible]	10 U	[illegible]	100 U
Methylene chloride	5	[illegible]	10 U	4 U	**100**
Styrene	5	[illegible]	10 U	4 U	100 U
Tetrachloroethene	5	[illegible]	10 U	[illegible]	**95 J**
Toluene	5	[illegible]	10 U	4 U	**170**
trans-1,2-Dichloroethene	5	[illegible]	10 U	[illegible]	100 U
Trichloroethene	5	[illegible]	10 U	13	**420**
Vinyl chloride	2	[illegible]	10 U	110	100 U
Xylenes, Total	5	4 U	10 U	4 U	100 U

Key at the end of Table.

APPENDIX D

FOCUSSED FEASIBILITY STUDY

FOCUSED FEASIBILITY STUDY

FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

SEPTEMBER 2010
REF. NO. 047392 (7) - AppD
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1.0 FOCUSED FEASIBILITY STUDY

This Focused Feasibility Study (FFS) evaluates potential remedial actions to address the deep bedrock groundwater contamination that exists beneath the Frontier Chemical Site in Niagara Falls, New York with the intent to identify the most appropriate action that is protective of human health and the environment. The remedial action also must comply with federal and state requirements pertaining to hazardous waste sites. In March 2006, the New York State Department of Environmental Conservation (NYSDEC) issued a Record of Decision (ROD) for the Frontier Chemical Site (a former permitted Treatment, Storage, and Disposal Facility (TSDF) that selected a remedy for the shallow groundwater as part of Operable Unit 1. The deep bedrock groundwater (deeper than 15 feet below the top of bedrock and administratively identified as Operable Unit 2) had not yet been fully investigated to determine whether it had been impacted by chemical releases from the Site. An investigation of the deep bedrock has now been completed and this FFS presents the possible remedial alternatives evaluated to select the appropriate alternative to address the chemicals found in the deep bedrock groundwater.

On August 15, 2008, the NYSDEC and Frontier Chemical PRP Group entered into an Order on Consent and Administrative Settlement (Index #89-0571-00-01) that governed the collection of additional data in the deep bedrock beneath the Site to determine the conditions at depth. The investigation of the deep bedrock was completed in 2008/2009 through the installation of three deep bedrock well nests, along with applicable hydraulic testing and groundwater chemical sampling. The results of this investigation are presented in Section 6.3 of the main report. The investigation has shown that there are chemicals present in the deep bedrock groundwater. However, the concentrations measured in the deep bedrock are orders of magnitude lower than those in the overburden and shallow bedrock groundwater. Furthermore, it has been determined that there is a significant upward gradient in the bedrock groundwater flow regime. This upward gradient results in upward groundwater flow that would restrict chemicals in the shallow groundwater from migrating into the deep bedrock zones. While the chemicals found in the deep bedrock groundwater are similar to chemicals known to be present on the Frontier Site, the concentrations found and the hydrogeologic conditions are not necessarily consistent with releases solely from the Frontier Site. Regardless of the source of the chemicals present, the concentrations and off-Site chemical migration loadings are so low that there is minimal potential for significant threat to human health or the environment from the current groundwater conditions in the deep bedrock. The fact that concentrations have reduced over time and are expected to continue to reduce following implementation of a planned Site soil remediation under Operable Unit 1, further minimizes any potential for a significant threat in the future.

In accordance with the Order on Consent and Administrative Settlement, the data from the deep bedrock investigation have been evaluated in this FFS to determine the most appropriate remedy to address the impact, if any, that these chemicals have on the deep bedrock groundwater, regardless of their source.

Based upon the data from the Site investigation program and the evaluations performed in this FFS, it has been determined that a deep bedrock groundwater remedy consisting of monitored natural attenuation with institutional controls is the recommended alternative. This alternative will be effective in addressing the chemicals of concern (COCs) present in the deep bedrock groundwater and will be protective of human health and the environment.

It is noted that this FFS is a sub-component of the overall groundwater remediation program for the entire Frontier Chemical Site. It is further noted that a Feasibility Study for shallow groundwater has already been completed by Ecology and Environment Engineering, P.C. in May 2004 and has been approved by the NYSDEC. Consequently, to the extent appropriate, this FFS relies upon the results and evaluations of the earlier Feasibility Study and some portions of the earlier Feasibility Study have been incorporated into or repeated in this FFS. The selection of a remedy for the deep bedrock groundwater needs to be effectively coordinated with the other remedial actions selected by NYSDEC for implementation at this Site.

2.0 SITE BACKGROUND

The Frontier Chemical Site is located on a 9-acre parcel of land in an industrial area of the City of Niagara Falls on Royal Avenue at 47th Street. Additional detail on the Site location, Site history, and remedial history are provided in the main text of the report, along with the details and discussion on the hydrogeologic and geochemical conditions in the groundwater flow regime at the Site.

Based on the investigations performed at the Site, a summary of the groundwater conditions is presented in the following:

- The overburden and upper bedrock groundwater flow regimes have been impacted by chemical releases on the Site.
- No off-Site horizontal migration of chemicals within the overburden and shallow bedrock groundwater has occurred. The overburden and shallow bedrock groundwater flow has been and is currently in a controlled state due to the dewatering effect of the adjacent 47th Street Tunnel and the Falls Street Tunnel. Consequently no shallow impacted groundwater migrates from the Site onto neighboring properties.
- Although horizontal migration of chemicals within the shallow groundwater flow has been controlled, there are vertical fractures in the bedrock that could allow vertical migration of chemicals into the deeper portions of the bedrock. However, the hydraulic gradient in the bedrock groundwater is upward from the E Zone continuous through the B Zone. These upward gradients restrict downward groundwater migration and therefore any chemicals in the upper groundwater flow zones are prevented from migrating to depth. The one possible exception to this is if dense NAPL is present. Dense NAPL, if present, migrates downward, counter to upward hydraulic gradients. However, no NAPL was observed during the deep bedrock groundwater investigation.
- The study performed on the deeper bedrock groundwater has identified some, but limited, chemical presence in the deeper bedrock zones. Given the previously noted factors, the source of these chemicals is not necessarily the Frontier Site.
- The primary direction of groundwater flow in the deep bedrock is generally in an easterly direction away from the Power Authority Conduits.

- The primary COCs for the Site are volatile organic compounds (VOCs) and include the following:
    - Monochlorotoluene
    - Chlorobenzene
    - 1,2-Dichlorobenzene
    - 1,3-Dichlorobenzene
    - 1,4-Dichlorobenzene
    - 1,2,4-Trichlorobenzene
    - Tetrachloroethene
    - Trichloroethene
    - 1,1,1-Trichloroethane
    - 1,1-Dichloroethane
    - Cis-1,2-Dichloroethene
    - Vinyl Chloride
    - Benzene
    - Toluene
    - Methylene Chloride

There are no users of the deep bedrock groundwater within the vicinity of the Site or in the downgradient direction from the Site.

3.0 FOCUSED FEASIBILITY STUDY PROTOCOLS

This FFS has been prepared in accordance with the Order on Consent and Administrative Settlement and Section 5.3 of the NYSDEC approved "Supplemental Soil Characterization and Pilot Test Work Plan" (CRA – November 2007). Further, this report has been prepared in a manner consistent with the USEPA guidance document "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" dated October 1988 (USEPA Guidance) and other appropriate USEPA and NYSDEC technical and administrative documents.

In accordance with the terms in the Work Plan, there are a limited number of viable alternatives to be considered for the deep bedrock groundwater, thus the decision to perform a more narrowly focussed Feasibility Study. The FFS is being conducted based upon the chemical concentrations found in the deep bedrock and without taking into account the source from which they came. The alternatives are being evaluated solely on the basis of their ability to address the specific chemicals present, regardless of their source.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) are used to develop remedial action objectives (RAOs) and to scope and formulate remedial action technologies and alternatives. ARARs may include Federal ARARs or standards if they are more stringent than State ARARs. ARARs are categorized as:

i) Chemical-specific requirements that define acceptable exposure levels and may, therefore, be used in establishing preliminary remediation goals

ii) Location-specific requirements that may set restrictions on activities without specific locations, such as floodplains or wetlands

iii) Action-specific requirements that may set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes

Potential ARARs are described in the following subsections.

3.1.1 CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs define health- or risk-based concentration limits in various environmental media for hazardous substances and contaminants. Concentration limits provide protective cleanup levels or may be used as a basis for estimating appropriate cleanup levels for the COCs in the designated media or an acceptable level of discharge if a discharge occurs during remediation. Chemical-specific ARARs may be used to determine treatment system discharge requirements or disposal restrictions for remedial activities and/or to assess the effectiveness or suitability of a remedial alternative. Chemical-specific ARARs are generally promulgated standards.

The groundwater in the deep bedrock is classified as Class GA or drinking water. As such, the following requirements may be considered ARARs for this study:

i) National Primary Drinking Water Standards – Maximum Contaminant Levels and Maximum Contaminant Level Goals

ii) New York Groundwater Standards – NYSDEC Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations

iii) New York Department of Environmental Conservation technical regulations for remediation (including Part 375 regulations)

Table 3.1 presents a summary of applicable cleanup criteria for groundwater. The cleanup criteria were determined by selecting the most stringent criteria for each COC, although it is noted that this Site is located in a heavily industrialized area of Niagara Falls.

3.1.2 ACTION-SPECIFIC ARARS

Action-specific ARARs are determined by the particular remedial activities that are selected for the cleanup. Action-specific requirements establish controls or restrictions on the design, implementation, and performance of remedial activities. Following the development of remedial alternatives, action-specific ARARs that specify performance levels, actions, technologies, or specific levels for discharged or residual chemicals provide a means for assessing the feasibility and effectiveness of the remedial activities.

The action-specific ARARs that may be applicable to Site groundwater remedial technologies are presented in Table 3.2.

3.1.3 LOCATION-SPECIFIC ARARS

Potential location-specific ARARs are requirements that set restrictions on activities depending on the physical and environmental characteristics of the Site or its immediate surroundings. For the Site groundwater these include:

i) Effluent discharge to Niagara Falls POTW

ii) Construction-related street closure and placement of equipment on streets, sidewalks, and other public ways

3.2 REMEDIAL ACTION GOALS AND OBJECTIVES

3.2.1 REMEDIAL ACTION GOALS

The primary goals of this remedial action are to:

i) Eliminate or mitigate significant threats to human health and the environment presented by Site COCs

ii) Maintain protection over time

iii) Minimize untreated waste

iv) Be compliant with the requirements of the National Contingency Plan.

The remedy selection process will be performed with the intent to ensure that these goals are achieved.

3.2.2 REMEDIAL ACTION OBJECTIVES

The USEPA Guidance states "*Remedial action objectives consist of medium-specific or operable-unit specific goals for protecting human health and the environment. The objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited.*" RAOs established for the protection of human health and the environment should specify:

i) The contaminants and media of concern

ii) The exposure routes and receptors

iii) An acceptable contaminant level or range of levels for each exposure route

The remedial actions evaluated for this FFS focus on the deep bedrock groundwater impacted by COCs, as identified in Section 2.0. The following RAOs have been established for the deep bedrock groundwater and are consistent with the primary goals initially established for groundwater in the Final Supplemental Remedial Investigation Report for the Former Frontier Chemical Waste Process, Inc. Site that was prepared by Ecology & Environment in February 2003. The RAOs are as follows:

i) Prevent to the extent practicable the further off-Site migration of contaminated groundwater

ii) Reduce, control, or eliminate to the extent practicable the groundwater contamination present within the overburden. (This is being addressed as a component of Operable Unit 1)

iii) Reduce, control, or eliminate to the extent practicable the groundwater contamination present within the bedrock groundwater zones of concern

iv) Eliminate to the extent practicable the potential for human exposures to contaminated groundwater

4.0 GENERAL RESPONSE ACTIONS AND IDENTIFICATION OF REMEDIAL TECHNOLOGIES

General response actions are remedial approaches encompassing those actions that will satisfy the RAOs. General response actions may include treatment, containment, disposal, institutional controls, or a combination of these, if required, to address groundwater impacts and to be effective in meeting all of the RAOs. The general response actions and remedial technologies evaluated for the deep bedrock groundwater at the Frontier Chemical Site are described in the following subsections and listed herein and in Table 4.1.

1. No Action
2. Institutional Control
3. Monitored Natural Attenuation
4. Containment
5. Groundwater Extraction/Collection
6. Ex Situ Treatment
7. In Situ Treatment
8. Waste Disposal

4.1 NO ACTION

The No Action response is primarily used as a basis for comparison with other alternatives. Under the No Action response, no remedial measures are taken to improve environmental conditions in the deep bedrock groundwater. This response does not reduce the volume, mobility, or toxicity of the hazardous constituents in groundwater beyond the reductions that are achieved through the ongoing natural attenuation mechanisms.

In the case of the deep bedrock groundwater, the No Action Alternative includes the engineering control measures for the Frontier Chemical Site that are currently in place or planned to be implemented for Operable Unit 1. These engineering controls include the following:

i) A groundwater collection and treatment system already exists for the overburden and shallow bedrock groundwater. This system involves groundwater collection in the sanitary sewer tunnel system located adjacent to the Site followed by treatment at the Niagara Falls POTW. This system will either remain in place or be replaced by a substitute system of comparable effectiveness to continue to collect and treat groundwater in the zones overlying the deep bedrock.

ii) Source control measures are planned to remove or treat soils with elevated chemical concentrations. This will reduce the volume of chemicals potentially available for migration toward and into the deep bedrock groundwater zone.

iii) The Frontier Chemical Site will be capped in some form to reduce the potential for precipitation infiltration. Less infiltration will result in less migration potential for the chemicals remaining in the overburden following the source control measure implementation.

As an additional protective measure, all of the area surrounding the Frontier Chemical Site has access to the public water supply and therefore there are no groundwater users in the immediate area. Information has been provided that there is a facility along Niagara Falls Boulevard that has installed a groundwater extraction well for their on-Site operations. Expectations are that the volume of groundwater being removed is low and will not impact groundwater flow beneath the Frontier Site, otherwise the NYSDEC would not have issued a water-taking permit for this application.

4.2 INSTITUTIONAL CONTROL

The institutional control response is not intended to reduce the toxicity, mobility, or volume of hazardous site COCs but to reduce the potential for human and wildlife exposure to those COCs. Institutional controls may include controls to restrict or limit the use of the deep bedrock groundwater until such time that it is restored to an acceptable quality consistent with the intended use. Implementation of a long-term monitoring program to track contaminant migration and transport, and/or development of protective work procedures to reduce the potential for exposure will be put in place until the deep bedrock groundwater restoration is complete.

The institutional controls that could be put in place to augment the engineering controls that have already been constructed and/or planned for Operable Unit 1 are as follows:

i) Groundwater documentation pertaining to the Frontier Chemical Site has been submitted to the NYSDEC so that this information is available to the public and plans for future bedrock wells in the area can be properly assessed and approved

ii) Where applicable and possible, deed restrictions can be filed for the Site

iii) Annual Site inspections and certifications will be prepared in compliance with the programs established for New York State Hazardous Waste Sites and submitted to NYSDEC

4.3 MONITORED NATURAL ATTENUATION

Natural attenuation refers to natural subsurface processes that reduce chemical concentrations. Natural attenuation can be sufficiently protective of human health and the environment and can be more cost effective than other remedial alternatives. Biodegradation is the most important natural in-situ destructive mechanism. Non-destructive natural mechanisms include sorption, dispersion, dilution, and volatilization.

Monitored Natural Attenuation (MNA) includes long-term groundwater monitoring within and downgradient of the Site until COC concentrations are deemed acceptable relative to applicable standards and intended use.

MNA is most applicable to Sites or portions of Sites where chemical concentrations are low and / or decreasing, as is the case for the Frontier Site.

4.4 CONTAINMENT AND GROUNDWATER EXTRACTION/COLLECTION

The purpose of groundwater containment is to isolate or restrict the flow of contaminated groundwater. This is generally accomplished through one of two methods; either by creating a physical barrier to groundwater movement or by creating a hydraulic barrier to groundwater movement. Physical barriers in the bedrock can be created by sealing the fracture network in the bedrock around the perimeter of the impacted groundwater area or the Site, as the case may be. In some shallow bedrock situations, excavation and backfilling with low permeable material is possible but for the Frontier Chemical Site's Operable Unit 2, it is the deep bedrock that needs to be addressed. Therefore, other methods of sealing the fracture network, such as chemical or cement grouting via injection are more applicable. Grout injection technologies will be evaluated in terms of effectiveness and cost benefits as a possible physical containment technology.

With regard to hydraulic containment, different technologies must be applied. In order to create hydraulic containment, it is necessary to extract groundwater from along a particular alignment at such a volume as to intercept groundwater before it can pass the intended control line. The interception of groundwater requires its removal in order to create an effective hydraulic barrier. The method most commonly used for groundwater removal from deep bedrock involves the installation of collection wells and pumping equipment. The wells are set at the appropriate elevation in order to intercept the groundwater flow of concern. The number of wells installed and the rate of groundwater pumping are determined by the hydraulic properties of the fractured bedrock. The flow of groundwater within the bedrock can also be influenced by the injection of water. However, injecting water to influence flow direction is not hydraulic containment but a form of hydraulic control or manipulation.

The degree to which groundwater collection/extraction technologies reduce the mass of chemicals is dependent on the aggressiveness of the collection/extraction effort, local hydrogeologic characteristics, and in-situ efficiency of the extraction process. Use of collection/extraction technologies may reduce the mobility of Site COCs by removal and subsequent disposition at a secure location. Collection/extraction technologies provide no treatment of contaminated media in and of themselves, but may be used in conjunction with an ex-situ treatment and/or disposal option to meet the Site-specific goals and objectives. Ex-situ treatment options accumulate contaminants, and in some cases generate treatment wastes (i.e., sludges, spent treatment media, etc.) that require disposal. The treated groundwater also requires a discharge mechanism in order to be feasible.

In conjunction with groundwater collection/extraction, it is necessary to have an effective groundwater monitoring program to confirm that the COCs are being hydraulically captured and that COC concentration reductions are occurring in the designated area, often including areas downgradient of the collection/extraction system.

Since the COCs are located in the deep bedrock, the most applicable collection technology would be a series of vertical extraction wells.

All of the groundwater alternatives require the development and implementation of a suitable Operation, Maintenance, and Monitoring Plan to ensure the remedy operates as designed and that groundwater control / improvement is occurring.

4.5 EX-SITU GROUNDWATER TREATMENT

For those cases where hydraulic containment is employed as a remedial technology, the impacted groundwater that is extracted requires treatment prior to its discharge. Since the treatment occurs on the extracted water, it is referred to as ex-situ groundwater treatment.

The purpose of an ex-situ groundwater treatment technology is to reduce the volume, toxicity, and/or mobility of Site COCs in extracted groundwater. The COCs in the groundwater at the Frontier Chemical Site consist primarily of VOCs but other compounds (such as inorganics) are also present. Potentially applicable technologies for treating the extracted groundwater from the Frontier Chemical Site must therefore be able to treat VOCs but may be subject to the effects of some inorganics that may complicate the treatment process.

The most applicable technologies for VOC treatment include air stripping, carbon treatment, and UV oxidation. The potentially applicable technologies for inorganic treatment include chemical oxidation, pH adjustment, sequestration, precipitation, sedimentation, filtration or combinations of these technologies.

For ex-situ treatment at the Frontier Chemical Site, there are two primary options available; the first of which involves treatment on-Site while the second would have the treatment performed at the City of Niagara Falls Waste Water Treatment Plant (WWTP). The second option involves discharging the extracted groundwater into the local sanitary sewer system for transport to the WWTP where it would be treated using the City's available biological system, aeration, sedimentation, and carbon facilities. Discharge to the WWTP could be performed without any on-Site treatment or pre-treatment since the City of Niagara Falls WWTP was designed to handle such chemicals and has the capability of handling the volume and chemical loading that would be generated from the Frontier Chemical Site. In the event that discharge to the WWTP is not desirable or allowable, an on-Site treatment system could be constructed and operated. Such a system would include treatment for the VOCs and likely for inorganics in order to protect the VOC treatment components and to meet discharge requirements. Treatment at an off-Site private treatment facility is also a possible alternative. However, given the expected volume of groundwater requiring treatment, the transportation costs and logistics involved in such a venture eliminate this as a viable alternative.

A brief description of each of the treatment technologies applicable for an on-Site treatment system is provided in the following:

- **Air stripping** involves partitioning the VOCs from extracted groundwater by increasing the surface area of the impacted groundwater exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.

Water droplets fall from the top of the air stripper, while air is forced countercurrent to the water flow. VOCs partition into the air, which is discharged into the atmosphere. Depending on the concentration of VOCs in the air, the air may require treatment prior to discharge.

- **Carbon treatment** involves passing the groundwater through beds of activated carbon which will adsorb the contaminants present. The effectiveness of the adsorption process is dependent upon the chemicals present and their concentrations. Carbon is effective for most VOCs with the exception of a few such as vinyl chloride. Once the carbon has reached its adsorptive capacity for the groundwater being passed through it, the carbon beds are replaced with fresh carbon. In most cases, carbon treatment is performed in a two-bed configuration. The beds are run in series such that the first bed in the series acts as the primary treatment bed and the second bed serves as a polishing bed to complete the treatment. Only the lead bed is changed out upon exhaustion of its adsorptive capacity and the polishing bed is then placed into the role as the lead bed with the fresh bed being placed into service as the polishing bed. This revolving change in bed status leads to the most effective usage of the carbon's adsorptive capacity.
- **UV oxidation** involves adding an oxidizer such as hydrogen peroxide to the groundwater and then passing the groundwater through an ultraviolet light source in a shallow flow stream. The combination of the oxidizer and the light serves to chemically oxidize the contaminants in the groundwater; converting them to their breakdown components. For VOCs, the most common breakdown components are water, carbon dioxide, and hydrogen chloride.
- **Limitations -** While the above listed treatment technologies will treat the VOCs, each of these technologies is subject to severe impact by inorganics present in the groundwater; particularly manganese and iron. These two inorganics foul air strippers, carbon beds, and light sources resulting in the need for substantial maintenance efforts. In some cases, these inorganics simply overwhelm maintenance efforts to the point that the VOC treatment system can not operate. Consequently, these treatment technologies must often be used in conjunction with a treatment technology that addresses the manganese and iron as well. Inorganic treatment technologies include pre-treating the groundwater with flocculants, sequestering agents, and pH adjustment to either remove the manganese, iron, and other inorganics of concern or keep them in their dissolved state. For the Frontier Chemical Site, it is expected that the inorganics can best be controlled through the use of sequestering agents (requires sufficient mixing action and retention times to ensure reactions occur). These agents will keep the inorganics in their dissolved state, thereby allowing them to pass through the VOC treatment system and be discharged from the Site along with the treated groundwater. This assumption will

have to be confirmed during the final design of the deep bedrock groundwater remedy. In the event that it is determined that sequestering agents will not be able to control the inorganics, it would be expected that a multiple step treatment process for inorganics would have to be added to protect the VOC treatment system.

For the Frontier Chemical Site conditions, the ex-situ treatment design would include the construction of a large, centralized treatment facility. The groundwater would be pumped from the extraction wells, treated, and then discharged under the applicable permit conditions.

4.6 DISPOSAL TECHNOLOGIES

Upon completion of the treatment process, the groundwater treated in an ex-situ treatment system has to be discharged to a receiving body. In addition, any contaminated media or residuals generated from the treatment processes also have to be disposed of in an environmentally responsible manner. Disposal technologies do not usually involve reduction of contaminant volume or toxicity, but are primarily intended to reduce contaminant mobility.

The alternatives for discharge of the treated groundwater include discharge to a surface water body, to the City of Niagara Falls WWTP, or reinjection back into the bedrock formation from which it came. Since there is no surface water body within reasonable distance of the Frontier Chemical Site, discharge to a local surface water body is not viable. The City of Niagara Falls WWTP is a viable alternative for discharge from the Site and can receive either treated or untreated groundwater extracted on the Frontier Chemical Site. The only obstacles to such discharge include obtaining approval from the Niagara Falls Water Board and the reasonableness of the fee for discharge/treatment. If the groundwater has been treated on Site, then discharge back into the groundwater formation from which it came is also a viable alternative. Recharge back into the formation would rely upon the use of forcemains and injection wells to pump the water back into the fracture zones. Using strategic placements for injection wells, the treated water could even be used to create hydraulic conditions that enhances capture and extraction of the impacted groundwater zone and promotes flushing/cleansing of the formation at the same time.

The alternatives for discharge of generated treatment residuals are limited to disposal at a permitted landfill or destruction facility.

The alternatives for discharge of contaminated treatment media include regeneration of activated carbon. All other contaminated media are limited to disposal at a permitted landfill or destruction facility.

4.7 IN-SITU GROUNDWATER TREATMENT

In-situ groundwater treatment technologies involve the removal or destruction of contaminants in place. For a bedrock groundwater setting, the realm of viable treatment technologies is more limited than for an overburden groundwater setting. Removal technologies are primarily limited to the use of an air stripping system to separate contaminants such as VOCs from the water particles. Due to the typically thin and horizontal nature of water bearing fractures in bedrock, there is limited chance for success of the air stripping technology. However, there are a number of possible destruction technologies. Most of the VOCs are susceptible to chemical changes induced through oxygen injection or deprivation making the aquifer aerobic or anaerobic, respectively. In addition, injections of other chemical compounds such as chemical oxidizers (Fenton's reagent, potassium permanganate, etc.) and compounds such as biodegradation enhancement agents are potentially applicable at the Frontier Chemical Site. Since some compounds are amenable to certain methods while others reject them, it may be necessary to devise a series of applications of different compounds to produce the overall desired results. A set of laboratory and possibly pilot tests would need to be run in order to determine the most effective design to address the COCs at the Frontier Chemical Site.

There are also natural processes in place that are actively working to reduce chemical presence in the deep bedrock groundwater. These natural processes include dilution, dispersion, and biodegradation. The effect of these natural processes was discussed in Section 6.3.5 of the main text of this report and found to be substantial. The effect of these natural processes is expected to become even more prevalent over time due to the implementation of other remedial actions planned for the source areas in the Site soils and continued remediation of the shallow bedrock groundwater zone.

A major component of any in-situ treatment system is the implementation of an effective groundwater monitoring program. Such a program is important to be able to identify and track changes that are occurring in Site chemistry. This allows for responsible changes to be made to injection media frequencies, volumes, and types. A groundwater monitoring program will therefore be included in the Operation, Maintenance, and Monitoring Plan for any in-situ groundwater treatment alternative.

5.0 INITIAL SCREENING OF REMEDIAL TECHNOLOGIES

The identified technologies described in Section 4 have been screened for the deep bedrock groundwater at the Frontier Site utilizing the following criteria:

i) Short- and long-term effectiveness
ii) Implementability
iii) Relative cost
iv) Short-term risk

The initial screening of remedial technologies and process options is designed to determine their applicability to the deep bedrock groundwater at the Frontier Chemical Site and eliminate those technologies that technically cannot be implemented.

The results of the initial screening of the remedial technologies assembled to address the general response actions presented in Section 4 and listed in Table 4.1, are shown in Tables 5.1 and 5.2.

In summary, the technologies listed below are retained for assembly into remedial alternatives and further evaluation. These technologies may be used individually or in combination.

i) No Action
ii) Institutional Control
iii) Monitored Natural Attenuation
iv) In situ Treatment Using Injected Agents
v) Hydraulic Containment/Collection Using Extraction Wells
vi) Ex-Situ Treatment Using the WWTP
vii) Ex-Situ Treatment Using an On-Site Treatment Plant
viii) Off-Site Discharge of Treated Groundwater at the WWTP
ix) On-Site Discharge Back to the Aquifer
x) Off-Site Disposal of Treatment Residues

6.0 DETAILED ANALYSES OF RETAINED REMEDIAL ALTERNATIVES

Remedial alternatives for the groundwater were developed in Section 5 for possible application in the deep bedrock groundwater at the Frontier Chemical Site. These alternatives are subject to a detailed analysis using the evaluation criteria outlined in USEPA and NYSDEC guidance. The evaluation criteria are as follows:

i) Overall protection of human health and the environment
ii) Compliance with ARARs
iii) Reduction of toxicity, mobility, or volume
iv) Short-term effectiveness
v) Long-term effectiveness and permanence
vi) Implementability
vii) Cost
viii) State acceptance
ix) Community acceptance

The criterion of State acceptance will be determined following submission of this FFS. Consequently, no further discussion of this criterion is provided in this FFS.

The criterion of community acceptance cannot be evaluated at the feasibility study stage because it is based upon public comments regarding the Site remedy. A public comment period is commonly held following State acceptance of the remedy. Consequently, no further discussion of this criterion is provided in this FFS.

The remaining seven criteria are divided into two primary groups, namely threshold criteria and balancing criteria.

The threshold criteria include compliance with applicable ARARs and overall protection of human health and the environment. With the exception of the No Action alternative, all remedial alternatives must meet the threshold criteria to be eligible for further consideration.

The remaining five evaluation criteria are considered the balancing criteria. Each of the remedial alternatives is assessed and analyzed on a comparative basis using these evaluation criteria. Ultimately, a remedial action plan is proposed that incorporates the alternative that provides the best solution with respect to the balancing criteria.

The detailed analysis of retained alternatives has been performed in a manner consistent with the applicable regulations cited above. The analyses are described in detail in the following subsections. Information for the cost estimates is presented in the Tables of Section 6.

The groundwater remedial technologies retained following the initial screening have been assembled into the following alternatives for detailed analysis.

Alternative 1: No Action
Alternative 2: MNA with Institutional Controls
Alternative 3: In-Situ Treatment Using Injected Agents Followed by MNA with Institutional Controls
Alternative 4A: Hydraulic Containment/Collection with Treatment at the WWTP and Institutional Controls
Alternative 4B: Hydraulic Containment/Collection with On-Site Treatment and Discharge to the WWTP and Institutional Controls
Alternative 4C: Hydraulic Containment/Collection with On-Site Treatment and Discharge Back into the Aquifer and Institutional Controls

Each of the groundwater remedial alternatives is described and evaluated in detail in the following subsections.

6.1 ALTERNATIVE 1 - NO ACTION

Description

Alternative 1, No Action, provides no active remedial measures to improve environmental conditions at the Site. Natural attenuation and biodegradation would reduce COC concentrations in groundwater over the long-term.

The No Action Alternative also includes the engineering controls already planned or in place. These engineering controls include the following:

- A fence has been constructed around the Site
- A shallow groundwater remedy is already in place (but may be modified to remain effective and compliant with the ROD for Operable Unit 1)
- The Site will be capped

- A chemical source control measure is proposed to be implemented in the overburden

No additional remedial actions, institutional controls, or monitoring would be implemented with Alternative 1. However, existing engineering controls and protective measures would be maintained until groundwater quality is restored to the extent necessary for the intended use. Proposed engineering controls will be installed and maintained until groundwater quality is restored to the extent necessary for the intended use.

Assessment

Overall Protection of Human Health and the Environment: Because no additional remedial measures are implemented with Alternative 1, the potential future risk to human health and the environment would not be reduced beyond that which would be achieved through natural attenuation processes (biodegradation and natural physical processes). However, it has been demonstrated that these processes are effectively reducing concentrations in the deep bedrock groundwater. Historical concentrations of total VOCs were as high as 563 ppb in 1988 at well MW-88-5C, which is located in the center of the Site. Groundwater monitoring results from 2009 have shown a decrease in total VOC concentrations in this well to 22 ppb.

Compliance with ARARs: Alternative 1 would not achieve the chemical-specific ARARs that apply to groundwater through a remedial action. However, the chemical-specific ARARs will be achieved over time through the natural attenuation processes. Since no remedial action would be implemented, no action-specific or location-specific ARARs apply to Alternative 1.

Reduction of Toxicity, Mobility, or Volume: Alternative 1 provides no active reduction of toxicity, mobility, or volume of the COCs. However, over the long-term, the volume and toxicity of COCs in the groundwater will be reduced in the deep bedrock groundwater through active natural attenuation processes including biological degradation, advection, dilution, and dispersion.

Short-Term Effectiveness: Alternative 1 requires no remedial actions. Therefore, there would be no additional short-term risks posed to the community, the workers, or the environment as a result of the implementation of this alternative.

Long-Term Effectiveness and Permanence: Alternative 1 would not result in any further remedial actions; therefore, the residual risks would not be reduced beyond that which will be achieved through natural attenuation and biological degradation processes and existing controls and practices. Alternative 1 will achieve the groundwater RAOs over time and will provide a permanent remedy once groundwater is restored through the natural attenuation processes.

Implementability: Because there are no active remedial actions being undertaken, the implementability criterion is not applicable.

Cost: There are no active remedial actions, institutional controls, or monitoring being undertaken in Alternative 1; therefore, there are no costs. This is reflected in the cost summary that is presented in Table 6.1.

6.2 ALTERNATIVE 2 - MONITORED NATURAL ATTENUATION WITH INSTITUTIONAL CONTROLS

Description

Alternative 2 consists of the use of Monitored Natural Attenuation (MNA) to address the chemical presence in the deep bedrock groundwater coupled with Institutional Controls to limit the use of this portion of the aquifer until such time as it is restored to the extent necessary for the intended use. Data from the ongoing studies demonstrate that significant natural attenuation of VOCs in groundwater is currently taking place in the deep bedrock groundwater and that the current chemical concentrations are significantly lower than those that existed at the time the studies for Operable Unit 1 were performed. The current decreasing trend in groundwater concentrations demonstrates that MNA is a viable alternative for the Frontier Chemical Site.

In Alternative 2, a long-term groundwater monitoring program would be conducted to evaluate the continuing effectiveness of the natural attenuation processes in restoring groundwater quality. The groundwater monitoring program would consist of both hydraulic and water quality monitoring. The purpose of the hydraulic monitoring program would be to confirm that the groundwater flow patterns do not change over time resulting in unexpected off-Site impact. Groundwater quality monitoring would be conducted to track the reductions in COC concentrations over time, evaluate the continuing favorable conditions for natural attenuation, and confirm the protectiveness of the remedy. To obtain a conservative cost estimate for use in this FFS, it has been assumed that the groundwater monitoring network would consist of three existing groundwater monitoring well nests and that groundwater samples would be analyzed for VOCs (including prominent breakdown components from the natural attenuation processes), on a semi-annual or annual basis. A complete monitoring plan for the next 30 years would be prepared and submitted to NYSDEC for approval prior to implementation of the remedy.

Alternative 2 also includes the engineering controls already in place and will be supplemented with others that are planned as noted in Alternative 1. In addition, institutional controls would be implemented which would include the following:

i) Groundwater documentation pertaining to the deep bedrock groundwater will be submitted to the NYSDEC so that the NYSDEC can advise the public of the groundwater conditions and control its use as required
ii) Deed restrictions will be filed for the Site to advise future potential owners of the Site and adjacent properties of the conditions at the Site (required as part of the remedial action for Operable Unit 1)
iii) Annual Site inspections and certifications will be prepared in compliance with the programs established for New York State Hazardous Waste Sites and submitted to the NYSDEC

Assessment

Overall Protection of Human Health and the Environment: The institutional controls and monitoring will be protective of human health by preventing potential exposure to contaminated groundwater. The potential future risk to the environment using Alternative 2 will not be reduced beyond that which will be achieved through natural attenuation processes (biodegradation and natural physical processes). However, it has been demonstrated that these processes are quickly and effectively reducing concentrations in the deep bedrock groundwater as discussed under Alternative 1.

Compliance with ARARs: Alternative 2 will not achieve the chemical-specific ARARs that apply to groundwater through a remedial action. However, the chemical-specific ARARs will be achieved over time through the natural attenuation processes. Since no remedial action would be implemented, no action-specific or location-specific ARARs apply to Alternative 2.

Reduction of Toxicity, Mobility, or Volume: Alternative 2 will provide reductions in toxicity and volume of the COCs in groundwater over time. The mobility of the COCs will not be reduced through the implementation of Alternative 2.

Short-Term Effectiveness: No additional short-term risk to the community or the environment would be posed as a result of the implementation of Alternative 2. Risk to workers conducting the monitoring program would be mitigated through the implementation of safe work practices and proper PPE.

Long-Term Effectiveness and Permanence: The institutional controls established for Alternative 2 would make this alternative effective in the long-term as long as they are enforced until groundwater has been restored to the quality necessary for its intended use.

Alternative 2 would achieve the groundwater RAOs if the institutional controls are imposed and enforced until groundwater has been restored to the quality necessary for its intended use.

Implementability: Alternative 2 is highly implementable. Groundwater monitoring wells and engineering controls are already in place and more are planned. The only limiting factors are the ability to enforce the institutional controls (which the NYSDEC has the authority and methods to control) and to retain access for monitoring purposes. A complete monitoring plan would be prepared and submitted to NYSDEC for approval prior to implementation of the remedy.

Cost: The estimated 30-year present worth cost for Alternative 2 is $225,000. The cost summary is presented in Table 6.2.

6.3 ALTERNATIVE 3 – IN-SITU TREATMENT USING INJECTED AGENTS WITH MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS

Description

Alternative 3 consists of injecting biodegradation or oxidizing agents to reduce the COC concentrations in the deep bedrock groundwater to acceptable levels from which MNA would be able to complete the cleanup to the quality necessary for its intended use. Alternative 3 would also take advantage of the institutional controls and engineering controls that are currently in place and those that are planned to address Operable Unit 1.

In-situ treatment involves the injection of a solution of biodegradation or oxidizing agents into the impacted bedrock groundwater interval of concern. The agents will either produce conditions in the bedrock fracture network that are conducive to degradation or react with the chemicals present to destroy them in place. The type of agent injected and the volumes required and the frequency of injections would be determined through a set of laboratory tests which would be followed by a confirmation application (pilot test) performed directly into the formation at the Site. The monitored results of the field application will be used to fine tune the injection requirements.

In order to inject the solution, a series of new injection wells will be drilled into the impacted groundwater fracture network. The locations of the wells will be selected so as to take maximum advantage of the natural hydraulic gradients of the groundwater flow in the chemical plume area. For the purposes of this study, it is assumed that approximately five injection well nests will have to be installed into and adjacent to the chemical plume to provide adequate injection coverage of the impacted area.

The effect of the injections will be tracked at the available monitoring and injection well locations to determine the reduction in the chemical concentrations and the changes that occur in the groundwater redox conditions that control the chemical reactions/ biodegradation. Expectations are that once the highest concentration locations have been measured to be at reduced concentrations, it will be possible to allow natural attenuation to complete the groundwater quality improvements to the concentrations necessary for its intended use. For the purpose of this study, it is assumed that two injections of the applicable agents would be necessary and that the long-term monitoring would be ongoing for another 10 years. Samples would be collected on a semi-annual or annual basis for the 10-year period of MNA.

Assessment

Overall Protection of Human Health and the Environment: Alternative 3 will be protective of human health and the environment through the in-situ treatment of COCs in groundwater and mitigation of the potential for future off-Site migration of COCs in groundwater and through the enforcement of institutional controls. The combination of the existing and planned remedies for Operable Unit 1 would result in further reductions in COC concentrations over and above that which would occur by the injections and natural attenuation.

Compliance with ARARs: Alternative 3 will hasten the achievement of the chemical-specific ARARs, which apply to groundwater on and downgradient of the Site. The potentially applicable action-specific and location-specific ARARs that may apply to Alternative 3 are those listed in Table 3.2.

Reduction of Toxicity, Mobility, or Volume: Alternative 3 will provide reduction of the toxicity and volume of all of the COCs in which the injected agents come in contact with or of all the COCs that fall within the treatment zone created by the injected agents. Alternative 3 will not address the mobility of the COCs that are downgradient beyond the influence of the leading edge of the treatment zone that will be created by the injections. However, the injected materials will migrate with the natural groundwater flow into the areas downgradient of the Site, thereby extending the treatment zone and reducing toxicity, volume, and mobility further into the downgradient areas. In addition, the mobility of the COCs will be reduced as the groundwater from the cleansed zone moves downgradient off Site. This process of reduction of toxicity, mobility, and volume will be further enhanced by the planned remedies that will be implemented in association with the remediation of Operable Unit 1.

Short-Term Effectiveness: Short-term hazards to workers during the in-situ treatment, well system installation, operation/maintenance period, injections, and monitoring events will be mitigated through the implementation of safe work practices and proper PPE. Injection mechanisms may be present on the ground surface during the construction and treatment processes; however, all solutions would be containerized and no additional short-term risks would be posed to the community, the workers, or the environment.

Long-Term Effectiveness and Permanence: The implementation of Alternative 3 will hasten the achievement of the groundwater RAOs on and downgradient of the Site. Once initiated, the groundwater quality will immediately begin to improve and will remain in a cleansed state with the possible exception that some impacted groundwater from the overlying shallower bedrock zone may leak into the deep bedrock zone. The current upward hydraulic gradient between the deep and shallow groundwater zones will continue to be a deterrent to such downward chemical migration. As time goes on, the potential for impact due to downward chemical migration will lessen as the groundwater quality in the overlying area will reduce over time; particularly since an Operable Unit 1 chemical source control program is planned for the overburden. Even in the current state, the analytical data show that the groundwater in the C Zone has improved dramatically over the years and therefore the effect of natural attenuation is stronger and able to overcome the impact of the downward migration of chemicals, if any is occurring, from the overlying zones.

Implementability: Alternative 3 is highly implementable. The components of the injection system (the installation of wells, the injection of liquid solutions, and the implementation of a groundwater monitoring program) are common environmental activities that have been employed on thousands of sites. The only limiting factors are the ability to enforce the institutional controls (which the NYSDEC has the authority and methods to control) and to retain access for monitoring purposes, should off-Site wells be included in the monitoring program.

Cost: The estimated 10-year present worth cost for Alternative 3 (which includes two injection operations and 10 years of monitoring) is $618,000. This is comprised of $375,000 to install the injection wells and perform the injections and $21,000 to $42,000 for the annual monitoring. A cost summary is presented in Table 6.3.

6.4 ALTERNATIVE 4A: HYDRAULIC CONTAINMENT/COLLECTION WITH TREATMENT AT THE WWTP AND INSTITUTIONAL CONTROLS

Description

Alternative 4A is a pump and treat remedy and consists of groundwater extraction from the deep bedrock with discharge of the untreated water directly to the City of Niagara Falls WWTP for treatment. The water will be transported to the WWTP via the sanitary sewer network which will be accessed immediately adjacent to the Site. Upon completion of the treatment at the WWTP, the water will be discharged to the Niagara River in accordance with the permit conditions applicable to the WWTP. The groundwater will be extracted from the deep bedrock via pumping wells which will be installed in strategic locations within and at the downgradient edge of the area of highest chemical concentrations. For the purpose of this FFS, it is assumed that five extraction well nests will be needed. The locations of the wells will be designed to create hydraulic containment of the deep bedrock groundwater plume so that off-Site migration does not occur and also so that the chemical mass in the plume is eliminated to the maximum extent practical. It is understood that pumping of the deep bedrock groundwater will cause a vertical gradient reversal that will draw impacted groundwater from the overlying bedrock zone down into the deep bedrock zone. Such pumping will impose hydraulic conditions that accelerate vertical and horizontal groundwater migration in the area. Consequently, the pumping system will operate for a considerable period of time. For the purpose of this study, it is assumed that the pump and treat remedy will be in operation for 20 years and that the combined extraction rate will be on the order of 50 gallons per minute.

Treatment at the City of Niagara Falls WWTP consists of biological treatment, aeration, sedimentation, filtration, and carbon adsorption. The Frontier Chemical PRP Group would have no input or responsibility for the running of the WWTP. The Group would pay the City a fee for the volume discharged including any surcharge for the chemical loading associated with that volume. The WWTP would be responsible for any treatment residues which are expected to be disposed of off Site at a permitted facility. The cost for such disposal would be covered by the discharge fee.

Alternative 4A would include a long-term groundwater monitoring program to evaluate the continuing effectiveness of the remedial action in restoring groundwater quality on and downgradient of the Site. The groundwater monitoring program would consist of both hydraulic and water quality monitoring. The purpose of the hydraulic monitoring program would be to confirm that the groundwater flow patterns do not change over time resulting in unexpected off-Site impact. Groundwater quality monitoring would be conducted to track the reductions in COC concentrations over time. To generate a cost estimate for use in this FFS, it has been assumed that the groundwater monitoring network would consist of the use of the three existing groundwater monitoring well nests and the construction of five additional well nests. Groundwater samples would be analyzed for VOCs (including monochlorotoluene). The sampling frequency would be on a semi-annual or annual basis. A complete monitoring plan would be prepared and submitted to NYSDEC for approval prior to implementation of the remedy.

Extraction system monitoring would be conducted as necessary to comply with the discharge permit requirements applicable from the WWTP. For the purpose of this FFS, it is assumed that sample analyses would be required on a monthly basis.

Alternative 4A also takes advantage of the engineering controls already in place and those that are planned for Operable Unit 1 which will be supplemented with the institutional controls proposed in Alternative 2.

Assessment

Overall Protection of Human Health and the Environment: Alternative 4A would be protective of human health and the environment through the hydraulic containment, collection, and treatment of contaminated groundwater (thereby mitigating potential for future off-Site migration of COCs in groundwater), and through the enforcement of institutional controls.

Compliance with ARARs: Alternative 4A will hasten the achievement of the chemical-specific ARARs, which apply to groundwater on and downgradient of the Site. The potentially applicable action-specific and location-specific ARARs that apply to Alternative 4A are those listed in Table 3.2.

Reduction of Toxicity, Mobility, or Volume: Alternative 4A will provide reduction of the toxicity and volume of the COCs. Alternative 4A will not address the mobility of the COCs that are downgradient beyond the hydraulic influence of the extraction system. However, immediately downgradient of the system, the mobility of the COCs will be addressed to the extent that any COCs in this area that are drawn back by the hydraulic capture system will be removed and treated. The process of reduction of toxicity, mobility, and volume has already begun as a result of the ongoing groundwater collection and treatment that naturally occurs due to the fact that the shallow bedrock and overburden groundwater is captured by the sanitary sewer tunnels along 47th Street and Royal Avenue.

Short-Term Effectiveness: Short-term hazards to workers during the extraction system installation and operation/maintenance and monitoring events would be mitigated through the implementation of safe work practices and proper PPE. The short-term hazards are considerably higher for Alternative 4A than for Alternative 3 since many more system components would have to be installed/constructed. The short-term effectiveness of Alternative 4A would begin upon startup of the extraction system (as a result of the commencement of reduction of the toxicity, mobility, and volume of COCs in groundwater.)

Long-Term Effectiveness and Permanence: Alternative 4A will hasten the achievement of the groundwater RAOs on and downgradient of the Site.

Implementability: The implementability of Alternative 4A is primarily dependent upon the willingness and ability of the WWTP to accept the extracted groundwater for a reasonable fee. In the event that the WWTP is unwilling or unable to accept the extracted groundwater, it will be necessary to revert to Alternative 4B or 4C as may be applicable. Another implementability factor is the ability to construct some of the monitoring system on off-Site properties. The ability to enforce the institutional controls will also be a factor although the NYSDEC has the authority and methods for control already in place.

The volume of water required to capture the plume and effectively treat the groundwater would be fairly low; expected to be on the order of 50 gallons per minute. The concentrations of inorganics are unlikely to be problematic to the operation or maintenance of the WWTP. However, it is possible that the WWTP could impose additional fees on the discharged water because of their presence.

Cost: The estimated cost for Alternative 4A (which includes operating and maintenance of the extraction system for 20 years) is $3,538,000. While the capital and installation costs of the extraction system are determinable ($940,000), the cost to discharge groundwater to the WWTP for treatment is variable and depends upon the category that the Niagara Falls Water Board assigns to this groundwater discharge. The Water Board has indicated that discharge from a managed extraction system could be allowed under their high volume industrial category which would result in a reasonable cost for treatment. If such categorization is not granted, the discharge and treatment cost could be an order of magnitude higher adding $17,000,000 to this alternative. The cost summary is presented in Table 6.4.

6.5 ALTERNATIVE 4B: HYDRAULIC CONTAINMENT/COLLECTION WITH ON-SITE TREATMENT AND DISCHARGE TO THE WWTP AND INSTITUTIONAL CONTROLS

Description

In the event that the WWTP can not accept untreated groundwater collected from the Frontier Chemical Site, it may be necessary to pre-treat the extracted groundwater prior to discharge to the WWTP. In this alternative, an on-Site treatment facility would be constructed to treat the groundwater down to concentrations acceptable for discharge to the WWTP. For the purpose of this study, it is assumed that the treatment process would include an air stripper preceded by the addition of a sequestering agent to keep dissolved metals such as iron in solution and allowing them to pass through the air stripper without fouling the treatment system.

A control center would be constructed to house the components of the pre-treatment system that require protection from the weather while the air stripper would be an out-door unit appropriately modified to be able to run year round including through the winter. The system would be automated to the extent practical to minimize operator labor and costs.

Other than the details associated with the discharge of the treated water to the City of Niagara Falls WWTP, all other components of this alternative would be essentially identical to Alternative 4A.

Overall Protection of Human Health and the Environment: Same as Alternative 4A.

Compliance with ARARs: Same as Alternative 4A.

Reduction of Toxicity, Mobility, or Volume: Same as Alternative 4A.

Short-Term Effectiveness: The short-term effectiveness would be similar to Alternative 4A but the potential for exposure to operators at the Site would be slightly higher due to the operation of the on-Site treatment plant. This potential for exposure can be overcome through establishment and implementation of an appropriate health and safety plan. The potential exposures include vapor emissions, handling of treatment chemicals and media, and handling of generated treatment plant wastes.

Long-Term Effectiveness and Permanence: Same as Alternative 4A.

Implementability: The implementability of Alternative 4B is primarily dependent upon the willingness and ability of the WWTP to accept the treated groundwater for a reasonable fee. In the event that the WWTP is unwilling or unable to accept the extracted groundwater, it will be necessary to revert to Alternative 4C. The construction of an on-Site treatment plant adds one additional layer of complexity to the implementation of this remedy. The operation and maintenance of the on-Site treatment system also add complexity to the implementation. All other aspects of the implementability of this remedy are the same as Alternative 4A.

Cost: The estimated cost for Alternative 4B (which includes operating and maintenance of the extraction and on-Site treatment system for 20 years) is $4,838,000. While the capital and installation costs of the extraction system are determinable ($1,106,000), the cost to discharge groundwater to the WWTP for treatment is variable and depends upon the category that the Niagara Falls Water Board assigns to this groundwater discharge. The Water Board has indicated that discharge from a managed extraction system could be allowed under their high volume industrial category which would result in a reasonable cost for treatment. If such categorization is not granted, the discharge and treatment costs could be an order of magnitude higher adding $17,000,000 to this alternative. The cost summary is presented in Table 6.5.

6.6 ALTERNATIVE 4C: HYDRAULIC CONTAINMENT / COLLECTION WITH ON-SITE TREATMENT AND DISCHARGE BACK INTO THE AQUIFER AND INSTITUTIONAL CONTROLS

Description

In the event that the WWTP can not accept the groundwater collected from the Frontier Chemical Site or is unwilling to do so for a reasonable cost, it may be necessary to provide complete on-Site treatment of the extracted groundwater and then find an alternate discharge for the treated water. In the case of the Frontier Chemical Site, there are no local surface water bodies in the area that could serve as an appropriate receiving body. Consequently, the only option available is to reinject the treated groundwater back into that portion of the aquifer from which it came. In this alternative, an on-Site treatment facility would be constructed to treat the groundwater down to concentrations acceptable for discharge back into the aquifer (which would have to be determined in conjunction with the NYSDEC). For the purpose of this FFS, it is assumed that the treatment process would include an air stripper preceded by the addition of a sequestering agent to keep dissolved metals such as iron in solution and allowing them to pass through the air stripper without fouling. It is also assumed that no additional treatment for inorganic compounds would be required since the concentrations present in the groundwater would be similar to background conditions or at least have not been impacted by operations of the Frontier Chemical Site and therefore treatment by the Frontier Chemical Group would not be a requirement.

A control center would be constructed to house the components of the pre-treatment system that require protection from the weather while the air stripper would be an out-door unit appropriately modified to be able to run year round including through the winter. The system would be automated to the extent practical to minimize operator labor and costs. Similarly, the control system for the aquifer reinjection would also be housed in an indoor facility, appropriately protected from the weather and winter conditions.

Other than the details associated with the discharge of the treated water back into the aquifer, all other components of this alternative would be identical to Alternative 4B.

<u>Overall Protection of Human Health and the Environment</u>: Same as Alternatives 4A and 4B with the exception that the reinjection of the treated water back into the aquifer could accelerate the time frame for completion of this remedy. The acceleration of the cleanup is heavily dependent upon the rate of vertical chemical migration from the overlying portion of the aquifer. The pumping of groundwater from the deep bedrock will draw groundwater (and the chemicals contained therein) from the shallower zones into the deep zones. Consequently, within the zone of capture of the pumping wells, there will be a downward hydraulic gradient created. Conversely, in the vicinity of the reinjection wells, the current upward gradient may be increased causing additional groundwater flow into the shallow zones, which may then migrate into the cone of influence of the pumping wells and be recirculated back toward the pumping wells. All of the reinjected water is expected to create a beneficial flushing action that will accelerate the cleansing of the aquifer along the lines of groundwater movement away from the reinjection wells. It would be expected that the flushing/cleansing action of the

reinjection will eventually eliminate the impact of continuing chemical migration from overlying layers.

Compliance with ARARs: The reinjection of treated water back into the aquifer will further hasten the cleanup of the deep bedrock groundwater beyond that which is achieved by Alternative 4A. The flushing action of the reinjected water will cause the formation to reach the cleanup criteria in an accelerated time frame (subject to the same vertical chemical migration situation discussed above). If the pump and treat remedies of Alternatives 4A and 4B can be completed in on the order of 20 years, the accelerated cleansing associated with Alternative 4C should reduce the cleanup time by half to 10 years.

Reduction of Toxicity, Mobility, or Volume: Similar to Alternative 4A although the cleanup will be accelerated due to the flushing action of the reinjected water. In addition, the reinjection of treated water will push some water into perimeter areas which will migrate into the downgradient areas. If so, the reinjection will actually increase the mobility of the residual chemicals in the downgradient area. But in doing so, it will dilute these residual concentrations, accelerate their migration, and thereby reduce the toxicity of the chemical residuals and clean the downgradient area in an accelerated time frame as well.

Short-Term Effectiveness: The short-term effectiveness would be similar to Alternative 4B except that Alternative 4C requires the construction and operation of a water reinjection system in addition to the other components of Alternative 4B. This potential for exposure can be overcome through establishment and implementation of an appropriate health and safety plan and operating procedures for the reinjection system.

Long-Term Effectiveness and Permanence: The long-term effectiveness and permanence for Alternative 4C would be similar to Alternative 4A and 4B with the exception that the reinjection of water will accelerate the remediation of the impacted groundwater area. It may also result in the acceleration of the remediation of the off-Site residual plume as the reinjected water migrates along the downgradient pathways.

Implementability: The implementability of Alternative 4C is primarily dependent upon the willingness of the NYSDEC to permit reinjection of the treated water back into the aquifer. All other aspects of the implementability of this remedy are the same as Alternative 4B.

Cost: Alternative 4C is expected to operate for less time than Alternative 4A or 4B. The flushing effect of the reinjected water is expected to reduce the necessary time of operation in half. Therefore, Alternative 4C is assumed to have to operate for a 10-year period. The estimated 10-year present worth cost for Alternative 4C (which includes operating and maintenance for 10 years) is $3,248,000. The cost summary is presented in Table 6.6.

7.0 COMPARATIVE ANALYSES OF REMEDIAL ALTERNATIVES

The purpose of the comparative analysis is to identify the relative advantages and disadvantages of each alternative evaluated in detail in the previous sections. The detailed evaluation assessed each remedial alternative independently. The comparison of remedial alternatives in this section evaluates the relative performance of each alternative with respect to the detailed evaluation criteria which include overall protection of human health and the environment; compliance with ARARs; short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; implementability; and cost.

As described in the following sections, the comparative analysis shows that all of the alternatives can effectively achieve the RAOs for the Site and, under the conditions present at the Site, the only essential differences are timing and cost.

7.1 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 7.1 presents a ranking of each of the groundwater remedial alternatives included in the detailed analysis presented in Section 6. Discussions of the relative advantages and disadvantages of the alternatives are presented in the following subsections.

7.1.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All of the alternatives provide effective overall protection of human health and the environment, and are ranked as follows based essentially on the length of time to complete the remediation of the existing Site conditions:

- Alternative 3, In-Situ Treatment
- Alternative 4C, Hydraulic Containment/Collection with On-Site Treatment, Aquifer Reinjection
- Alternative 4A Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP
- Alternative 2, MNA and Institutional Controls
- Alternative 1, No Action

Alternatives 3, 4A, 4B, and 4C offer similar protection of human health and the environment. Each one relies upon the groundwater flow paths and migration routes to achieve COC treatment. Once the chemicals reach the locations where the injections or extraction occur, the chemicals are quickly treated.

Alternative 3 (In-Situ Treatment) would be the most protective of human health and the environment as it will quickly begin to treat the groundwater thereby initiating the process toward meeting the groundwater quality criteria. In addition, Alternative 3 has the following advantages:

- The treatment is performed in-situ and there is no contact with the COCs either on-Site, in the sewer systems, or at a treatment plant
- The treatment process begins with the injections and therefore improvements in groundwater quality begin immediately and quickly
- The treatment process does not cease upon completion of the injections but is ongoing until the injected media are exhausted and therefore can result in cleanup below the criteria, in some cases
- The injected media migrate with the natural groundwater flow into the downgradient areas of the plume and cause treatment to occur in these off-Site areas
- There is no off-Site disposal of treatment residues

Of the groundwater pump and treat alternatives, Alternative 4C is the most protective since the reinjection of the treated groundwater accelerates the remediation of the aquifer through the flushing action. This acceleration will result in the remedy being completed in a shorter time frame which is superior to the longer time required for Alternatives 4A and 4B.

Both Alternatives 4B and 4C require the additional step of on-Site treatment and therefore create additional potential for exposure to Site workers due to the operation of the treatment plant and the handling of chemicals and waste residuals. Conversely, Alternative 4A relies on off-Site treatment at the WWTP. By the time the water reaches the WWTP, there is so much dilution that there would be minimal, if any, additional potential for exposure to workers at the WWTP. The volume of chemicals that would be discharged from the Site is so small compared to the WWTP's typical daily chemical handling that it is insignificant. The discharge of untreated groundwater into the City sewer system for Alternative 4A (and to a lesser extent Alternative 4B if full treatment prior to discharge does not occur) poses some additional potential for exposure to the sewer workers. However, this is their current work environment and they are trained and equipped to manage such exposure potential. Based upon these conditions, the alternatives are ranked 4C, 4A, and 4B (in descending order) in terms of overall protection.

Another factor that has to be taken into consideration is the environmental footprint or impact of the remedies. In other words "how green" are the alternatives? Alternatives 4B and 4C are significantly less "green" than Alternatives 3 and 4A due to the following factors:

- Alternatives 4B and 4C require the construction of a treatment plant and therefore will consume considerably more energy to supply the parts and construct the system and will create additional truck traffic and related air emissions
- Due to the handling of water and year round operations, the treatment plant will require some form of supplemental heating to protect the plant from freezing conditions, thus consuming considerably more energy than the heating requirements for the other Alternatives
- The on-Site treatment plant consumes considerable electricity to operate
- The on-Site treatment plant consumes water which will be required for equipment and personnel cleaning
- The on-Site treatment plant generates wastes (sludge and cleaning activities) that require handling
- The on-Site treatment system requires considerably more labor to operate and maintain and therefore will consume considerably more energy in support of this labor

By comparison, Alternatives 1 and 2 are more environmentally friendly than Alternatives 3 and 4A, which are more friendly than Alternatives 4B and 4C.

MNA will effectively address the remainder of the COCs present, although the time frame in which this would occur is longer than for any of the active remedial alternatives. When all factors are analyzed in light of Site conditions, MNA becomes the preferred alternative for the following reasons:

- MNA appears to be eliminating the chemicals present
- The concentrations present are low and continuing to decrease
- The current upward gradients are protecting the water quality in the deep bedrock groundwater zones

The monitoring conducted in conjunction with Alternative 2 (MNA) would make this alternative more protective than Alternative 1 (No Action) as it would allow changes to the plan to be made if the monitoring identifies such a need. However, the restoration of groundwater quality would not be accelerated beyond that which would be achieved by the natural attenuation processes. The ongoing groundwater monitoring to date demonstrates that natural attenuation is quickly and effectively reducing chemical presence on Site.

Alternative 1 (No Action) provides the least additional protection to human health or the environment.

7.1.2 COMPLIANCE WITH ARARs

The alternatives are ranked as follows relative to compliance with ARARs:

- GW Alternative 3, In-Situ Treatment
- GW Alternative 4C, Hydraulic Containment/Collection with On-Site Treatment, Aquifer Reinjection
- Alternative 4A Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP
- Alternative 2, MNA
- Alternative 1, No Action

All the Alternatives considered for the Site are expected to achieve compliance with ARARs over time. Alternatives 1 and 2 (No Action and MNA) are ranked in a tie for fifth in compliance with ARARs as they will not contain or reduce the COCs in the deep bedrock groundwater but rely on natural attenuation to achieve the prescribed groundwater quality. With no mechanical assistance, attenuation of COCs will occur over a longer period of time, than for the remaining Alternatives.

Of the four remaining alternatives, it is expected that in-situ treatment would achieve compliance with groundwater quality criteria the fastest followed by Alternative 4C, pump and treat with reinjection back into the aquifer. The remaining two pump and treat Alternatives (4A and 4B) are ranked equally. While both of these pumping alternatives will achieve the chemical-specific ARARs, they still rely on the imposed gradients to draw the chemicals to the extraction point whereas the reinjection included in Alternative 4C adds a second influencing force which will push the chemicals toward the extraction point, thereby accelerating the remedy. All of the alternatives rely upon natural attenuation to complete the remediation downgradient of the system. However, the injections performed under Alternative 3 will migrate into the downgradient area and stimulate the remediation of the aquifer in this area more so than the other alternatives. Consequently, Alternative 3 is ranked first in compliance with ARARs.

All of the pumping alternatives actually cause vertical migration of chemicals into the deep bedrock from the overlying shallower bedrock zones. Consequently, the duration for which each pumping alternative has to be in operation is indeterminate. Expectations are that the reinjection of treated water in Alternatives 4C would accelerate the vertical downward migration which may more quickly deplete the overlying chemical source and thereby slightly reduce the length of time that this alternative is required to operate to eliminate the downward chemical migration. Once the source control remedies associated with Operable Unit 1 are completed, the resulting chemical discharges from the overburden and shallow bedrock may be so depleted that continued vertical migration of chemicals into the deeper bedrock is small enough to be inconsequential. Based upon the 2009 groundwater data, the groundwater quality in the C Zone is considerably cleaner than it was in 1988 and therefore confirms that under the influence of natural attenuation, the deeper bedrock zone quality is improving. Consequently, the long-term potential for migration from the overlying bedrock zones is already believed to be small (and will continue to reduce over time).

All groundwater alternatives will comply with the applicable action- and location-specific ARARs, where such exist.

7.1.3 REDUCTION OF TOXICITY, MOBILITY, AND VOLUME

All the alternatives considered for the Site will achieve reductions in toxicity and volume over time. Alternatives 3, 4A, 4B, and 4C also result in reductions in mobility. The alternatives are ranked as follows relative to reduction of toxicity, mobility, and volume based primarily on timing:

- Alternative 3, In-Situ Treatment
- Alternative 4C, Hydraulic Containment/Collection with On-Site Treatment, Aquifer Reinjection
- Alternative 4A Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP

- Alternative 2, MNA
- Alternative 1, No Action

Alternative 3 (In-situ Treatment) is ranked as the highest for reduction of toxicity, mobility, and volume since the degradation and/or destruction begins immediately upon start up of the injections and spreads as the groundwater and injection media continue to flow including into off-Site downgradient areas. Alternative 4C is the next most effective in terms of reduction of toxicity, mobility, and volume since the reinjection of treated water will accelerate the cleansing of the deep bedrock zone. The remaining two pump and treat alternatives (4A and 4B) are identical in reduction of toxicity, mobility, and volume since they both have the exact same extraction scheme. Both of these alternatives eliminate the ability of the COCs to continue to migrate beyond the hydraulic limits created by the extraction. Neither of these alternatives has an impact on the downgradient area beyond the hydraulic capture zone created by the pumping and therefore rely on natural attenuation to address the COC residuals in downgradient areas. The reinjection of treated water in Alternative 4C may actually increase the mobility of COCs in the downgradient areas beyond the limits of the hydraulic capture zone created. However, this may be a benefit in that it will also accelerate the restoration of these downgradient areas to background conditions sooner due to the dilution and cleansing effect of the injected treated water as it may cause an artificial increase in the flow conditions in and through the downgradient areas.

Alternatives 4A and 4B will accelerate the rate at which chemicals from the overlying bedrock zone migrate into the deeper bedrock due to the downward hydraulic gradient created by the pumping of the deep bedrock. Alternative 4C will also cause some additional draw of the overlying chemicals into the deeper bedrock zone but this effect will be partially offset and may actually be reversed in the immediate area of the reinjection wells by the reinjection of treated water into the deep bedrock. The injection of treated water may cause some of the water to flow up into sections of the overlying B Zone thus assisting with the remediation in this zone as well. The act of pumping groundwater from the aquifer will accelerate the groundwater flow in the vicinity of the pumping wells and therefore draw the COCs to the extraction point faster than Alternative 3. However, this will not have an impact on the overlying source attenuation and therefore the length of time that both alternatives need to operate will be identical. All of the alternatives are subject to the conditions surrounding the potential release of chemicals in the upper bedrock zones into the deeper bedrock and therefore all are impacted in terms of the length of time for which these alternatives are required to operate.

Alternatives 1 and 2 (No Action and MNA) are ranked sixth and fifth in reduction of toxicity, mobility, and volume, respectively. The reductions in toxicity and volume of COCs in groundwater will be the same in both remedial alternatives. However, the monitoring component of Alternative 2 could reduce mobility through identification of changes in groundwater flow patterns, to which some active remediation could be applied if so needed.

7.1.4 SHORT-TERM EFFECTIVENESS

The alternatives are ranked as follows relative to short-term effectiveness:

- Alternative 1, No Action
- Alternative 2, MNA
- Alternative 3, In-Situ Treatment
- Alternative 4A Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP
- Alternative 4C, Hydraulic Containment/Collection with On-Site Treatment, Aquifer Reinjection

No risk to the community, workers, or the environment would be presented by the implementation of Alternative 1, No Action. Therefore, Alternative 1 is ranked first in short-term effectiveness. The current concentrations in the deep bedrock on the Site are low and the chemical loading into downgradient areas adjacent to the Site are very low as presented in the main text of the report. With there being no off-Site downgradient receptors of the groundwater, there are no significant threats due to such migration.

Given sufficient time, all of the alternatives are expected to reach cleanup standards and this will occur within the existing footprint of where the chemicals are currently present. No expansion of the chemical plume, over and above that which currently exists, will occur.

Alternative 2 (MNA) is ranked second in short-term effectiveness because the only risk is a low one to workers conducting monitoring activities. However, this risk can be mitigated through proper and safe work procedures.

The differences in short-term effectiveness associated with Alternatives 3, 4A, 4B, and 4C are associated with the risks posed by the remedial system construction and maintenance, monitoring activities, and the potential for spills or leaks of treatment solutions or extracted groundwater. All these risks can be minimized through the implementation of proper work procedures and operating plans. Alternative 3 involves the least amount of construction activity and therefore has less short-term risk than any of the Alternative 4 options. Consequently, Alternative 3 (in situ treatment) is ranked third in short-term effectiveness.

Risks to workers conducting monitoring activities are the same in GW Alternatives 3, 4A, 4B, and 4C.

There are also additional risks associated with the handling of injection media for Alternative 3. However, these risks are less than the risks associated with the handling of impacted groundwater, treatment media, and generated wastes from operating the pumping/treatment systems associated with Alternatives 4A, 4B, and 4C. The fact that Alternative 4A does not include the operation of an on-Site treatment plant makes this alternative slightly less risky than Alternatives 4B and 4C. Alternatives 4B and 4C are the highest risk alternatives in terms of short-term effectiveness since they are the most labor intensive. The reinjection of treated water back into the aquifer adds another component to the remedy for Alternative 4C making it the highest risk alternative in terms of short-term effectiveness.

7.1.5 LONG-TERM EFFECTIVENESS AND PERMANENCE

The alternatives are ranked as follows relative to long-term effectiveness and permanence based primarily on timing:

- Alternative 3, In-Situ Treatment
- Alternative 4A Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP
- Alternative 4C, Hydraulic Containment/Collection with On-Site Treatment, Aquifer Reinjection
- Alternative 2, MNA
- Alternative 1, No Action

Source controls which will be implemented in the overburden at the Frontier Chemical Site as part of the Operable Unit 1 remedy will reduce the potential for chemical migration into the shallow bedrock zone and thereby into the deep bedrock zone. Given that the loading into the deep bedrock zone is already low (and possibly nonexistent), with less chemical presence in the overlying zones, the loading into the deep bedrock will become even lower. Based on the current low chemical presence in the deep bedrock and the potential of even less chemical loading from overlying zones in the future, all of the remedial alternatives evaluated will provide long-term effectiveness and permanence. However, all of these alternatives are still subject to the rate at which chemicals from the overlying zones has the potential to continue to migrate into the deep bedrock zone.

Alternative 3 (In-Situ Treatment) is ranked first in long-term protectiveness and permanence because the injected media actually begin to degrade or destroy the chemicals in the deep bedrock on contact. Therefore, this remedy is quick acting and also permanent. It is also likely to achieve the desired reductions of chemical concentrations in the deep bedrock in the shortest time frame. In addition, the migration of the injected media into the downgradient areas will also address these impacted areas, whereas the other alternatives all rely on natural attenuation to address the downgradient area.

Alternative 4A (Hydraulic Containment/Collection/Treatment at WWTP) is ranked second in long-term protectiveness and permanence due to the fact that it relies upon the City's WWTP for treatment. The City's WWTP has been effectively treating the groundwater discharges from the Site since the Site began operating. Thus it is a proven and effective technology and requires no additional remedial measures to be performed on the Site. Comparatively, Alternatives 4B and 4C both require the construction and operation of an on-Site treatment plant. Some uncertainty exists regarding the potential impact of inorganics on the operation and maintenance of an on-Site treatment system and therefore these alternatives are ranked lower than Alternative 4A. In addition, Alternative 4C includes a reinjection system which could pose further operational difficulties, again due to possible effects from inorganics which could foul the reinjection system or the aquifer.

Alternative 2 (MNA) provides greater long-term effectiveness than Alternative 1 (No Action) through the monitoring of groundwater and enforcement of institutional controls for protection of residents and workers while restoration of the groundwater quality is underway.

The long-term effectiveness and permanence of Alternative 1 (No Action) is the lowest of the remedial alternatives evaluated.

For all of the alternatives, the implementation and enforcement of the institutional controls will protect residents until the groundwater quality meets the concentrations necessary for its intended purpose.

7.1.6 IMPLEMENTABILITY

The alternatives are ranked as follows relative to implementability:

- Alternative 1, No Action
- Alternative 2, MNA
- Alternative 3, In-Situ Treatment
- Alternative 4A, Hydraulic Containment/Collection with Treatment at the WWTP
- Alternative 4B, Hydraulic Containment/Collection with on-Site Treatment, Discharge to WWTP
- Alternative 4C, Hydraulic Containment/Collection with on-Site Treatment, Aquifer Reinjection

Alternative 1 (No Action) would be the most implementable since there would be no work involved. In addition, some of the institutional controls are already in place.

Alternative 2 (MNA) would also be easily implemented and only requires the implementation of a few institutional controls. Some minimal effort may also have to be made to gain access to off-Site properties for monitoring purposes.

Alternative 3 (In-situ treatment) involves the least construction effort of the active remedies and the injection of treatment media is a simple process. Therefore it is ranked third.

All three of the Alternative 4 solutions require the construction of a groundwater extraction and monitoring system and are therefore equal in this regard. The difference between the three pump and treat alternatives revolves around the treatment and handling of the extracted groundwater. Alternative 4A (Hydraulic Containment/ Collection/Discharge to WWTP) utilizes the City's WWTP and therefore requires no on-Site treatment system construction or operation. Therefore, this alternative is ranked fourth. Alternative 4C requires not only the construction and operation of an on-Site treatment system (as does Alternative 4B), but it also requires the construction and operation of a reinjection system. Consequently, Alternative 4C is the most complex to implement and is ranked sixth.

7.1.7 COST

The cost associated with the implementation of the groundwater remedial alternatives is lowest for Alternative 1 (No Action) which has no associated cost. The costs of the alternatives, including capital cost and operation and maintenance costs for the expected number of years, are as follows:

Alternative 1	No Action	$0	0 Years
Alternative 2	MNA	$225,000	30 Years
Alternative 3	In-Situ Treatment	$618,000	10 Years
Alternative 4A	Pump, Treat at WWTP	$3,538,000	20 Years
Alternative 4B	Pump, Treat on Site, to WWTP	$4,838,000	20 Years
Alternative 4C	Pump, Treat on Site, Reinject	$3,248,000	10 Years

8.0 RECOMMENDED REMEDIAL ALTERNATIVE

The remedial alternative recommended for the deep bedrock groundwater component of the Site is dependent upon one primary factor and that is; whether the existing groundwater quality conditions in the deep bedrock require an active remedy to be implemented, or, put another way, timing. As the comparative analysis shows, all of the alternatives will effectively achieve the Site RAOs, with the only essential difference (besides cost) being that active remedial alternatives will take less time to attain the status of remediation completion. Given the conditions at the Site and the absence of groundwater users, the requirement for accelerated remedial timeframes is not necessarily a driving factor. As a result, an active remedy is not required and monitored natural attenuation is the recommended remedial alternative.

The data presented in the main text of the report identify the following to be an accurate depiction of the groundwater conditions in the bedrock.

- There are concentrations of COCs above New York State Class GA Groundwater Criteria in the deep bedrock (Zones C through E). By comparison to the overlying Bedrock Zones A and B, the concentrations in the deep bedrock are low with the highest total VOC concentrations in Zones C, D, and E being 74, 798, and 136 ppb, respectively.
- The direction of groundwater flow in the deep bedrock is primarily eastward away from the Power Conduits which are equipped with an exterior drain system that dewater the upper groundwater zones and recharge the deep groundwater zones on a regional basis.
- The calculated chemical loading from the deep bedrock groundwater zones beneath the Frontier Chemical Site onto off-Site properties is less than one pound per year of total VOCs combined for all three of the deep bedrock C, D, and E Zones.
- The chemical concentrations in the deep bedrock are reducing with time.
- The potential for chemical migration from the shallow groundwater into the deep bedrock is minimal due to the upward vertical gradients and is expected to be further reduced by the planned source remediation work that will be undertaken in the overburden for Operable Unit 1.

The net effects of any chemical presence or off-Site loading from the deep bedrock zones at the Frontier Chemical Site are inconsequential given the following groundwater and geochemical facts:

- While migrating beyond the Site boundaries, the deep bedrock groundwater will undergo further concentration reductions due to natural attenuation
- There are no groundwater users of the deep bedrock within the vicinity of the Site or in the downgradient direction

Consequently, there is no scenario in which humans could be exposed to this groundwater or the environment put at risk. With such a low chemical flux from the Site and the lack of any possible exposure, there is no need for an active remedy for the deep bedrock groundwater at the Frontier Chemical Site. Based upon these facts, the additional planned soil remediation under Operable Unit 1, and the protective upward gradient, Alternative 2, monitored natural attenuation, is the recommended remedy for the deep bedrock groundwater at the Frontier Chemical Site.

Performing a Feasibility Study in compliance with the guidance documents will always bias the results toward an active remediation and away from a remedy such as MNA. In any case where chemicals are present in the groundwater at concentrations that exceed groundwater quality criteria, an active groundwater remedy will always rank as a superior alternative to MNA. However, when all of the facts are considered, MNA for the deep bedrock groundwater remedy for the Frontier Site is an effective and protective remedy, as the facts surrounding the Site show.

The total estimated cost of the recommended remedial Alternative 2 is $225,000.

In the event that there is some institutional necessity to select an active remedy for the deep bedrock groundwater, this FFS shows that Alternative 3, in-situ treatment with MNA is the highest ranking alternative and would be the recommended remedy.

TABLE D.3.1

GROUNDWATER CRITERIA
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NY

Parameter	*Units*	*New York State TOGs* *Guidance Value*	*Standard*	*Most Stringent Criteria*
Volatile Organic Compounds				
1,1,1-Trichloroethane	μg/L	NC	5	5
1,1,2,2-Tetrachloroethane	μg/L	NC	5	5
1,1,2-Trichloroethane	μg/L	NC	1	1
1,1-Dichloroethane	μg/L	NC	5	5
1,1-Dichloroethene	μg/L	NC	5	5
1,2,4-Trichlorobenzene	μg/L	NC	5	5
1,2-Dibromo-3-chloropropane (DBCP)	μg/L	NC	0.04	0.04
1,2-Dibromoethane (Ethylene Dibromide)	μg/L	NC	0.0006	0.0006
1,2-Dichlorobenzene	μg/L	NC	3	3
1,2-Dichloroethane	μg/L	NC	0.6	0.6
1,2-Dichloropropane	μg/L	NC	1	1
1,3-Dichlorobenzene	μg/L	NC	3	3
1,4-Dichlorobenzene	μg/L	NC	3	3
2-Butanone (Methyl Ethyl Ketone)	μg/L	50	NC	50
2-Hexanone	μg/L	50	NC	50
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	μg/L	NC	NC	
Acetone	μg/L	50	NC	50
Benzene	μg/L	NC	1	1
Bromodichloromethane	μg/L	50	NC	50
Bromoform	μg/L	50	NC	50
Bromomethane (Methyl Bromide)	μg/L	NC	5	5
Carbon disulfide	μg/L	60	NC	60
Carbon tetrachloride	μg/L	NC	5	5
Chlorobenzene	μg/L	NC	5	5
Chloroethane	μg/L	NC	5	5
Chloroform (Trichloromethane)	μg/L	NC	7	7
Chloromethane (Methyl Chloride)	μg/L	NC	5	5
cis-1,2-Dichloroethene	μg/L	NC	5	5
cis-1,3-Dichloropropene	μg/L	NC	NC	
Cyclohexane	μg/L	NC	NC	
Dibromochloromethane	μg/L	50	NC	50
Dibromodifluoromethane	μg/L	NC	NC	
Dichlorodifluoromethane (CFC-12)	μg/L	NC	5	5
Ethylbenzene	μg/L	NC	5	5
Isopropylbenzene	μg/L	NC	5	5
Methyl acetate	μg/L	NC	NC	
Methyl cyclohexane	μg/L	NC	NC	
Methyl Tert Butyl Ether	μg/L	10	NC	10
Methylene chloride	μg/L	NC	5	5
Styrene	μg/L	NC	5	5
Tetrachloroethene	μg/L	NC	5	5
Toluene	μg/L	NC	5	5
Total Monochlorotoluenes	μg/L	NC	NC	
trans-1,2-Dichloroethene	μg/L	NC	5	5
trans-1,3-Dichloropropene	μg/L	NC	NC	
Trichloroethene	μg/L	NC	5	5
Trichlorofluoromethane (CFC-11)	μg/L	NC	5	5
Trifluorotrichloroethane (Freon 113)	μg/L	NC	5	5
Vinyl chloride	μg/L	NC	2	2
Xylene (total)	μg/L	NC	NC	
Total VOCs	μg/L	NC	NC	

Note:
NC - No criteria.

TABLE D.3.2

POTENTIAL ACTION-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

	Federal ARARs			*New York ARARs*	
Activity	*Title*	*Subtitle*	*Citation*	*Title*	*Citation*
Disposal of Wastewater Treatment Sludges	Criteria for Classification of Solid Waste Disposal Facilities and Practices	--	40 CFR Part 257	Land Disposal Restrictions	6 NYCRR Part 372 and 376
	Identification and Listing of Hazardous Waste	--	40 CFR Part 261		
Discharge of Treatment System Effluent to Surface or Groundwater	Administered permit programs: The national pollutant discharge elimination system	Establishing limitations, standards and other permit conditions	40 CFR 122.44 and State regulations approved under 40 CFR 131	State Pollutant Discharge Elimination System New York Surface Water Quality Standards	6 NYCRR Part 750 6 NYCRR Part 703
	Criteria and standards for the national pollutant discharge elimination program	Best management practices Discharge to waters of the U.S.	40 CFR 125.100 40 CFR 125.104		
	Guidelines establishing test procedures for the analysis of pollutants	Identification of test procedures and alternate test procedures	40 CFR 136.1-4		
	Effluent guidelines and standards	Organic chemicals, plastics, and synthetic fibers	40 CFR Part 414		
	Wetlands Protection Act of 1970		Executive Order 11990	New York Freshwater Wetlands Act	6 NYCRR Part 665
Discharge to Publicly Owned Treatment Works	National Pretreatment Standards	--	40 CFR Part 403	New York Pretreatment Regulations Niagara Falls Water Board Criteria	6 NYCRR Part 750
Vapor Emissions	Air emissions standards for process vents	--	40 CFR Part 264 (Subpart AA)	New York Regulations for Air Pollution	6 NYCRR Part 200, 202, 256, 257, 258
	National Ambient Air Quality Standards	--	40 CFR Part 50		
	National Emission Standards for Hazardous Air Pollutants	--	40 CFR Part 61		
	New Source Performance Standards	--	40 CFR Part 60		

TABLE D.4.1

POTENTIAL RESPONSE ACTIONS AND REMEDIAL TECHNOLOGIES
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

Medium	*General Response Action*	*Remedial Technology*	*Process Options*	*Description*
Groundwater	No Action	None	Not Applicable	No action. Natural processes are allowed to reduce chemical concentrations to acceptable levels.
	Institutional Control	None	Deed Restrictions	Restrict groundwater usage in the plume and immediate vicinity and initiate long-term monitoring.
	Monitored Natural Attenuation	Natural Attenuation	None	Monitor the natural degradation and attenuation of COCs in groundwater through sampling and analysis to document the reduction of contaminants over time.
	In Situ Groundwater Treatment	Biological Treatment	Enhanced Biological Degradation	Nutrients and oxygen are injected into groundwater to stimulate biological degradation by indigenous (native) bacteria. If the indigenous microbial population is inactive or inadequate, can supplement with microbes specifically designed for the treatment.
		Chemical Treatment	Bio Sparging	Installation of an oxygen injection system to enhance biodegradation of contaminants in the groundwater.
			In-situ Chemical Oxidation	Oxidizing agents are used to convert the target compounds into non-hazardous or less toxic compounds, primarily carbon dioxide, water, and chloride.
		Physical Treatment	In-well Stripping	Installation of a series of double-walled wells in which air can be injected, passed through the water column and then collected for treatment of stripped chemicals
	Hydraulic Containment / Collection	Groundwater Extraction	Groundwater Extraction Well Network	Installation and operation of groundwater extraction wells to create a hydraulic barrier to groundwater migration through the establishment and maintenance of an inward hydraulic gradient.
	Ex Situ Treatment	On-site Physical Treatment	Air Stripping	Strip contaminants to vapor phase. Requires subsequent disposal of treated water. Vapor treatment may be required.
			Activated Carbon	Adsorption of contaminants onto activated carbon. Requires subsequent disposal of treated water and used carbon.
			Chemical Oxidation/ Precipitation	Remove inorganic compounds present through addition of oxygen, flocculants, sequestering agents, pH adjustment, and filtration. Requires subsequent disposal of treated water and sludges.
	Disposal	Off-site Disposal	Discharge to WWTP	Discharge of extracted, treated groundwater to a municipal treatment works.
			Discharge to Surface Water	Discharge of extracted, treated groundwater to a surface water body.
		On-site Disposal	Injection	Extracted, treated groundwater is injected back into the aquifer through on-site wells or trenches.. May also be used to supplement hydraulic containment.

TABLE D.5.1

SCREENING OF IDENTIFIED REMEDIAL ALTERNATIVES FOR GROUNDWATER
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

General Response Action	*Description*	*Effectiveness*	*Implementability*
NO ACTION	No measures are taken to improve groundwater conditions. All contaminants remain. Environmental risks and potential exposure pathways are not addressed by any active remedial activities.	- Reduction in volume and toxicity of COCs will be achieved over time through natural processes. - Slowest effective in meeting all RAOs. - No additional risk during implementation.	- Readily implemented.
INSTITUTIONAL CONTROL			
Deed Restrictions	Implementation of institutional controls, such as deed restrictions to reduce potential exposure to contaminated groundwater.	- Reduction in volume and toxicity of COCs will be achieved over time through natural processes. - Effectiveness is dependant on future enforcement of restrictions and procedures. - Effective in reducing potential for human exposure to COCs.	- Readily implemented.
MONITORED NATURAL ATTENUATION			
Natural Attenuation	COCs are allowed to naturally attenuate.	- Reduction in volume and toxicity of COCs will be achieved over time through natural processes. - Available data demonstrates that it is effective.	- Readily implemented. - Groundwater monitoring will be required to track restoration and migration of groundwater.
IN SITU TREATMENT			
Enhanced Biological Degradation	Delivery of nutrients to stimulate biological degradation by indigenous (native) bacteria. May be used in hotspots to accelerate natural attenuation.	- Reduction in volume and toxicity of COCs will be achieved. - Effectiveness depends on whether sufficient oxygen exists to promote biodegradation.	- Fracture network in bedrock provides unique opportunity that enhance technology and also some difficulties. - Access to adjacent properties may be needed. - Nutrients commercially available and easy to handle.
Biosparging	Injection of oxygen into groundwater to enhance biodegradation. May be used in hotspots to accelerate natural attenuation.	- Reduction in volume and toxicity of COCs in groundwater will be achieved.	- Fracture network hinders oxygen delivery/migration.
In Well Stripping	Air would be injected into double-screened wells installed to the bottom of the contaminated interval lifting the water and stripping the contaminants.	- Reduction in volume, toxicity, and mobility of COCs will be achieved.	- Location of plume in bedrock would make this technically difficult to implement.

TABLE D.5.1

SCREENING OF IDENTIFIED REMEDIAL ALTERNATIVES FOR GROUNDWATER
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

General Response Action	*Description*	*Effectiveness*	*Implementability*
EX SITU TREATMENT			
Air Stripping	Contaminants (VOCs) are removed from the water using an air purging system. Product vapor may need treatment prior to discharge.	- Effective in reducing VOC concentrations.	- Pretreatment of groundwater may be required to remove high concentrations of iron and manganese. - Requires routine maintenance. - May require vapor treatment. - Air permitting may be required.
Activated Carbon	Water is passed through activated carbon and VOCs are removed by being adsorbed to the carbon.	- Generally effective in reducing VOC concentrations.	- Pretreatment of groundwater may be required to remove high concentrations of iron and manganese. - Requires routine maintenance.
DISPOSAL			
Off-Site Disposal			
Discharge to WWTP	Discharge of pre-treated or untreated groundwater directly into municipal sewer for subsequent treatment at WWTP.	- Eliminates potential for human exposure to Site chemicals from groundwater. - Reduces volume, toxicity, and mobility of Site contaminants.	- Concern regarding permitting. - Pre-treatment prior to discharge may be required.
Discharge to surface water	Permitted discharge of treated groundwater directly to surface water.	- Eliminates potential for human exposure to chemicals from groundwater. - Reduces volume, toxicity, and mobility of contaminants.	- Concern regarding permitting. - Long-term access to adjacent properties will be needed. - Water would have to be treated prior to discharge. - No surface water bodies in immediate area.
On-Site Disposal			
Discharge to Aquifer	Discharge extracted and treated groundwater directly back into deep bedrock through injection wells.	- Eliminates potential for human exposure to contaminants from groundwater. - Reduces volume, toxicity, and mobility of contaminants in groundwater.	- Concern regarding permitting. - Water would have to be treated prior to discharge.

TABLE D.5.2

SUMMARY OF DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES FOR GROUNDWATER
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

				In Situ Treatment			*Hydraulic Containment & Collection*	*Treatment of Collected Groundwater*		*Disposal*		
	No Action	*Institutional Control*	*Monitored Natural Attenuation*	*Enhanced Biodegradation*	*In-Situ Chemical Oxidation*	*Biosparging*	*Extraction Wells*	*Air Stripping*	*Activated Carbon*	*Discharge to WWTP*	*Discharge to Surface Water*	*Discharge to Aquifer*
Effectiveness												
• Further reduces toxicity, mobility, and volume of COCs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
• Further minimizes residual risk and affords additional long-term protection	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implementability	Readily implemented	Implentable or Already in place	Readily implemented	Easy to Implement	Easy to Implement	Difficult to implement	Easy to Implement	Easy to Implement	Easy to Implement	Easy to Implement	Difficult to implement	Easy to Implement
Relative Cost												
• Capital	None	Low	None	Low	Low	Moderate - High	Moderate	Low	Low	Low	Moderate	Moderate
• O&M (30 years)	None	Low	Low	Low	Low	Moderate	High	High	High	Low - Moderate	Low	Low
Recommendation	Required for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Retained for detailed analysis	Eliminated from further consideration	Retained for detailed analysis

TABLE D.6.1

COST ANALYSIS SUMMARY
ALTERNATIVE 1 - NO ACTION
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE
NIAGARA FALLS, NEW YORK

	Item	*Estimated Cost*
A.	Remedial Actions, Institutional Control, Monitoring (no action for any of these; only existing engineering controls)	$0
	TOTAL ESTIMATED COST - ALTERNATIVE 1:	$0

TABLE D.6.2

COST ANALYSIS SUMMARY
ALTERNATIVE 2 - MONITORED NATURAL ATTENUATION AND INSTITUTIONAL CONTROL
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

		Item		*Estimated Cost*
A.		Administrative Cost		
		Work Plan		$15,000
		Institutional Controls		$5,000
			Sub-Total, Administrative Cost:	**$20,000**
B.		Direct Capital Cost		$0
			Sub-Total, Direct Capital Cost:	$0
C.		Indirect Capital Cost		$0
			Sub-Total, Indirect Capital Cost:	$0
D.		Contingency		$0
			Total Capital Cost - Alternative 2:	**$20,000**

			Estimated Annual Cost	*Present Worth* [(1)]
E.		Annual Operation & Maintenance		
	i)	Years 1 through 5 (Semi-annual Monitoring)	$18,000	$77,931
	ii)	Years 6 through 30 (Annual Monitoring)	$9,000	$126,846
			Sub-Total, Operation & Maintenance:	**$205,000**
			TOTAL ESTIMATED COST - ALTERNATIVE 2:	**$225,000**

Notes:

(1) Present worth calculated using a 5% interest rate.
Estimates are rounded to the nearest $1,000.

TABLE D.6.3

COST ANALYSIS SUMMARY
ALTERNATIVE 3 - IN-SITU TREATMENT WITH MONITORED NATURAL ATTTENUATION AND INSTITUTIONAL CONTROL
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

		Item		*Estimated Cost*
A.		Administrative Cost		
	1	Work Plan		$25,000
	2	Institutional Control		$5,000
			Total, Administrative Cost:	**$30,000**
B.		Direct Capital Cost		
	1	Injection Wells		$138,000
	2	Treatability Study		$20,000
	3	Mix tanks, pumps, hoses		$14,000
	4	Site services, trailers, water		$41,000
	5	Perform injections (2 times)		$49,000
	6	Injection media		$75,000
			Sub-Total, Direct Capital Cost:	$262,000
D.		Indirect Capital Cost		
	1	Oversight of injection well installation		$34,000
	2	Engineering (assume 15% of capital cost)		$39,300
	3	Contingency Allowance (assume 15% of capital cost)		$39,300
			Sub-Total, Indirect Capital Cost:	$112,600
			Total Capital Cost - Alternative 3:	**$374,600**
			Estimated Annual Cost	***Present Worth*** (1)
D.		O&M		
		Annual Monitoring years 1and 2 (semi-annu	$42,000	$78,095
		Annual Monitoring years 3 - 10 (annual)	$21,000	$135,727
			Sub-Total, Operation & Maintenance:	**$213,823**
			TOTAL ESTIMATED COST - ALTERNATIVE 3:	**$618,000**

Notes:

(1) Present worth calculated using a 5% interest rate.

Estimates are rounded to the nearest $1,000.

TABLE D.6.4

COST ANALYSIS SUMMARY
ALTERNATIVE 4A - HYDRAULIC CONTAINMENT/COLLECTION
WITH DISCHARGE to WWTP
& INSTITUTIONAL CONTROL
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

		Item	*Estimated Cost*
A.		Administrative Cost	
	1	Work Plan	$35,000
	2	Institutional Control	$5,000
		Total, Administrative Cost:	**$40,000**
B.		Direct Capital Cost	
	1	Install Pumping Well Nests (5)	$198,000
	2	Install New Monitoring Well Nests (5)	$135,000
	3	Groundwater Modeling	$40,000
	4	Pump Tests	$45,000
	5	Pumps	$25,000
	6	Pipe Network (2,000 lf)	$67,000
	7	Valves, meters, back-flow preventers	$38,000
	8	Discharge pipe & connection to sewer	$26,000
	9	Control Building	$25,000
	10	Electrical Supply & Connections	$21,000
	11	Telephone Connection	$2,000
	12	SCADA System & Controls	$31,000
		Sub-Total, Direct Capital Cost:	**$653,000**
C.		Indirect Capital Cost	
	1	Oversight of well installations	$69,000
	2	Oversight of pumping systems	$22,000
	3	Engineering (assume 15% of capital cost)	$97,950
	4	Contingency Allowance (assume 15% of capital cost)	$97,950
		Sub-Total, Indirect Capital Cost:	**$286,900**
		Total Capital Cost - Alternative 4A:	**$939,900**

		Estimated Annual Cost	*Present Worth* (1)
D.	O&M		
1	Annual Maintenance/Repairs years 1- 20	$27,000	$336,480
2	Annual Operation of Pumping System years 1-2(	$49,000	$610,648
3	Annual Discharge Monitoring years 1-20	$3,000	$37,387
4	Annual Groundwater Monitoring years 1-3	$31,000	$84,421
5	Annual Groundwater Monitoring years 4-20	$16,000	$180,385
	Sub-Total, Operation & Maintenance:		**$1,249,320**
E.	Discharge Fee to WWTP years 1 - 20		
1	50 gpm @ $0.004/gal	$105,000	**$1,308,532**
	TOTAL ESTIMATED COST - ALTERNATIVE 4A:		**$3,538,000**

Notes:

(1) Present worth calculated using a 5% interest rate.

Estimates are rounded to the nearest $1,000.

TABLE D.6.5

COST ANALYSIS SUMMARY
ALTERNATIVE 4B - HYDRAULIC CONTAINMENT/COLLECTION
WITH ON-SITE TREATMENT and DISCHARGE to WWTP
& INSTITUTIONAL CONTROL
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

		Item	*Estimated Cost*
A.		Administrative Cost	
	1	Work Plan	$35,000
	2	Institutional Control	$5,000
		Total, Administrative Cost:	**$40,000**
B.		Direct Capital Cost	
	1	Install Pumping Well Nests (5)	$198,000
	2	Install New Monitoring Well Nests (5)	$135,000
	3	Groundwater Modeling	$40,000
	4	Pump Tests	$45,000
	5	Pumps	$25,000
	6	Pipe Network (2,000 lf)	$67,000
	7	Valves, meters, back-flow preventers	$38,000
	8	Discharge pipe & connection to sewer	$26,000
	9	Control / Treatment Building	$85,000
	10	Electrical Supply & Connections	$46,000
	11	Telephone Connection	$2,000
	12	SCADA System & Controls	$57,000
	13	Treatment System tanks, filters, air stripper	$82,000
		Sub-Total, Direct Capital Cost:	**$764,000**
C.		Indirect Capital Cost	
	1	Oversight of well installations	$69,000
	2	Oversight of pumping systems	$22,000
	3	Oversight of treatment system	$22,000
	2	Engineering (assume 15% of capital cost)	$114,600
	3	Contingency Allowance (assume 15% of capital cost)	$114,600
		Sub-Total, Indirect Capital Cost:	**$342,200**
		Total Capital Cost - Alternative 4B :	**$1,106,200**

		Estimated Annual Cost	*Present Worth (1)*
D.	O&M		
1	Annual Maintenance/Repairs years 1- 20	$36,000	$448,640
2	Annual Operation of Pumping System years 1-20	$49,000	$610,648
3	Annual Operation of Treatment System years 1-20	$82,000	$1,021,901
3	Annual Discharge Monitoring years 1-20	$3,000	$37,387
4	Annual Groundwater Monitoring years 1-3	$31,000	$84,421
5	Annual Groundwater Monitoring years 4-20	$16,000	$180,385
	Sub-Total, Operation & Maintenance:		**$2,383,382**
E.	Discharge Fee to WWTP years 1 - 20		
1	50 gpm @ $0.004/gal	$105,000	**$1,308,532**

TOTAL ESTIMATED COST - ALTERNATIVE 4B: $4,838,000

Note:

(1) Present worth calculated using a 5% interest rate.
Estimates are rounded to the nearest $1,000.

TABLE D.6.6

COST ANALYSIS SUMMARY
ALTERNATIVE 4C - HYDRAULIC CONTAINMENT/COLLECTION
WITH ON-SITE TREATMENT and DISCHARGE to AQUIFER
& INSTITUTIONAL CONTROL
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

		Item	*Estimated Cost*
A.		Administrative Cost	
	1	Work Plan	$35,000
	2	Institutional Control	$5,000
		Total, Administrative Cost:	**$40,000**
B.		Direct Capital Cost	
	1	Install Pumping Well Nests (5)	$198,000
	2	Install New Monitoring Well Nests (5)	$135,000
	3	Install Reinjection Well Nests (10)	$270,000
	4	Groundwater Modeling	$40,000
	5	Pump Tests	$45,000
	6	Pumps	$34,000
	7	Pipe Network (3,500 lf)	$116,000
	8	Valves, meters, back-flow preventers	$93,000
	9	Discharge pipe & connection to sewer	$0
	10	Control / Treatment Building	$85,000
	11	Electrical Supply & Connections	$46,000
	12	Telephone Connection	$2,000
	13	SCADA System & Controls	$67,000
	14	Treatment System tanks, filters, air stripper	$82,000
		Sub-Total, Direct Capital Cost:	**$1,131,000**
C.		Indirect Capital Cost	
	1	Oversight of well installations	$138,000
	2	Oversight of pumping /reinjection systems	$49,000
	3	Oversight of treatment system	$22,000
	2	Engineering (assume 15% of capital cost)	$169,650
	3	Contingency Allowance (assume 15% of capital cost)	$169,650
		Sub-Total, Indirect Capital Cost:	**$548,300**
		Total Capital Cost - Alternative 4C:	**$1,679,300**

			Estimated Annual Cost	*Present Worth (1)*
D.		O&M		
1		Annual Maintenance/Repairs years 1- 10	$36,000	$277,982
2		Annual Operation of Pumping System years	$49,000	$378,365
3		Annual Operation of Treatment System yea	$82,000	$633,182
3		Annual Discharge Monitoring years 1-10	$3,000	$23,165
4		Annual Groundwater Monitoring years 1-3	$31,000	$84,421
5		Annual Groundwater Monitoring years 4-1	$16,000	$92,582
		Sub-Total, Operation & Maintenance:		**$1,489,698**
E.		Discharge Permit		
1		to NYSDEC years 1-10	$5,000	$38,609
		TOTAL ESTIMATED COST - ALTERNATIVE 4C:		**$3,248,000**

Notes:

(1) Present worth calculated using a 5% interest rate.

Estimates are rounded to the nearest $1,000.

TABLE D.7.1

COMPARATIVE RANKING OF GROUNDWATER REMEDIAL ALTERNATIVES
FOCUSED FEASIBILITY STUDY
FRONTIER CHEMICAL SITE

	Groundwater Alternative					
	1	***2***	***3***	***4A***	***4B***	***4C***
	No Action	*MNA with Institutional Control*	*In-Situ Treatment With MNA and Institutional Control*	*Hydraulic Containment/ Collection with Discharge to WWTP and Institutional Control*	*Hydraulic Containment/Collection with On-Site Treatment, Discharge to WWTP and Institutional Control*	*Hydraulic Containment/Collection with On-Site Treatment, Aquifer Discharge and Institutional Control*
Overall Protection of Human Health	6	5	1	3	4	2
Compliance with ARARs	5	5	1	3	3	2
Reduction of Toxicity, Mobility, and Volume	6	5	1	3	3	2
Short-Term Effectiveness	1	2	3	4	5	6
Long-Term Effectiveness and Permanence	6	5	1	2	3	4
Implementability	1	2	3	4	5	6
Net Present Worth Cost*	$0	$225,000 30 years	$618,000 10 years	$3,538,000 20 years	$4,838,000 20 years	$3,248,000 10 years

Note:

* Present worth calculated using a 5 percent interest rate.