FINAL DESIGN REPORT

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Frontier Chemical - Pendleton Site
Town of Pendleton, Niagara County, New York
Remedial Design
Volume I

Pendleton Site PRP Group

February 1995
Revised June 1995

O'BRIEN & GERE
ENGINEERS, INC.

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Report

Remedial Design

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O'BRIEN & GERE ENGINEERS, INC.

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Executive Summary

This report, along with the separately bound Technical Specifications and Contract Drawings, comprises the remedial design for the Frontier Chemical-Pendleton Site which is site #9-32-043 on the Registry of Inactive Hazardous Waste Disposal Sites in New York State. The remedial design, prepared on behalf of the Pendleton Site Potentially Responsible Parties (PRPs), presents a final design in accordance with the requirements of the Record of Decision (ROD) and the Remedial Design/Remedial Action (RD/RA) Work Plan for the site. The final remedial design documents are being submitted to the New York State Department of Environmental Conservation (NYSDEC) as required by the Order on Consent (#B9-0270-89-05) which the PRPs have entered into with the NYSDEC.

The ROD defines the following remedial action objectives for the Frontier Chemical-Pendleton Site:

- Reduce or eliminate the potential for human contact with contaminated soil, fugitive dust, ground water, sediment, and surface water.
- Dispose of or otherwise treat the wastes in a manner consistent with all state and federal Applicable or Relevant and Appropriate Requirements (ARARs).
- Restore the site to a condition allowing use with few restrictions.

The remedial design presented in this report achieves these stated remedial action objectives. The major features of the remedial design include:

- Draining Quarry Lake to allow drying, stabilization, and consolidation of sediments;
- Reconstruct the berm around Quarry Lake, and install a new outlet structure;

- Capping of consolidated sediments, previously dredged materials, and surface soils with a low-permeability cap;
- Installation, in conjunction with the cap, of a low-permeability barrier to ground water flow;
- Construction of a ground water collection trench along the eastern shore of Quarry Lake;
- Conveyance of collected ground water to the local Publicly Owned Treatment Works (POTW); and
- Creation of new wetlands at the site.

Prior to initiating the preliminary remedial design, pre-design investigations were completed in accordance with the approved RD/RA Work Plan. Those investigations were conducted to provide additional information necessary to prepare the final remedial design, and are discussed in Section 2 of this report. The pre-design investigations are summarized below:

Site survey. An updated topographic map of the site was prepared from aerial photography made in April 1994.

Wetland delineation. Eight wetland areas were delineated at the site in accordance with appropriate Army Corps of Engineers (ACOE) procedures. The NYSDEC verified that the delineated boundaries are consistent with the freshwater wetlands identified in accordance with ACOE delineation procedures.

Ground water and surface water sampling. Samples of ground water and Quarry Lake surface water were collected and analyzed for parameters specified by the local POTW operated by the Niagara County Sewer District No. 1 (District). Those data were submitted in December 1994 to the District to obtain authorization to discharge surface water and ground water from the site to the local POTW.

Test pits. A total of 18 test pits were excavated at the site to evaluate subsurface soil conditions, to collect soil samples for geotechnical analyses, and to evaluate the potential presence of a non-aqueous phase liquid. Information from the test pits was used to assess the limits of fill material at the site, and the geotechnical analyses provided data for design of the proposed cap and ground water collection system.

Background soil sampling. Fourteen samples of soils from undisturbed locations adjacent to the site were collected and analyzed for chromium and cadmium to calculate background concentrations of those contaminants. The background concentrations (or NYSDEC guidance values, whichever are greater) establish site-specific cleanup levels for the remedial action.

Quarry Lake sediment profiling and sampling. The depth and thickness of Quarry Lake sediments were measured on a 100-foot grid to calculate the volume of sediments present in the lake. Samples of the sediments were collected from 52 locations, analyzed for cadmium and chromium, and compared to cleanup levels to define the extent of sediments to be excavated as part of the remedial action.

Treatability testing. Samples of Quarry Lake sediments and previously dredged materials were collected and subjected to stability testing. The results of the tests demonstrated that the sediments exhibit the physical properties necessary to support the proposed cap, and that contaminant concentrations in extracted leachate from the stabilized samples were within regulatory limits.

Vane shear tests. A total of eight *in situ* vane shear tests were performed to evaluate the shear strength of the clay/silty clay layer. Results of the testing were used to evaluate the short-term and long-term slope stability of the capped area.

The pre-design investigations and the final remedial design presented herein satisfy the requirements of the ROD, the Order on Consent, and the approved RD/RA Work Plan.

1. Introduction

This report, along with the separately bound Technical Specifications and Contract Drawings, represents the Final Remedial Design for the Frontier Chemical-Pendleton Site on behalf of the Pendleton Site Potentially Responsible Parties (PRPs). The design has been prepared in accordance with the requirements of the Record of Decision (ROD) (NYSDEC, 1992) and the Remedial Design/Remedial Action (RD/RA) Work Plan (Remcor, 1993), and comments received from the New York State Department of Environmental Conservation (NYSDEC) on the Preliminary Remedial Design.

The following sections discuss the history of the site, pre-design investigation activities, components of the remedial design and anticipated construction schedule.

1.1. Site History

The Frontier Chemical-Pendleton Site is located on Town Line Road in the Town of Pendleton, Niagara County, New York, as shown on Figure 1-1. The site comprises approximately 22 acres of the 75 acre Frontier Chemical property. Fifteen acres of the 22 acre site are occupied by Quarry Lake, a flooded quarry which resulted from the excavation of clay for use in clay brick and tile manufacturing at an on-site facility. The remaining 7 acres, identified as the former Process Area, were utilized by Frontier Chemical Waste Process, Inc. (Frontier) when the site was operated as an industrial waste treatment facility from 1958 to 1974. Plating wastes, pickle liquors and other liquid acid wastes from plating and metal finishing industries were treated at the site, with residuals from the waste treatment process being discharged into Quarry Lake. Much of the former Process Area was filled and graded following termination of waste treatment operations.

Between 1980 and 1987 attempts were made to remediate Quarry Lake by reportedly pumping water to the Town of Wheatfield Sewage Treatment Plant and excavating sediments from the lake bottom for placement in an on-site landfill. This work was discontinued in 1988, with stockpiled sediments remaining in the former Process Area.

A Remedial Investigation (RI) conducted by URS Consultants (URS) for the NYSDEC between 1990 and 1991 identified the presence of contaminated soils, sediments, and ground water at the site. Surface water in Quarry Lake and Bull Creek, which borders the Frontier Chemical property to the north, was found to be relatively uncontaminated.

In 1992, URS utilized the findings of the RI to prepare a Feasibility Study (FS) for the site. In March 1992, NYSDEC issued a ROD presenting a selected remedy for the site (NYSDEC, 1992). The selected remedy presented in the ROD included the following components:

- Contaminated sediments from Quarry Lake will be dredged, stabilized, and placed on site within the containment area. Previously dredged sediments on site will be similarly placed;
- A multilayered cap incorporating a geomembrane (or technical equivalent) installed over the containment area;
- A ground water collection system installed within the contained area to maintain an inward hydraulic gradient. The collected ground water is to be treated and disposed of.
- A grouted sheetpile wall (or technical equivalent) installed around the site to provide a containment boundary for contaminated soils and assist the ground water collection system in maintaining an inward gradient;
- Physical controls installed to control surface drainage and overflow from the lake;
- A monitoring system to monitor the effectiveness of the remedy.

The ROD defined the following remedial action objectives for the Frontier Chemical-Pendleton Site:

- Reduce or eliminate the potential for human contact with contaminated soil, fugitive dust, ground water, sediment, and surface water.

- Dispose of or otherwise treat the wastes in a manner consistent with all state and federal Applicable or Relevant and Appropriate Requirements (ARARs).

- Restore the site to a condition allowing use with few restrictions.

Following issuance of the ROD, Remcor, Inc. was retained by the Frontier-Pendleton PRPs to prepare a RD/RA Work Plan (Remcor, 1993). According to Revision No.2 of the RD/RA Work Plan dated November 3, 1993, the following remedial components were proposed by Remcor for the site:

- Provision of site controls (erosion, sediment, and inadvertent access controls) for the construction period. Site controls will be implemented to prevent erosion of soils and sediments at the site with the potential for off-site migration. Security, gates and fencing will limit the potential for inadvertent access.

- Consolidation of soils and previously dredged sediments into a limited area within the former Process Area. This will limit exposure to infiltrating rainwater as well as meet ROD recommendations to consolidate the area to be capped. The consolidation will also allow approximately two additional acres of the site to revert to wetlands. Previously dredged sediments placed beneath the cap will be placed in a manner such that they are capable of supporting the cap.

- Removal of the contaminated sediments from Quarry Lake. The sediments in the western portion of Quarry Lake adjacent to the former Process Area will be removed due to the detection of organics and polychlorinated biphenyls (PCBs).

  Sediments in the remaining portion of Quarry Lake will be removed in areas where chromium or cadmium concentrations exceed the defined site-specific background values. All newly dredged sediments will be solidified and incorporated with previously dredged sediments and soils removed from other portions of the former Process Area. Solidification of the newly dredged materials will be conducted to remove free liquids and to provide strength to support the cap.

- Placement of a modified multilayered cap with synthetic geomembrane (MSG) capping system: flexible membrane liner (FML) or geosynthetic clay liner keyed into underlying clay, 6 inches of sand, a geotextile fabric, 12 inches of unclassified soil, and 6 inches of topsoil. This capping system will provide a vertical barrier by keying the FML or geosynthetic clay liner into the underlying clay, minimize recharge to the shallow ground water system in the former Process Area, and direct surface water that has not been in contact with existing site materials from the capping system to the surrounding wetlands. The results of this capping system will be: (1) the minimization of shallow ground water drainage from the former Process Area; (2) the elimination of infiltration into and through the former Process Area soils above the shallow ground water surface; (3) the minimization of the potential for the shallow ground water in the former Process Area to rise to the ground surface as postulated in the RI risk assessment; and (4) the provision of a system to maintain flow to the surrounding wetlands.

- Reconstruction of the embankment and outlet from Quarry Lake.

- Installation of a ground water recovery trench along the perimeter of the capping system. The ground water recovery trench will be installed to provide an inward gradient at the perimeter of the capping area. The combination of the trench and the liner keyed into clay will provide effective ground water control at the site.

- Installation of a ground water monitoring system, in conjunction with existing monitoring wells, around the site boundary.

- Provide monitoring of ground water and surficial conditions at the site.

In March 1994, the PRP Group entered into an Order on Consent (#B9-0270-89-05) with NYSDEC to implement the RD/RA Work Plan. The Order on Consent requires preparation of a Remedial Design.

This document represents the Final Remedial Design Report. Corresponding Technical Specifications and Contract Drawings are separately bound.

Section 4 of this report discusses modifications to the design proposed by Remcor including:

- Expansion of the proposed limits of area to be capped;
- Modification of the proposed cap design; and
- Construction of approximately 1.3 acres of wetlands.

1.2. Existing Site Conditions

The Frontier Chemical-Pendleton Site is bounded by Town Line Road to the west, an abandoned railroad right of way to the southeast, and Bull Creek to the north. Access to the site is through a locked gate off of Town Line Road.

1.2.1. Topography

The Frontier Chemical-Pendleton Site is located in the drainage basin of the Niagara River at a point approximately 5 miles east-northeast of the river, 15 miles south of Lake Ontario, and 15 miles north of Lake Erie. Relief in the area is gentle, ranging from 593 feet above mean seal level (msl) to 573 feet msl within a one mile radius of the site. The site itself is relatively flat, its only significant relief appearing around Quarry Lake is in the form of a berm (0-5 feet) encompassing the lake and in the waste and fill piles of the former Process Area (up to 20 feet) (URS, 1991).

1.2.2. Regional geology

The site is located within the extreme western portion of the Erie-Ontario Lowlands physiographic province. This province forms a band across the western half of New York State, lying east of Lake Erie and largely south of Lake Ontario. The Erie-Ontario Lowlands are characterized by relatively flat-lying, low relief topographic features. The major physiographic feature of the area is the east-west trending Niagara Escarpment which extends westward into Ontario, Canada and becomes discontinuous towards Rochester, New York to the east. The Middle Silurian Lockport Dolomite forms the Escarpment's resistant cap rock. The Niagara Escarpment is located approximately 5 miles north of the site.

Glacial erosion and deposition have significantly modified the topography of the Erie-Ontario Lowlands. The area has experienced repeated southward advance and northward retreat of the glacial ice margin, resulting in the deposition of a variety of glacial sediments. Glacial deposits in the immediate vicinity of the site include lacustrine sediments and ground moraine.

Much of the site's clay deposits are fine grained sediments that settled into the basin of glacial lake Tonawanda during Pleistocene and Holocene time. These sediments were laid into a depressional trough shaped by glacial erosion of the underlying bedrock with subsequent deposition of ground moraine (crushed rock material transported by and lodged beneath actively flowing ice).

The bedrock in the vicinity is a nearly flat lying sequence of Silurian-aged limestone, dolomite, shale, and sandstone deposits. This sequence, exposed along the Niagara Escarpment and in the Niagara River Gorge, dips gently southward at a grade of approximately 30 feet per mile. The site is underlain by the Oak Orchard (Guelph) Dolomite Member of the Lockport Formation (URS, 1991).

1.2.3. Site stratigraphy

Stratigraphy of the Frontier Chemical-Pendleton Site generally consists, from the ground surface down, of a fill and weathered clay layer, a clay confining layer, and a permeable layer of silty sand and fractured dolostone. The fill material typically includes brick and brick fragments, construction and demolition (C&D) debris, and crushed drums and other metal objects in a silty clay to a sandy gravel matrix. The fill layer is commonly three to six feet thick and is incorporated within a weathered clay and clayey silt material in some areas as observed during predesign activities (Section 2.3.1) and as discussed in the RI (URS, 1991).

The clay confining layer consists of a clay or silty clay that is soft to very soft, wet and plastic. Gray horizontal silty seams increase in size and number with depth and contribute to an overall coarsening of the unit with depth. This unit is highly impermeable and acts as a confining layer between the overlying fill and weathered clay layers and underlying permeable layer.

The clay confining layer varies in thickness from less than five feet in the western basin of Quarry Lake to greater than 20 feet beneath the fill of the former Process Area.

The underlying layer consists of relatively permeable mixtures of silt, sand and gravel, dolostone bedrock and weathered bedrock. The silty sand unit is predominantly silty sand with some clay and gravel. The top of the unit grades from a sandy silt with trace gravel to a gravelly sand with some silt with increasing depth. The silty sand layer ranges from 17 feet in thickness at the southeast end of the site to less than five feet in thickness at the northeast end of the site (URS, 1991).

The dolostone bedrock consists of fractured, dark gray, very hard dolostone. The weathered bedrock zone contains weathered dolostone, which was formed at the soil/rock interface, and consists of a mixture of dolostone fragments in a silty/sandy matrix (URS, 1991).

1.2.4. Site ground water flow

Based on results of ground water monitoring activities, shallow ground water appears to be flowing away from a ground water mound centered over the former Process Area. Horizontal ground water flow in the silty sand unit is generally towards the west-northwest towards Bull Creek.

2. Pre-design Investigations

Investigations were conducted at the site to provide additional information required for preparation of the preliminary remedial design conducted in accordance with the NYSDEC approved RD/RA Work Plan (Revision No. 2) (Remcor, 1993). The pre-design investigations included the following:

- additional site characterization activities
- wetland identification and delineation
- evaluation of subsurface conditions in the vicinity of the proposed ground water collection trench and perimeter
- evaluation of the absence or presence of a separate phase liquid
- evaluation of the characteristics and volumes of Quarry Lake sediments
- evaluation of potential off-site borrow sources
- evaluation of geosynthetic liner materials with respect to site ground water characteristics
- evaluation of the local POTW potentially accepting water discharged from the site

The results of the pre-design investigations are summarized in this Section.

2.1. General Activities

2.1.1. Site survey

A survey was performed to develop a topographic map with two-foot contour intervals of the site and one-foot contour intervals of the lake bottom. The survey included an aerial and site survey of the former Process Area, existing above-ground pipeline connecting to the District, and perimeter berm in the vicinity of Quarry Lake. Wetland boundaries, test pits, and boreholes were also surveyed. In addition, a survey was performed to develop a profile of the depth and thickness of sediments in Quarry Lake. Niagara Boundary & Mapping, P.C. of Niagara Falls, New York provided surveying services. The existing site plan is shown on Figure 1-2.

2.1.2. Wetlands delineation

Eight individual wetlands were delineated during the pre-design activities in accordance with the U.S. Army Corps of Engineers (ACOE) Delineation Manual. NYSDEC conducted a wetland boundary verification visit. Locations of the wetlands are shown on Figure 1-2. A detailed description of the field delineation work is included in Appendix A.

2.2. Publicly Owned Treatment Works (POTW) Parameters

2.2.1. Background

The local POTW that is potentially available to receive surface and ground water discharges from the site is operated by the Niagara County Sewer District No. 1 (District). The District facility is a biological treatment plant designed for 9 million gallons per day (mgd) average daily flow with an 18 mgd peak flow. Major unit processes of the plant include raw sewage pumping station, aerated grit chambers, aeration tanks, clarifiers, phosphorous removal facilities, tertiary filtration, and disinfection. District effluent is discharged to the Niagara River through an outfall which extends 660 feet into the river. Solids handling facilities include sludge thickeners, Zimpro thermal sludge conditioning system, vacuum filter, and a multiple hearth incinerator. The resultant ash is hauled to a landfill for final disposal.

In accordance with a September 9, 1980 agreement between the District and Frontier, various discharges occurred through the 1980's from Frontier. Prior to the agreement, Frontier had the following reports prepared:

- Report of Quarry Lake Treatability Study by Ecology and Environment, Inc. dated July 14, 1978;

- Metals Analysis on Neutralized Samples of Pendleton Lake Water by Frontier dated February 4, 1980; and

- Engineering Report for Treating, Dewatering and Closure of Quarry Lake, Town of Pendleton by Milton E. Abraham, Ph.D., P.E., R.B. MacMullin Associates dated February 29, 1980.

The agreement permitted Frontier to connect a force main to Manhole No. 16, limited copper concentrations to 1.0 mg/l, and contained flow and pH limitations. Monitoring parameters included pH, cadmium, copper, zinc, iron, arsenic, barium, boron, chromium, lead, mercury, manganese, nickel, selenium, silver, total dissolved solids, ammonia, and total halogenated organics. Frontier began dewatering Quarry Lake in July 1981 by pumping surface water to the District. Dewatering continued for several years during previous remedial programs. The last discharge from Quarry Lake was on April 15, 1988 to the District.

2.2.2. Sampling and analysis

The PRP Group has initiated discussions with the District regarding authorization to discharge surface water (during construction) and a permit to discharge collected ground water to the local POTW. The pre-design investigations included surface water and ground water sampling and analysis to enable the District to evaluate the proposed discharge.

Based on correspondence between the PRP Group and the District, the pre-design analyses recommended by the District included:

- TCL VOCs
- pH
- Cyanide
- Dioxins
- TCL SVOCs
- Pesticides/PCBs
- Phenol

In addition to the above analyses, the parameters listed in Table B-1 are delineated in the Sewer Use Law, Local Law No. 4, Niagara County Sewer District No. 1, Niagara County, New York, adopted by the Niagara County Legislature May 7, 1985, Resolution No. 172-85.

Ground water and surface water sampling activities were performed on June 13, 1994 and during the period of June 20 through 22, 1994. The sampling activities included the collection of a surface water sample from Quarry Lake and ground water samples from the following wells (shown on Figure 1-2):

MW-85-2S
MW-85-3S
MW-88-1A
MW-88-2A
MW-88-4A
MW-88-8A
MW-88-10A
MW-88-11A
MW-88-13A

Samples from the above wells and Quarry Lake were analyzed for target compound list (TCL) volatile organic compounds (VOCs) in accordance with NYSDEC Analytical Services Protocol (ASP) 91-1. A surface water sample and two composite samples of ground water were collected for analysis of TCL semi-volatile organic compounds (SVOCs) (ASP Method 91-2), PCBs and pesticides (ASP Method 91-3), metals and boron (ASP 200-CLP-M series), total dissolved solids (TDS) (ASP Method 160.1), total suspended solids (TSS) (ASP Method 160.2), biological oxygen demand (BOD) (ASP Method 405.1), pH (ASP Method 150.1), phosphorous (ASP Method 365.4), phenols (ASP Method 420.1), and total cyanide (ASP Method 335.2-CLP-M). Composite 1 ground water sample was comprised of ground water collected from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A. Composite 2 ground water sample was prepared using ground water collected from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A. The two samples were composited to be generally representative of ground water quality along the boundary of the former Process Area (Composite 1) and in the former Process Area (Composite 2). In addition, a surface water sample and one composite ground water sample, comprised of ground water sampled from MW-85-2S, MW-85-3S, MW-88-1A, MW-88-2A, MW-88-4A, MW-88-8A, MW-88-10A, MW-88-11A, and MW-88-13A, was collected and analyzed for dioxin (USEPA Method 8290).

Analytical data are included in Appendix C-1. Ground water and surface water sampling logs and chain of custody forms are included in Appendices D and E, respectively. Summary results of laboratory analyses for the ground water and surface water samples are presented in Tables B-2 through B-7 of Appendix B.

Conclusion. Based on results of the laboratory analyses, it does not appear that either water from Quarry Lake or ground water collected from the site will require pre-treatment prior to conveyance to the local POTW for treatment. The ultimate authority for requiring pre-treatment rests with the local POTW.

2.2.3. Projected discharge evaluation

The quality of effluent from the ground water collection trench was evaluated to aid in the design of the proposed remedial system. Data from monitoring wells sampled as part of the pre-design investigations as well as data from previous investigations were used to estimate the concentration of VOCs that could be present in the effluent of the collection trench (see Table F-1 of Appendix F). An iso-concentration map was prepared using the total VOC concentrations and is presented as Figure 2-1. The figure illustrates that ground water from 170 ft of the collection trench will contain approximately 50 mg/L of total VOCs and ground water from the remaining 980 ft of the collection trench will contain approximately 10 mg/L of total VOCs. The "weighted" average of total VOCs was calculated to be 17.2 mg/L. The total VOC concentrations and the calculations are presented in Appendix F. The calculations are based on information presented in the reference Powers, 1981.

It should be recognized that actual total VOC effluent concentration may vary significantly from the estimated concentration. Due to the varying permeabilities of the soils, certain portions of the collection trench may yield significantly greater volumes of water than other portions of the collection trench. The calculations presented in Appendix F assume that each portion of the trench contributes equal amounts of ground water. Additionally, there is limited ground water chemistry data along the northern portion of the proposed collection trench. A value of 10 mg/l was assigned to this area. Given available data, this value is believed to be representative of conditions at this location.

2.3. Collection Trench and Cap Perimeter Evaluation

2.3.1. Test pits

The purpose of the ground water collection trench and cap perimeter evaluation was to evaluate subsurface conditions and collect samples from test pits located in the vicinity of the proposed ground water collection trench and perimeter of the proposed cap. The test pits were excavated between June 6 and 9, 1994 by SJB Services, Inc. of Buffalo, New York.

A total of 18 test pits were installed at the site. Locations of the test pits are shown on Figure 1-2. Corresponding test pit logs are included in Appendix G. Test pits TP-1 through TP-8 were installed for geotechnical evaluation of the ground water collection trench and capping system. Test pits TP-9 through TP-11 were installed to evaluate the absence or presence of a separate phase liquid as discussed in Section 2.4.1. Test pits TP-12 through TP-18 were installed to evaluate the composition and distribution of fill as discussed in Section 2.6.

Six of the test pits installed for the collection trench and cap perimeter evaluation were excavated to depths of up to 15 feet below ground surface. Two other test pits were discontinued due to a rapid inflow of water into the pits, collapse of the side walls or the presence of construction debris that could not be practically excavated. In general, the subsurface conditions consisted of approximately three to five feet of fill material (metal, concrete, brick, and cinders) overlying a three to five foot thick layer of red/grey mottled clay. The mottled clay layer was underlain by approximately four to five feet of varved clay. A red plastic clay was encountered below the varved clay. The mottled clay layer corresponds to the layer described as weathered clay during previous subsurface investigations. The varved and red plastic clay layers comprise the clay/silty clay layer noted during previous investigations.

Test pits TP-1 and TP-6 were abandoned at relatively shallow depths (approximately 8 and 4 feet, respectively) due to the rapid inflow of water into the pits. The majority of the remaining test pits were left open for a period of approximately 12 hours to observe the level of ground water, if present, in the excavations. Water was observed to be present in several test pits at depths ranging from ground surface to approximately five feet below ground surface. The test pits were subsequently backfilled with the previously excavated materials.

Air monitoring was performed in the vicinity of each test pit during excavation. Measurements were taken with a photoionization detector (PID), respirable dust monitor, and explosive gas meter. No readings above background in the breathing zone were recorded.

2.3.2. Geotechnical sampling and analysis

Table B-8 of Appendix B summarizes the depths and soil types sampled for geotechnical analyses from respective test pits. Table B-8 also shows the type of laboratory testing specified for each sample. Soil samples were collected to obtain each type of soil encountered (fill, mottled clay, varved clay, and plastic clay) for testing of moisture content, particle size (including hydrometer), specific gravity, and plasticity index. Two Shelby tube samples were collected from each of two clay layers encountered (mottled clay and plastic clay) for use in triaxial (strength) and consolidation testing.

Six samples were collected for analysis of unit weight. Two additional values of unit weight were obtained in accordance with the standard procedures for consolidation testing.

Results of geotechnical testing performed are included in Appendix H. Geotechnical testing services were performed by Huntingdon/ Empire Soils Investigations, Inc. of Middleport, New York.

2.3.3. Hydraulic control evaluation

This section presents an evaluation of the hydraulic control induced by the proposed ground water collection trench considering the effects of reduced infiltration. Additionally, the yield of the proposed collection trench was evaluated.

Site hydrogeology. A complete discussion of the site hydrogeology is presented in the RI (URS, 1991). The following discussion presents a summary of the site hydrogeology based on the RI and data collected during the pre-design investigations. With respect to the upper portion of the overburden and the site hydrogeology, the findings of the pre-design investigations are consistent with the findings of the RI.

The general stratigraphy at the site from the ground surface consists of fill material, weathered clay, a clay confining layer, and a more permeable silty sand layer which is underlain by bedrock.

At the site, fill material consisting of broken bricks, refuse, construction debris, drainage tiles, building foundations and other material was encountered in a sand-gravel or silty clay matrix. Beneath the fill material, a weathered clay material was encountered. The weathered clay is generally mottled and contains vertical fractures and extends to a depth of approximately 11 ft below ground surface.

TP-12 through TP-14 were installed to evaluate the lateral extent of fill to the northeast. During these activities, fill material was encountered to a depth of at least 13 ft below grade in TP-14. The existence of the weathered clay in this area was not documented.

Across the site a clay confining unit was encountered in the monitoring wells installed during previous investigations and in test pits installed as part of the pre-design investigations. The confining layer consists of clay or silty clay that is soft to very soft and plastic. In the vicinity of the former Process Area this layer is reportedly 20 ft thick (URS, 1991). Beneath the clay confining layer a more permeable silty sand deposit was encountered which is underlain by bedrock.

Shallow monitoring wells MW-88-3A through MW-88-12A and monitoring well MW-88-14A installed in the area to be capped are screened in the fill and weathered clay layers. *In situ* hydraulic conductivity tests were completed by Golder Associates and URS to evaluate the horizontal permeability of the screened material. The results indicate that the material is heterogenous as the horizontal hydraulic conductivity ranged from 7.3×10^{-7} cm/sec to 9.2×10^{-3} cm/sec. The permeability of wells screened in only the weathered clay (MW-85-1S, MW-85-2S, MW-85-5S, MW-85-7S, MW-88-1A, MW-88-2A, MW-88-13A, URS-8S, URS-9S, and URS-14S) also varied significantly, from 2.0×10^{-3} cm/sec to 4.3×10^{-8} cm/sec.

Ground water in the vicinity of the collection trench ranges from a depth of 1 to 5 ft below grade and is generally found at an elevation of 579 to 580 ft msl (URS, 1991). Shallow ground water flow maps presented in the RI indicate that shallow ground water in the former Process Area flows radially away from a ground water mound located at monitoring wells MW-88-10A and MW-85-3S. Ground water elevation data collected as part of the pre-design investigations confirmed the presence of the ground water mound. This ground water mound is likely due to the varying permeability of the fill material found in this area. The potentiometric surface of the silty sand and underlying bedrock is towards the west-northwest towards Bull Creek based on data presented in the RI and from the pre-design investigations.

In the vicinity of the former Process Area, a downward vertical hydraulic gradient exists between wells screened in the fill-weathered clay layer and the wells screened in the silty sand layer. The results of triaxial permeability tests completed as part of the RI indicate that the vertical permeability of the clay confining layer ranges from 7.2×10^{-7} cm/sec to 1.0×10^{-8} cm/sec.

Volume of ground water. The volume of ground water under the area to be capped (261,895 ft^2) that could be drained via gravity was estimated to be 4.4 million gallons, assuming an average saturated thickness of 11 ft and a specific yield of 20% which is typical of fine sand or fill material. This volume in conjunction with the estimated yield of the collection trench will be used to estimate the time necessary to dewater the fill-weathered clay layer beneath the area to be capped. The calculations are included in Appendix F.

Ground water flow calculations The hydraulic theory and calculations used to estimate the yield to the ground water collection trench are discussed below. The yield to the collection trench will decrease with time, as infiltration is reduced and the fill material and weathered clay layer are dewatered. The yield to the collection trench was estimated for early, transient, and late times.

Early time is defined as the period during construction of the ground water collection trench, installation of the vertical barrier along the perimeter of the area to be capped, installation of the cap, and initial pumping of the collection trench. During this period, water stored in the fill-weathered clay layer will be released.

Observed inflow of ground water into the test pits constructed as part of the pre-design investigations indicated that ground water seeped into the excavations at slow rates (indicative of weathered clay or fill material in a silty clay matrix); however, at three test pit locations substantial quantities of ground water entered the test pits over a short period of time. Specific calculations pertaining to the yields encountered while constructing the test pits are included in Appendix F.

At TP-9 and TP-10, ground water quickly filled the test pits indicating high recharge capacity. At TP-1 ground water was estimated to recharge the excavation at approximately 124 gallons/minute (gpm). Based on these observations and the varying permeability of the fill and weathered clay layer it is not reasonable to calculate the yield of the collection trench during this period. However, since 124 gpm was encountered in a single test pit, it is anticipated that the cumulative yield of the collection trench would be greater than 124 gpm during this time period.

Transient time includes the period following completion of the cap and when the ground water collection trench is operating. During this period the material beneath the cap is being dewatered. The yield to the collection trench during this time period will decrease and will approach the yield calculated during the late time.

Table 3-3, of the RI report summarizes the horizontal hydraulic conductivity results obtained by Golder Associates and those obtained by URS (see Appendix F). The data indicate that the horizontal permeability of the fill-weathered clay material ranges from 9.2 x 10^{-3} cm/sec to 7.3 x 10^{-7} cm/sec. This range of permeabilities indicates that the fill-weathered clay is heterogenous. This is consistent with the wide variation of ground water inflow data noted during the excavation of the test pits completed as part of the pre-design investigations.

The horizontal hydraulic conductivity tests completed by Golder Associates were analyzed using Hvorslev's method and were up to two orders of magnitude less than those calculated by URS using the Bouwer Rice Method. The geometric mean of the horizontal hydraulic conductivity values for wells screened in the fill material and weathered clay were 1.5 x 10^{-5} cm/sec (Golder Associates) to 1.3 x 10^{-3} cm/sec (URS).

The yield to the collection trench was calculated using an equation developed for water table flow from a line source (Powers, 1981). This equation which is derived from Darcy's Law assumes that there will be a continuous source of ground water to the system. However, as previously mentioned infiltration of water to the capped area will be greatly reduced, therefore the yield to the collection trench will decrease with time.

During early transient time, the collection trench will initially receive water from the area adjacent to the collection trench. A steep hydraulic gradient will be induced and greater yields can be expected to the collection trench than during late transient time. The quantity of ground water flowing to the collection trench, assuming that water is being contributed from an area 50 ft perpendicular to the collection trench, was calculated to range between 0.43 gpm to 37 gpm with an average of 18 gpm. The range of the yields is due to the range of hydraulic conductivities values previously mentioned. Areas of high hydraulic conductivity will readily yield ground water to the collection trench. Areas of low hydraulic conductivity will produce low flow rates. Based on the heterogeneities of the fill-weathered clay material observed at the site, it is reasonable to assume that during early transient time the average yield of 18 gpm is most representative of the overall collection trench. It should be recognized that the range could vary. The calculations are included in Appendix F.

Actual yield of the trench will continuously decline from high flow in early transient time to lower flow during late transient time. With time, as the material is dewatered, the hydraulic gradient within the capped area will be reduced and therefore the yield to the collection trench will be continuously reduced. The yield to the collection trench during this time was calculated to range between 0.07 gpm to 5.6 gpm with an average of 2.8 gpm. It is likely that during this period the average concentration is most representative of the actual yield to the collection trench. The calculations are included in Appendix F.

The time necessary to dewater the fill material and weathered clay material varies according to the horizontal hydraulic conductivity of the soil. Using an average hydraulic conductivity from Golder and URS, which is believed to be representative of overall site conditions, a period of 0.8 years will be required to produce a dewatered condition in the fill-weathered clay material.

Late Time (steady state) is the period where the fill material and weathered clay have been dewatered. During this time, the yield to the collection trench will be equal to the infiltration rate of water to the system. Infiltration sources are:

- Infiltration of precipitation through the liner
- Infiltration of ground water through the perimeter of the capped area
- Recharge from the underlying clay layer

Calculations for each of these scenarios are included in Appendix F.

Infiltration of precipitation through the liner. The United States Environmental Protection Agency (USEPA) Hydrologic Evaluation of Landfill Performance (HELP) Model was used to predict the maximum amount of percolation through the landfill liner. This model assumes that the cover and flexible membrane liner are in place. Temperature and precipitation data for the area stored in the model's database were utilized in the model. Results of the analyses indicate that approximately 24 gallons per day (gpd) could infiltrate the cap under peak precipitation or snow melt events. The results of the computer modelling are presented in Appendix I.

Infiltration of ground water through the perimeter of the capped area. Darcy's law was used to estimate the infiltration rate of ground water through the vertical barrier along the perimeter of the containment area. As a conservative estimate, a permeability of 1×10^{-7} cm/sec was assigned to the vertical barrier. In reality, the permeability of the barrier will be $1\text{x}10^{-12}$ cm/sec, however the $1\text{x}10^{-7}$ cm/sec value was used as this is the minimum permeability of a liner required by the NYSDEC. This value accounts for possible defects to the liner system and provides a conservative estimate for infiltration rate. The results of the analyses indicated that 754 gpd would infiltrate through the vertical barrier. The calculations are included in Appendix F.

Recharge from the underlying clay layer. Ground water recharge from the underlying clay layer will occur during late time. During early and transient times the ground water elevation in the capped area will be greater than the ground water elevation of wells screened in the silty sand and gravel layer. Therefore, ground water from the fill-weathered clay interval would theoretically migrate through the underlying clay confining layer and could recharge the silty sand and gravel layer. The hydraulic head in the fill-weathered clay material will be reduced as a result of dewatering; therefore, an upward hydraulic gradient will be induced allowing water from the clay confining layer to recharge the fill-weathered clay material.

The estimated quantity of water recharging the system from the underlying clay layer was calculated using Darcy's law. The calculations are included in Appendix F. The vertical permeability of the clay confining layer used in the calculation was based on the results of triaxial permeability tests of the clay layer completed during the RI (see Table 3-2 in Appendix F).

The induced hydraulic gradient between the fill-weathered clay layer and silty sand and gravel layer was estimated based on ground water elevation data presented in Table 3-5 of the RI (see Table 3-5 in Appendix F). The ground water elevation of the shallow wells was assigned a value of 567 ft (near the bottom of trench) and the vertical hydraulic gradients were recalculated. An average upward hydraulic gradient of 0.32 ft was calculated (see Appendix F). The quantity of ground water recharging from the underlying clay layer was estimated to be 106 gpd.

In summary, the yield of the recovery trench during the late time was estimated to be approximately 900 gpd.

Conclusion. The results of the hydraulic control evaluation indicate that an inward hydraulic gradient from the perimeter of the capped area will be created by the proposed remedial system and that ground water contained within the capped area will be contained by the collection trench. The elevation of the proposed ground water collection trench is lower than the elevation of ground water outside the containment area (580 ft at URS-14S) and lower than the surface water elevation of Quarry Lake (576 ft).

Infiltration will be reduced by installing the cap at the surface and extending the flexible membrane into the underlying clay confining layer.

In summary, during construction of the collection trench, installation of the cap and initial pumping of the collection trench, ground water in storage will be released. It is not possible to calculate the yield during this period due to the heterogeneities of the fill-weathered clay material and the timing of construction and precipitation. However, since a yield of approximately 124 gpm was observed at one test pit location, it is likely that a cumulative yield greater than 124 gpm could be encountered.

Following the initial release of stored water, the fill and weathered clay material beneath the capped area will begin to dewater. During early transient dewatering time, yields in the range of 10 to 20 gpm are expected. However, as the fill-weathered clay material continues to dewater and the hydraulic gradient is reduced, the yield could be expected to decline to approximately 3 gpm.

When the fill-weathered clay material has been dewatered, the yield to the collection trench will be equal to the amount of infiltration to the capped area. Infiltration of precipitation through the cap was estimated to be 0.016 gpm. Infiltration through the vertical barrier installed along the perimeter of the capped area was estimated to be

0.52 gpm. Ground water recharge to capped area from the underlying clay layer was estimated to be 0.073 gpm. In late time (steady state) the yield to the collection trench is estimated to be 0.625 gpm.

2.4. Separate Phase Liquid Evaluation

2.4.1. Test pits

Test pits were installed in areas identified during the RI to confirm the absence or presence of a separate phase liquid as described in the RD/RA Work Plan. The test pits included TP-9, TP-10, and TP-11 as shown on Figure 1-2. Corresponding test pit logs are included in Appendix G. As noted on the test pit log for TP-10, a sample of thick, black material was collected for laboratory analysis. Field screening of the sample with a PID indicated a reading of 400 to 600 ppm.

In addition, six test pits (TP-3, TP-4, TP-6, TP-9, TP-10 and TP-11), were observed to fill with a green liquid. Based on a review of well logs, the presence of a green liquid was also noted during the RI. A sample of the green liquid was collected from TP-9 and submitted for laboratory analysis.

2.4.2. Laboratory analysis

Summary results of laboratory analyses performed on the sample of thick, black material collected from TP-10 are summarized in Tables B-9 through B-11 of Appendix B. Analytical data are included in Appendix C-2. A copy of the chain of custody form is included in Appendix E. The sample was analyzed for TCL VOCs, TCL SVOCs, and PCBs in accordance with NYSDEC ASP 91-1, 91-2, and 91-3, respectively. Results of the TCL VOC analyses (Table B-9) indicated that measured concentrations of toluene, ethylbenzene, and xylene were above the detection limits at concentrations of 240, 15, and 240 ppm, respectively. TCL SVOCs present at concentrations (Table B-10) above the detection limit include naphthalene at 15 ppm, 2-methylnaphthalene at 26 ppm, bis (2-ethylhexyl)phthalate at

42 ppm, and fluoranthene at 5.8 ppm. Phenanthrene, anthracene, pyrene, benzo(a)anthracene, and chrysene were at concentrations below standard detection limits but above the detection limits of the laboratory equipment. Results of the PCB analyses (Table B-11) indicate that PCB-1254 was detected above the detection limit at a concentration of 27 ppm.

Summary results of laboratory analyses performed on the sample of green liquid collected from TP-9 are presented in Tables B-9, B-10, and B-12 of Appendix B. Analytical data are included in Appendix C-2. The sample was analyzed for TCL VOCs, TCL SVOCs, and TCL metals in accordance with NYSDEC ASP 91-1, 91-2, and ASP-Contract Laboratory Procedures (CLP) respectively. Results of the analyses show that TCL VOCs (Table B-9) including 1,2-dichloroethene (total), 1,2-dichloroethane, and 1,1,1-trichloroethane were detected at concentrations of 6.4, 1.8, and 2.2 ppm, respectively. Trichloroethene, tetrachloroethene, and toluene were detected at concentrations of 1.3, 1.6, and 5.7 ppm, respectively. TCL SVOCs (Table B-10) above the detection limit include bis(2-chloroethyl)ether and nitrobenzene at concentrations of 0.96 and 1.7 ppm, respectively. Summary results of analyses for metals are listed in Table B-12 of Appendix B.

To confirm that the green liquid did not contain antifreeze, the sample was analyzed for ethylene glycol with non-detect results. Similarly, a sample was analyzed for hexavalent chromium with non-detect results.

A visual comparison of the green liquid from the site to a synthesized solution of fluorescein dye was made under a black light. Based on the visual observation, and anecdotal reports of past activities at the site, the green liquid is presumed to be fluorescein dye.

Qualitative tests were performed by O'Brien & Gere Engineers to assess potential methods of color removal. Based on results of the testing, it appears that color removal could be accomplished by carbon absorption or oxidation if color becomes a constraint for discharge to the local POTW.

Conclusion. A separate phase liquid was not observed during pre-design investigations. Measures will be implemented to collect dense non-aqueous phase liquid (DNAPL), if encountered. Any collected DNAPL will be treated off-site at a permitted facility.

2.5. Quarry Lake Sediment Removal Evaluation

In accordance with the RD/RA Work Plan, the remedial action for the Frontier Chemical-Pendleton Site includes the removal of sediments from the western portion of Quarry Lake adjacent to the former Process Area, and other areas of Quarry Lake where concentrations of cadmium or chromium exceed the greater of NYSDEC guidance values or established site-specific background levels. Subtasks associated with evaluating the quantity of sediment to be removed include evaluating cadmium and chromium concentrations in undisturbed background soils and the extent of cadmium, chromium, and total organic carbon (TOC) in the sediments. The sediment samples were also tested to evaluate the requirements to provide a stabilized material that would be free of liquid and provide structural stability for the cap.

2.5.1. Background sampling of cadmium and chromium

Sampling was performed to define background concentrations of cadmium and chromium in subsurface soil samples. The background concentration, as defined in the ROD, is a site-specific value or a concentration as stated in the NYSDEC Technical Guidance and Administrative Guidance Memorandum (TAGM) 4046 on Determination of Soil Cleanup Objectives and Cleanup Levels, whichever is greater. The site-specific value is determined from the analytical results for cadmium and chromium from a minimum of twelve samples collected in undisturbed soils near the site.

Soil borings and sample collection. Two subsurface soil samples from each of seven locations (SB-1 through SB-6 and SB-7B) outside of the influence of Quarry Lake and on-site activities, as shown on Figure 1-2, were collected by O'Brien & Gere Engineers between June 9 and June 13, 1994 in accordance with the approved RD/RA Work Plan. Samples of the clay/silt layer were collected with split-barrel samplers at depths of 6- and 12-feet below grade. Collected samples were properly packaged, documented on chain of custody forms and submitted to O'Brien & Gere Laboratories, Inc. for analysis. Copies of the soil boring logs are included in Appendix J. Chain of custody forms are included in Appendix E.

Background soils analysis. Fourteen subsurface soil samples were collected and analyzed for cadmium and chromium in accordance with 200.7 CLP-M and for TCL VOCs in accordance with NYSDEC ASP 91-1. The detection limit for cadmium in the background subsurface soil samples was 0.1 mg/kg wet weight in accordance with the Contract Required Detection Limit provided for in the NYSDEC ASP protocol. The analytical results for cadmium and chromium were transmitted to H2M Labs, Inc. of Melville, New York for data validation in accordance with EPA CLP program protocols and the approved RD/RA Work Plan. The results of the data validation indicated that there were no major deviations from the protocol and the data may be considered usable. The data validation report is included in Appendix K.

The validated analytical results indicated no detectable concentrations of cadmium in the background subsurface soil samples. Concentrations of total chromium ranging from 18 ppm to 34.8 ppm were measured in the background subsurface soil samples. The validated analytical results are presented in Table B-13 of Appendix B. Minimal concentrations of VOCs were detected in the background soil samples, as shown in Table B-14 of Appendix B.

Statistical determination of background. Background concentrations were established by collecting and analyzing two samples from each of seven reference locations outside of the influence of the abandoned quarry. Each sample was analyzed for TCL VOCs to assess the suitability of the sample to be included in the background calculation. Any samples indicating the presence of VOCs were to be eliminated from the background calculation. As shown in Table B-14 of Appendix B, minimal concentrations of VOCs were detected in background samples, predominately attributable to blank contamination. Based upon this information, no background samples were excluded in calculating background concentrations of cadmium and chromium.

Cadmium concentrations were below detection limits in all background samples. Background concentrations of cadmium were therefore based upon NYSDEC TAGM Determination of Soil

Cleanup Objectives and Cleanup levels of 1 ppm. The mean chromium concentration is 27.3 ppm and the standard deviation is 5.4. In accordance with the approved RD/RA Work Plan, the site-specific background level of chromium was calculated as the mean plus two standard deviations. The site-specific background concentration of 38 ppm was greater than the NYSDEC TAGM value of 10 ppm. Therefore, the background concentration of chromium for the site is 38 ppm. Site-specific background calculations are included in Appendix L.

A test for "outliers" was conducted based on the statistical approach presented in the 1989 USEPA Guidance Document "Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities". The test determines whether any of the sample results fall outside of the 95 percent upper confidence interval. No outliers were identified, therefore, no samples were excluded in calculating background concentrations of chromium. Outlier calculations are also included in Appendix L.

2.5.2. Sediment profile and characterization

A hydrographic survey of Quarry Lake was conducted by O'Brien & Gere Engineers at the Pendleton Site between June 7, 1994 and June 10, 1994 to develop a bottom profile of the sediments in the abandoned quarry. The hydrographic survey was based on a 100-foot by 100-foot grid tied into the existing site survey control. Soundings were conducted at each sample node location, as shown on Figure 1-3. Sampling activities included field measurements of water depth and sediment thickness at each location, and sediment sample collection at the 52 nodes specified in the RD/RA Work Plan.

Water and sediment depth measurements were taken and sediment samples were collected from the bottom of Quarry Lake from a boat at the respective node points, as shown on Figure 1-3. Depth profiling was performed by lowering a clear rigid Lexan® tube into the water until resistance was encountered, indicating the top of sediment. This measurement is the measured depth of water at the node point. The Lexan® tube was then pushed through the sediment until the underlying clay was encountered, determined by greater resistance. The Lexan® tube was then withdrawn and the sediment thickness was visually observed and measured and sediment sample collected. This approach provided a reasonable definition of sediment thickness and distinction between the sediment and underlying clay layer. The thickness of the sediment layer was also confirmed by visual examination of the samples.

Water depth and sediment thickness measurements were taken at sixty-four locations in the abandoned quarry, as shown on Figure 1-3 and summarized on Table B-15 of Appendix B. A maximum water depth of 20.3 ft was measured at node 43. The average water depth was calculated to be 9.3 ft. A maximum sediment depth of 1.8 ft was measured at node 7. The average sediment depth was calculated to be 0.4 ft. Sediment samples were collected at fifty-two designated sampling locations (nodes 1 through 35, 39 through 42, 46 through 51, and 55 through 61) and transmitted to O'Brien & Gere Laboratories for chromium and cadmium analysis in accordance with 200.7 CLP-M and TOC in accordance with the Walkley Black method. Analytical results are summarized in Tables B-16 (cadmium and chromium) and B-17 (TOC) of Appendix B. Analytical data is included in Appendix C-4. Copies of chain of custody forms are included in Appendix E.

Concentrations of cadmium ranged from 0.39 ppm to 127 ppm, with the maximum concentration detected at node 35. Detected concentrations of total chromium ranged from 26.7 ppm to 1790 ppm, with the maximum concentration detected at node 30. TOC concentrations ranged from 4030 mg/kg to 20,100 mg/kg.

Conclusion. Results of the Quarry Lake sediment analyses indicated that 48 of the 52 sampling locations exhibited levels of cadmium or chromium above the TAGM limit of 1 ppm and/or background level of 38 ppm. Therefore, it appears that sediments above the cleanup levels extend over the majority of the Quarry Lake bottom.

2.5.3. Treatability testing

The term solidification/stabilization (S/S) describes a category of waste treatment technologies that are increasingly being considered for remediation. Solidification refers to the process of converting a liquid or semisolid into a solid waste form by the addition of a binding agent such as cement, to reduce contaminant mobility and improve a waste's handling and disposal characteristics. Stabilization refers to the chemical modification or complexing of contaminants to render them less toxic (sometimes referred to as "fixation").

Physical encapsulation, as opposed to chemical fixation, is the dominant S/S mechanism for organics such as oil and grease and PCBs.. Metals fixation can occur due to the pH-dependent solubility of most metal cations (e.g. cadmium), especially when reacted with alkaline additive systems, such as Portland Type I cement reagent. Gel type hydration reaction products will form insoluble metal hydroxides and oxides. S/S processes can form hardened monolithic materials which are somewhat impervious to water, thus reducing the possible transport of contaminants out of a waste to the ground water.

Treatability testing of Quarry Lake sediments, surface soils, and previously dredged materials was conducted to identify remedial options to consolidate and stabilize those materials under the area to be capped, minimize estimated remedial action cost, and optimize the process of consolidating and stabilizing dredged sediments exceeding cadmium and chromium criteria under the area to be capped. Bench scale treatability studies involving the solidification/ stabilization of Quarry Lake sediments, surface soils, previously dredged materials and "commercial" agents were conducted to: form a homogeneous chemically stabilized mixture; have no free liquids as determined by the Paint Filter Liquids Test (EPA SW 846 Method 9095); have a minimum unconfined compressive strength and structural stability to support the proposed cap overburden; and have physical characteristics to allow easy handling for replacement on site. In addition, mixtures of Quarry Lake sediments were tested for leachate characteristics relative to land disposal restrictions. The testing program emphasized treat-in-place batch treatment systems, (as opposed to ex-situ pugmill batch plant mixing) or area-layering approaches (considering the depth of contamination found at the site and the more achievable level of quality control involving effective shallow-soil/sediment treatment).

Materials for treatability testing. Quarry Lake sediment samples were collected from ten randomly selected sampling locations (nodes 2, 7 (7A and 7B), 11, 20, 25, 29, 30, 39, and 49) as specified in the RD/RA Work Plan. Five samples each of surface soils and previously dredged materials that will be consolidated under the cap were collected at random locations, along with one sample from an on-site waste pile reported to consist of lime.

The testing laboratory (OBG Laboratories, Inc.) provided several dry commercial S/S agents (ordinary portland cement and two kiln dusts) determined, in advance, to be readily available and in sufficient supply to proceed with field application of the successful formula(s) at the site. These powdery binders had gradation specifications of greater than 90% passing the #200 sieve, and the chemistry of each is well-known. Table M-1 of Appendix M identifies materials tested under the treatability program.

Geotechnical testing for treatability. The as-sampled site materials were evaluated and characterized for various physical properties prior to waste-to-waste blending or proportioning, and subsequent bench solidification mixing steps. These parameters included:

- Unit weight density
- Moisture/solids content
- Specific gravity
- Particle size distribution

Table M-2 of Appendix M presents geotechnical test results for the various waste media. Separate particle size curves for the three waste media "grand composites" (sediment, previously dredged material and surface soil) are presented in Appendix M.

Proportioning determination. Waste proportioning ratios were evaluated prior to bench solidification of the waste media with various commercial reagent systems. The final proportioning scheme was developed after completion of pre-design site investigations, resulting in calculation of the estimated volumes of the different wastes. Table M-3 of Appendix M presents the waste proportioning combinations used to develop the mixtures. Table M-4 of Appendix M provides the material characteristics for the six waste blending or proportioning conditions. Based on visual observation and qualitative evaluation of the six mixtures, four combinations were selected for blending with three commercial agents at up to three dosage levels (36 mixes total). Table M-5 of Appendix M shows the evaluation criteria that were used in the waste proportioning selection process. Subsequently, a fifth condition (dewatered sediment alone, without commingling with other site waste media) was judged to be more representative of potential remedial actions than the other possible combinations of site materials. This final condition was the prevalent waste treatment concern thereafter, with the majority of the S/S mixes performed on this waste only (identified as "Mixture #5"). Mixture #2 (aqueous, non-dewatered sediment only) was eliminated from further consideration due to its high moisture content and low stability. Table M-6 of Appendix M presents the preliminary performance test results from the various S/S formulations applied to the four initial waste proportioning blends (Mixtures #1, #3, #4, and #6). Table M-6 of Appendix M also presents data on the supplemental S/S formulations developed for the preferred dewatered sediment condition (Mixture #5), as selected later in the testing program.

Stability/Toxicity Characteristic Leaching Procedure (TCLP) testing. Results of penetration resistance testing (time of initial set), mixture workability, and relative treatment processing cost were used to screen the preferred mixes from the preliminary sample matrix. From the six preliminary treated Mixture #5 compositions, three mixtures (2 containing cement, and 1 containing cement kiln dust (CKD) were selected to undergo further stability testing, including moisture density relationships, strength, and leaching characteristics. Table M-7 of Appendix M presents the available data on dewatered compositions involving Mixture #5 (pre-conditioned sediment-only materials).

Three final mixture conditions were selected for TCLP evaluation specifically those formulations having optimum dry density values and relatively high 7-day unconfined compressive strength results. Other considerations involved the selection of successful mixtures containing practical dosage levels (less than 20% added) of S/S agents, to assure that the waste was adequately treated, but not overly treated, while maintaining appropriate chemical and physical stability for on-site placement under the cap.

The final selected mix designs were two low-dose (5% & 10% added) portland cement mixes (Mix A-5 and A-10, respectively) and one medium-to-low range (20% added) CKD mixture utilizing Bessemer CKD (Mix BB-20). These three S/S treatment formulations are conditionally recommended for the affected sediments, as provided in this bench investigation. Results of TCLP testing are presented in Appendix M and indicate that none of the parameters were detected above the detection limit, with the exception of the detection of methyl ethyl ketone in sample HSS-BB20 at a concentration of 0.013 ppm. The regulatory limit for methyl ethyl ketone is 200 ppm.

An in-place dewatering approach was simulated by Mixture #5. That process involves a preliminary sediment conditioning (drying) step using a low-dose alkaline agent (i.e., quicklime). Thereafter, a final S/S binder can be added to further treat (fix) the pre-conditioned waste. The net effect of this two step system is to reduce moisture for more complete solidification and effect significant impacts in volume reduction or dewatering in this case.

Unconfined compression testing. Unconfined compression testing was performed on Mixture #5 in accordance with American Society for Testing and Materials (ASTM) D2166 Standard Test Method for Unconfined Compressive Strength of Cohesive Soil. Prior to testing, the sample was compacted in accordance with ASTM D698 Standard Test Methods For Moisture - Density Relations of Soils and soil Aggregate Mixtures using 5.5-lb Rammer and 12-inch mold. At a moisture content of 27%, the tested mixture had an unconfined compressive strength of 64 pounds per square inch (psi).

Conclusion. The bench scale studies demonstrated that the tested materials can be readily treated to have adequate strength to support the overlying materials and cap system while still having a minimal volume increase.

2.6. Additional Subsurface Investigations

Additional subsurface investigations were conducted and consisted of the excavation of additional test pits. Test pits TP-12 through TP-14 were installed northeast of the former Process Area as shown on Figure 1-2. The test pits were installed to evaluate the composition and distribution of fill. Corresponding test pit logs are included in Appendix G.

Test pits TP-15 through TP-18 were also installed in the vicinity of the peninsula located on the eastern side of Quarry Lake, as shown on Figure 1-2. The test pits were installed to evaluate the composition of the peninsula. Corresponding test pits logs are included in Appendix G and indicate the presence of fill, waste, and debris to depths up to 12 and 13 feet. Samples were collected from the test pits and submitted for laboratory analysis of cadmium and chromium in accordance with 200.7 CLP-M. Results of the analyses are summarized in Table B-18. Analytical data is included in Appendix C-5.

Conclusion. Based on observations made during field activities and laboratory analyses of collected samples, fill materials extend northeast of the former Process Area and the peninsula is partially constructed of fill. As discussed in Section 4.1.1 it is proposed to extend the cap system and excavate the peninsula to the extent shown on Sheet G-4 and place the excavated materials under the cap.

2.7. Borrow Source Identification and Evaluation

A review of required cap construction materials was conducted to verify the quantity and quality of locally available sources of construction materials. The proposed capping system incorporates, from the surface of the waste up, the following components: 60 mil HDPE FMC, 18 inches of soil barrier protection layer, and 6 inches of topsoil.

To evaluate the local availability of soil barrier protection layer and topsoil materials for use in construction of the cover system, a literature search of available information on soil materials, and a telephone survey of potential borrow sources within a thirty mile radius of the site were conducted. A summary of the borrow source investigation is presented in Table B-19.

Conclusion. Based on correspondence with local suppliers, it appears that materials for construction of the soil barrier protection and topsoil layers of the cover are available locally.

2.8. Liner Compatibility

The requirement for liner compatibility testing presented in the RD/RA Work Plan was discussed with NYSDEC. Based on correspondence with NYSDEC, it was concluded that liner compatibility would be adequately determined through vendor information and literature review. A copy of the correspondence is included in Appendix N.

Consequently, the compatibility of synthetic lining material to be used in the cap and in the ground water collection trench was evaluated through vendor information and literature review.

Potential geosynthetic materials include 60 mil high-density polyethylene (HDPE) geomembrane to be used in the cap and 80 mil HDPE vertical barrier to be used in the ground water collection trench. Two manufacturers of HDPE materials were contacted: Gundle Lining Systems (Gundle), and Poly-Flex, Inc. (Poly-Flex). The manufacturers were provided with general specifications for required liner materials and on-site ground water chemistry data.

Copies of correspondence received from the manufacturers are included in Appendix N.

Conclusion. Based on vendor information and literature review, the concentrations of contaminants encountered at the site are not anticipated to be a concern regarding compatibility with proposed geosynthetic materials.

3. Design Criteria and Permit Requirements

The remedial design is based on a review of Applicable or Relevant and Appropriate Requirements (ARARs). The following sections discuss the ARARs and permit requirements for the remedial design and remedial action at the Frontier Chemical -Pendleton Site.

3.1. Compliance with ARARs

ARARs considered for the site were discussed in Section 6 of the RI (URS, 1991). Those ARARs, including New York State Standards, Criteria, and Guidance (SCGs) are summarized on Table B-20 of Appendix B, along with a notation specifying whether the requirements are "Applicable" (required by applicable regulations), "Relevant and Appropriate" (covered by guidance but not enforceable as regulations), "To Be Considered" (TBC, neither regulatory requirement or relevant guidance), or SCGs. In addition, Table B-20 of Appendix B specifies whether each ARAR is considered chemical-specific, action-specific, or location-specific.

Chemical-specific requirements. This class of requirements includes drinking water, ground water, and surface water standards, soil and sediment cleanup standards or risk-based values, and treatment standards for hazardous wastes.

Currently, ground water in the vicinity of the former Process Area contains contaminants at concentrations exceeding identified drinking water and ground water standards, although that ground water is not currently used as a drinking water supply. The proposed remedy will maintain the quality of ground water outside of the former Process Area by containing contaminants and through hydraulic controls to develop an inward hydraulic gradient and minimize contaminant migration.

Analyses of surface water from Quarry Lake show it to be relatively free from contamination. During the remedial action, it is proposed to drain Quarry Lake to access the underlying sediments. When Quarry Lake refills, it is anticipated to achieve Class C water quality standards. Prior reports (URS, 1991, 1992) have concluded that Bull Creek (a Class C stream) showed no effects attributable to the Frontier Chemical-Pendleton Site.

Consolidation of the Quarry Lake sediments and surface soils will be followed by verification sampling to demonstrate compliance with the appropriate soil and sediment cleanup standards.

Testing conducted during the RI showed that the materials at the Frontier Chemical-Pendleton Site did not exhibit the characteristics of hazardous waste in effect at the time.

Action-specific requirements. These requirements define the regulatory framework within which the remedial action may be executed. Defined requirements include air quality standards, surface water discharge standards, hazardous waste disposal restrictions, and health and safety laws.

The proposed remedial action does not include technologies which produce a discharge of contaminants to the air. The specifications for the remedial action will include dust and erosion control requirements to control fugitive emissions during the soil and sediment excavation, handling, and consolidation activities.

The proposed remedy does not include direct discharges to surface water or ground water. It is proposed to direct discharges to the local POTW, in accordance with the standards of the sewer district and its current State Pollution Discharge Elimination System (SPDES) permit.

Quarry Lake sediments are to be excavated and consolidated in the former Process Area, which is considered within the Area of Contamination for the site; therefore hazardous waste manifesting and disposal requirements do not apply. Quarry Lake sediments will be tested by TCLP to verify compliance with treatment standards associated with Land Disposal Restrictions.

Other materials, such as asbestos, may require off site disposal. All such materials will be handled in accordance with applicable rules and regulations.

As discussed in Section 4 of this report, all remedial action activities will be conducted in accordance with a site-specific Health and Safety Plan to be prepared and implemented by the selected Remedial Action Contractor.

Location-specific requirements. The presence of regulated wetlands on a portion of the site and its location within the 100-year flood plain of Bull Creek triggers location-specific requirements.

Disturbance to delineated wetlands will be required to implement the remedy specified in the ROD. A joint ACOE and NYSDEC permit will be prepared to allow removal of the contaminated sediments and construction of the containment area and related structures in the vicinity of the wetlands as discussed in Section 3.2.3.

The 100-year flood plain for the site occurs at approximately elevation 580. The proposed capping system will include berms to protect it from possible impacts associated with the 100-year flood. Construction of the specified remedy will involve no net loss of storage volume within the 100-year flood plain.

Conclusion. In summary, the proposed remedial action complies with the ARARs, SCGs, and TBCs identified in the RI report for the site.

3.2. Permit Requirements

Permits or related requirements which may be applicable to the implementation of the Frontier Chemical - Pendleton Site remedial design include local, state, and federal permits. Federal permits will be required for remediation of the site. Although state permits are not required, the substantive requirements of state permits will be followed. Approvals will be required from the state as provided in the Consent Order. The following sections summarize the permit applications that are anticipated to be required for this project.

3.2.1. Local permits

Local permits which may be required to implement this remedial action include a local discharge permit, local building permit, and local erosion and sediment control plan. A permit will be required for discharging ground water from the ground water collection system to the nearest sewer, Manhole No. 16, for treatment at the local POTW as shown on Figure 1-2. The site lies within the area discharging to the Niagara County Sewer District No. 1. The application to the local POTW will include the draft effluent standards.

A local building permit application will be submitted for construction of the pump station and other applicable structures. The permit application will include plans and specifications for the pump station and other applicable structures.

A County Erosion and Sediment Control Plan will be prepared and submitted. The plan will address earthwork activities associated with the implementation of the project including:

- Containment berm construction
- Perimeter berm and outlet reconstruction
- Quarry Lake sediment stabilization and removal
- Ground water collection system installation
- Surface soil movement
- Wetlands reconstruction
- Cap construction

The condition of local roads to be used by the Remedial Action Contractor will be reviewed with local officials before and after implementation of the remedial action.

3.2.2. State permits

The excavation of sediments from Quarry Lake and construction adjacent to the designated wetlands are activities that would normally require state permits. As previously discussed, although state permits are not required, the substantive requirements of state permits will be followed and approvals will be required from the state as provided in the Consent Order. The excavation of sediments from Quarry Lake will be subject to the requirements of 6 NYCRR 500 -

Floodplain Management Regulations Development Permits. Construction in the vicinity of wetlands will be subject to the requirements of 6 NYCRR 662 Freshwater Wetlands Interim Permits and 663 - Freshwater Wetland Permit Requirements. Appropriate data will be provided to NYSDEC to document that implementation of the remedial action will be performed in accordance with the requirements of a permitted activity.

The Remedial Action Contractor will be required to prepare a Storm Water Pollution Prevention Plan (SWPPP) consistent with the application requirements set forth in the NYSDEC SPDES General Permit for Storm Water Discharges Activities that are classified as "Associated with Construction Activity", as discussed in Section 4.4. Contract Documents will also require that the contractor develop a Dust Control Program consistent with the requirements of OSHA 29 CFR 1910.1000 and NYSDEC TAGM No. 4031 titled, "Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites".

A technical specification relative to construction water management is included in the Contract Documents. Should the contractor elect to perform on-site treatment of construction water, he will be required to meet the substantive requirements of a SPDES permit for the discharge of treated construction water.

3.2.3. Federal permits

Federal permits which will be required for remedial activities at the Frontier Chemical - Pendleton Site include permits for dredging and filling and wetlands encroachment. The ACOE regulates dredging and filling operations and operations within and adjacent to designated wetlands (Section 404). As discussed in the RD/RA Work Plan, the ACOE and NYSDEC have a joint application procedure for dredge and fill and wetland permits. It is assumed that a joint application will be acceptable to both agencies.

The joint ACOE and NYSDEC permit application will be prepared to allow removal of the contaminated sediments and construction of the containment area and related structures in the vicinity of the wetlands. The dredge and fill permit application will address removal of the contaminated sediments and placement of the stabilized materials within regulated wetland boundaries. The wetlands permit will address protection of the wetlands during implementation of the remedial action and design of the reconstructed wetlands.

Permit applications will be developed during the final design phase in conjunction with the contract drawings and specifications developed as part of the final design package. The permit applications will be submitted as part of the Final Design.

3.3. Access agreements

The Group is currently attempting to obtain access agreements to the site. The construction of the remedial action will also require access agreements to cross the brine line and railroad right-of-way in order to obtain access to Manhole No. 16.

4. Remedial Design

In accordance with the approved RD/RA Work Plan, the remedial design is to consist of:

- Provision of site controls (erosion and sediment and inadvertent access controls) for the construction period.
- Consolidation of the soils and previously dredged materials into a limited area within the former Process Area.
- Removal and placement of contaminated sediments from Quarry Lake.
- Placement of a MSG capping system.
- A vertical barrier consisting of keying the FML of the cap into the underlying clay/silty clay layer.
- Reconstruction of the embankment and outlet from Quarry Lake.
- Installation of a ground water recovery trench beneath the capping system, to provide an inward gradient at the perimeter of the capping area.
- Installation of a monitoring system around the site boundary to confirm an inward hydraulic gradient under the cap.
- Provide monitoring of the ground water and surficial conditions at the site.

This section of the Report presents the basis of design for these remedial components.

4.1. Material Consolidation

Remediation at the Frontier Chemical - Pendleton Site will involve the removal of contaminated sediments from Quarry Lake and consolidation of potentially impacted soils and previously dredged materials into a limited area within the former Process Area. The following sections discuss proposed activities with respect to consolidation of the previously dredged sediments, surface soils, and Quarry Lake sediments.

4.1.1. On-site soils and previously dredged materials

Surface soils and previously dredged materials will be consolidated within the area shown on Figure 4-1 and capped with a low-permeability capping system. It should be noted that this area is larger than the 3.8 acre area initially proposed in the RD/RA Work Plan. The areal extent of the proposed cap has been increased to minimize the amount of excavation of potentially impacted soils and previously dredged material. The limits of the cap may be further extended to the south/southwest based on conditions encountered during construction.

The soils and previously dredged materials will be relocated and graded to the limits of the capping system shown on Sheet G-4 using conventional construction equipment. Surface soils to be consolidated which are located outside the proposed limits of the capping system will initially be removed to a depth of approximately three feet. Surface soil relocation activities will be performed in accordance with the Erosion and Sediment Control Plan (Section 4.4) to minimize the potential for airborne or waterborne transport from the site.

Based on estimates performed using the Integrated Design Earthwork Systems (IDES), approximately 8,700 cubic yards of surface soils will require excavation and relocation to areas within the proposed limits of the capping system. Surface soils and previously dredged materials within the limits of the capping system will be graded and compacted as necessary to meet the proposed final grades. The volume of soils to be removed from the peninsula along the eastern shore of Quarry Lake is estimated to be approximately 5,800 cubic yards. Calculations associated with these estimates are included in Appendix O.

4.1.2. Verification sampling for on-site soils

Areas from which surface soils are removed will be sampled to verify that soils have been removed to the cleanup levels established in Section 2.5.1. Initial screening of the areas from which the surface soils have been removed will include a walkover with visual and olfactory observations in addition to grab samples taken for HNu headspace screening at locations determined by field inspection. Areas observed to exhibit grossly stained soils, noticeable odor, or buried objects related to the former Process Area will be identified for additional removal.

Headspace samples will be allowed to stabilize to room temperature in closed jars for a minimum of 30 minutes, as stated in the approved RD/RA Work Plan. Following stabilization, the jar lid will be removed and the probe of an HNu, 10.2 electron volt lamp calibrated with isobutylene at 98.2 ppm will be inserted into the air space above the sample. Readings above 25 ppm will require a field determination, in consultation between the PRPs and the NYSDEC, of potential impact or a decision that the soils in the area of the sample are to be removed.

Following the site walkover and soil removal identified, conducted as a result of screening by the HNu, and visual and olfactory screening, verification sampling will be conducted. The verification sampling will consist of collecting samples from five locations located outside of the proposed limits of the cap as shown on Figure 4-1 or as otherwise modified in the field in consultation with NYSDEC. Samples will be collected for analysis of TCL VOCs in accordance with ASP 91-1 and cadmium and chromium in accordance with 200.7 CLP-M.

The verification samples will be shipped to an analytical laboratory for analysis. If the laboratory analyses indicate that the samples meet the cleanup criteria, the excavated area will be backfilled with clean off-site soils as required to achieve appropriate grades. The cleanup criteria are as follows:

Parameter	Criteria	Basis
Chromium	38 mg/kg	Background
Cadmium	1 mg/kg	TAGM 4046
VOCs (total)	10 mg/kg	TAGM 4046

Soil concentrations in excess of the criteria will require a field determination, in consultation between the PRPs and NYSDEC, of the most appropriate action. The most appropriate actions may include, but are not necessarily limited to:

- placement of soils under the capping system
- extending the capping system
- containment in place or
- containment in place with ground water monitoring.

Selection of the most appropriate action will be dependent on the depth and volume of soils with concentrations in excess of the established criteria and the presence of ground water.

If removal of additional soils is required, additional samples will be collected and analyzed to verify attainment of the cleanup criteria.

4.1.3. Excavation and stabilization of Quarry Lake sediments

Results of the Quarry Lake sediment analyses indicate that 48 of the 52 sediment sampling locations exhibited concentrations of cadmium above the TAGM level of 1 ppm or chromium concentrations above the background level of 38 ppm. Therefore, it is proposed that Quarry Lake sediments be excavated within the limits of Quarry Lake as shown on Figure 4-1.

It is anticipated that Quarry Lake will be dewatered to allow for in-place stabilization of the sediments. Water will likely be conveyed to the District POTW for treatment. Sediments will be stabilized to remove free liquids and to provide strength to support the cap. Following stabilization, the sediments will be placed with surface soils and previously dredged materials within the limits of the final cover.

Based on sediment thickness measurements during pre-design activities, it is estimated that approximately 8,500 cubic yards of sediments will be removed from Quarry Lake. This volume is based on an average sediment depth of 0.4 feet. Calculations associated with these estimates are included in Appendix O. Small volumes of soils underlying the sediments will likely be removed along with the sediments during construction activities due to the relatively thin layer of sediments to be removed. Therefore, an allowance was made for removal of an additional 50% of the volume of sediments to be removed from Quarry Lake. An additional allowance of 20% has been included in the volumes to account for the addition of stabilizing agents.

4.1.4. Verification sampling for Quarry Lake sediments

Following removal of sediments from Quarry Lake, verification sampling will be performed at ten randomly selected grid locations based on the grid shown on Figure 1-3. The sampling will be performed to evaluate whether soils remaining are below cleanup levels.

Verification samples will be collected for analysis of cadmium and chromium in accordance with 200.7 CLP-M and shipped or transported to an analytical laboratory for analysis. If results of the analyses indicate that levels of chromium and cadmium are above the background level of 38 ppm or TAGM level of 1 ppm, respectively, an additional three to six inches of soils will be removed in the vicinity of the sample exceeding the clean up criteria, and additional verification samples will be obtained and submitted for analysis. This procedure will be repeated until soils with concentrations above background or TAGM levels are removed.

Conclusion. Surface soils and the peninsula along the eastern shore of Quarry Lake will be removed to the limits shown on Figure 4-1. Verification sampling will be performed at the locations shown outside of the proposed limits of cap (Figure 4-1). Verification samples will be analyzed for VOCs, cadmium and chromium. Analytical results will be evaluated with respect to cleanup criteria of 1 ppm, 38 ppm and 10 ppm for cadmium, chromium, and total VOCs, respectively. Sediments will be removed from Quarry Lake to the extent shown on Figure 4-1. Verification samples will be collected at 10 randomly selected locations. Samples will be collected for analysis of cadmium and chromium. Results of the analyses will be evaluated with respect to the corresponding cleanup criteria.

4.2. Capping System

The RD/RA Work Plan recommended that a low-permeability landfill cap be installed over the waste materials. The cap system was proposed to consist of the following from the bottom up:

- FML or geosynthetic clay liner keyed into the underlying clay;
- 6 inches of sand;
- A geotextile fabric;
- 12 inches of unclassified soil; and
- 6 inches of topsoil.

The RD/RA Work Plan indicated that the capping system will provide a vertical barrier by keying the FML or geosynthetic clay liner (maximum permeability 5 x 10^{-9} cm/sec) into the underlying clay, minimize recharge to the shallow ground water system in the former Process Area, and direct the discharge that has not been in contact with existing site materials from the capping system to the surrounding wetlands.

The results of this capping system will be the: (1) minimization of radial shallow ground water drainage from the former Process Area; (2) minimization of infiltration into and through the former Process Area soils above the shallow ground water surface; (3) minimization of the potential for the shallow ground water in the former Process Area to rise to the ground surface, as postulated in the risk assessment; and (4) provision of a system to maintain flow to the surrounding wetlands.

The cap proposed as part of the Final Remedial Design consists of the following from the bottom up:

- 60 mil (HDPE) geomembrane flexible membrane cover (FMC);
- 18-inch soil barrier protection layer, and
- 6-inch vegetated topsoil layer.

The following sections discuss the design of the components of the proposed cap system and its equivalency to the cap system recommended in the RD/RA Work Plan.

4.2.1. Flexible membrane cover

The FMC will consist of a 60 mil HDPE geomembrane with a maximum water vapor transmission rate of 0.03 grams/meter ^{2}-day. HDPE was selected for the FMC due to its favorable degree of chemical resistance. The FMC will be anchored into the underlying clay/silty clay at a minimum key-in depth of one foot. This will act as a vertical barrier between the sediments and soil placed under the final cap and adjacent soils, and will minimize the migration of ground water out of or into the capped area.

4.2.2. Soil Barrier protection layer

An 18-inch thick soil barrier protection layer will be installed on top of the flexible membrane cover. The soil barrier protection layer will serve to protect the flexible membrane cover from external forces such as frost action and root penetration.

4.2.3. Vegetated topsoil layer

Six inches of topsoil will be placed above the soil barrier protection layer. Fertilizer will be provided as necessary. The topsoil, along with areas disturbed during construction, will be seeded in accordance with the RD/RA Work Plan as reviewed by O'Brien & Gere Engineers.

4.2.4. Gas venting layer evaluation

In accordance with the RD/RA Work Plan, TOC analyses were performed on sediment samples from Quarry Lake. Results of the analyses are summarized in Table B-17. Based on a review of available literature, no direct relationship between TOC and potential production of landfill gas was found. The production of landfill gas is primarily associated with the decay of organic waste typical of municipal landfills. Since the waste material at the Frontier Chemical - Pendleton site will consist of soils and stabilized sediments, the generation of landfill gas is not anticipated. Therefore, a gas venting layer is not included in the cap design.

4.2.5. Hydrologic evaluation of landfill performance model

The HELP Model was used to predict the maximum percolation through the fill layer. This analysis, included as Appendix I, assumes that the entire cover is in place. Results of the analysis indicate that the peak amount of percolation through the fill layer will be approximately 24 gpd. The HELP Model was also used to predict the maximum percolation through the fill area using the RD/RA Work Plan cap configuration. Results of the analysis are included in Appendix I. The HELP Model results for this cap configuration also indicated that 24 gpd would infiltrate through the fill layer and therefore demonstrates equivalency between the cap as designed and that presented in the RD/RA Work Plan. It should be noted that 6 NYCRR Part 360 regulations do not require a drainage layer as part of a cap system.

The volume of water estimated to percolate through the fill layer is relatively small with respect to the estimated flow of ground water to the ground water collection trench. Therefore, design of the ground water collection system will be governed by the flow of ground water to the trench.

4.2.6. Slope stability

The proposed final grades of the cover system will range between a minimum of 4% (top slope) to a maximum of 15.4% (side slope). The 15.4% slope corresponds to a slope of one vertical to 6.5 horizontal. These grades are within the limits placed on minimum and maximum grades of 4% and 33%, respectively, presented in NYCRR Part 360-2.13(r).

The proposed minimum and maximum grades will be achieved by grading existing piles of previously dredged materials, relocating on-site surface soils located outside the limits of the proposed cap, and placing stabilized sediments from the lake.

Slope stability analyses were performed to assess the ability of the slopes to remain stable when the load from the cover system is applied. The analyses were performed on a slope of 1 vertical on 6.5 horizontal. As shown on Figure 4-2 and discussed in Section 4.3.1, it is proposed to construct a containment berm between Quarry Lake and the proposed capped area. The construction of the containment berm was also considered in the slope stability analyses.

In order to analyze the slope stability, it was necessary to evaluate the results of geotechnical testing performed during pre-design investigations (Section 2.3.2), review existing information regarding previous subsurface investigation activities, and estimate the properties of the in-place foundation soils, the waste, and the soils to be used in the construction of the capping system and containment berm.

For purposes of the stability analyses, the subsurface foundation soils were modeled to represent, from the surface down, the existing layers of weathered clay, clay/silty clay, silty sand, and dolostone. Table B-21 of Appendix B summarizes the geotechnical parameters used for the slope stability analyses. The weathered clay layer was assigned an internal friction angle of 21° based on the results of triaxial testing (sample TP-6 3.3-5.3').

Slope stability analyses were performed by modeling the strength of the clay/silty clay layer under two scenarios to model short and long term loading conditions. Preliminary analyses were performed by modeling the clay/silty clay layer as a soft, cohesive soil with a cohesive strength of 250 pounds per square foot (psf) for short term conditions. The shear strength was estimated based on minimum Standard Penetration Test (SPT) values ranging from the weight of hammer (WH) to 4 blows/foot observed during previous subsurface investigations at the site. Based on information presented in *Soil Mechanics in Engineering Practice* (Terzaghi and Peck, 1948), blow counts in this range correspond to a shear strength of approximately

250 psf. The preliminary analyses indicated estimated factors of safety less than 1 for these conditions. Since the strength parameters of the clay/silty clay layer are critical to the design, *in situ* vane shear tests were performed prior to the final remedial design to obtain additional information for estimating the cohesive strength of the clay/silty clay layer.

The *in situ* vane shear tests were performed during the period of October 8 through 10, 1994. Subsurface drilling and testing services were performed by SJB Services Inc., of Buffalo, New York and were observed by O'Brien & Gere Engineers. A total of 5 boreholes were drilled for testing at the locations shown on Figure 1-2. Vane shear tests were performed at two and three depths within the clay/silty clay layer at boreholes VSB-2 and VSB-3, respectively, to evaluate changes in shear strength with increasing depth. Vane shear tests were performed at depths of low blow counts in the clay/silty clay layer in the remaining three boreholes (VSB-1, VSB-3, BSB-5). Boring logs and a summary of the vane shear test results are included in Appendix P. Based on the vane shear tests performed, the cohesive strength of the clay/silty clay layer ranged from approximately 416 to 1428 psf. An average value of 650 psf was used to model the cohesive strength of the clay/silty clay layer for the stability analyses.

The clay/silty clay layer was also modeled as a soil with an internal friction angle of 23° based on results of triaxial testing performed on sample TP-3 10-12'. The analysis performed with an internal friction angle of 23° may be more representative of long-term conditions, when the clay/silty clay layer has consolidated and excess pore pressures have dissipated. The case where the clay/silty clay layer is modeled as a cohesive soil with a shear strength of 650 psf is more representative of short term conditions including those during construction and the period following construction as the clay/silty clay layer consolidates.

The fill and cap system was modeled as a material with cohesive strength of approximately 1440 psf (10 psi) corresponding to an unconfined compressive strength of 2880 psf (20 psi).

Using the above described structural parameters and the proposed geometry of the steepest slope of the capping system, an analysis of the stability of the capping system was performed utilizing the computer program "Geoslope" developed by Geocomp Corporation. The program calculates a factor of safety for a given set of slope conditions using the Modified Bishop Method. A detailed discussion of this method may be found in the reference by Duncan, 1992.

Analyses were performed to evaluate slope stability for short term loading conditions with critical surfaces passing through the crest of the containment berm, crest of the capped area, and through the toe of the containment berm. The critical surfaces were also evaluated with a uniform load of 1,100 psf across the width of the containment berm to model potential loads due to construction activities. Results of the analyses are summarized on Table B-22 of Appendix B and indicate estimated factors of safety ranging from 1.73 to 2.76. the analysis performed to model long term loading conditions indicated an estimated factor of safety of 2.79. Detailed results of the slope stability analyses are included in Appendix P.

The computed factors of safety were compared to the minimum factor of safety stated in the RD/RA Work Plan of 1.5 and those provided in the USEPA Permit Applicant Guidance Manual for Hazardous Waste Land Treatment, Storage and Disposal Facilities (USEPA, 1984). These criteria are as follows:

Recommended Minimum Values of Factors of Safety for Slope Stability Analyses

	Uncertainty of strength measurements	
Consequences of slope failure	**Small**	**Large**
No imminent danger to human health or major environmental impact if slope fails	1.25	1.5
Imminent danger to human health or major environmental impact if slope fails	1.5	2.0 or greater

Utilizing this comparison with site conditions, it is noted that the estimated factors of safety against failure for the cases analyzed are greater than the above recommended minimum factors of safety and minimum factor of safety of 1.5 stated in the RD/RA Work Plan.

4.2.7. Containment capacity

A summary of the estimated quantities of soils and sediments to be contained within the limits of the proposed limits of the cap is presented in Table B-23. Based on the final grading plan shown on Sheet G-5 and calculations performed using the Computer Aided Design (CAD) System, the containment area has a total capacity of approximately 68,100 cubic yards (cy). The cap is estimated to occupy approximately 19,400 cy of this volume. The total volume of waste to be disposed of is estimated to be 30,800 cy. The estimated remaining available volume for disposal is estimated to be approximately 17,900 cy. The additional capacity will be used if conditions encountered during construction require excavation and disposal of additional quantities of soils and sediments. Similarly, the grading plan may be modified during the construction phase if the volume of sediments and soils requiring disposal is significantly less than the estimated quantities.

4.2.8. Sliding stability

An analysis of the stability between the geomembrane and soil materials in contact with the geomembrane was performed to evaluate if the capping system would potentially slide at the maximum design slope of one vertical on 6.5 horizontal. A critical factor in evaluating the sliding stability is determining the interface friction angle between the geomembrane and the soil. Analyses for sliding stability were performed utilizing a shear failure evaluation presented in *Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments* (Richardson and Koerner). A copy of the calculations is provided as Appendix Q to this report.

The calculations indicate that at a slope of 1 to 6.5, there are geosynthetic materials available which will provide a minimum factor of safety of 1.5 against sliding. The Technical Specifications incorporate provisions for performing laboratory friction testing utilizing the actual components of construction to evaluate the actual factor of safety which will be obtained.

4.2.9. Settlement analyses

Analyses were performed to evaluate potential settlement of the underlying weathered clay and clay/silty clay layers. The analyses were performed using the results of consolidation testing performed on weathered clay and clay/silty clay layers. Due to its being placed as an engineered fill, the waste layer is expected to experience minimal amount of settlement. Results of the consolidation tests are included in Appendix H. Calculations performed to estimate potential settlement are included in Appendix R.

The calculations estimate that approximately 8 inches of settlement may occur. This is an estimated total amount of settlement and is anticipated to occur in the vicinity of the capped area. This estimate is based on the application of loading from the maximum height of waste on a 20-foot thick clay/silty clay layer. The settlement will be greatest at the center of the capped area where the waste will be thickest and approach zero at the edges of the capped area. Therefore, the change in grade due to a settlement of 8 inches at the middle of the capped area is estimated to result in a change in grade of 0.67% with respect to a point located at the edge of the cap and approximately 100 feet from the center of the capped area. The geomembrane will be capable of accommodating this minimal differential settlement.

4.2.10. Estimated soil loss

In addition, the proposed slopes do not yield an estimated soil loss due to erosion in excess of 2 tons/per acre per year with respect to the Universal Soil Loss Equation calculation (Appendix S).

Conclusion. The proposed cap will minimize infiltration into the capped area and meets regulatory requirements.

4.3. Ground Water Collection and Conveyance System

A ground water collection system will be installed to provide an inward gradient around the perimeter of the capping system and will consist of a ground water collection trench and pumping station. Pending discussions with the District POTW, discharge of collected ground water via connection to the local POTW is proposed. Components of the ground water collection system are discussed in the following sections.

4.3.1. Ground water collection trench

The proposed ground water collection trench will extend along the existing shoreline of the eastern edge of Quarry Lake as shown on Sheet G-5. A containment berm will be constructed on the lake side of the collection trench as shown on Figure 4-2. The location of the ground water collection trench was modified from the location shown in the RD/RA Work Plan, where the trench was located between the proposed capped area and the eastern shore of Quarry Lake to provide isolation of potentially contaminated fill within the capped area. Based on a review of existing subsurface information and observations made during excavation of test pits during pre-design activities, it is likely that materials located in the area between the initially proposed alignment of the ground water collection trench and shoreline of the lake may have been impacted by past operations at the site. In order to minimize the amount of excavation of impacted materials and associated risks of airborne and waterborne transport of potentially impacted materials, the alignment of the collection trench was modified to follow along the existing lakeshore.

The ground water collection system will consist of perforated 6-inch diameter HDPE piping installed in the collection trench which will be excavated into the clay/silty clay layer. The actual location of the top of the clay/silty clay layer in the vicinity of the ground water collection trench along its complete length will not be accurately known until the ground water collection trench has been excavated. Conditions encountered at that time may preclude installation of the perforated pipe exactly as shown on the Ground Water Collection Trench Profile (Sheet G-6). Conditions encountered in the field which may dictate modifications to the design shown on Sheet G-6 include, but are not limited to:

- Adjustment of the invert elevations of the ground water collection trench;
- Backfilling portions of the trench with a low permeability material (clay) to aid in establishing required trench inverts; and/or

- Leaving the invert of the ground water collection trench as designed, but increasing the depth of installation of the HDPE vertical barrier to achieve a downgradient cutoff of flow beneath the invert of the trench.

A typical detail of the ground water collection trench is shown on Sheet G-9.

The trench will be lined with a geotextile filter fabric to minimize the migration of fine-grained materials into the ground water collection trench and backfilled with a cohesionless drainage material. An 80 mil HDPE low-permeability vertical barrier will be installed along the western edge of the collection trench to create a barrier to the flow of lake water into the ground water collection trench. Calculations associated with design of the ground water collection system piping are included in Appendix T.

As discussed in Section 2.3.3., the amount of ground water collected in the trench is expected to decrease over time. Therefore, a flow rate of 10 gpm was selected as a design flow for dewatering the existing fill material. Collected ground water will flow by gravity through the system at slopes ranging from 0.002 to 0.012 foot/foot. Manholes and cleanouts will be installed along the ground water collection system to permit inspection and cleaning of the ground water collection system. It is proposed to utilize HDPE manholes and piping for construction of the cleanouts as shown on sheets G-12 and G-10, respectively. HDPE pipe will convey collected ground water by gravity from the collection trench to the pumping station.

The selected contractor will be required to minimize the amount of construction water generated during construction of the ground water collection trench and other construction activities. The technical specifications will require that the contractor collect and manage ground water encountered during construction activities. This may include conveying the water to the District POTW, providing on-site treatment, or collecting the construction water for treatment at an approved off-site treatment facility in accordance with appropriate discharge requirements.

4.3.2. Pumping station

The ground water pumping station will consist of a wet well/dry well pump station designed to convey a maximum flow rate of 10 gpm. Self-priming progressive cavity pumps will be installed within the dry well. During the initial stages following completion of the cap, it is expected that the pumping station will run continuously as free water within the fill drains to the ground water collection system. After that initial volume of water is removed, the pumping station will only be required to remove that water which flows into the capped area, as discussed in Section 2.3.3.

The pumping station will be located near the north end of the containment area, as shown on Sheet G-5. Mechanical details associated with the pump station are shown on Sheets G-11 and G-12. The proposed road will provide access to the pumping station for routine maintenance and repairs.

4.3.3. POTW connection

A buried HDPE force main will be installed to replace the existing above grade discharge line previously used to convey water from Quarry Lake to the POTW. The existing line is subject to freezing and is reportedly filled with sediments and precipitates; it will be removed and placed within the limits of the capped area.

The new force main will consist of a 1-inch carrier pipe installed within a 3-inch secondary containment pipe. The pipeline will discharge to Manhole 16 on the District trunk sewer which is located just east of the site. Construction of the force main will require access over privately owned property.

Conclusion. The ground water collection trench will provide an inward hydraulic gradient around the cap perimeter. The need for pretreatment of ground water is undetermined at this time and will be evaluated with respect to POTW discharge permit requirements.

4.4. Site Controls

The technical specifications will require that the contractor prepare a Storm Water Pollution Prevention Plan (SWPPP) for implementation during the construction period. The contractor's SWPPP will be consistent with the application requirements set forth in the NYSDEC General Permit for Storm Water Discharges that are classified as "Associated with Construction Activities". By allowing the contractor to develop its own SWPPP with subsequent approval by the NYSDEC and the PRP Group, the contractor is responsible for his own means and methods while still being required to provide appropriate control for erosion and sediment control and storm water discharge from the site.

Typical silt fence and other erosion and sediment control structure details are shown on Sheet G-8. A discussion of surface water controls associated with the cap system is presented in Section 4.6.

Access to the containment area will be provided by a roadway entering the site from Town Line Road, extending along either side of the cap to a turnaround as shown on Sheet G-5. The access road is designed to accommodate traffic loads such as those resulting from pickup trucks. The road will be sloped to drain away from the toe of the cap at a minimum slope of 2% towards Quarry Lake.

A six-foot high chain link fence is proposed to be installed around the cap perimeter to limit unauthorized entry to the site. Vehicle access gates will be provided at the main access road. Man gates will also be provided at appropriate locations.

Conclusion. The proposed access roads will provide access to areas of the site for operation and maintenance activities. The chain link fence will control unauthorized access to the site.

4.5. Ground Water Monitoring System

Ground water monitoring will be completed following construction of the capped area and ground water collection trench. The monitoring program will be completed in accordance with the

Ground Water Monitoring Program presented in Section 8 of the RD/RA Work Plan, included as Appendix U to this report, with the following modifications:

4.5.1. Monitoring wells

Monitoring wells URS-14I and URS-14D are proposed to be used as background wells for the statistical evaluation of ground water chemistry. Monitoring well URS-14I will be used to represent background concentrations for the intermediate zone (sandy silt) whereas monitoring well URS-14D will be used to represent background conditions for the deep zone (bedrock). These wells are located upgradient of the facility.

In addition, there is a discrepancy in the monitoring wells to be sampled that are identified in the RD/RA Work Plan and Figure 8-1 of the RD/RA Work Plan. The wells to be sampled as presented on Sheet G-7 of this report are URS-14I, URS-14D, URS-9I, URS-9D, 85-5R, URS-5D, 85-7R, URS-7D, 88-12C and 88-12D.

4.5.2. Analyses

The analyses to be completed as part of the ground water monitoring plan were not presented in the RD/RA Work Plan. During the first year ground water samples will be collected semi-annually and analyzed for TCL VOCs, TCL SVOCs, PCBs/Pesticides and TAL metals.

Sampling will be conducted semi-annually for TCL VOCs and TAL metals during the second through fifth years of monitoring. The sampling program will be re-evaluated after the fifth year of monitoring.

4.5.3. Piezometers

Eight piezometers will be installed at the site. Water elevations from the eight piezometers and from a stand pipe in the collection trench will be used to verify that an inward hydraulic gradient exists at the perimeter of the capped area. Along the eastern perimeter of the capped area, one piezometer will be installed inside the capped area and one piezometer will be installed outside the capped area. Piezometers will also be located inside and outside of the capped area in vicinity of the northeastern and southern portions of the containment area. Along the western perimeter of the capped area, one piezometer will be installed within the capped area near the collection trench and a stand pipe within the collection trench will also be monitored. The locations of the proposed piezometers and the stand pipe to be monitored are illustrated on Sheet G-7. The piezometer locations may be modified based on conditions encountered in the field. Where possible, the piezometers will be installed such that the screened interval includes the coarser grained fill material for purposes of monitoring the hydraulic gradient. The piezometers will be completed as open standpipe, direct reading piezometers, with locking protective caps as outlined in Section 8 of the RD/RA Work Plan. No remote piezometers will be installed.

The piezometers will be installed after the area to be capped has been graded, but prior to the installation of the FMC and cover material. This will reduce the possibility of puncturing the FMC or damaging the final cover. The contractors will be required to work around the piezometers during installation of the FMC cover. Details of the piezometers are shown on Sheet G-10.

4.5.4. Monitoring well abandonment

Existing monitoring wells (85-1R, 85-1S, 85-6S, 88-1A, 88-2A, 88-3A, 88-4A, 88-5A, 88-6A, 88-7A, 88-8A, 88-9A, 88-10A, 88-10B, 88-10C, 88-10D, 88-11A, 88-11B, 88-11C, 88-11D, 88-13A, 88-14A) which are located in the area to be capped will be abandoned in accordance with the NYSDEC Monitoring Well Decommissioning Procedures prepared by Malcolm Pirnie dated April 1993 (see Appendix V) and as described in the Technical Specifications.

Conclusion. The ground water monitoring program will be effective in monitoring the inward hydraulic gradient within the capped area and ground water collection trench.

4.6. Surface Water Controls and Wetland Construction

Due to the construction of the containment area and access roads approximately 1.2 acres of existing wetlands will be lost. Approximately 1.3 acres of wetlands will be constructed to replace those eliminated. The new wetlands will be developed between the lake edge and the reconstructed berm.

Surface water controls will be established for the constructed wetlands; existing wetlands; storm water runoff from and adjacent to the cap system; and Quarry Lake.

A hydrologic evaluation was performed to estimate the average annual storm water runoff and the runoff associated with a 25-year, 24-hour storm event, which will support the wetlands. The storm water management design was established to convey the runoff from the cap and the lake to the constructed and existing wetlands.

4.6.1. Wetland construction

The design of the approximately 1.3 acres of wetland construction considers the following:

- The constructed wetland will be developed at the edge of the lake between the waters edge and the berm. The constructed environment includes upland wetlands by the berm, which are hydraulically connected to the lake.

- Water elevation will fluctuate seasonally and daily according to rainfall intensity. The variation will foster diverse varieties of plant associations.

- The shore line will undulate, vary in degree of incline, and create areas of trapped water, as well as small recesses and coves. The variations will create a variety for wildlife habitats, as well as plant types.

4.6.2. Wetland hydrology
The constructed and existing wetlands will receive surface water runoff from the cap system, Quarry Lake, and other areas of the site (i.e. swales, access roads, undisturbed areas which are hydraulically connected).

Approximately 2.8 acres of the capping system will direct surface waters directly to Quarry Lake. The constructed wetlands are to be established directly adjacent to Quarry Lake and will be hydrologically supplemented by storm water which falls on the lake and 2.8 acres of the cap. Approximately 281,000 cubic feet of storm water runoff will reach the constructed wetlands during the 25-year, 24-hour rainfall event. The storm water will be routed through the constructed wetlands, and discharged from the lake area, via the newly constructed outlet weir, to the existing wetlands.

Based on the average annual rainfall for Buffalo, NY (37.5 inches/year) the constructed wetlands will receive approximately 2,640,000 cubic feet of storm water runoff per year (Appendix W).

The existing wetlands will be supplemented with approximately 46,000 cubic feet of water, due to runoff from the capping system during a 25-year, 24-hour event. Approximately 2.1 acres of the cap will drain to the existing wetlands to the north, while approximately 1.0 acre of the cap will drain to the existing wetlands to the south. A controlled overflow will be constructed on the wetland to the south to direct overflows to Quarry Lake.

Based on the average annual rainfall for Buffalo, NY (37.5 inches/year) the existing wetlands are expected to be directly supplemented with approximately 431,500 cubic feet of storm water runoff per year, from the cap system. Further, Quarry Lake's overflow directs additional storm water to the existing wetlands located outside of the lake's berm.

4.6.3. Capping system storm water management
Post-construction surface water drainage patterns are shown on Figure 4-3. Storm water runoff from the cap will be conveyed away from the cap to Quarry Lake and the adjacent wetlands. Ultimately the runoff will reach Bull Creek, from the adjacent wetlands.

Storm water, which currently drains towards the cap area, will be directed to the existing wetlands, north of the cap. A small area, between the former railroad to the east and the cap, which appears to currently drain towards the cap, will have its storm water runoff intercepted by a proposed swale. The swale, which is to be constructed adjacent to the cap access road, will direct storm water to the north and to the south. The east half of the cap will drain across the access road to this swale. The swale is sized to convey the peak runoff associated with the 25-year rainfall event. Design calculations are included in Appendix W.

The north and south portions of the cap will drain directly to the existing wetland areas. The cap will be a minimum of two feet above the wetland elevations.

The west half of the cap will direct its storm water runoff across the western access road directly into the lake. Silt fencing or straw bale dikes should be constructed between the cap and the access road until a vegetative cover is established on the cap. This will minimize the transport of sediments into Quarry Lake.

4.6.4. Perimeter berm and outlet

The existing perimeter berm surrounding Quarry Lake will be reconstructed to provide a stable embankment designed to contain runoff associated with a 25-year, 24-hour storm event. As discussed above, the western half of the cap system and overflow from the wetland to the south, will drain to the lake. No other areas outside the berm will convey runoff to Quarry Lake.

The reconstructed berm will have a top elevation at approximately 580.5 ft., United States Geologic Survey (USGS) datum. At this elevation the complete rainfall event contributory to the lake (the lake, plus the western half of the cap) during the 25-year, 24-hour event can be stored, while still maintaining two feet of freeboard.

The outlet from Quarry Lake is designed as a broad-crested weir with a crest elevation at 578 ft. Discharge through the weir will occur when the water surface elevation rises above elevation 578 ft. The weir is designed to discharge approximately 5.3 cfs, with a head of 4.7 inches. Corresponding design calculations are included in Appendix W.

The weir will be constructed with fine stone filling protection to prevent erosion. The fine stone filling will be placed along the crest and sides of the weir. Fine stone filling will be extended approximately 3 feet, beyond the toe of the berm where the flow no longer poses an erosion concern. The low flow rate, which equates to a low velocity, further reduces the potential for erosion impacts.

Prior to reconstruction of the berm, silt fencing will be installed in accordance with the SWPPP. The silt fencing will reduce the potential for migration of sediments from the newly constructed berm. The silt fencing will remain in place and be maintained until the berm is stabilized with an established vegetative cover.

Conclusion. The construction of the containment area will require the construction of some surface water controls to limit potential storm water impacts. These controls include the reconstruction of the berm surrounding Quarry Lake, the construction of perimeter swales to direct storm water away from the cap and effective grading of the cap above flood levels. The loss of 1.2 acres of wetlands can be mitigated by constructing 1.3 acres of wetlands adjacent to Quarry Lake as shown on Sheet G-7.

4.7. Basis of Design Summary

A Basis of Design Summary is included as Appendix X to the Report.

4.8. Other Design Features

In addition to activities associated with consolidating sediments and surface soils within the limits of the capping system and construction of the ground water collection system, other remedial activities will be conducted at the Frontier Chemical-Pendleton Site. These activities include management of drummed wastes, building demolition, and management of an existing underground storage tank. In addition, loose soils have been removed from a ditch adjacent to the site along Town Line Road. The following sections discuss these activities in detail.

4.8.1. Management of drummed waste

As shown on Figure 4-1, a drum storage area is located in the southwestern portion of the site. Based on available information and site inspection, it is concluded that 98 drums of waste (personal protective equipment, soil cuttings, and purge water) generated during the RI and 81 drums of residues and protective clothing from previous tank clean-out activities have been placed in the storage area. During removal of residues from the tanks, limited sampling and analyses of tank contents were performed to define worker health and safety requirements.

During the remedial action, drums containing soil cuttings and/or personal protective equipment (PPE) will be consolidated beneath the cap. Drums containing water will be disposed of by emptying the drums and properly managing the water. The empty drums will then be crushed and disposed of within the capped area. A visual inventory of the drummed residues from tank clean-out activities will be conducted. The drum contents will be sampled and analyzed in accordance with the Sampling and Waste Characterization Plan to establish waste characteristics and obtain analytical data for proper off-site disposal as described in the Technical Specifications.

4.8.2. Building demolition

The existing structure located in the southeastern portion of the site and noted on Figure 4-1 will be demolished. Based on the results of previous activities at the site, components of the structure may contain limited amounts of asbestos. Material containing asbestos will be segregated for proper disposal in accordance with the Technical Specifications. Debris resulting from demolition of the building which does not contain asbestos will be disposed of within the limits of the capping system.

4.8.3. Underground storage tank

The underground storage tank (UST) shown on Figure 4-1 will be managed by removing its contents by pumping or other appropriate methods. The materials removed from the tank will be sampled and analyzed to evaluate alternatives for appropriate disposal. The UST will then be filled with sand or concrete slurry and left in place. As shown on Figure 4-1, the UST is located within the limits of the proposed capping system.

4.8.4. Loose soil

As discussed in the RD/RA Work Plan, "loose soils" were to be removed from the ditch adjacent to the site along Town Line Road. This activity was performed during late 1994 rather than during the remedial action in 1995. The consolidation of "loose soils" involved the removal of three to six inches of "loose soils" from a section of the ditch approximately 1,350 feet long. The removed soils were placed directly on the ground at the Frontier Chemical - Pendleton Site within the area to be capped.

A summary of activities associated with removal of "loose soils" from the ditch, including analytical results, was submitted to the NYSDEC as a separate document.

5. Construction Phase Health and Safety Requirements

Prior to the commencement of on-site remedial activities at the Frontier Chemical-Pendleton Site, the Remedial Action Contractor (RA Contractor) will prepare and implement a site-specific Health and Safety Plan (HASP) for persons working at and/or living in the vicinity of the site in accordance with the Federal Regulations found under 29 CFR 1910.120 for Hazardous Waste Operations and Emergency Response, 29 CFR 1926 "Safety and Health Regulations for Construction", and the citations adopted by reference. Detailed requirements for Health and Safety are presented in Section 02006 - Health and Safety of the Technical Specifications. Additionally, the following may be used as reference in the development and implementation of the HASP (Remcor, 1993):

- National Institute for Occupational Safety and Health Administration/Occupational Safety and Health Administration/U.S. Coast Guard/U.S. Environmental Protection Agency (NIOSH/OSHA/USCG/EPA), "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985.

- U.S. Department of Health and Human Services, June 1990, Public Health Service, Center for Disease Control, NIOSH, "NIOSH Pocket Guide to Chemical Hazards."

- American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1991-1992."

- EPA, Office of Emergency and Remedial Response, 1988, "Standard Operating Safety Guides."

- Sax,. I.N., Editor, "Dangerous Properties of Industrial Materials," 7th Edition.

- OSHA "Permissible Exposure Limits, "29 CFR, Part 1910, Subpart Z-Toxic and Hazardous Substances.

In accordance with the Order on Consent, the HASP shall be developed by a certified health and safety professional. The site-specific HASP will at a minimum, address the following elements:

- Program organization and responsibilities.
- Health and safety risk or hazard analysis for each site task and operation.
- Employee training.
- Required Personal Protective Equipment (PPE) for each site task and operation.
- Medical surveillance requirements.
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used.
- Site control measures.
- Decontamination measures.
- Emergency response plan.
- Confined space entry procedures (when applicable).
- Handling of drums and containers (when applicable).
- Spill containment program (when applicable).
- Exclusion zone security and entry procedures.
- OSHA Requirements in 29 CFR 1910.120, and citations adopted in reference.

6. Post Construction Maintenance and Monitoring Activities

The remedial design for the Frontier Chemical-Pendleton Site includes the following major components:

- Low-permeability cover
- Ground water collection system
- Surface water runoff channels
- Replacement wetlands
- Perimeter berm
- Ground water monitoring system
- Site access road

The following sections discuss post-construction maintenance and monitoring activities associated with the components of the remedial design. A separate operation and maintenance (O & M) manual will be provided following completion of construction to reflect as-built conditions.

6.1. Low-permeability Cover

Routine inspection of the capped area and immediately adjacent areas will be performed concurrently with the ground water monitoring plan presented in Appendix U. Inspections will be performed quarterly the first year and semi-annually thereafter. Periodic mowing of the vegetated cap will be performed to maintain satisfactory runoff. The inspector will observe the condition of the vegetative cover for areas of settlement, erosion, slope instability, or any other damage to the cap. If such features are noted, appropriate engineered solutions will be implemented.

No deep rooting shrubs, brush, or trees will be allowed to germinate or establish on the cover. Mowing will be performed only as required to prevent the establishment of woody plants (trees) that may penetrate the final cover. Routine cover inspection will also note any problems with thinning of vegetation.

6.2. Ground Water Collection System

The ground water collection system will be inspected routinely following closure. This will include a visual inspection of the pump station, collection system cleanouts, and manholes. If any component of the pumping system is found to be damaged or malfunctioning, it will be promptly repaired or replaced.

6.3. Surface Water Runoff Facilities

In general, runoff from the capped area will flow either to Quarry Lake or to the drainage ditch installed at the toe of the capped area and ultimately discharge to the wetlands in the vicinity of the site. Inspection of drainage facilities will be conducted at the same frequency as inspection of the capped area cover. Drainage facilities will be inspected for accumulation of debris which may inhibit flow and for excessive scouring which may erode ditches. Should debris accumulation be noted, it will be promptly removed to maintain flow capacity. If excessive scouring is noted, channel protection consisting of rip-rap or geosynthetic protection may be required.

6.4. Access Road

During routine inspections following closure, the access road will be observed for rutting, potholes, or settlement. Should these conditions be observed they will be corrected by filling with appropriate material. During the winter, the road will be plowed as needed to facilitate access for site inspections and routine sampling of ground water monitoring wells.

6.5. Ground Water Monitoring

Ground water monitoring will be performed in accordance with the ground water monitoring program discussed in Section 4.5 and presented in Section 8 of the approved RD/RA Work Plan.

A copy of the proposed program is included in Appendix U.

During each sampling event, ground water monitoring wells and piezometers will be inspected for signs of damage. If damage is detected, or if routine sampling indicates a problem with one or more of the ground water monitoring wells or piezometers, any action to be taken will be discussed with NYSDEC.

6.6. Constructed Wetlands

Inspection of the constructed wetlands will be performed routinely following closure. The inspector will observe the condition of the constructed wetlands. Corrective actions to be taken in response to noted deficiencies may include replacement of wetland plantings as required.

6.7. Perimeter and Containment Berms

Inspection of the perimeter and containment berms will be performed routinely following closure. The inspector will observe the condition of the berms. Should areas of erosion, settlement, slope instability, or other damage to the cap be noted, the berms will be regraded or reconstructed in those areas.

6.8. Recordkeeping

Maintenance and monitoring activities will be performed for an estimated period of thirty years following closure unless reviews indicate that a different maintenance and monitoring period is warranted. An inspection checklist will be developed and filled out during routine inspections. Copies of records, reports, or other information relative to maintenance and monitoring activities at the Frontier Chemical-Pendleton Site will be provided to NYSDEC by the PRP Group.

7. Contingency Plan

The contingency plan presented in this Section is applicable to the period following construction. The contingency plan will be implemented in the event that any component of the implemented remedy fails to operate in accordance with the Remedial Design.

7.1. Freezing Conditions

If freeze/thaw activity causes heaving that may impact the integrity of the final cover, the heaved area should be scarified, recompacted, topsoil reinstalled, and the area reseeded. Freeze/thaw activity could also cause excessive rutting or pot hole formation in the site access road. If this occurs, the damaged portion of the road would be filled with a suitable granular material.

7.2. Heavy Rains

Repeated heavy rainfall could cause erosion of the final cover, prior to establishment of a vegetative cover. If this occurs, the eroded area would be scarified and additional cover material added, if necessary, and recompacted. Topsoil would then be applied and reseeded. Areas of persistent erosion may require utilization of an erosion control fabric or ditching and rip-rap.

7.3. Seepage

The low-permeability cover and surface water controls will limit infiltration of water into the area beneath the cap. If routine inspections or water quality monitoring identify the presence of seeps, the point at which the seep starts would be located by visual observation and excavation, if necessary, and the seep eliminated. This may be accomplished by removing and reinstalling the cover as required to stop the flow of the seep. As an additional measure, the seep may be piped directly to the ground water collection system. Erosion of the side slopes which may result from the seep would also be repaired by regrading, filling, and reseeding. If a seep is persistent, an investigation would be undertaken to determine the cause of the seep and an appropriate plan and schedule would be developed for permanently controlling the seep.

7.4. Ground Water Quantities

In the event that quantities of ground water generated do not decrease with time as predicted, an evaluation would be performed to determine the source of the seepage quantities being collected, including the contribution of ground water to the system.

7.5. Ground Water Collection System

In the event that the ground water collection system piping becomes clogged, cleaning of the pipes will be necessary to maintain the flow capacities in the ground water collection system. If any component of the pumping station becomes damaged or malfunctions, it will be replaced.

7.6. Surface Water Control Channels

Should flow in the surface water runoff control channels become inhibited by the displacement of fine stone filling or the accumulation of excessive debris or soils from the erosion of the adjacent embankment, appropriate measures would be taken to repair or clean the channel to maintain flow capacities. Areas of persistent channel erosion may require additional improvements including regrading, filling or placement of rip-rap.

7.7. Ground Water Contamination

Potential impacts on ground water quality will be monitored by routine sampling and analysis of site ground water monitoring wells. The NYSDEC will be provided with the results of sampling and analyses. If the routine sampling indicates that ground water quality is degrading, additional sampling and analyses should be performed to verify the initial results. If warranted by the initial data evaluation and the verification sampling, further action could be necessary to determine the cause of and solution to the problem.

7.8. Health and Safety

As concluded in the ROD, implementation of the recommended alternative will be protective of human health and the environment. Therefore, no additional health and safety measures are required during the post-closure period as long as the remedial components continue to properly function. Health and safety measures to be implemented during the post closure period include restricting site access and ground water monitoring. These measures are meant to both monitor the effectiveness of the remedial components and prevent human contact with site-related contaminants.

In the event that routine maintenance and monitoring activities indicate problems with the remedial components, activities outlined in this contingency plan would be implemented. The type of health and safety requirements to be implemented in the event of failure of the remedial components would depend on the type of failure and field activities conducted in implementing this contingency plan. It is likely that health and safety requirements utilized in the event of implementation of this contingency plan will be similar to those implemented during remedial construction. However, it may be necessary to develop specific health and safety requirements and procedures to address the specific conditions encountered.

7.9. Emergency Contacts

An emergency contact will be identified following determination of an Operation and Maintenance (O&M) Contractor.

8. Anticipated Construction Schedule and Sequence

8.1. General

An anticipated schedule for construction of the remedial action at the Frontier Chemical-Pendleton Site is presented as Figure 8-1. It indicates that the total estimated time for construction will be on the order of 16 months over 2 construction seasons. The anticipated schedule includes a 5 month winter shutdown, but it does not otherwise take into account delays associated with prolonged periods of inclement weather. In the event of prolonged inclement weather, the schedule may be impacted. The Contract Documents will require the contractor to submit a time frame for completion of this project with the bid. The selected contractor may propose a schedule which differs in construction sequence or duration of various tasks from that shown in Figure 8-1.

The anticipated schedule was prepared based on experience with similar projects and the NYSDEC approved Schedule for Remedial Activities showing a final design submittal of February 17, 1995.

8.2. Construction Sequence

Following contract award, the contractor will prepare and submit required plans for review and acceptance. It is anticipated that these will include a site specific HASP, a SWPPP, a Dust Control Plan, a Construction Water Management Plan, a Sampling and Waste Characterization Plan, a Construction Quality Control Plan, a Staging Plan, and a Spill and Discharge Control Plan.

Construction will be initiated with mobilization to the site and construction of ancillary facilities. These will likely include trailers, decontamination facilities, and appropriate portions of the erosion control facilities. One month has been allowed for mobilization. Following mobilization, pumping of water from Quarry Lake will be initiated. Assuming that Quarry Lake contains 40 million gallons of water, two months have been allowed to remove the water by continuous pumping during this time frame. Concurrent with pumping of water from Quarry Lake, the contractor will begin to shape sediments and soils within the capped area as well as relocate soils from outside of the capped area to within the capped area. Also, concurrent with pumping of the water from Quarry Lake, work on construction of the berm around the perimeter of Quarry Lake will be initiated.

Following completion of pumping water from Quarry Lake, sediment solidification will be initiated within the confines of Quarry Lake. This will likely be accomplished by mixing the sediments with the selected admixtures using track mounted mixing equipment. Following curing, the solidified sediments will be excavated and placed within the capped area. A total of two months has been included for sediment solidification and excavation.

It is anticipated that the contractor will initiate sediment solidification along the eastern shoreline closest to the capped area. Concurrent with solidification of sediments, the peninsula into Quarry Lake will be excavated and placed in the capped area. These activities will allow construction of the containment berm adjacent to the shore of Quarry Lake to proceed. Two months have been allowed for construction of the containment berm.

Following completion of the containment berm, the ground water collection and conveyance system will be constructed. Concurrent with construction of the ground water collection and conveyance system, site access roads will be constructed. One month has been allowed for these activities. The anticipated construction schedule shows a 5 month winter shutdown at this point. During this time, the contractor will be required to maintain the sediment and erosion control facilities.

Construction will be resumed in May 1996 with final shaping of the site. The FMC will then be placed and covered with the barrier protection layer. Piezometers will be installed concurrent with the installation of the FMC. The barrier protection layer will in turn be covered with topsoil and seeded. As the importation of topsoil is completed, the site perimeter fence will be installed completing construction of the remedial action.

Respectfully submitted,

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Acronyms/Abbreviations

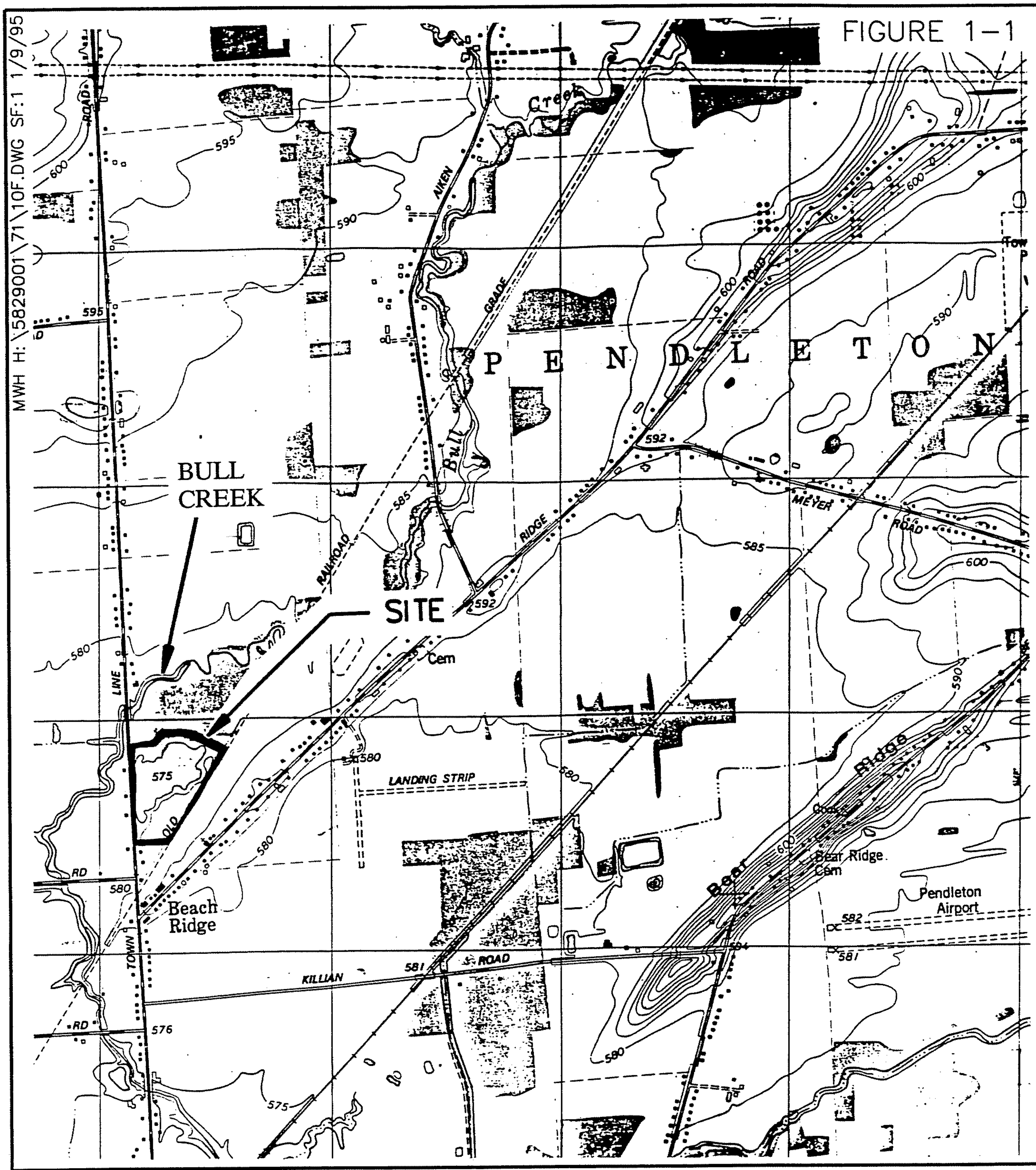
ACGIH	American Conference of Governmental Industrial Hygienists
ACOE	U.S. Army Corps of Engineers
ARARs	Applicable or Relevant and Appropriate Requirements
ASP	Analytical Services Protocol
ASTM	American Society for Testing and Materials
BOD	biological oxygen demand
C&D	construction and demolition
CAD	computer aided design
CKD	cement kiln dust
CLP	Contract Laboratory Procedures
cy	cubic yards
DISTRICT	Niagara County Sewer District No. 1
DNAPL	dense non-aqueous phase liquid
EPA	U.S. Environmental Protection Agency
ESCP	Erosion and Sediment Control Plan
FMC	flexible membrane cover
FML	flexible membrane liner
FS	Feasibility Study
gpd	gallons per day
gpm	gallons per minute
HASP	Health and Safety Plan
HDPE	high density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
IDES	Integrated Design Earthwork Systems
mgd	million gallons per day
MSG	multilayered cap with synthetic geomembrane
msl	Mean Sea Level
NIOSH	National Institute for Occupational Safety and Health
NYSDEC	New York State Department of Environmental Conservation
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyl compounds

PID	photoionization detector
POTW	Publicly Owned Treatment Works
PPE	personal protective equipment
ppm	parts per million
PRP	Potentially Responsible Party
pcf	pounds per cubic foot
psf	pounds per square foot
psi	pounds per square inch
RA	Remedial Action
RA Contractor	Remedial Action contractor
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
SCGs	New York State Standards, Criteria, and Guidance
SPDES	State Pollution Discharge Elimination System
SPT	Standard Penetration Test
S/S	solidification/stabilization
SVOCs	semivolatile organic compounds
SWPPP	Storm Water Pollution Prevention Plan
TAGM	Technical and Administrative Guidance Memorandum
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TCL	Target Compound List
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
USCG	U.S. Coast Guard
USGS	United States Geological Survey
UST	underground storage tank
VLDPE	very low density polyethylene
VOCs	volatile organic compounds
WH	weight of hammer

Figures

O'BRIEN & GERE
ENGINEERS, INC.

FIGURE 1-1



ADAPTED FROM 7.5 MIN. U.S.G.S. TONAWANDA EAST QUAD MAP, TONAWANDA, NEW YORK

FRONTIER CHEMICAL – PENDLETON SITE
TOWN OF PENDLETON, NIAGARA COUNTY, NY
REMEDIAL DESIGN

SITE LOCATION PLAN

NOT TO SCALE

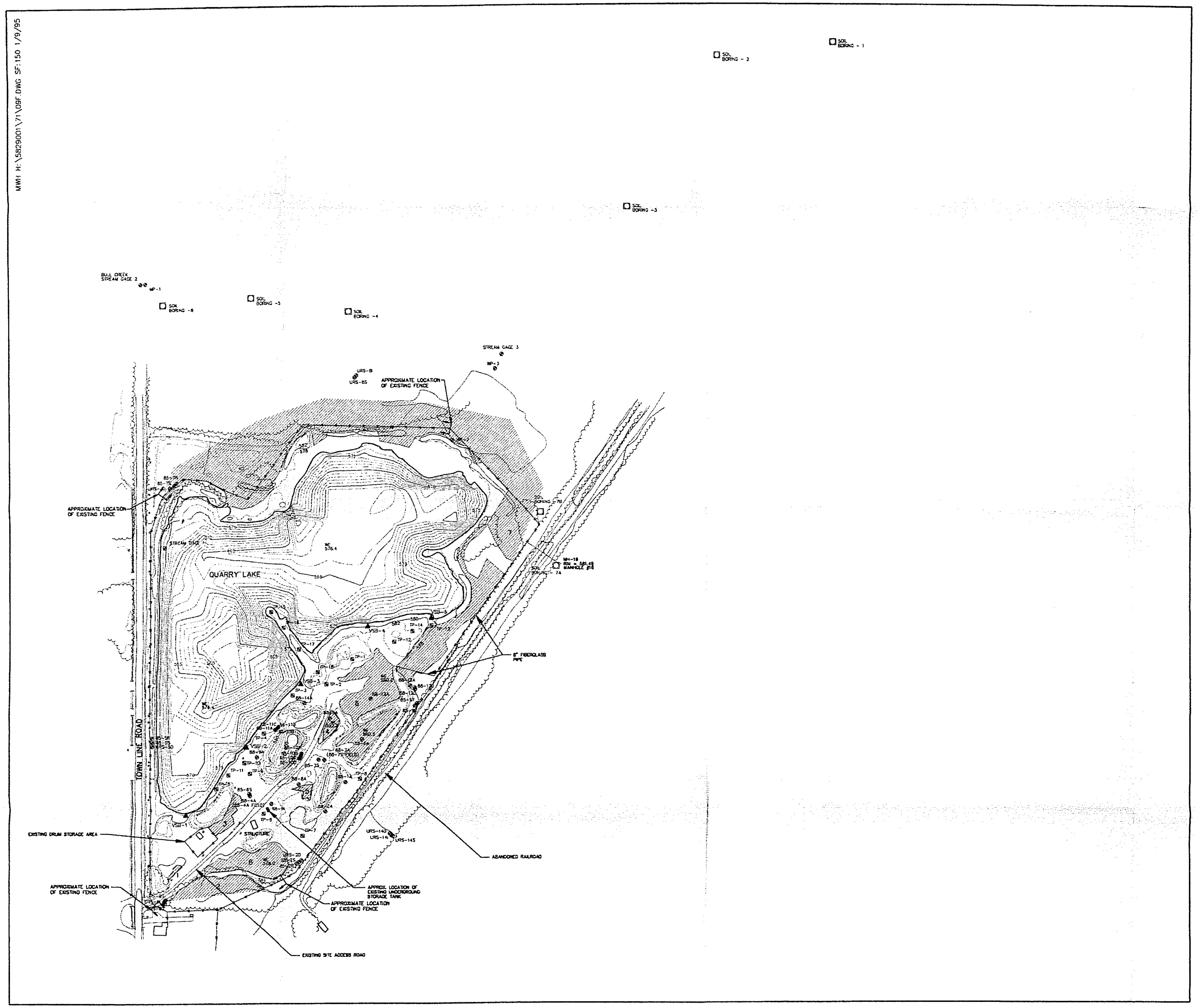
0 2.5 5

APPROX. SCALE IN MILES

FILE NO. 5829.001-10F

O'BRIEN & GERE ENGINEERS INC.

FIGURE 1-2



LEGEND

- TP-3 — TEST PIT
- 88-8A — MONITORING WELL OR PIEZOMETER
- SG-3 — STREAM GAGE
- TREE LINE
- WETLAND AREA
- FENCE
- UTILITY POLE
- 565 — EXISTING ELEVATION CONTOUR
- LIMITS OF QUARRY LAKE
- SOIL BORING
- VSB-1 — VANE SHEAR BORING

NOTES:

1. MAPPING ADOPTED FROM TOPOGRAPHIC SURVEY MAP PREPARED BY NIAGARA BOUNDARY & MAPPING SERVICES, LSPC 345 THIRD STREET, SUITE 470 - CARBORUNDUM CENTER NIAGARA FALLS, NEW YORK 14303 AERIAL PHOTOGRAPHY DATED APRIL 1994
2. LOCATIONS OF TEST PITS TP-15 THROUGH TP-18 ARE APPROXIMATE ONLY AND ARE NOT THE RESULT OF AN INSTRUMENT SURVEY.
3. LOCATIONS OF VANE SHEAR BORINGS VSB-1 THROUGH VSB-5 ARE APPROXIMATE ONLY AND ARE NOT THE RESULT OF AN INSTRUMENT SURVEY.

FRONTIER CHEMICAL
PENDLETON SITE
TOWN OF PENDLETON,
NIAGARA COUNTY, NY
REMEDIAL DESIGN

EXISTING SITE PLAN

0 150 300
APPROX. SCALE IN FEET

FILE NO. 5829.001-09F

O'BRIEN & GERE ENGINEERS, INC.

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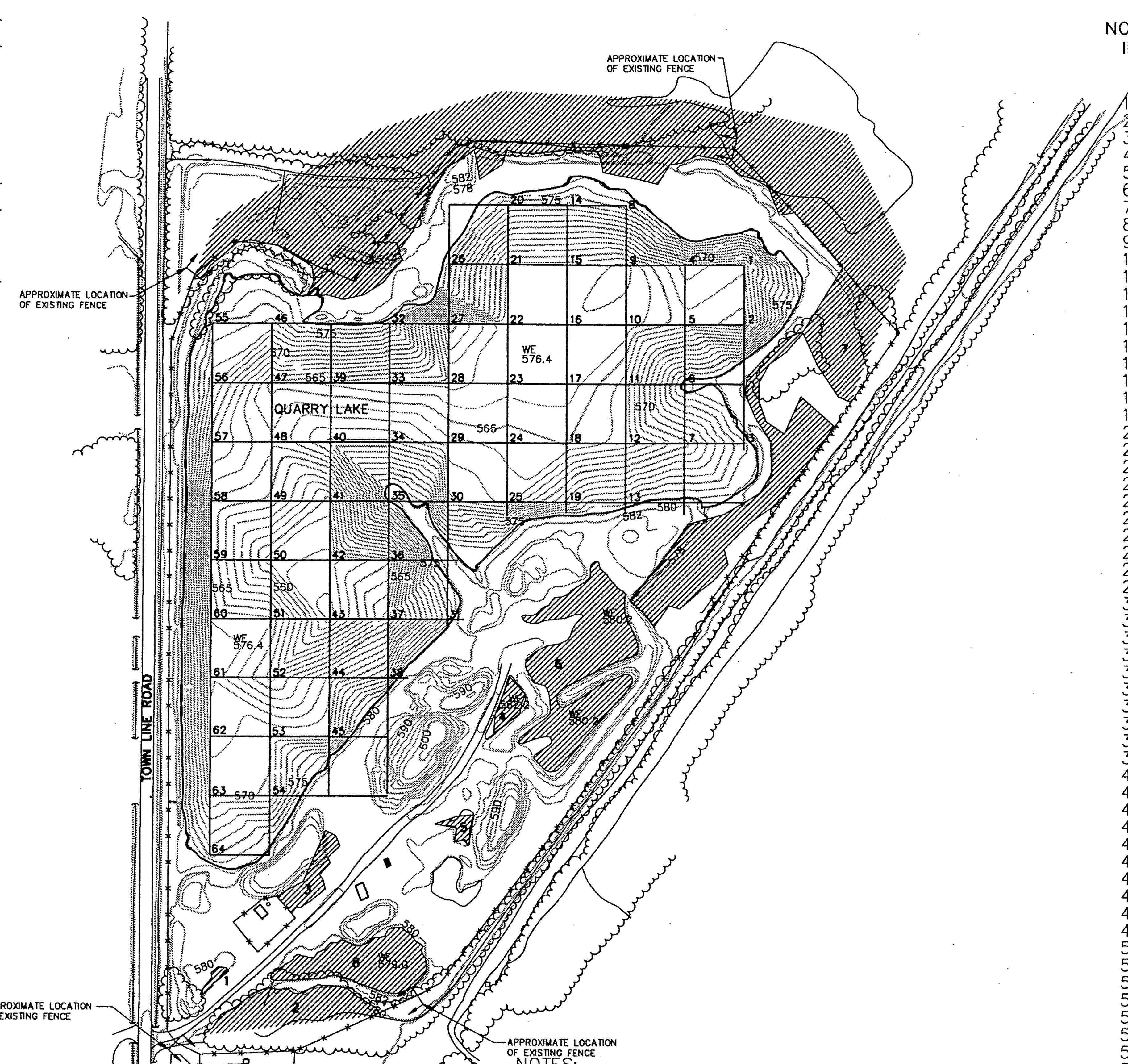

NODE ID	BORING DEPTH (FT)	WATER DEPTH (FT)	SEDIMENT DEPTH (FT)
1	10.8	10.5	0.3
2	12.7	12.3	0.4
3	1.2	1.1	0.1
4	9.3	9.2	0.1
5	11.2	11.1	0.1
6	0.525	0.5	0
7	9	7.2	1.8
8	1.2	1.2	0
9	14.4	14	0.4
10	13.8	13.5	0.3
11	11	10.3	0.7
12	11	10.5	0.5
13	1.2	1.2	0
14	3.2	3	0.2
15	13.5	13.2	0.3
16	14	13.7	0.3
17	13.6	13.4	0.2
18	12.3	11.8	0.5
19	4.7	4.5	0.2
20	3.5	2.8	0.7
21	13.4	13	0.4
22	13.5	13.4	0.1
23	13.7	13.2	0.5
24	12	11.1	0.9
25	11	10.2	0.8
26	1.4	1.2	0.2
27	17.6	17.4	0.2
28	14.9	14.1	0.8
29	11.1	10.4	0.7
30	9.2	8.5	0.7
31	2.6	2	0.6
32	1.2	1.1	0.1
33	14	13.9	0.1
34	8	7.5	0.5
35	0.4	0.3	0.1
36	17.2	17	0.2
37	13.6	13.2	0.4
38	4.7	4.2	0.5
39	13.5	13	0.5
40	8.2	7.5	0.7
41	17.6	17.3	0.3
42	19.5	19.2	0.3
43	20.6	20.3	0.3
44	8.8	8.5	0.3
45	7.1	6.7	0.4
46	4	3.1	0.9
47	12.8	12.1	0.7
48	10.8	10.5	0.3
49	12.4	12	0.4
50	18.6	18.3	0.3
51	11	10.5	0.5
52	13.6	13.1	0.5
53	7	6.8	0.2
54	6.9	6.7	0.2
55	2.3	2	0.3
56	4.8	4.4	0.4
57	8.3	7.6	0.7
58	11.4	10.9	0.5
59	11.5	11	0.5
60	10	9.8	0.2
61	9.2	8.9	0.3
62	8.7	8.5	0.2
63	7.3	6.9	0.4
64	3	2.1	0.9

NOTES:

1. SAMPLES FOR TREATABILITY TESTING COLLECTED FROM GRID LOCATIONS 2, 7, 11, 20, 25, 29, 30, 39 AND 49.
2. MAPPING ADOPTED FROM TOPOGRAPHIC SURVEY MAP PREPARED BY NIAGARA BOUNDARY & MAPPING SERVICES, LSPC 345 THIRD STREET, SUITE 470 - CARBORUNDUM CENTER NIAGARA FALLS, NEW YORK 14303 AERIAL PHOTOGRAPHY DATED APRIL 1994

FIGURE 1-3

LEGEND

- LIMITS OF QUARRY LAKE
- 16 — SAMPLING GRID LOCATION
- TREE LINE
- WETLAND AREA
- FENCE
- 565 — EXISTING ELEVATION CONTOUR
- 22 — SAMPLING NODE

FRONTIER CHEMICAL
PENDLETON SITE
TOWN OF PENDLETON,
NIAGARA COUNTY, NY
REMEDIAL DESIGN

QUARRY LAKE SEDIMENT SAMPLING LOCATIONS

0 200 400
SCALE IN FEET

FILE NO. 5829.001-12F

O'BRIEN & GERE ENGINEERS INC.

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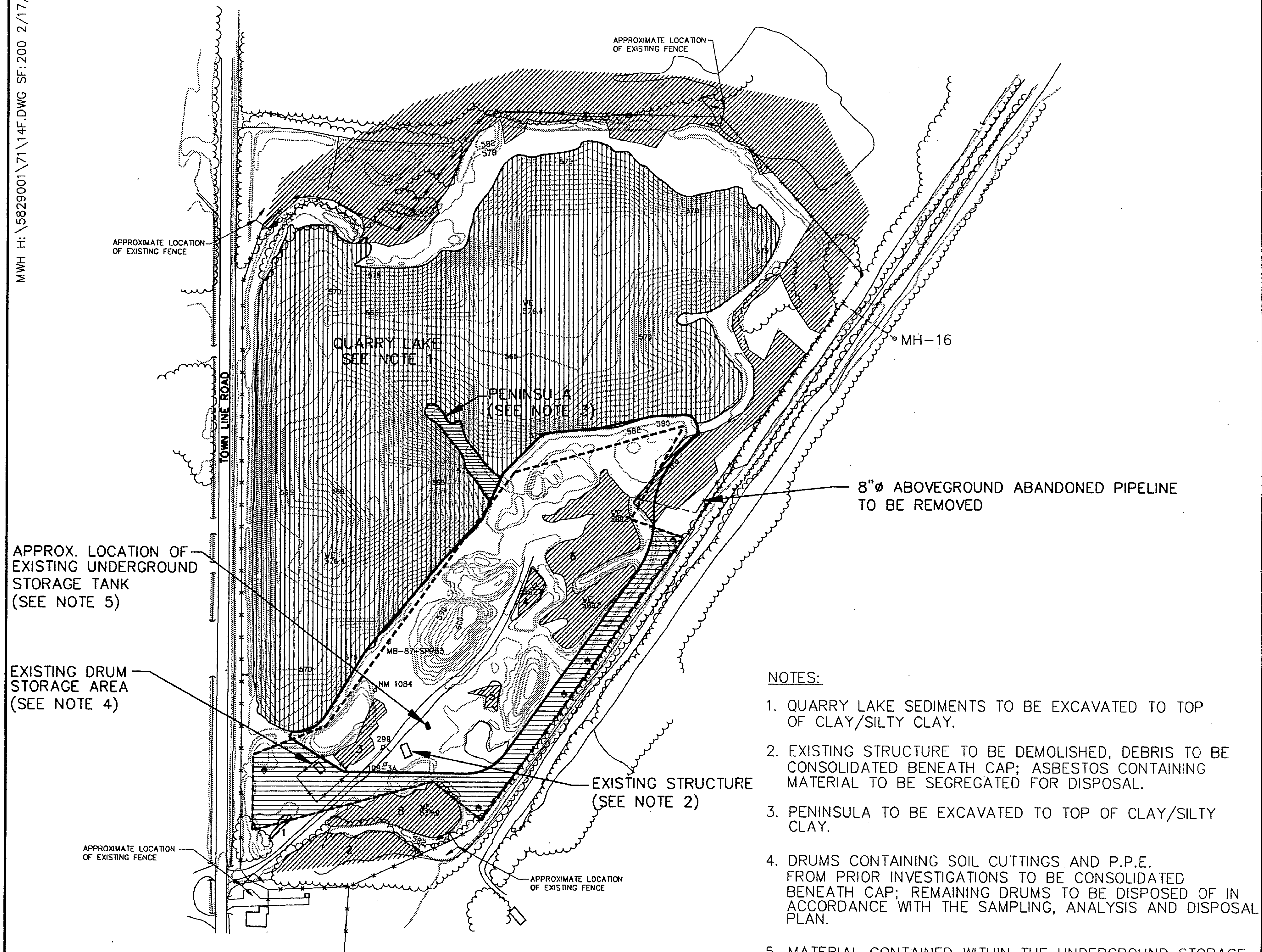

NOTES:

1. QUARRY LAKE SEDIMENTS TO BE EXCAVATED TO TOP OF CLAY/SILTY CLAY.
2. EXISTING STRUCTURE TO BE DEMOLISHED, DEBRIS TO BE CONSOLIDATED BENEATH CAP; ASBESTOS CONTAINING MATERIAL TO BE SEGREGATED FOR DISPOSAL.
3. PENINSULA TO BE EXCAVATED TO TOP OF CLAY/SILTY CLAY.
4. DRUMS CONTAINING SOIL CUTTINGS AND P.P.E. FROM PRIOR INVESTIGATIONS TO BE CONSOLIDATED BENEATH CAP; REMAINING DRUMS TO BE DISPOSED OF IN ACCORDANCE WITH THE SAMPLING, ANALYSIS AND DISPOSAL PLAN.
5. MATERIAL CONTAINED WITHIN THE UNDERGROUND STORAGE TANK (UST) TO BE REMOVED AND DISPOSED OF IN ACCORDANCE WITH THE SAMPLING, ANALYSIS AND DISPOSAL PLAN. UST TO BE BACKFILLED WITH LOW STRENGTH CONCRETE OR SAND.

FIGURE 4-1

LEGEND

- PROPOSED LIMITS OF CAP
- LIMITS OF QUARRY LAKE
- LIMITS OF SOIL REMOVAL AS PROPOSED IN RD/RA WORK PLAN
- TREE LINE
- SEDIMENT TO BE CONSOLIDATED
- SURFACE SOIL TO BE CONSOLIDATED
- WETLAND AREA
- FENCE
- 565 EXISTING ELEVATION CONTOUR
- NM 1084 UTILITY POLE TO BE REMOVED
- VERIFICATION SAMPLE LOCATION (SOIL CONSOLIDATION)

FRONTIER CHEMICAL PENDLETON SITE
TOWN OF PENDLETON, NIAGARA COUNTY, NY
REMEDIAL DESIGN

SOIL AND SEDIMENT RELOCATION AND CONSOLIDATION PLAN

0 200 400

SCALE IN FEET

FILE NO. 5829.001-14F

O'BRIEN & GERE ENGINEERS INC.

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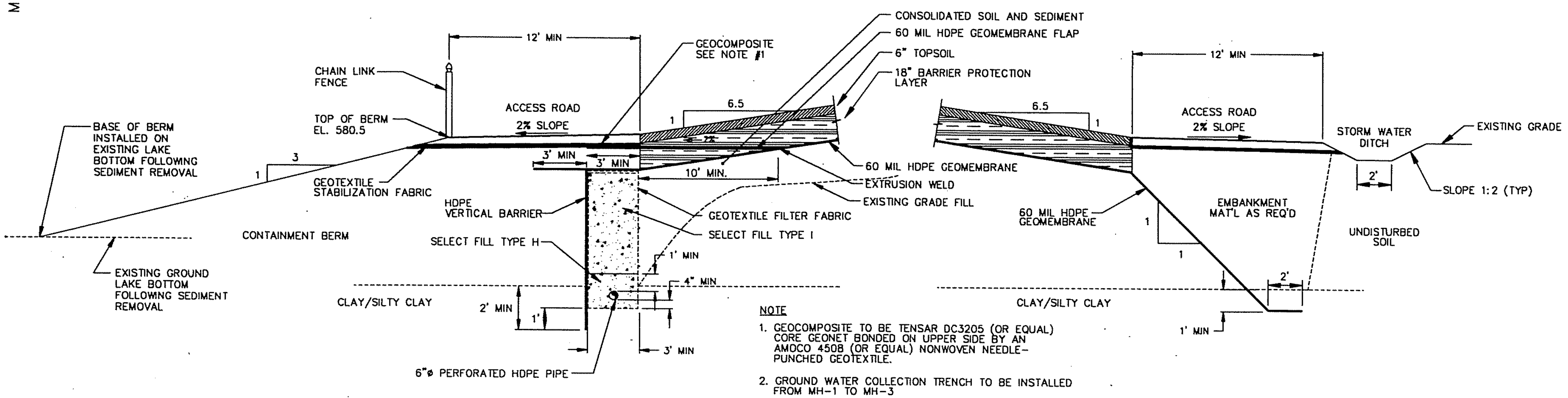


NOTE

1. GEOCOMPOSITE TO BE TENSAR DC3205 (OR EQUAL) CORE GEONET BONDED ON UPPER SIDE BY AN AMOCO 4508 (OR EQUAL) NONWOVEN NEEDLE-PUNCHED GEOTEXTILE.

2. GROUND WATER COLLECTION TRENCH TO BE INSTALLED FROM MH-1 TO MH-3

FIGURE 4-2

FRONTIER CHEMICAL
PENDLETON SITE
TOWN OF PENDLETON,
NIAGARA COUNTY, NY
REMEDIAL DESIGN

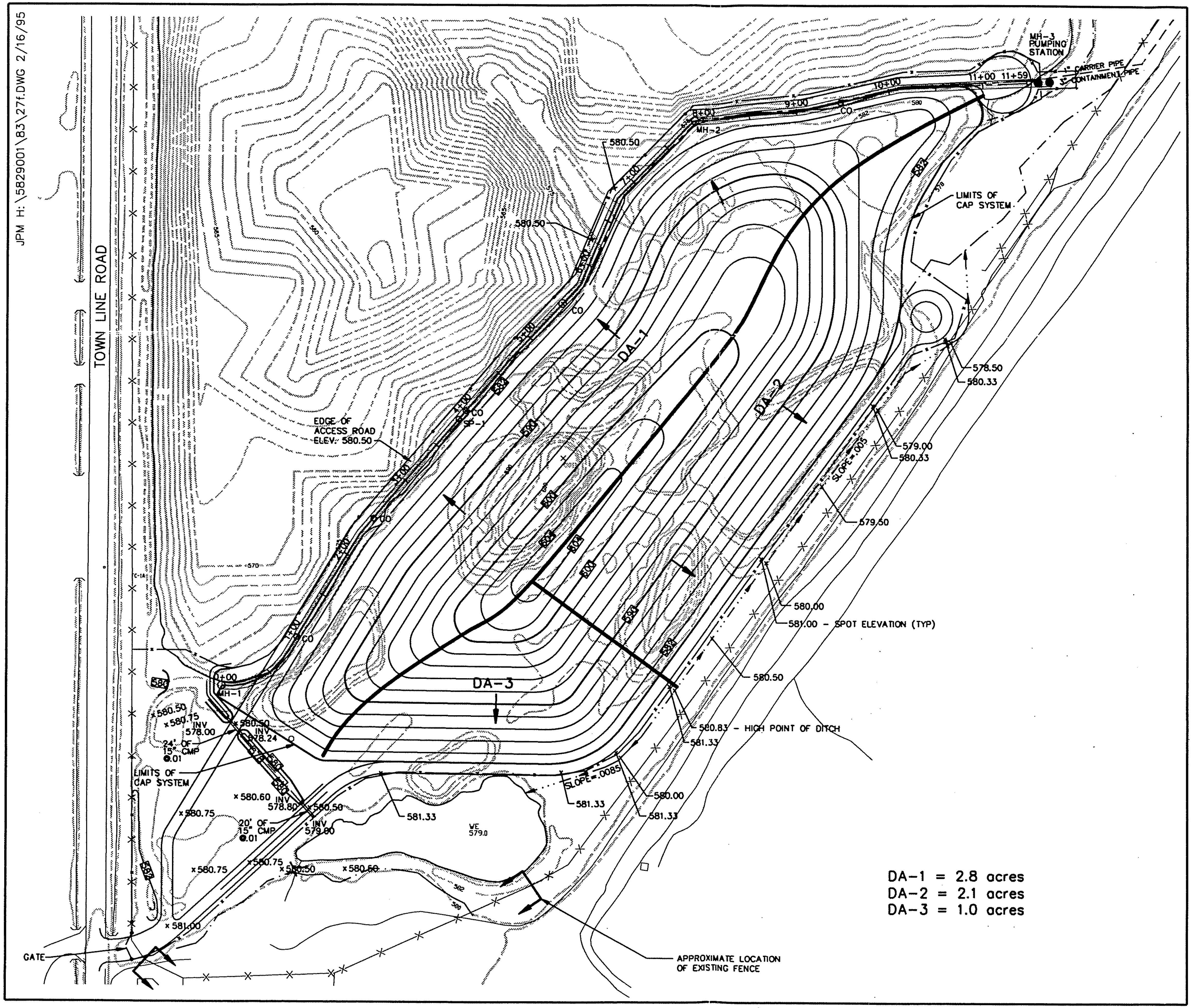
TYPICAL CROSS-SECTION GROUND WATER COLLECTION TRENCH & CONTAINMENT BERM

NOT TO SCALE

FILE NO. 5829.001-19F

O'BRIEN & GERE ENGINEERS INC.

FIGURE 4-3



LEGEND

- WETLAND AREA
- EXISTING FENCE
- UTILITY POLE
- 565 EXISTING ELEVATION CONTOUR
- 1" HDPE PROPOSED PUMP STATION AND DOUBLED WALL FORCE MAIN
- ℄ PROPOSED SWALE
- 5+00 CO GROUND WATER COLLECTION TRENCH & CLEAN OUT
- PROPOSED SIX FOOT HIGH CHAINLINK FENCE
- DRAINAGE AREA BOUNDARY
- SURFACE WATER FLOW DIRECTION
- DA-1 DRAINAGE AREA 1

FRONTIER CHEMICAL
PENDLETON SITE
TOWN OF PENDLETON,
NIAGARA COUNTY, NY
REMEDIAL DESIGN

SURFACE WATER DRAINAGE PATTERNS

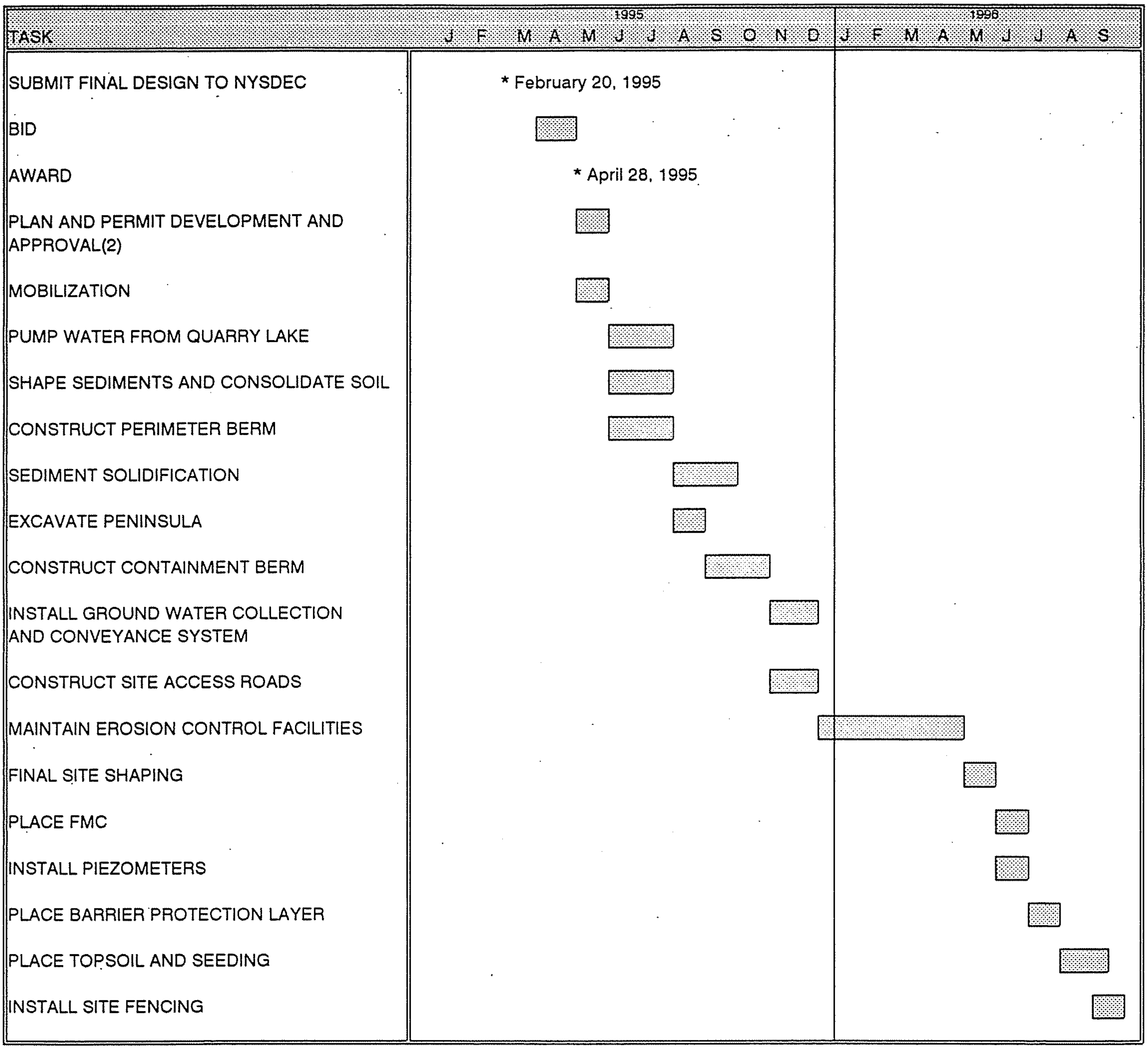
NOT TO SCALE

FILE NO. 5829.001-27F

O'BRIEN & GERE ENGINEERS INC.

FIGURE 8-1

FRONTIER CHEMICAL - PENDLETON SITE
TOWN OF PENDLETON, NIAGARA COUNTY, NEW YORK
ANTICIPATED CONSTRUCTION SCHEDULE(1)



NOTES:
(1) The schedule will be reviewed and revised, as appropriate, by the Remedial Action Contractor.
(2) Assumes all plans and permits will be submitted simultaneously for NYSDEC review.

SC:PEN(1)\109
1/17/95

Appendices

O'BRIEN & GERE
ENGINEERS, INC.

APPENDIX A

WETLAND DELINEATION REPORT

5829.001

Report

Wetland Delineation

Frontier Chemical - Pendleton Site
Town of Pendleton, Niagara County, New York

Pendleton Site PRP Group

October 1994

O'BRIEN & GERE ENGINEERS, INC.

5000 Brittonfield Parkway
East Syracuse, New York 13221

Contents

Figures

Appendixes

1. Introduction

This report presents the results of the wetland identification and delineation performed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere Engineers) at the 22-acre Frontier Chemical - Pendleton Site (site), Town of Pendleton, Niagara County, New York (Figure 1-1). The wetland delineation was performed to accurately locate wetland boundaries to enable an evaluation of wetland impacts associated with remedial activities on the site. The site visit for wetland identification and delineation was performed on June 8 and 9, 1994. The wetland identification and delineation for this project was performed pursuant to policy set forth by Section 404 of the U.S. Clean Water Act and in accordance with the U.S. Army Corps of Engineers (ACOE) 1987 Wetlands Delineation Manual (Manual).

Level 3 of the Routine Determination Method outlined in the Manual was the method selected for the delineation of the wetland boundaries. Level 1 or 2 can be used if sufficient site-specific environmental information is available which would preclude the performance of a site visit. Routine determinations, as described in the Manual, involve rapid methods for determining wetland and nonwetland areas. The Comprehensive Determination Method was not selected for use at this site as it is only used for very complex conditions or when rigorous quantitative documentation is required. Level 3 of the Routine Determination Method is a combination of:

1. Off-site data review; and
2. On-site inspection.

Level 3 is used when there is insufficient off-site data available on the vegetation, soils, and hydrology of a site to characterize and determine the extent of wetlands without an on-site inspection. Off-site activities were conducted by O'Brien & Gere Engineers to gather and evaluate available background information regarding environmental conditions at the site. On-site activities consisted of collecting field data related to soils, vegetation, and hydrology required to identify and delineate wetland boundaries. Field data was gathered at sample plots in each potential wetland area as well as in corresponding adjacent upland areas.

2.1.2. Topographic and wetland mapping

NYSDEC delineates regulated wetlands in New York State primarily on the presence of hydrophytic vegetation using aerial photographs and on-site surveys. Identified wetlands greater than 12.4 acres are regulated by NYSDEC. Regulated wetland boundaries are presented on Freshwater Wetland Maps. Upon review of the NYSDEC Freshwater Wetland Map for the Tonawanda East Quadrangle (NYSDEC, 1984), it appears that a portion of NYSDEC Freshwater Wetland TE-6 is located on the Frontier Chemical-Pendleton Site. See Figure 2-2 for the location of the NYSDEC Fresh Water Wetland TE-6.

Frontier Chemical-Pendleton. The United States Fish and Wildlife Service (USFWS), through its National Wetlands Inventory Project, has produced a series of maps that identify wetland and deepwater areas that provide significant waterfowl habitat in the U.S. Although these maps are helpful in the preliminary identification of wetlands, they do not represent federally regulated wetlands in the United States. Figure 2-3 presents the NWI map for the project area (Tonawanda East Quadrangle, USFWS, 1978) Quadrangle. Three wetland habitat systems exist within the project boundary: a palustrine, open water system (POWZx) and two palustrine, broad-leaved deciduous forest systems (PFO1A, PFO1C). Based on the NWI map, the site plan, and the field visit conducted by O'Brien & Gere Engineers, the POWZx system was identified by O'Brien & Gere Engineers as Quarry Lake and the PFO1A system as the wetland areas at the northern and eastern portions of the site.

The topographic maps of the project site were used to characterize the topography and relief of the project area, relative to adjacent areas. The topographic map illustrates the area has a flat relief which may be favorable for wetlands or ponding water. Figure 1-1 presents the topography of the project area.

2.2. On-site Investigation

The on-site determination procedure consisted of collecting information on the hydrology, vegetation, and soils at chosen sample plots in potential wetland areas and corresponding upland areas at the site. ACOE data sheets were completed for sample plots at each potential wetland and upland location and are presented in Appendix A. Figure 2-4 presents the locations of the sample plots documented in each wetland area.

2.2.1. Soil criterion

Investigatory boreholes were advanced with a Dutch auger at the sample plots in each wetland and upland area to a depth of 12 to 18 inches to evaluate the presence of hydric soil indicators. Based on information presented in the Feasibility Study and observed surface soil characteristics, areas in the vicinity of the Process Area, between Quarry Lake and the abandoned railroad, were disturbed by past industrial activities at the site (URS, 1992). Boreholes were not advanced for sample plots in areas that appeared to have been disturbed from past activities, to avoid contact with potentially contaminated soils. For the sample plots in these areas, vegetative and hydrologic parameters were evaluated to assess the presence of wetlands. Soil conditions within the sample plots were recorded on ACOE Wetland Data Form 1. See Appendix A for the completed forms.

2.2.2. Vegetation criterion

The vegetation criterion of the Manual requires a dominance of hydrophytic vegetation in wetland acres. The USFWS has published the *National List of Plant Species That Occur in Wetlands* (USFWS, 1988) which separates vascular plants into five groups based on their wetland indicator status. The groups are based on a plant species' frequency of occurrence in wetlands as follows:

- Obligate Wetland Plants (OBL) - plants that occur almost always (estimated probability greater than 99%) in wetlands under natural conditions,

- Facultative Wetland Plants (FACW) - plants that occur usually (estimated probability greater than 67% to 99%) in wetlands, but also occur in nonwetlands,

- Facultative Plants (FAC) - plants with a similar likelihood (estimated probability 33% to 67%) of occurring in both wetlands and nonwetlands,

- Facultative Upland Plants (FACU) - Plants that occur sometimes (estimated probability 1% to less than 33%) in wetlands, but occur more often in nonwetlands,
- Obligate Upland Plants (UPL) - Plants that occur rarely (estimated probability less than 1%) in wetlands, but occur almost always in nonwetlands under natural conditions.

A vegetative species is considered hydrophytic if it is classified as either OBL, FACW, or FAC. A dominance of hydrophytic vegetation requires more than 50% of the vegetation in an area be hydrophytic.

In accordance with the ACOE Manual, observations on vegetation focused on dominant plant species for four categories: trees ($\geq$5-inch diameter at breast height), saplings/shrubs (<3-inch diameter and >3.2-feet tall), herbs, and woody vines. Vegetation in the project area at the time of the site visit consisted of a variety of grasses, sedges, rushes, wildflowers, shrubs, and trees. Vegetative species present at the site ranged from FACU species such as *Erigeron philadelphicus* (common fleabane) to OBL species such as *Typha* sp. (cattail). Vegetative species within the sample plots were recorded on ACOE Wetland Data Form 1. See Appendix A for the completed forms.

2.2.3. Hydrology criterion

According to the ACOE Manual, wetland hydrology consists of permanent or periodic inundation, or soil saturation to the surface during the growing season. The project area was examined during the growing season for field indicators of wetland hydrology. The sample plot was considered to exhibit wetland hydrology if the ground surface was, or appeared to have been inundated, the soils were saturated within 12 inches of the ground surface, and/or standing water was visible within the advanced boreholes. Hydrologic indicators within the sample plots were recorded on ACOE Wetland Data Form 1. See Appendix A for the completed forms.

2.2.4. Wetland boundary

The data collected regarding the vegetation, soil, and hydrology were evaluated for the sample plots to identify the wetland boundary. Vegetative and hydrologic indicators were predominantly used to ascertain the wetland/upland boundary at the site. Numerous borehole evaluations were conducted at each site to verify the wetland boundary location. The additional borehole evaluations conducted along the wetland boundaries were not documented on the report forms if they were consistent with the conditions documented in the representative borehole for the area. The identified wetland boundaries were flagged with sequentially numbered orange surveyors tape. These flags were surveyed and transferred to the site plan. See Figure 2-4 for the location of wetlands at the project site.

Based on the wetland identification and delineation activities described in this summary, eight wetland areas were delineated at the site. Representative photographs of the delineated wetlands at the site are presented in Appendix B. Upon completion of the wetland boundary delineations, NYSDEC conducted a wetland boundary verification visit. NYSDEC verbally agreed that the delineated wetland boundaries were consistent with the actual boundaries of NYS Regulated Wetland #TE-6.

References

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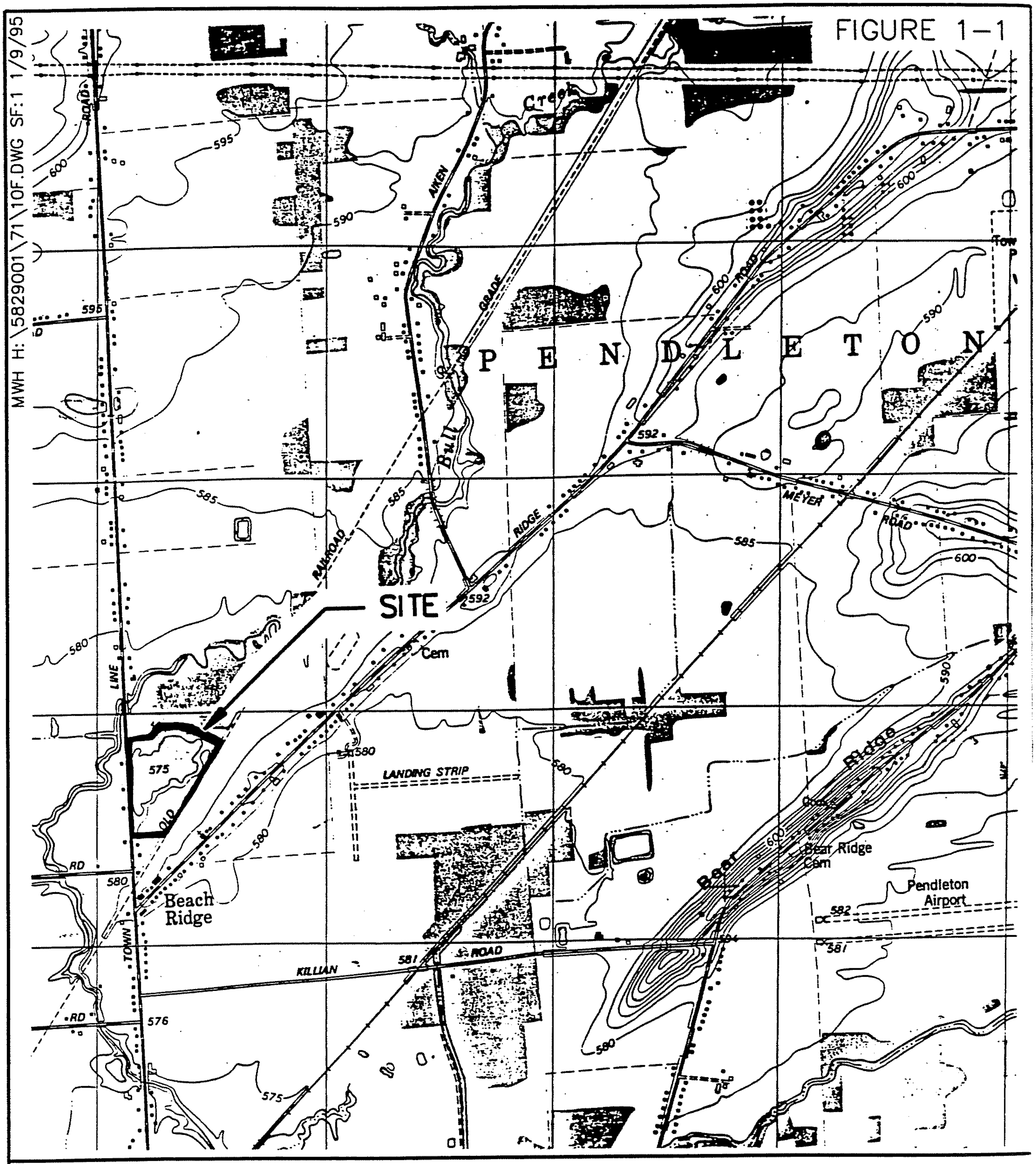
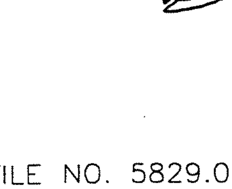
FIGURES

FIGURE 1-1



ADAPTED FROM 7.5 MIN. U.S.G.S. TONAWANDA EAST QUAD MAP, TONAWANDA, NEW YORK



FRONTIER CHEMICAL - PENDLETON SITE
TOWN OF PENDLETON, NIAGARA COUNTY, NY
REMEDIAL DESIGN

SITE LOCATION PLAN

NOT TO SCALE

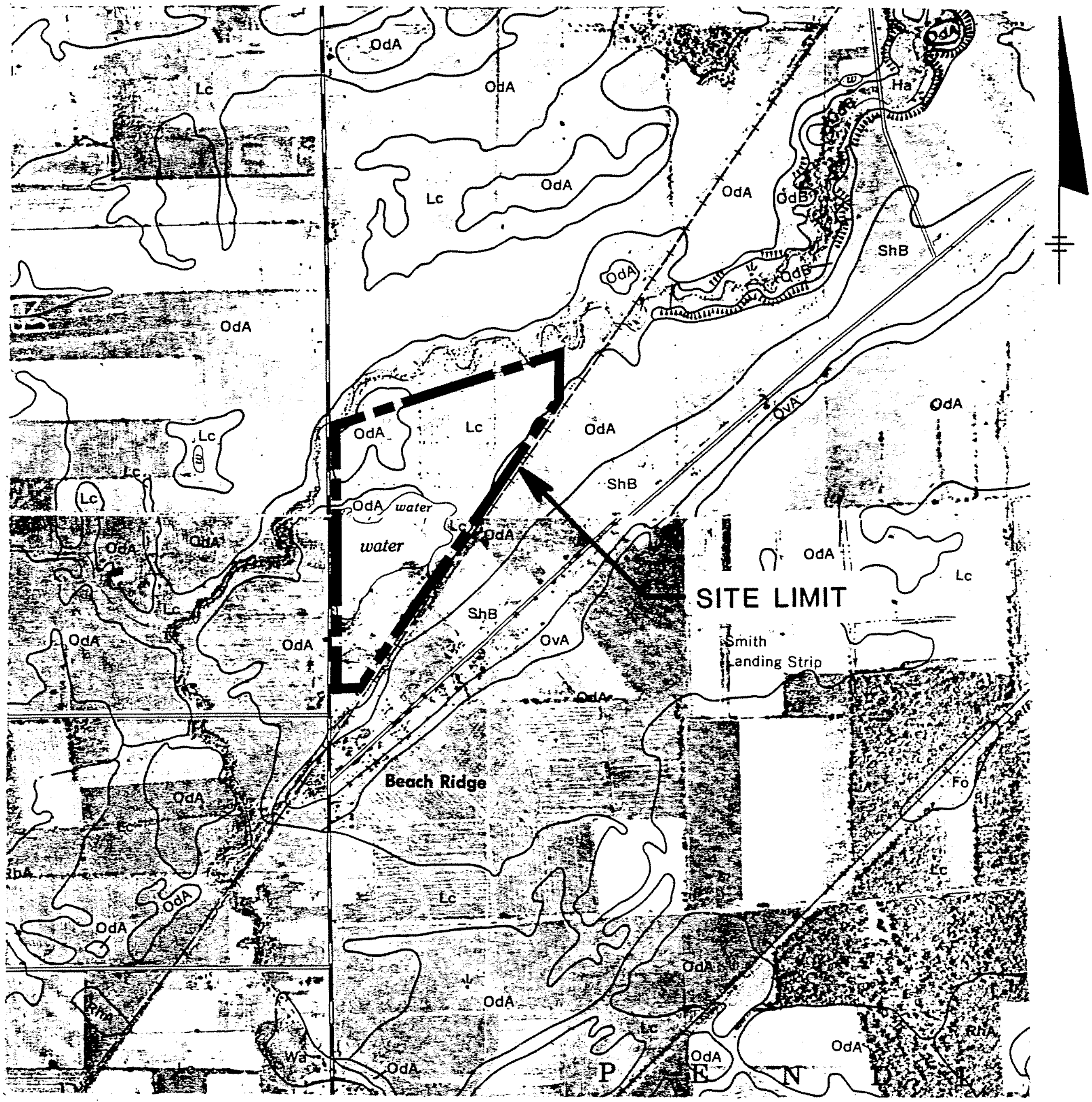
0 2.5 5

APPROX. SCALE IN MILES

FILE NO. 5829.001-10F

O'BRIEN & GERE ENGINEERS INC.

FIGURE 2-1



SOILS MAP

NOT TO SCALE

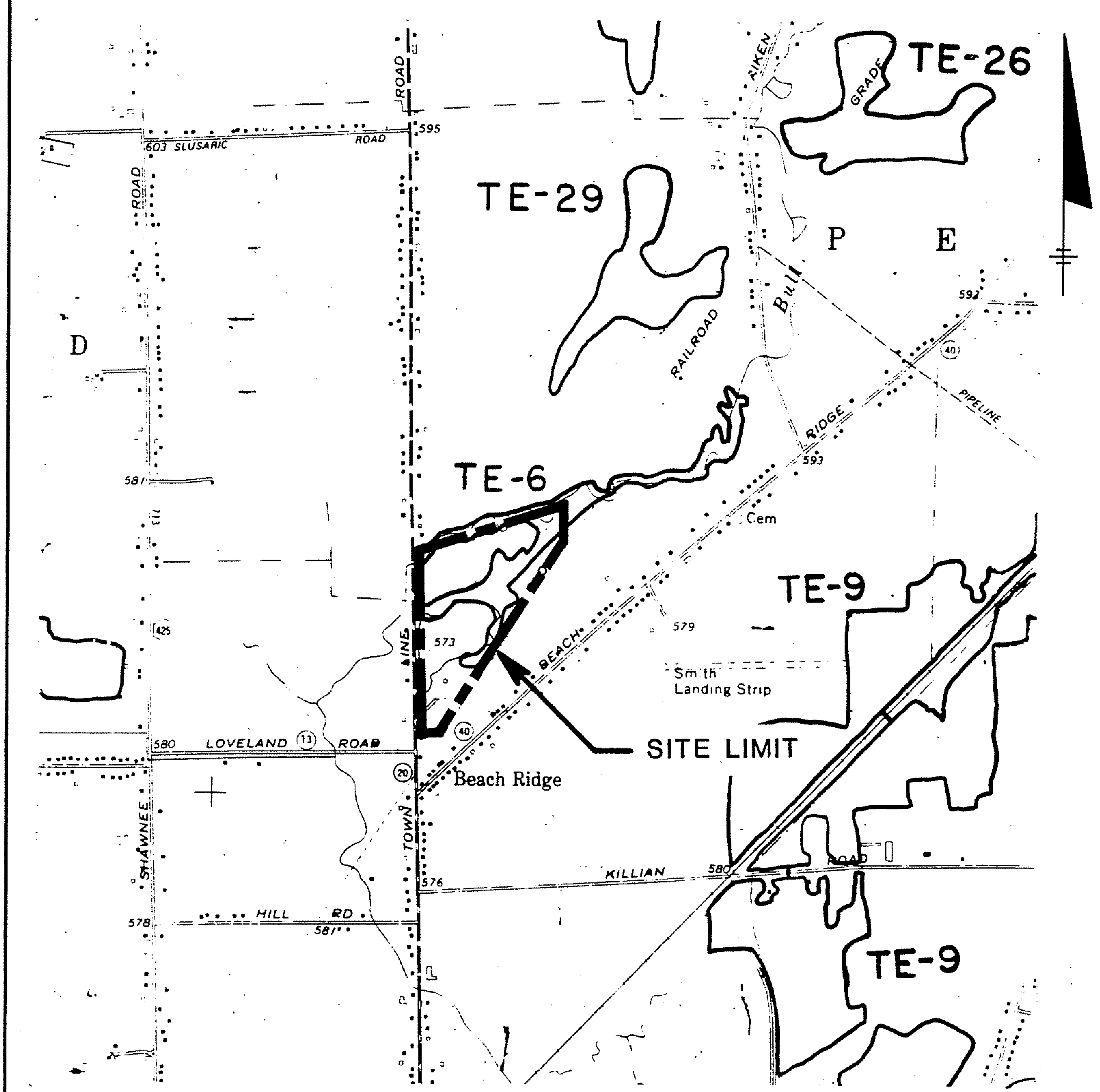
FRONTIER CHEMICAL–PENDLETON SITE
TOWN OF PENDLETON
NIAGARA COUNTY, NEW YORK

SOURCE: NIAGARA COUNTY SOIL SURVEY

DATE: OCT. 3, 1994
FILE No. 5829.001-22F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2-2



NYSDEC REGULATED FRESHWATER WETLAND MAP

APPROX. SCALE: 1"=2000'

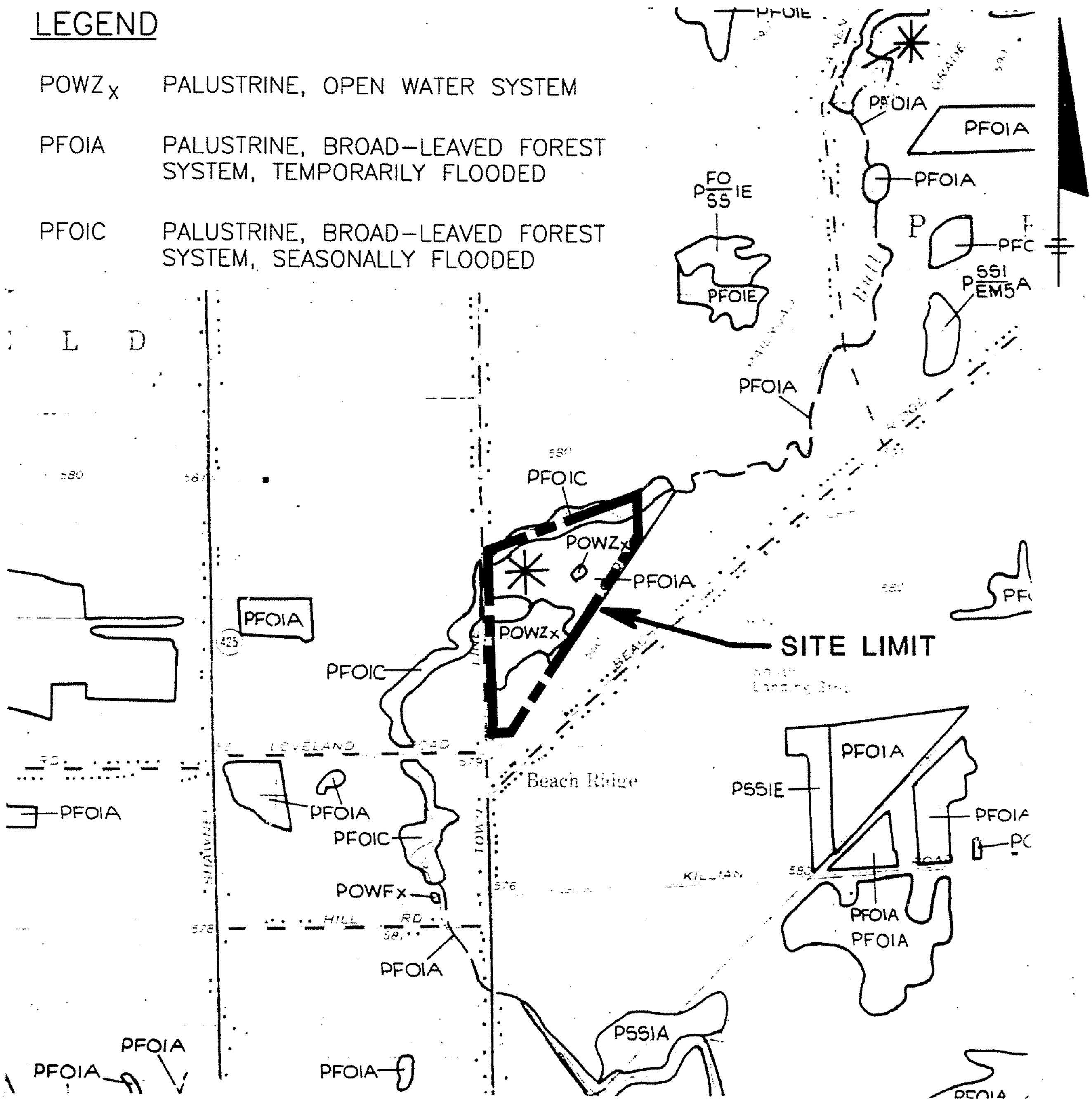
FRONTIER CHEMICAL-PENDLETON SITE
TOWN OF PENDLETON
NIAGARA COUNTY, NEW YORK

SOURCE: NYSDEC FRESHWATER WETLAND MAP
FOR TONAWANDA EAST, N.Y. QUADRANGLE

DATE: OCT. 3, 1994
FILE No. 5829.001-23F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2-3



NATIONAL WETLAND INVENTORY MAP

APPROX. SCALE: 1"=2000'

FRONTIER CHEMICAL-PENDLETON SITE
TOWN OF PENDLETON
NIAGARA COUNTY, NEW YORK

SOURCE: U.S. FISH & WILDLIFE SERVICE-NATIONAL WETLAND INVENTORY. TONAWANDA EAST, N.Y. QUADRANGLE

DATE: OCT. 3, 1994
FILE No. 5829.001-24F

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2-4

NOTE: MAPPING ADOPTED FROM TOPOGRAPHIC SURVEY MAP PREPARED BY NIAGARA BOUNDARY & MAPPING SERVICES, LSPC 345 THIRD STREET, SUITE 470 – CARBORUNDUM CENTER NIAGARA FALLS, NEW YORK 14303
AERIAL PHOTOGRAPHY DATED APRIL 1994

LEGEND

- LIMITS OF QUARRY LAKE
- TREE LINE
- WETLAND AREA
- FENCE
- 565 EXISTING ELEVATION CONTOUR
- 1 APPROX. LOCATION OF WETLAND AREA SAMPLE PLOT

FRONTIER CHEMICAL
PENDLETON SITE
TOWN OF PENDLETON,
NIAGARA COUNTY, NY
REMEDIAL DESIGN

DELINEATED WETLANDS

0 200 400
SCALE IN FEET

FILE NO. 5829.001-25F

O'BRIEN & GERE ENGINEERS INC.

APPENDICES

APPENDIX A

DATA SHEETS

SUMMARY SHEET

PLOT #1

Project/Site: Pendleton - Frontier Chemical
Field Investigator(s): R. Chiarello M. Murphy
Applicant/Owner: ____

Date: 6/8/94
State: NY County: Niagara
Plant Community: ____

#1

Do normal environmental conditions exist at the plant community? (if no, explain) ☐ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☐ Yes ☐ No

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Salix discolor	FACW	Sap/Shrub
2. Populus deltoides	FACW	Sap/Shrub
3. Erigeron philadelphicus	FACU	Herb
4. Solidago graminifolia	FAC	Herb
5. Solidago altissima	FACU-	Herb
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 60 %

Remarks: ____

Rationale
- ☒ Greater than 50% of plant species FAC or wetter.
- ☐ Less than or equal to 50% of plant species FAC or wetter.
- ☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☐ No

Mapped Series/phase: Fill material
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: — Mottle color: —

Remarks: Fill area - disturbed soils

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- __ Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- __ Mottled
- X Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☐ Yes ☒ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☒ No
Depth of Surface Water: — (in.)

Is the soil saturated? ☐ Yes ☒ No
Depth to Saturated Soil: — (in.)

Remarks: ____

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- __ Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- __ Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- X Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☐ Yes ☒ No

- ☐ All wetland criteria met
- ☒ Not all three wetland criteria met.

PLOT #2

SUMMARY SHEET

Project/Site: Pendleton-Frontier Chemical
Field Investigator(s): R. Chiarello + M. Murphy
Applicant/Owner: ____
Date: 6/8/94
State: NY County: Niagara
Plant Community: ____

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☒ Yes ☐ No — Soils have been disturbed ~ fill pla[illegible]

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Salix discolor	FACW	Sap/Shrub
2. Populus deltoides	FACW	Sap/Shrub
3. Typha sp.	FACW	Herb
4. Juncus effusus	FACW+	Herb
5. Fraxinus pennsylvanica	FACW	Sap/Shrub
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %
Remarks: ____

Rationale
☒ Greater than 50% of plant species FAC or wetter.
☐ Less than or equal to 50% of plant species FAC or wetter.
☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☐ No

Mapped Series/phase: Fill material
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: — Mottle color: —

Remarks: Soils disturbed but wet

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- __ Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- __ Mottled
- X Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☑ Yes ☐ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☑ No
Depth of Surface Water: —— (in.)

Is the soil saturated? ☑ Yes ☐ No
Depth to Saturated Soil: 0 (in.)

Remarks: ____

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- ✓ Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- ✓ Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- __ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☒ Yes ☐ No

☒ All wetland criteria met
☐ Not all three wetland criteria met.

PLOT #3

SUMMARY SHEET

Project/Site: Pendleton - Frontier Chem.
Field Investigator(s): R. Chiarello M Murphy
Applicant/Owner:
Date: 6/8/94
State: NY County: Niagara
Plant Community:

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☒ Yes ☐ No soil disturbed fill material plac

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

	Dominant Plant Species	Indicator Status	Stratum
1.	Solidago graminifolia	FAC	Herb
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %
Remarks:

Rationale
☐ Greater than 50% of plant species FAC or wetter.
☒ Less than or equal to 50% of plant species FAC or wetter.
☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☐ No

Mapped Series/phase: disturbed/fill material
Is the soil on the hydric soils list? ☐ Yes ☒ No
Is the soil on the potential hydric soils list? ☐ Yes ☒ No
Is the soil different than mapped? ☒ Yes ☐ No

Matrix color: Mottle color:

Remarks: fill material

Rationale

Hydric Soil Indicators:
__ Histosol
__ Histic Epipedon
__ Sulfidic Odor
__ Aquic Moisture Regime
__ Reducing Conditions
__ Gleyed or Low-Chroma Colors
__ Concretions
__ Organic Streaking in Sandy Soils
__ Mottled
__ Other

Upland Soil Indicators:
__ Matrix chroma of 2 without mottles
__ Matrix chroma greater than 2
X Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☐ Yes ☒ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☒ No
Depth of Surface Water: ____ (in.)

Is the soil saturated? ☐ Yes ☒ No
Depth to Saturated Soil: ____ (in.)

Remarks: Road fill material → no H_2O

Rationale

Wetland Indicators
Primary Indicators:
__ Inundated
__ Saturated in Upper 12 Inches
__ Water Marks
__ Drift Lines
__ Sediment Deposits
__ Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
__ Oxidized Root Channels in Upper 12 inches
__ Water-Stained Leaves
__ Local Soil Survey Data
__ FAC-Neutral Test
__ Other

Upland Indicators:
✓ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☐ Yes ☒ No

☐ All wetland criteria met
☒ Not all three wetland criteria met.

PLOT 4

SUMMARY SHEET

Project/Site: Pendleton - Frontier Chemical
Field Investigator(s): R. Chiarello, M. Murphy
Applicant/Owner: ______

Date: 6/8/94
State: NY County: Niagara
Plant Community: ______

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☐ Yes ☒ No

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☑ Yes ☐ No

	Dominant Plant Species	Indicator Status	Stratum
1.	Ulmus americana	FACW-	Tree
2.	Fraxinus pennsylvanica	FACW	Tree
3.	" "	FACW	Sap/shrub
4.	Juncus effusus	FACW+	Herb
*5.	Salix spp.	FACW	Tree
6.			
7.			
8.			
9.			
10.			
11.			
12.			

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %

Remarks: ______

Rationale
- ☑ Greater than 50% of plant species FAC or wetter.
- ☐ Less than or equal to 50% of plant species FAC or wetter.
- ☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☑ Yes ☐ No

Mapped Series/phase: ______
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: 10YR3/2 Mottle color: 10YR 5/6

Remarks: ______

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- ✓ Mottled
- __ Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☑ Yes ☐ No

Field Observations:

Is the ground surface inundated? ☑ Yes ☐ No
Depth of Surface Water: 1-6 (in.)

Is the soil saturated? ☑ Yes ☐ No
Depth to Saturated Soil: ______ (in.)

Remarks: ______

Rationale

Wetland Indicators

Primary Indicators:
- ✓ Inundated
- ✓ Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- ✓ Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- __ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☑ Yes ☐ No

- ☑ All wetland criteria met
- ☐ Not all three wetland criteria met.

* not in plot, but in wetland boundary

SUMMARY SHEET

PLOT
5

Project/Site: Pendleton - Frontier Chemical
Field Investigator(s): R. Chiarello M. Murphy
Applicant/Owner: ______

Date: 6/8/94
State: NY County: Niagara
Plant Community: ______

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No ______
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☒ Yes ☐ No ~~[illegible]~~ area of fill material

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Populus deltoides	FACW	sap/shrub
2. Typha sp.	OBL	Herb
3. Salix discolor	FACW	Sap/Shrub
4. Salix sp.	FACW	Sap/Shrub
5. Eleocharis sp	FACW/OBL	Herb
6. Juncus spp.	FACW	Herb
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %
Remarks: ______

Rationale
☒ Greater than 50% of plant species FAC or wetter.
☐ Less than or equal to 50% of plant species FAC or wetter.
☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☐ No

Mapped Series/phase: Soil disturbed / fill
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: ______ Mottle color: ______

Remarks: No auger hole advanced - potential cont. conditions.

Rationale

Hydric Soil Indicators:
__ Histosol
__ Histic Epipedon
__ Sulfidic Odor
__ Aquic Moisture Regime
__ Reducing Conditions
__ Gleyed or Low-Chroma Colors
__ Concretions
__ Organic Streaking in Sandy Soils
__ Mottled
X Other

Upland Soil Indicators:
__ Matrix chroma of 2 without mottles
__ Matrix chroma greater than 2
__ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☒ Yes ☐ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☒ No
Depth of Surface Water: ______ (in.)

Is the soil saturated? ☒ Yes ☐ No
Depth to Saturated Soil: NA (in.)

Remarks: Soil boring not advanced because soils wet at surface

Rationale

Wetland Indicators
Primary Indicators:
__ Inundated
__ Saturated in Upper 12 Inches
__ Water Marks
__ Drift Lines
__ Sediment Deposits
X Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
__ Oxidized Root Channels in Upper 12 inches
__ Water-Stained Leaves
__ Local Soil Survey Data
__ FAC-Neutral Test
__ Other

Upland Indicators:
__ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☒ Yes ☐ No

☒ All wetland criteria met
☐ Not all three wetland criteria met.

PLOT	6

SUMMARY SHEET

Project/Site: Pendleton - Frontier Chem
Field Investigator(s): R. Chiarello M Murphy
Applicant/Owner: ____

Date: 6/9/94
State: NY County: Niagara
Plant Community: ____

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☒ Yes ☐ No ~~[illegible]~~ Soils disturbed

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Juncus spp.	FACW	Herb
2. Phragmites communis	FACW	Herb
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %
Remarks: ____

Rationale
☒ Greater than 50% of plant species FAC or wetter.
☐ Less than or equal to 50% of plant species FAC or wetter.
☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☐ No

Mapped Series/phase: Soil disturbed
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: ____ Mottle color: ____

Remarks: No auger hole done pot. cont. conditions

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- __ Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- __ Mottled
- X Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☒ Yes ☐ No

Field Observations:

Is the ground surface inundated? ☒ Yes ☐ No
Depth of Surface Water: 0-3 (in.)

Is the soil saturated? ☒ Yes ☐ No
Depth to Saturated Soil: NA (in.)

Remarks: Soil boring not done, however wet at surface

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- X Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- __ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☒ Yes ☐ No

☒ All wetland criteria met
☐ Not all three wetland criteria met.

PLOT 7

SUMMARY SHEET

Project/Site: Pendleton - Frontier Chemical
Field Investigator(s): R. Chiarello M. Murphy
Applicant/Owner: ______
Date: 6/9/94
State: NY County: Niagara
Plant Community: ______

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☐ Yes ☒ No

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☐ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Typha sp	OBL	Herb
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %

Remarks: ______

Rationale
- ☐ Greater than 50% of plant species FAC or wetter.
- ☐ Less than or equal to 50% of plant species FAC or wetter.
- ☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☒ Yes ☐ No

Mapped Series/phase ______
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: 5Y 4/1 Mottle color: 7.5YR 5/8

Remarks: ______

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- X Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- X Mottled
- __ Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☒ Yes ☐ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☒ No
Depth of Surface Water: ______ (in.)

Is the soil saturated? ☒ Yes ☐ No
Depth to Saturated Soil: 2 (in.)

Remarks: ______

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- X Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- __ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☒ Yes ☐ No

☒ All wetland criteria met
☐ Not all three wetland criteria met.

PLOT 8

SUMMARY SHEET

Project/Site: Pendleton Frontier Chem
Field Investigator(s): R Chiarello M Murphy
Applicant/Owner: ______

Date: 6/9/94
State: NY County: Niagara
Plant Community: ______

Do normal environmental conditions exist at the plant community? (if no, explain) ☒ Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☐ Yes ☒ No

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? ☒ Yes ☐ No

Dominant Plant Species	Indicator Status	Stratum
1. Solidago graminifolia	FAC	Herb
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %

Remarks: ______

Rationale
- ☐ Greater than 50% of plant species FAC or wetter.
- ☐ Less than or equal to 50% of plant species FAC or wetter.
- ☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? ☐ Yes ☒ No

Mapped Series/phase ______
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: 10 YR 3/3 Mottle color: 10YR 5/6

Remarks: ______

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- __ Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- __ Mottled
- __ Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- X Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? ☐ Yes ☒ No

Field Observations:

Is the ground surface inundated? ☐ Yes ☒ No
Depth of Surface Water: ______ (in.)

Is the soil saturated? ☐ Yes ☒ No
Depth to Saturated Soil: ______ (in.)

Remarks: ______

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- __ Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- __ Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- X Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? ☐ Yes ☒ No

- ☐ All wetland criteria met
- ☒ Not all three wetland criteria met.

PLOT	9

SUMMARY SHEET

Project/Site: Pendleton Frontier Chem
Field Investigator(s): R Chiarello M Murphy
Applicant/Owner: ______

Date: 6/9/94
State: NY County: Niagara
Plant Community: ______

Do normal environmental conditions exist at the plant community? (if no, explain) [X] Yes ☐ No
Has the vegetation, soils, and/or hydrology been significantly disturbed? (if yes, explain) ☐ Yes [X] No

VEGETATION

IS THE HYDROPHYTIC VEGETATION CRITERION MET? [X] Yes ☐ No

	Dominant Plant Species	Indicator Status	Stratum
1.	Fraxinus pennsylvanica	FACW	Sap/Shrub
2.	Typha	OBL	Herb
3.	Juncus effusus	FACW	Herb
4.	Salix sp	FACW/OBL	Sap/Shrub
5.	Fraxinus pennsylvanica	FACW	Tree
6.	" "	FACW	Sap/Shrub
7.	Purple loosestrife	FACW	Herb
8.	Salix discolor	FACW	Herb
9.	Carex tribuloides (?)	FACW+	Herb
10.	Carex sp. (vulpinoidea ?)	OBL	Herb
11.			
12.			

Percent of dominant species that are OBL, FACW, and/or FAC: 100 %

Remarks: ______

Rationale

[X] Greater than 50% of plant species FAC or wetter.
☐ Less than or equal to 50% of plant species FAC or wetter.
☐ Other

SOILS

IS THE SOIL HYDRIC CRITERION MET? [X] Yes ☐ No

Mapped Series/phase: ______
Is the soil on the hydric soils list? ☐ Yes ☐ No
Is the soil on the potential hydric soils list? ☐ Yes ☐ No
Is the soil different than mapped? ☐ Yes ☐ No

Matrix color: 2.5Y 5/2 Mottle color: 7.5YR 5/8

Remarks: ______

Rationale

Hydric Soil Indicators:
- __ Histosol
- __ Histic Epipedon
- __ Sulfidic Odor
- __ Aquic Moisture Regime
- __ Reducing Conditions
- [X] Gleyed or Low-Chroma Colors
- __ Concretions
- __ Organic Streaking in Sandy Soils
- [X] Mottled
- __ Other

Upland Soil Indicators:
- __ Matrix chroma of 2 without mottles
- __ Matrix chroma greater than 2
- __ Other

HYDROLOGY

IS THE HYDROLOGY CRITERION MET? [X] Yes ☐ No

Field Observations:

Is the ground surface inundated? ☐ Yes [X] No
Depth of Surface Water: ______ (in.)

Is the soil saturated? [X] Yes ☐ No
Depth to Saturated Soil: ~6 (in.)

Remarks: ______

Rationale

Wetland Indicators

Primary Indicators:
- __ Inundated
- [X] Saturated in Upper 12 Inches
- __ Water Marks
- __ Drift Lines
- __ Sediment Deposits
- [X] Drainage Patterns in Wetlands

Secondary Indicators (2 or more):
- __ Oxidized Root Channels in Upper 12 inches
- __ Water-Stained Leaves
- __ Local Soil Survey Data
- __ FAC-Neutral Test
- __ Other

Upland Indicators:
- __ Insufficient hydrologic indicators met. No primary indicators and less than two secondary indicators observed.

JURISDICTIONAL DETERMINATION AND RATIONALE

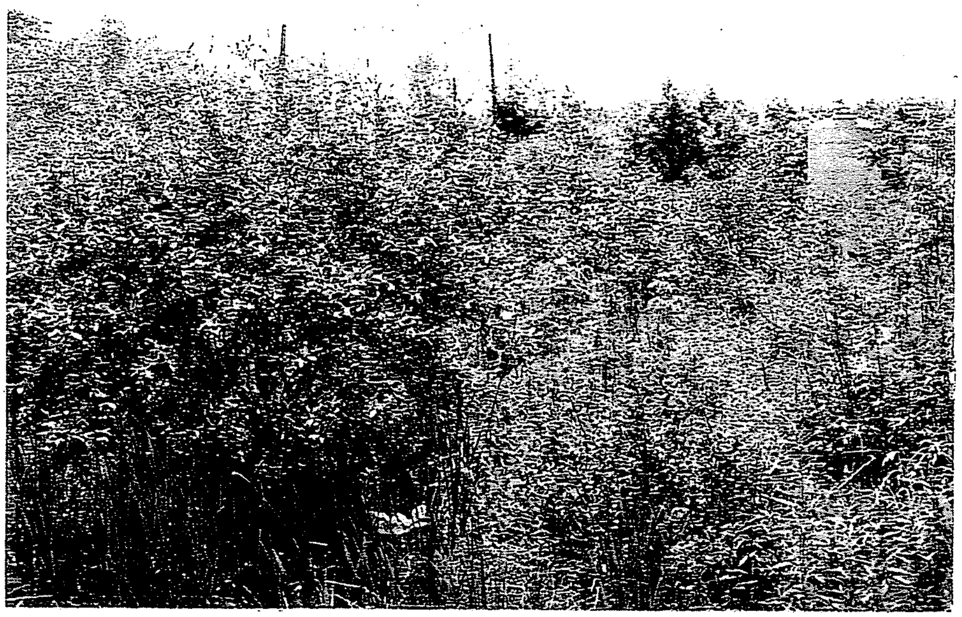
Is the plant community a wetland? [X] Yes ☐ No

[X] All wetland criteria met
☐ Not all three wetland criteria met.

APPENDIX B

SITE PHOTOGRAPHS

<u>PHOTOGRAPH LOG SHEET</u>



PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 1

PHOTO BY: Ron Chiarello

PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 2

PHOTO BY: Ron Chiarello

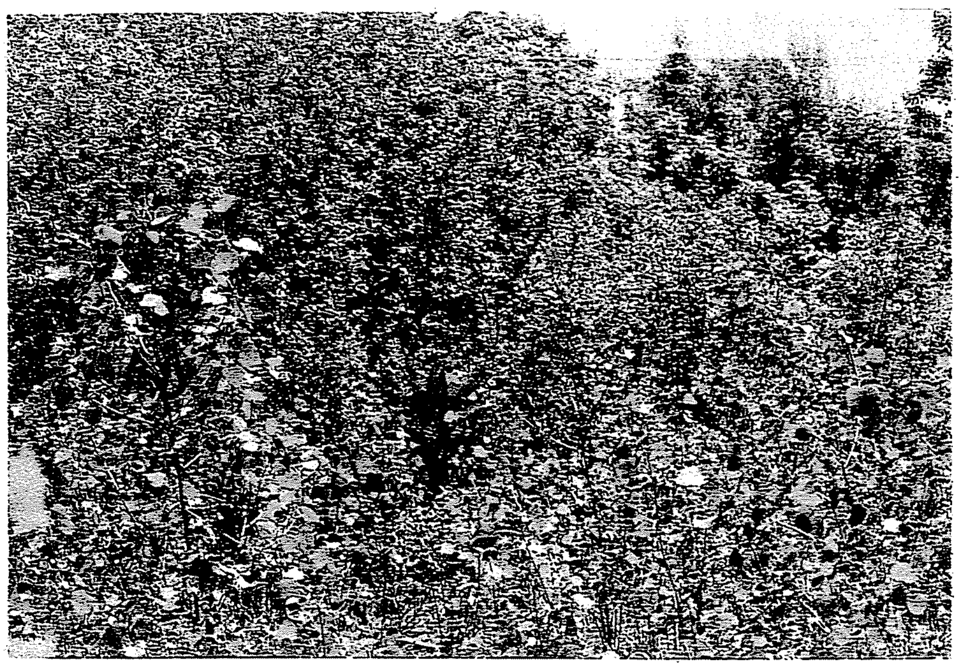
PHOTOGRAPH LOG SHEET

PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 3

PHOTO BY: Ron Chiarello



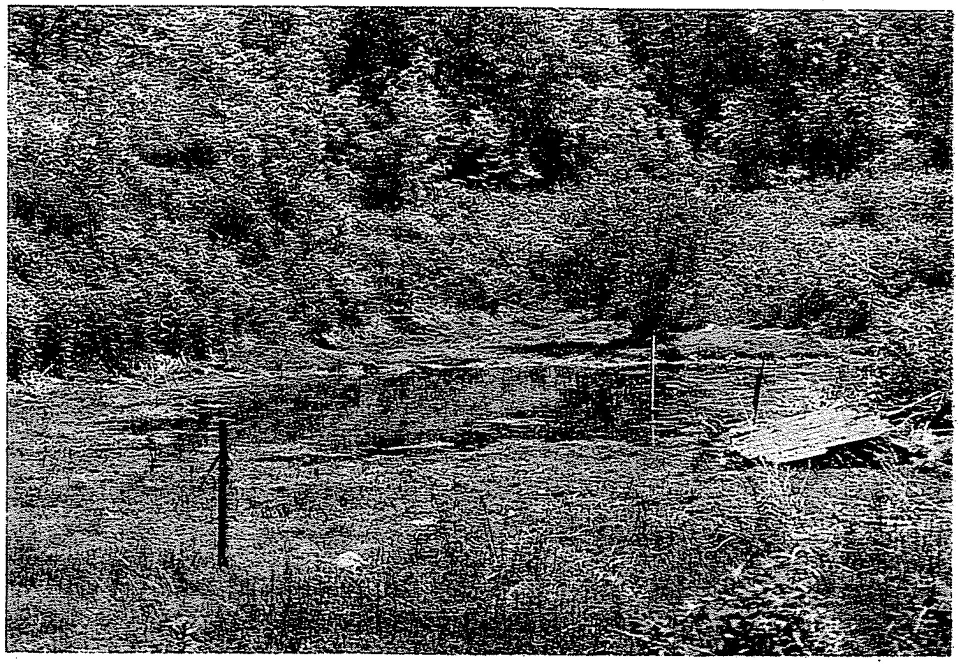
PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 4

PHOTO BY: Ron Chiarello

PHOTOGRAPH LOG SHEET



PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 5

PHOTO BY: Ron Chiarello

PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 6

PHOTO BY: Ron Chiarello

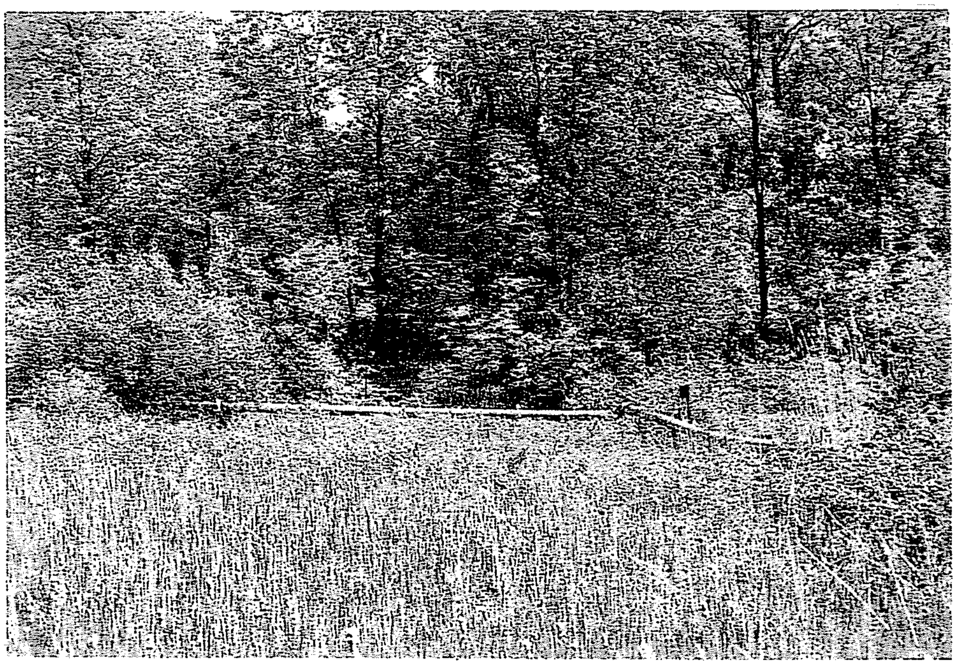
PHOTOGRAPH LOG SHEET

PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 7

PHOTO BY: Ron Chiarello



PROJECT: Frontier Chemical -Pendleton Site, Town of Pendleton, Niagara County, NY

DATE: September 9, 1994

DESCRIPTION: Wetland # 8

PHOTO BY: Ron Chiarello

APPENDIX B

TABLES

TABLE B-1
FRONTIER CHEMICAL - PENDLETON SITE

NIAGARA COUNTY SEWER DISTRICT NO.1
DISCHARGE PARAMETERS

Compound	Maximum Concentration (Unless Noted)
pH	allowable range: 5.5 - 9.5 SU
Cyanides	2 mg/l
Temperature	150°F
Oil & Grease	100 mg/l
Chromium (Total)	5.33 mg/l
Copper	3.38 mg/l
Zinc	4.66 mg/l
Nickel	4.33 mg/l
Cadmium	0.22 mg/l
Arsenic	0.40 mg/l
Barium	4.0 mg/l
Boron	4.0 mg/l
Lead	1.0 mg/l
Manganese	4.0 mg/l
Mercury	0.001 mg/l
Selenium	0.02 mg/l
Silver	0.66 mg/l
BOD*	300 mg/l
Suspended Solids*	300 mg/l
Total Phosphorus*	10 mg/l

* Discharge may be above limits as negotiated with District.

TABLE B-2
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER & GROUND WATER
VOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	GROUND WATER									SURFACE WATER
	MW88-13A	MW85-2S	MW88-2A	MW88-1A	MW85-3S	MW88-10A	MW88-4A	MW88-11A	MW88-8A	SW-1
Chloromethane	ND	ND	ND	ND	ND (4)	ND (6)	ND (7)	ND (8)	ND (9)	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	1 J	ND	ND	ND	ND	ND	140	2,100	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	2 BJ	ND	ND	ND	ND	ND	ND	ND	3,200	3 BJ
Acetone	10 J	ND	ND	14	36,000	ND	ND	ND	33,000	5 J
Carbon Disulfide	ND	73	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	51	ND	ND	ND
1,1-Dichloroethane	8 J	ND	15	14	ND	ND	100	ND	ND	ND
1,2-Dichloroethene (total)	2 J	ND	ND	130	ND	16,000	460	27,000	25,000	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	3 J	ND	ND	ND	250,000 (5)	ND	110	1,000 J	32,000	ND
2-Butanone	ND	ND	ND	ND	ND (4)	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	360	ND	ND	ND
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	12,000	ND	5,500	20,000	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	1 J	ND	ND	ND	ND	ND	ND	1,000 J	6,500	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	11,000	16,000	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	510,000 (5)	94,000	350	4,100	16,000	ND
Chlorobenzene	4 J	ND	ND	ND	ND (4)	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTE: (1) All concentrations are expressed in ug/l (ppb).
(2) J - Indicates an estimated value.
(3) B - Indicates contaminant also found in Blank.
(4) Samples were analyzed at a dilution factor of 1000.
(5) Samples were analyzed at a dilution factor of 5000.
(6) Samples were analyzed at a dilution factor of 500.
(7) Samples were analyzed at a dilution factor of 5.
(8) Samples were analyzed at a dilution factor of 100.
(9) Samples were analyzed at a dilution factor of 200.
(10) ND - Not Detected.

TABLE B-3
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER AND GROUND WATER
SEMIVOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	SW-1 (ug/l)	COMP 1 (ug/l)	COMP 2 (ug/l)
Phenol	ND	ND	7900 (4)
bis(2-Chloroethyl)ether	ND	ND	ND
2-Chlorophenol	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND
1,2-Dichlorobenzene	ND	3 J	ND
2-Methylphenol	ND	ND	310 J
2,2'-oxybis(1-Chloropropane)	ND	ND	ND
4-Methylphenol	ND	ND	890 J
N-Nitroso-di-n-propylamine	ND	ND	ND
Hexachloroethane	ND	ND	ND
Nitrobenzene	ND	ND	ND
Isophorone	34	ND	ND
2-Nitrophenol	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND
Benzoic Acid	ND	ND	ND
bis(2-Chloroethoxy)methane	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND
Naphthalene	ND	ND	ND
4-Chloroaniline	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND
2-Nitroaniline	ND	ND	ND
Dimethylphthalate	ND	ND	ND
Acenaphthylene	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND

NOTE: (1) All concentrations reported in ug/l (ppb).
(2) B - Indicates contaminant also found in Blank.
(3) J - Indicates an estimated value.
(4) Samples were analyzed at a dilution factor of 100.
(5) ND - Not Detected.
(6) Composite 1 comprised of samples from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A.
(7) Composite 2 comprised of samples from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A.

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TABLE B-3
(Continued)

FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER AND GROUND WATER
SEMIVOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	SW-1 (ug/l)	COMP 1 (ug/l)	COMP 2 (ug/l)
3-Nitroaniline	ND	ND	ND (4)
Acenaphthylene	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND
4-Nitrophenol	ND	ND	ND
Dibenzofuran	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND
Diethylphthalate	ND	ND	ND
4-Chlorophenyl-phenylether	ND	ND	ND
Fluorene	ND	ND	ND
4-Nitroaniline	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND
4-Bromophenyl-phenylether	ND	ND	ND
Hexachlorobenzene	ND	ND	ND
Pentachlorophenol	ND	ND	ND
Phenanthrene	ND	ND	ND
Anthracene	ND	ND	ND
Carbazole	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Butylbenzylphthalate	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND
Chrysene	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ND	4 BJ	ND
Di-n-octylphthalate	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND

NOTE: (1) All concentrations reported in ug/l (ppb).
(2) B - Indicates contaminant also found in Blank.
(3) J - Indicates an estimated value.
(4) Samples were analyzed at a dilution factor of 100.
(5) ND - Not Detected.
(6) Composite 1 comprised of samples from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A.
(7) Composite 2 comprised of samples from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A.

TABLE B-4
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER & GROUND WATER
PESTICIDE/PCBs
JUNE 1994

PARAMETER	SURFACE WATER	GROUND WATER	
	SW-1	COMPOSITE 1	COMPOSITE 2
alpha-BHC	ND	ND	0.059 P
beta-BHC	0.0035 JP	ND	ND
delta-BHC	0.0082 J	ND	ND
gamma-BHC (Lindane)	0.0067 JP	0.0087 JP	ND
Heptachlor	0.0085 JP	0.0077 JP	ND
Aldrin	0.0038 J	ND	0.064 BP
Heptachlor epoxide	ND	ND	0.016 JP
Endosulfan I	0.0026 JP	ND	ND
Dieldrin	ND	ND	ND
4,4'-DDE	0.0027 BJ	ND	0.036 BJP
Endrin	ND	ND	ND
Endosulfan II	0.0025 BJP	0.0096 BJP	0.055 JP
4,4'-DDD	ND	0.034 J	ND
Endosulfan sulfate	ND	ND	ND
4,4'-DDT	ND	ND	ND
Methoxychlor	ND	0.0062 JP	ND
Endrin ketone	ND	ND	ND
Endrin aldehyde	ND	ND	ND
alpha-Chlordane	ND	ND	ND
gamma-Chlordane	ND	ND	ND
Toxaphene	ND	ND	ND
Aroclor-1016	ND	ND	ND
Aroclor-1221	ND	ND	ND
Aroclor-1232	ND	ND	ND
Aroclor-1242	ND	ND	ND
Aroclor-1248	ND	ND	ND
Aroclor-1254	ND	ND	ND
Aroclor-1260	ND	ND	ND

NOTE: (1) All concentrations are expressed in ug/l (ppb).
(2) B - Indicates contaminant also found in Blank.
(3) J - Indicates an estimated value.
(4) P - Indicates that there is greater than 25% difference for detected concentrations between the two gas chromatograph (GC) column analyses. The lower of the two values is reported in accordance with NYSDEC ASP 91-3.
(5) ND - Not Detected.
(6) Composite 1 comprised of samples from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A.
(7) Composite 2 comprised of samples from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A.

TABLE B-5
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER & GROUND WATER
METALS
JUNE 1994

PARAMETER	SW-1		COMPOSITE 1		COMPOSITE 2	
Aluminum	0.642		21.9		3.89	
Antimony	0.0025	B	0.0041	B	0.0331	B
Arsenic	ND		0.0068	B	0.013	
Barium	0.0394	B	0.192	B	0.0847	B
Beryllium	ND		0.0015	B	0.0006	B
Boron	0.309	B	0.857	B	1.52	
Cadmium	0.00062	B	0.0012	B	0.0022	B
Calcium	96.4		383		374	
Chromium	0.0068	B	0.0626		26.4	
Cobalt	0.0012	B	0.0153	B	0.0094	B
Copper	0.0043	B	0.0624		0.0237	B
Cyanide	ND		ND		1.4	(5)
Iron	0.69		24.7		6.97	
Lead	0.0012	B	0.0265	(4)	0.0114	B (4)
Magnesium	21.8		179		68.7	
Manganese	0.0105	B	1.13		0.588	
Mercury	ND		0.00036		0.00028	
Nickel	0.017	B	0.0792		0.146	
Potassium	2.97	B	10.5		65.5	
Selenium	ND		0.0022	B	0.0031	B
Silver	ND		ND		ND	
Sodium	26.7		88.3		439	
Thallium	0.0059	B	0.0055	B	ND	
Vanadium	0.0012	B	0.0394	B	0.0098	B
Zinc	0.0203		0.155		0.0747	

NOTE: (1) All concentrations are expressed in mg/l (ppm).
(2) B - Indicates contaminant also found in Blank.
(3) ND - Not Detected.
(4) Lead was analyzed at a 1/5 dilution.
(5) Cyanide was analyzed at a 1/5 dilution.
(6) Composite 1 comprised of samples from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A.
(7) Composite 2 comprised of samples from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A.

TABLE B-6
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER AND GROUND WATER
WATER MATRIX
JULY 1994

PARAMETER	SURFACE WATER	GROUND WATER	
	SW-1	COMPOSITE-1	COMPOSITE-2
BOD 5	ND	ND	ND
Phenol	ND	ND	10
Total cyanide	ND	ND	1.4
Total dissolved solids	600	2700	3200
Total phosphorus	ND	1.2	0.26
Total suspended solids	9	890	190
pH (STD units)	8.2	7.1	7.6

NOTE: (1) All concentrations are expressed in mg/l (ppm) unless otherwise noted.
(2) ND - Not Detected.
(3) Composite 1 comprised of samples from MW-88-2A, MW-85-2S, MW-88-13A, and MW-88-1A.
(4) Composite 2 comprised of samples from MW-88-10A, MW-85-3S, MW-88-8A, MW-88-4A, and MW-88-11A.

TABLE B-7
FRONTIER CHEMICAL - PENDLETON SITE

ANALYTICAL RESULTS - SURFACE WATER AND GROUND WATER
DIOXIN ANALYSIS
NOVEMBER 1994

PARAMETER	SURFACE WATER	GROUND WATER
	SW-1	COMPOSITE 1
2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ND

NOTE: (1) All concentrations are expressed in parts per quadrillion (ppq) unless otherwise noted.
(2) ND - Not Detected.
(3) Composite 1 is comprised of samples from MW-85-2S, MW-85-3S, MW-88-1A, MW-88-2A, MW-88-4A, MW-88-8A, MW-88-10A, MW-88-11A, and MW-88-13A.

TABLE B-8

FRONTIER CHEMICAL - PENDLETON SITE

SUMMARY OF GEOTECHNICAL TESTING PROGRAM

SAMPLE IDENTIFICATION	SOIL TYPE	METHOD OF SAMPLE COLLECTION	MOISTURE CONTENT (ASTM D2216)	UNIT WEIGHT	PARTICLE SIZE (ASTM D422)	HYDROMETER (ASTM D422)	SPECIFIC GRAVITY (ASTM D854)	PLASTICITY INDEX (ASTM D4318)	CU TRIAXIAL (ASTM D4767)	CONSOLIDATION (ASTM D2435)	BASIS OF SELECTION FOR TESTING
TP-1 5'	clay	5 gallon bucket			X	X	X	X			along collection trench alignment
TP-2 1.5'	fill	16 oz. glass jar	X								along collection trench alignment
TP-2 1-2'	fill	5 gallon bucket			X	X	X	X			along collection trench alignment
TP-2 14 - 16'	plastic clay	shelby tube								X	along collection trench alignment
TP-2 15'	plastic clay	16 oz. glass jar	X								along collection trench alignment
TP-3 4'	mottled clay	16 oz. glass jar	X								along collection trench alignment
TP-3 10-12'	plastic clay	shelby tube		X					X		along collection trench alignment
TP-4 5.5'	mottled clay	16 oz. glass jar	X								along collection trench alignment
TP-4 5.5-7.5'	varved light and mottled clay	shelby tube		X							along collection trench alignment
TP-4 8.5'	light varved clay	16 oz. glass jar	X								along collection trench alignment
TP-4 12.5'	plastic clay	16 oz. glass jar	X								along collection trench alignment
TP-4 14'	plastic clay	5 gallon bucket			X	X	X	X			along collection trench alignment
TP-4 14'	plastic clay	16 oz. glass jar	X								along collection trench alignment
TP-5 3' north	mottled clay	16 oz. glass jar	X								along collection trench alignment
TP-5 3' south	mottled clay	16 oz. glass jar	X								along collection trench alignment
TP-5 9'	light varved clay	5 gallon bucket			X	X	X	X			along collection trench alignment
TP-5 12-14'	plastic clay	shelby tube		X							along collection trench alignment
TP-6 1-2'	mottled clay	16 oz. glass jar	X								perimeter of proposed cap
TP-6 3.3-5.3'	mottled clay	shelby tube		X					X		perimeter of proposed cap

TABLE B-8

(CONTINUED)

FRONTIER CHEMICAL - PENDLETON SITE

SUMMARY OF GEOTECHNICAL TESTING PROGRAM

SAMPLE IDENTIFICATION	SOIL TYPE	METHOD OF SAMPLE COLLECTION	MOISTURE CONTENT (ASTM D2216)	UNIT WEIGHT	PARTICLE SIZE (ASTM D422)	HYDROMETER (ASTM D422)	SPECIFIC GRAVITY (ASTM D854)	PLASTICITY INDEX (ASTM D4318)	CU TRIAXIAL (ASTM D476	CONSOLIDATION (ASTM D2435)	BASIS OF SELECTION FOR TESTING
TP-6 4'	mottled clay	5 gallon bucket			X	X	X	X			perimeter of proposed cap
TP-6 4'	fill	16 oz. glass jar	X								perimeter of proposed cap
TP-7 1-2'	fill	5 gallon bucket			X	X	X	X			perimeter of proposed cap
TP-7 5'	mottled clay	16 oz. glass jar	X								perimeter of proposed cap
TP-7 6.5-8.5'	mottled clay	shelby tube								X	perimeter of proposed cap
TP-7 12'	plastic clay	5 gallon bucket			X	X	X	X			perimeter of proposed cap
TP-7 13'	plastic clay	16 oz. glass jar	X								perimeter of proposed cap
TP-7 15-17'	plastic clay	shelby tube		X							perimeter of proposed cap
TP-8 9'	light varved clay	16 oz. glass jar	X								perimeter of proposed cap
TP-11 fill	fill	16 oz. glass jar	X								along collection trench alignment
TP-11 11.5-13 5'	light varved clay	shelby tube		X							along collection trench alignment
TOTAL NUMBER OF SAMPLES SUBMITTED			15	6	7	7	7	7	2	2	
TOTAL NUMBER OF TEST RESULTS			21 (note 3)	8 (note 4)	7	7	9 (note 5)	7	2	2	

NOTES:

1. Test pits TP-1 through TP-5 and TP-10 through TP-14 were installed in vicinity of proposed ground water collection trench.
2. Test pits TP-6 through TP-8 were installed in vicinity of proposed cap perimeter.
3. Six additional values of moisture content are obtained from samples used for analysis of unit weight.
4. Two additional values of unit weight are obtained from samples used for consolidation testing.
5. Two additional values of specific gravity are obtained from samples used for consolidation testing.

TABLE B-9

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - TEST PITS TP-9 AND TP-10
VOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	TP#9 (ug/L)	TP#10, SLUDGE #2 (ug/kg)
Chloromethane	ND	ND
Bromomethane	ND	ND
Vinyl Chloride	ND	ND
Chloroethane	ND	ND
Methylene Chloride	ND	ND
Acetone	ND	ND
Carbon Disulfide	ND	ND
1,1-Dichloroethene	ND	ND
1,1-Dichloroethane	ND	ND
1,2-Dichloroethene (total)	6,400	ND
Chloroform	ND	ND
1,2-Dichloroethane	1,800	ND
2-Butanone	ND	ND
1,1,1-Trichloroethane	2,200	ND
Carbon Tetrachloride	ND	ND
Vinyl Acetate	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
cis-1,3-Dichloropropene	ND	ND
Trichloroethene	1,300	ND
Dibromochloromethane	ND	ND
1,1,2-Trichloroethane	ND	ND
Benzene	ND	ND
trans-1,3-Dichloropropene	ND	ND
Bromoform	ND	ND
4-Methyl-2-pentanone	ND	ND
2-Hexanone	ND	ND
Tetrachloroethene	1,600	ND
1,1,2,2-Tetrachloroethane	ND	ND
Toluene	5,700	240,000
Chlorobenzene	ND	ND
Ethylbenzene	ND	15,000
Styrene	ND	ND
Xylene	ND	240,000

NOTE: (1) TP#9 expressed in ug/l (ppb).
(2) TP#10 expressed in ug/kg (ppb) dry weight.
(3) ND - Not Detected.

TABLE B-10

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - TEST PITS TP-9 AND TP-10
SEMIVOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	TP #9 (ug/l)	TP #10, SLUDGE #2 (ug/kg)
Phenol	ND	ND
bis(2-Chloroethyl)ether	960	ND
2-Chlorophenol	ND	ND
1,3-Dichlorobenzene	ND	ND
1,4-Dichlorobenzene	ND	ND
1,2-Dichlorobenzene	ND	ND
2-Methylphenol	ND	ND
2,2'-oxybis(1-Chloropropane)	ND	ND
4-Methylphenol	ND	ND
N-Nitroso-di-n-propylamine	ND	ND
Hexachloroethane	ND	ND
Nitrobenzene	1700	ND
Isophorone	ND	ND
2-Nitrophenol	ND	ND
2,4-Dimethylphenol	ND	ND
Benzoic Acid	ND	ND
bis(2-Chloroethoxy)methane	ND	ND
2,4-Dichlorophenol	ND	ND
1,2,4-Trichlorobenzene	ND	ND
Naphthalene	ND	15000
4-Chloroaniline	ND	ND
Hexachlorobutadiene	ND	ND
4-Chloro-3-methylphenol	ND	ND
2-Methylnaphthalene	ND	26000
Hexachlorocyclopentadiene	ND	ND
2,4,6-Trichlorophenol	ND	ND
2,4,5-Trichlorophenol	ND	ND
2-Chloronaphthalene	ND	ND
2-Nitroaniline	ND	ND
Dimethylphthalate	ND	ND
Acenaphthylene	ND	ND
2,6-Dinitrotoluene	ND	ND

NOTE: (1) ND - Not Detected.
(2) TP#9 expressed in ug/l (ppb).
(3) TP#9 expressed in ug/kg (ppb) dry weight.
(4) J - Indicates an estimated value.

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TABLE B-10
(Continued)

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - TEST PITS TP-9 AND TP-10
SEMIVOLATILE ORGANIC COMPOUNDS
JUNE 1994

PARAMETER	TP #9 (ug/l)	TP #10, SLUDGE #2 (ug/kg)
3-Nitroaniline	ND	ND
Acenaphthylene	ND	ND
2,4-Dinitrophenol	ND	ND
4-Nitrophenol	ND	ND
Dibenzofuran	ND	ND
2,4-Dinitrotoluene	ND	ND
Diethylphthalate	ND	ND
4-Chlorophenyl-phenylether	ND	ND
Fluorene	ND	ND
4-Nitroaniline	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND
N-Nitrosodiphenylamine (1)	ND	ND
4-Bromophenyl-phenylether	ND	ND
Hexachlorobenzene	ND	ND
Pentachlorophenol	ND	ND
Phenanthrene	ND	4,900 J
Anthracene	ND	1,100 J
Di-n-butylphthalate	ND	ND
Fluoranthene	ND	5,800
Pyrene	ND	3,400 J
Butylbenzylphthalate	ND	ND
3,3'-Dichlorobenzidine	ND	ND
Benzo(a)anthracene	ND	2,400 J
Chrysene	ND	2,100 J
bis(2-Ethylhexyl)phthalate	ND	42,000 *
Di-n-octylphthalate	ND	ND
Benzo(b)fluoranthene	ND	ND
Benzo(k)fluoranthene	ND	ND
Benzo(a)pyrene	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND
Dibenz(a,h)anthracene	ND	ND
Benzo(g,h,i)perylene	ND	ND

NOTE: (1) ND - Not Detected.
(2) TP#9 expressed in ug/l (ppb).
(3) TP#9 expressed in ug/kg (ppb) dry weight.
(4) J - Indicates an estimated value.
(5) * - Laboratory Contamination.

TABLE B-11

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - TEST PIT TP-10
POLYCHLORINATED BIPHENYLS (PCBs)
JUNE 1994

PARAMETER	TP#10, SLUDGE #2
PCB-1016	ND
PCB-1221	ND
PCB-1232	ND
PCB-1242	ND
PCB-1248	ND
PCB-1254	27
PCB-1260	ND

NOTE: (1) All concentrations are expressed in mg/kg (ppm) dry weight.
(2) ND - Not Detected

TABLE B-12

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - TEST PIT TP-9

METALS

JUNE 1994

PARAMETER	TP#9
Aluminum	0.3
Antimony	ND
Arsenic	0.016
Barium	ND
Berullium	ND
Cadmium	ND
Calcium	250
Chromium	0.04
Cobalt	ND
Copper	0.01
Iron	3.5
Lead	0.006
Magnesium	39
Manganese	0.99
Mercury	ND
Nickel	ND
Potassium	21
Selenium	ND
Silver	ND
Sodium	53
Thallium	ND
Vanadium	ND
Zinc	0.12

NOTE: (1) All concentrations are expressed in mg/l (ppm).
(2) ND - Not Detected.

TABLE B-13
FRONTIER CHEMICAL-PENDLETON SITE

VALIDATED ANALYTICAL RESULTS - BACKGROUND SOILS ANALYSIS
METALS
JUNE 1994

Soil Boring: Depth (ft.): PARAMETER	#1 4-6	#1 12-14	#2 4-6	#2 16-18	#3 4-6	#3 14-16	#4 4-6	#4 14-16	#5 4-6	#5 14-16	#6 4-6	#6 14-16	7B 4-6	7B 14-16
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	31.5	18.0	29.2	21.4	34.3	20.3	29.5	30.8	23.0	21.8	29.0	29.1	34.8	29.2

NOTE: (1) All concentrations are expressed in mg/kg (ppm) dry weight.
(2) ND - Not Detected.

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TABLE B-14
FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - BACKGROUND SOILS ANALYSIS
VOLATILE ORGANIC COMPOUNDS
JUNE 1994

Soil Boring:	SB #1	#1	#2	#2	#3	#3	#3	#4	#4	#5	#5	#6	#6	7B	7B
Depth (ft.):	12-14	4-6	4-6	16-18	4-6	14-16	14-16 RE	4-6	14-16	4-6	14-16	4-6	14-16	4-6	14-16
PARAMETER															
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	4 BJ	5 BJ	9 BJ	13 B	5 BJ	5 BJ	5 BJ	4 BJ	4 BJ	5 BJ	6 BJ	3 BJ	2 BJ	4 BJ	2 BJ
Acetone	20 B	19 B	16 B	50 B	8 BJ	6 BJ	6 BJ	4 BJ	13 BJ	4 BJ	13 B	ND	15 B	ND	23 B
Carbon Disulfide	2 J	ND	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3 J
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene (total)	ND	1 J	8 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	5 J	2 J	ND	ND	ND	ND	ND	1 J	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	3 BJ	7 BJ	3 BJ	1 BJ	ND	ND	ND	2 J	ND	2 J	ND	2 J	3 BJ	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 J	ND
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	2 J	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	1 J	2 J	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTE: (1) All concentrations are expressed in ug/kg (ppb) dry weight.
(2) ND - Not Detected
(3) B - Indicates contaminant also found in Blank.
(4) J - Indicates an estimated value.

TABLE B-15
FRONTIER CHEMICAL - PENDLETON SITE

SUMMARY OF SEDIMENT DEPTHS

NODE	BORING DEPTH FT	WATER DEPTH FT	SEDIMENT DEPTH FT
1	10.8	10.5	0.3
2	12.7	12.3	0.4
3	1.2	1.1	0.1
4	9.3	9.2	0.1
5	11.2	11.1	0.1
6	0.525	0.5	0
7	9	7.2	1.8
8	1.2	1.2	0
9	14.4	14	0.4
10	13.8	13.5	0.3
11	11	10.3	0.7
12	11	10.5	0.5
13	1.2	1.2	0
14	3.2	3	0.2
15	13.5	13.2	0.3
16	14	13.7	0.3
17	13.6	13.4	0.2
18	12.3	11.8	0.5
19	4.7	4.5	0.2
20	3.5	2.8	0.7
21	13.4	13	0.4
22	13.5	13.4	0.1
23	13.7	13.2	0.5
24	12	11.1	0.9
25	11	10.2	0.8
26	1.4	1.2	0.2
27	17.6	17.4	0.2
28	14.9	14.1	0.8
29	11.1	10.4	0.7
30	9.2	8.5	0.7
31	2.6	2	0.6
32	1.2	1.1	0.1
33	14	13.9	0.1
34	8	7.5	0.5
35	0.4	0.3	0.1
36	17.2	17	0.2
37	13.6	13.2	0.4
38	4.7	4.2	0.5
39	13.5	13	0.5
40	8.2	7.5	0.7
41	17.6	17.3	0.3
42	19.5	19.2	0.3
43	20.6	20.3	0.3
44	8.8	8.5	0.3
45	7.1	6.7	0.4
46	4	3.1	0.9
47	12.8	12.1	0.7
48	10.8	10.5	0.3
49	12.4	12	0.4
50	18.6	18.3	0.3
51	11	10.5	0.5
52	13.6	13.1	0.5
53	7	6.8	0.2
54	6.9	6.7	0.2
55	2.3	2	0.3
56	4.8	4.4	0.4
57	8.3	7.6	0.7
58	11.4	10.9	0.5
59	11.5	11	0.5
60	10	9.8	0.2
61	9.2	8.9	0.3
62	8.7	8.5	0.2
63	7.3	6.9	0.4
64	3	2.1	0.9

TABLE B-16

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - QUARRY LAKE SEDIMENT ANALYSIS
METALS
JUNE 1994

GRID NUMBER	CADMIUM	CHROMIUM
1	13.8	135.0
2	16.7	110.0
3	1.2 B	107.0
4	3.0	41.5
5	10.9	112.0
6	23.6	365.0
7	27.8	218.0
8	0.39 B	31.4
9	12.9	122.0
10	23.3	210.0
11	33.5	175.0
12	36.7	337.0
13	25.6	476.0
14	2.7	41.0
15	26.2	216.0
16	23.5	199.0
17	16.9	161.0
18	14.1	120.0
19	40.1	598.0
20	2.5	42.1
21	17.5	130.0
22	7.9	74.0
23	42.0	332.0
24	111.0	912.0
25	56.9	1100.0
26	ND	43.3
27	1.8	47.8

NOTE: (1) All concentrations are expressed in mg/kg (ppm) dry weight.
(2) B - Indicates contaminant also found in Blank.
(3) ND - Not Detected.

TABLE B-16
(Continued)

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - QUARRY LAKE SEDIMENT ANALYSIS
METALS
JUNE 1994

GRID NUMBER	CADMIUM	CHROMIUM
28	11.4	144.0
29	48.2	523.0
30	89.7	1790.0
31	10.2	188.0
32	1.7 B	54.0
33	20.3	170.0
34	10.5	155.0
35	127.0	1630.0
39	6.0	86.5
40	41.0	735.0
41	13.3	248.0
42	18.9	231.0
46	9.6	97.5
47	11.0	114.0
48	11.2	150.0
49	2.6	69.2
50	ND	26.7
51	0.74 B	44.4
55	2.3	45.5
56	25.7	258.0
57	ND	30.8
58	ND	51.3
59	ND	36.3
60	ND	39.8
61	0.63 B	47.3

NOTE: (1) All concentrations are expressed in mg/kg (ppm) dry weight.
(2) B - Indicates contaminant also found in Blank.
(3) ND - Not Detected

TABLE B-17

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - QUARRY LAKE SEDIMENT ANALYSIS
TOTAL ORGANIC CARBON
JUNE 1994

GRID NUMBER	Total Solids (TS) (%)	Total Organic Carbon (mg/kg)
1	48.6	13,800
2	49.2	11,100
3	59.6	6,890
4	48.8	4,440
5	38.4	9,470
6	53.6	20,100
7	43.6	17,700
8	57.3	6,800
9	43.6	8,450
10	38.9	7,380
11	42.6	9,500
12	44.4	10,400
13	42.3	14,400
14	53.9	3,900
15	41.0	8,620
16	34.2	9,650
17	31.1	9,020
18	40.9	9,820
19	63.5	11,200
20	56.2	6,720
21	38.2	7,780
22	42.2	6,680
23	37.3	9,970
24	44.4	15,400
25	36.9	13,100
26	55.8	6,480
27	60.6	4,030

NOTE: TOC expressed in mg/kg (ppm) dry weight.

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TABLE B-17
(Continued)

FRONTIER CHEMICAL-PENDLETON SITE

ANALYTICAL RESULTS - QUARRY LAKE SEDIMENT ANALYSIS
TOTAL ORGANIC CARBON
JUNE 1994

GRID NUMBER	Total Solids (TS) (%)	Total Organic Carbon (mg/kg)
28	42.1	8,280
29	55.4	6,500
30	66.2	4,600
31	55.5	5,470
32	59.8	9,210
33	36.4	9,230
34	64.8	9,260
35	53.2	8,160
39	39.8	8,130
40	48.5	9,450
41	36.3	8,770
42	68.6	3,860
46	38.3	11,500
47	72.7	6,250
48	59.9	5,060
49	45.4	5,800
50	52.5	3,500
51	55.7	3,240
55	64.7	4,140
56	67.3	12,200
57	60.4	3,410
58	69.9	3,690
59	47.7	4,520
60	47.0	5,790
61	62.0	4,960

NOTE: TOC expressed in mg/kg (ppm) dry weight.

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TABLE B-18

FRONTIER CHEMICAL - PENDLETON SITE

PENINSULA SOIL ANALYSIS
METALS
JUNE 1994

SAMPLE IDENTIFICATION	CADMIUM	CHROMIUM
TP 15 - 3 FT	26.2	516
TP 15 - 12 FT	38	645
TP 17 - 10 FT	114	1590
TP 17 - 13 FT	28.8	597

NOTE: (1) All concentrations are expressed in mg/kg (ppm) dry weight.
(2) Samples were of fill material.

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TABLE B-19

FRONTIER CHEMICAL-PENDLETON SITE

Borrow Source Investigation Summary

SOURCE	Barrier Protection Soil (Sandy Loam)	Topsoil	REMARKS
Haseley Trucking Company (716) 297-3590 Contact: Marc Haseley	Available	Available	Specialize in providing soil for landfills. Have strong references.
Bush Trucking N. Tonowanda, NY (716) 692-0239 Contact: Bill or Roger Bush	Available	Available	Small operation. Limited quantities.
Leo Brennon Soil Amherst, NY (716) 691-8623 Contact: Jerry	Available	Available	Costs may be reduced due to the short distance from the site to their facilities.
Siltstone Building Company Inc. (716) 297-2654	Not Available	Not Available	Do not deal in soils.
Yanacek Enterprises Niagara Falls, NY (716) 692-0239	Not Available	Not Available	Do not deal in soils.
Frontier Stone Inc. (716) 434-8817 Contact: Tom Biamonte	Not Available	Not Available	
Nanook Farms Stockton, NY (716) 595-2638 Contact: Bob Reuther	Available	Available	Topsoil and barrier protection soil can be custom made to meet specs and/or requirements. Refer to letter received June 14, 1994.

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TABLE B-20

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs), TO BE CONSIDERED (TBC) NEW YORK STANDARDS CRITERIA, AND GUIDANCE FOR THE FRONTIER CHEMICAL PENDLETON SITE

ITEM	CITATION	DESCRIPTION	APPLICA-ABILITY[1]	CATE-GORY[2]
<u>FEDERAL GROUND WATER STANDARDS</u>				
SAFE DRINKING WATER ACT				
PRIMARY DRINKING WATER STANDARDS	40 CFR 141	WATER STANDARDS FOR PUBLIC WATER SUPPLIES	RA	CS
SECONDARY DRINKING WATER	40 CFR 143	WATER STANDARDS FOR PUBLIC WATER SUPPLIES	TBC	CS
CLEAN WATER ACT		WATER QUALITY STANDARDS FOR DRINKING WATER	TBC	CS
<u>NEW YORK STATE GROUND WATER STANDARDS</u>				
NYSDEC GROUND WATER QUALITY STANDARDS	TOGS 1.1.1 SEPTEMBER 1990	GROUND WATER STANDARDS AND GUIDELINES FOR NEW YORK STATE GROUND WATER	RA	CS
	6NYCRR PART 703.5	GROUND WATER STANDARDS	A	CS
NYSDOH MCLs, PUBLIC WATER SUPPLIES	10 NYCRR SUBPART 5-1	WATER STANDARDS FOR DRINKING WATER MCLs	RA	CS

TABLE B-20
(CONTINUED)

ITEM	CITATION	DESCRIPTION	APPLI-CABILITY[(1)]	CATE-GORY[(2)]
FEDERAL SURFACE WATER STANDARDS				
CLEAN WATER ACT		WATER QUALITY STANDARDS FOR FISH AND DRINKING WATER	TBC	CS
REGULATION OF ACTIVITIES AFFECTING WATER OF THE U.S.	33 CFR 320-329	CORPS OF ENGINEERS REGULATIONS FOR WETLANDS AND NAVIGABLE WATERS	A	LS
EXECUTIVE ORDER ON PROTECTION OF WETLANDS	ORDER #11990 40 CFR 6 APPENDIX A	REQUIRED FOR CONSIDERATION DURING REMEDIAL ACTIONS THAT MAY IMPACT WETLANDS	RA	LS
FISH AND WILDLIFE COORDINATION ACT IMPROVEMENT ACT CONSERVATION ACT	16 USC 661 16 USC 742 16 USC 2901	REGULATES REMEDIAL ACTIONS THAT MAY EFFECT WETLANDS	A	LS
NEW YORK STATE SURFACE WATER STANDARDS				
NYSDEC SURFACE WATER QUALITY STANDARDS	6 NYCRR 701	STANDARDS AND GUIDELINES FOR SURFACE WATER QUALITY	A	CS
USE AND PROTECTION OF WATERS	6 NYCRR 608	PERMIT REQUIREMENTS FOR CONSTRUCTING DOCKS OR DAMS AND EXCAVATION OR PLACEMENT OF FILL	TBC	LS
USE AND PROTECTION OF FRESH WATER WETLANDS	6 NYCRR 662-665	PERMIT REQUIREMENTS FOR DISTURBANCE TO FRESH WATER WETLANDS	RA	LS

TABLE B-20
(CONTINUED)

ITEM	CITATION	DESCRIPTION	APPLI-CABILITY(1)	CATE-GORY(2)
FEDERAL SOIL STANDARDS				
TOXIC SUBSTANCE CONTROLS ACT	40 CFR 761	REGULATES POLYCHLORINATED BIPHENYL (PCB) CLEANUP LEVELS	A	CS
TOXICITY CHARACTERISTIC RULE	TOXICITY CHARACTERISTICRULE 40 CFR 261	REGULATION FOR CLASSIFICATIONS OF HAZARDOUS WASTE	A	CS
TREATMENT OF RCRA WASTES	40 CFR 264	STANDARDS FOR TREATMENT, STORAGE, DISPOSAL OF RCRA WASTES	TBC	CS
NEW YORK STATE SOIL AND SEDIMENT STANDARDS				
LAND DISPOSAL RESTRICTIONS	6 NYCRR PART 376	TREATMENT STANDARDS FOR FINAL DEPOSITION OF HAZARDOUS WASTES	SCG	AS
CLEANUP STANDARDS	NYSDEC TAGM 4046	DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS	SCG	CS
NYSDEC DIVISION OF FISH AND WILDLIFE SEDIMENT CRITERIA		SEDIMENT CRITERIA FORMULA MAY BE APPROPRIATE FOR DEVELOPING CLEANUP LEVELS	TBC	CS
FEDERAL AIR STANDARDS				
CLEAN AIR ACT			TBC	AS
NATIONAL AMBIENT AIR QUALITY STANDARDS	40 CFR 50	AIR STANDARDS	TBC	AS
NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS	40 CFR 268	FOR ASBESTOS AND WET DUST, BERYLLIUM, VINYL CHLORIDE, BENZENE, ETC.	SCG	AS

TABLE B-20
(CONTINUED)

ITEM	CITATION	DESCRIPTION	APPLICABILITY[1]	CATEGORY[2]
NEW YORK STATE AIR STANDARDS				
DIVISION OF AIR	6 NYCRR PART 200,201,211, 212,257	DIVISION OF AIR GENERAL PROVISIONS PERMITS AND CERTIFICATES AND AIR QUALITY STANDARD	TBC	AS
DIVISION OF AIR	AIR GUIDE 1	GUIDELINES FOR CONTROLS OF TOXIC AMBIENT AIR CONTAMINANTS	TBC	AS
ADDITIONAL FEDERAL CONSIDERATIONS				
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)	29 CFR 1904 29 CFR 1910 29 CFR 1226	WORKER SAFETY AT HAZARDOUS WASTE SITES	A	AS
LAND DISPOSAL RESTRICTIONS	40 CFR 268	TREATMENT STANDARDS FOR FINAL DEPOSITION OF HAZARDOUS WASTES	TBC	AS

NOTES:

(1) "A" - APPLICABLE, "RA" - RELEVANT OR APPROPRIATE, "TBC" - TO BE CONSIDERED, "SCG" - STANDARDS, CRITERIA, & GUIDANCE
(2) "AS" - ACTION SPECIFIC, "CS" - CHEMICAL SPECIFIC, "LS" - LOCATION SPECIFIC

REFERENCE:

URS CONSULTANTS, INC., JUNE 1991, "REMEDIAL INVESTIGATIONS AT THE FRONTIER CHEMICAL -- PENDLETON SITE," NYSDEC SITE NO. 9-32-043.

SC:PEN(1)\99TABLE

TABLE B-21
FRONTIER CHEMICAL-PENDLETON SITE

SUMMARY OF GEOTECHNICAL PARAMETERS FOR SLOPE STABILITY ANALYSES

SOIL LAYER	UNIT WEIGHT Moist (PCF)	UNIT WEIGHT Saturated (PCF)	COHESIVE STRENGTH (PSF)	INTERNAL FRICTION ANGLE (DEGREES)
Weathered Clay	126 (estimated from site specific geotechnical testing results)	29 (estimated from site specific geotechnical testing results)	—	21° (based on geotechnical testing results)
Clay/Silty Clay	117 (estimated from site specific geotechnical testing results)	121 (estimated from site specific geotechnical testing results)	650[(1)] average value (estimated from in-situ vane shear test results)	23°[(2)] (based on geotechnical testing results)
Silty Sand	115	125	—	27° (Carter and Bentley, 1991)
Dolostone/ Bedrock	160	175	943,200 (Goodman, 1980)	—
Containment Berm	118	125	2,000 [(1)] (Terzaghi and Peck, 1948)	19°[(2)] (Carter and Bentley, 1991)
Fill and Cap System	120	125	1,440	—

Notes:

(1) Indicates value used for short-term loading conditions only.
(2) Indicates value used for long-term loading conditions only.

TABLE B-22
FRONTIER CHEMICAL-PENDLETON SITE

SUMMARY OF SLOPE STABILITY ANALYSES

RUN	CONDITIONS MODELED	ESTIMATED FACTOR OF SAFETY
4N2	Critical surface through crest of containment berm (short-term loading conditions)	2.76
4N3	Critical surface through crest of containment berm with uniform load* (short-term loading conditions)	2.04
4R1	Critical surface through crest of capped area (short-term loading conditions)	1.76
4R2	Critical surface through crest of capped area with uniform load* (short-term loading conditions)	1.78
4R5	Critical surface through toe of containment berm (short-term loading conditions)	1.73
4R6	Critical surface through toe of containment berm with uniform load (short-term loading conditions)	1.77
4R4	Critical surface through crest of capped area (long-term loading conditions)	2.79

* Uniform load assumed to be 1,100 psf to model load from Caterpillar 219/219LC across width of containment berm.

TABLE B-23
FRONTIER CHEMICAL - PENDLETON SITE

SUMMARY OF CAPPED AREA CAPACITY AND ESTIMATED DISPOSAL QUANTITIES

Capped Area Waste Capacity		68,100 cy
Waste Volumes		
Surface Soils (3' depth)	8,700 cy	
Previously dredged materials and soils within proposed capped area limits	1,000 cy	
Quarry Lake Sediments	8,500 cy	
Additional material from the bottom of Quarry Lake (assume additional 50%)	4,250 cy	
Additional increase in volume due to addition of stabilization materials (assume additional 20% of total volume of materials removed from Quarry Lake)	2,550 cy	
Peninsula Soils	5,800 cy	
Total Volume Required for Disposal		30,800 cy
Volume of Proposed Cap		19,400 cy
Remaining Capacity of Capped Area		**17,900 cy**