FEASIBILITY STUDY

AT THE

FRONTIER CHEMICAL – PENDLETON SITE

PENDLETON (T), NIAGARA (C), NEW YORK

NYSDEC SITE NO. 9-32-043
WORK ASSIGNMENT NO. D002340-4

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 Wolf Road, Albany, New York

Thomas C. Jorling, Commissioner

DIVISION OF HAZARDOUS WASTE REMEDIATION

Michael J. O'Toole, Jr., P.E. – Director

URS Consultants, Inc.

282 Delaware Avenue
Buffalo, New York 14202

MARCH 1992

FEASIBILITY STUDY

AT THE

FRONTIER CHEMICAL - PENDLETON SITE

PENDLETON (T), NIAGARA (C), NEW YORK

NYSDEC SITE NO. 9-32-043
WORK ASSIGNMENT NO. D002340-4

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 Wolf Road, Albany, New York

Thomas C. Jorling, Commissioner

STATE OF NEW YORK
JAMES A. LANZO
No. 65478
LICENSED PROFESSIONAL ENGINEER

DIVISION OF HAZARDOUS WASTE REMEDIATION

Michael J. O'Toole, Jr., P.E. - Director

URS Consultants, Inc.

282 Delaware Avenue
Buffalo, New York 14202

MARCH 1992

TABLE OF CONTENTS

	Page No.
1. Introduction	1-1
1.1 Purpose and Organization of Report	1-1
1.2 Background Information	1-2
1.2.1 Site Description and History	1-2
1.2.2 Nature and Extent of Contamination	1-4
1.2.2.1 Soil/Fill Contamination	1-5
1.2.2.2 Quarry Lake Water	1-7
1.2.2.3 Quarry Lake Sediments	1-8
1.2.2.4 Bull Creek and Pond Contamination	1-9
1.2.2.5 Groundwater Contamination	1-9
1.2.3 Baseline Health Risk Assessment	1-11
1.3 Initial Remedial Action	1-12
2. Identification of General Response Actions	2-1
2.1 Remedial Action Objectives	2-1
2.2 General Response Actions	2-2
2.3 Extent of Remediation	2-3
2.3.1 Soil	2-3
2.3.2 Groundwater	2-4
2.3.3 Sediment	2-4
2.3.4 Surface Water	2-4
2.3.5 Air	2-5
2.4 Applicable or Relevant and Appropriate Requirements (ARARs)	2-5
2.4.1 Chemical Specific Requirements	2-6
2.4.2 Location - Specific Requirements	2-7
2.4.3 Action-Specific Requirements	2-9
3. Identification/Screening of Technology Types and Process Options	3-1
3.1 Identification of Remedial Technologies	3-1
3.1.1 Remedial Technologies for Soil/Fill/Waste	3-1

TABLE OF CONTENTS (Continued)

		Page No.
	3.1.2 Remedial Technologies for Groundwater ..	3-7
	3.1.3 Remedial Technologies for Surface Water	3-9
	3.1.4 Remedial Technologies for Sediments	3-10
	3.1.5 Technologies for Air	3-11
	3.1.6 Selection of Technologies	3-12
3.2	Screening of Remedial Technologies/Process Options	3-13
	3.2.1 General	3-13
	3.2.2 Technology Screening for Soil/Waste/Fill	3-15
	3.2.2.1 Soil Capping	3-15
	3.2.2.2 Erosion Controls	3-17
	3.2.2.3 Excavation and Onsite Treatment	3-18
	3.2.2.4 In-Situ Treatment	3-22
	3.2.3 Technology Screening for Groundwater ...	3-24
	3.2.3.1 Vertical Barriers	3-24
	3.2.3.2 Groundwater Collection	3-25
	3.2.3.3 Groundwater Treatment	3-26
	3.2.4 Technology Screening for Surface Water .	3-28
	3.2.4.1 Diversion of Runon From Off Site	3-28
	3.2.4.2 Diversion/Collection of Onsite Runoff	3-28
	3.2.4.3 Control Overflow	3-29
	3.2.5 Technology Screening for Sediments	3-30
	3.2.5.1 Dredging of Sediments	3-30
	3.2.5.2 Treatment of Dredge Spoils	3-30
3.3	Summary	3-31
3.4	Development of Alternatives	3-31
4.	Detailed Evaluation of Alternatives and Selection of a Remedy	4-1
4.1	General	4-1
4.2	Weighted-Matrix Scoring System	4-3
	4.2.1 Procedure	4-3

TABLE OF CONTENTS (Continued)

			Page No.
	4.2.2	Alternative 1 - No Action	4-4
	4.2.3	Alternative 2 - Institutional Action ...	4-6
	4.2.4	Alternative 3A - Containment	4-8
	4.2.5	Alternative 3B - Containment with Solidification of Sediment and Spoils ..	4-10
	4.2.6	Alternative 4 - Hot Spot Treatment with Ex-Situ Solidification	4-13
	4.2.7	Alternative 5 - Hot-Spot Treatment with In-Situ Solidification	4-15
	4.2.8	Alternative 6 - Full Treatment with Solidification and Hot-Spot Thermal Desorption	4-18
4.3	Economic Evaluation of Alternative		4-22
	4.3.1	General	4-22
	4.3.2	Estimation of Quantities	4-23
4.4	Cost Estimates for Individual Technologies		4-27
4.5	Cost Estimates for Alternatives		4-35
	4.5.1	Alternative 1 - No Action	4-35
	4.5.2	Alternative 2 - Institutional Action ...	4-36
	4.5.3	Alternative 3A - Containment	4-36
	4.5.4	Alternative 3B - Containment with Solidification of Sediment and Spoils ..	4-36
	4.5.5	Alternative 4 - Hot Spot Treatment with Ex-Situ Solidification	4-37
	4.5.6	Alternative 5 - Hot-Spot Treatment with In-Situ Solidification	4-37
	4.5.7	Alternative 6 - Full Treatment with Solidification and Hot Spot Thermal Desorption	4-37
4.6	Comparison of Alternatives		4-38
4.7	Selection of Preferred Alternative		4-40
5.	Conceptual Design and Preliminary Cost Estimate of Preferred Alternative		5-1
5.1	Conceptual Design		5-1

TABLE OF CONTENTS (Continued)

		Page No.
	5.1.1 Physical Controls	5-1
	5.1.2 Sheet Piling	5-2
	5.1.3 Sediment Dredging	5-2
	5.1.4 Sediment Treatment (Ex-Situ Solidification)	5-3
	5.1.5 Placement of Treated Sediments	5-4
	5.1.6 Multilayered Cap with Synthetic Geomembrane	5-4
	5.1.7 Groundwater Monitoring Wells	5-5
5.2	Preliminary Cost Estimate	5-5
5.3	Implementation Schedule	5-7

LIST OF TABLES

		Following Page No.
Table 2-1 -	HRA Based Acceptable Contaminant Concentrations	2-7
Table 3-1	Technology Screening Summary	3-1
Table 4-1 -	Weighted-Matrix Scoring System for Remedial Alternatives	4-4
Table 4-2 -	Summary of Design Quantities	4-27
Table 4-3 -	Capital Cost Estimate - MSG and Soil Cap	4-29
Table 4-4 -	Annual O&M Cost Estimate - MSG and Soil Cap ...	4-29
Table 4-5 -	Capital Cost Estimate - Sheetpile Cutoff Wall .	4-30
Table 4-6 -	Capital Cost Estimate - Physical Controls	4-30
Table 4-7 -	Capital Cost Estimate - Groundwater Collection Trench	4-30
Table 4-8 -	Capital Cost Estimate - Dredging of Sediments and Sludges	4-31
Table 4-9 -	Capital Cost Estimate - Ex-Situ Solidification/ Stabilization of Hot Spot Contamination Area ..	4-31
Table 4-10-	Capital Cost Estimate - In-Situ Solidification/ Stabilization Hot Spot/Non-Hot Spot Contamination Area	4-32
Table 4-11-	Capital Cost Estimate - Ex-Situ Solidification/ Stabilization Sediments and Sludges	4-32
Table 4-12-	Capital Cost Estimate - Excavation and On-Site Thermal Desorption Hot Spot Contamination Area	4-32
Table 4-13-	Capital Cost Estimate - Lake Cell	4-33
Table 4-14-	Capital Cost Estimate - Air Emissions Control .	4-33
Table 4-15-	Summary of Groundwater Treatment Design Data ..	4-34
Table 4-16-	Equipment Sizing and Design Criteria	4-35
Table 4-17-	Capital Cost Estimate - Groundwater Pretreatment	4-35
Table 4-18-	O&M Cost Estimate Basis - Groundwater Collection and Pretreatment	4-35
Table 4-19-	Annual O&M Cost Estimate - Groundwater Collection and Pretreatment	4-35
Table 4-20-	Capital Cost Estimate - Groundwater Monitoring	4-35
Table 4-21-	Annual O&M Cost Estimate - Groundwater Monitoring	4-35
Table 4-22-	Cost Estimates for Remedial Alternatives	4-35

LIST OF FIGURES

	Following Page No.
Figure 1-1 - Remedial Alternative Development Process	1-1
Figure 1-2 - Site Vicinity Map	1-2
Figure 1-3 - Site Features	1-2
Figure 1-4 - Regions of Contamination	1-4
Figure 3-1 - Summary of Selected Remedial Technologies	3-31
Figure 3-2 - Remedial Alternatives	3-31
Figure 4-1 - Alternatives 3A and 3B - Containment Alternatives	4-1
Figure 4-2 - Alternative 4 - Hot Spot Treatment with Ex-Situ Solidification	4-2
Figure 4-3 - Alternative 5 - Hot-Spot Treatment with In-Situ Solidification	4-2
Figure 4-4 - Alternative 6 - Full Treatment with Solidification and Hot-Spot Thermal Desorption	4-2
Figure 4-5 - Groundwater Treatment System (Pretreatment Option)	4-35

1. INTRODUCTION

1.1 Purpose and Organization of Report

This Feasibility Study, based upon the information generated by the Remedial Investigation (RI), will:

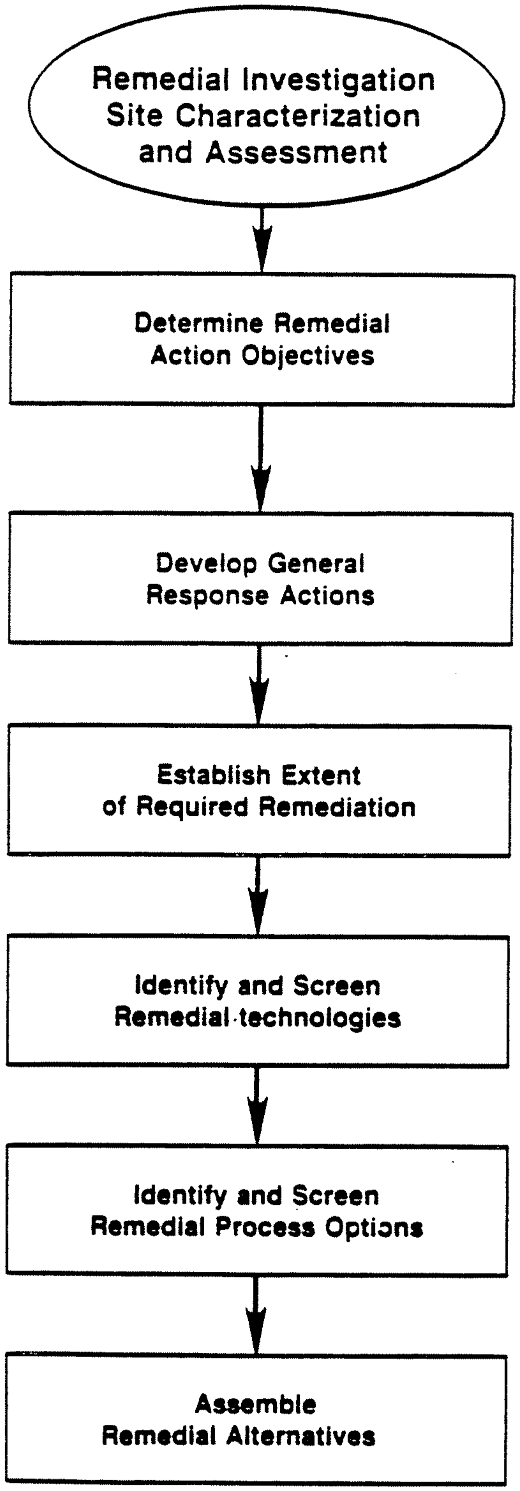
- establish specific goals for remedial action;
- develop and evaluate alternative methods by which those goals may be reached; and
- select the alternative best suited for reaching those goals.

The generalized process for developing remedial alternatives at a hazardous waste site is depicted in Figure 1-1.

The purpose of this report is to present the results of the study and to describe the remedial action selected. This report is organized as follows:

Section 1 - This section will provide a summary of information presented in the RI. Development of site-specific remedial action objectives and potentially applicable remedial alternatives is based upon this information.

Section 2 - General remedial action objectives and the extent of remediation for this site are identified in this section. General response actions to satisfy the remedial action objectives are also presented in this section for each medium of interest. Potentially applicable remedial technologies are identified and screened based on results of URS site investigations. This screening eliminates those technologies and process options which are not technically feasible, and, if possible, allows for the selection of a single process representative of each technology.



A-3779

URS CONSULTANTS

REMEDIAL ALTERNATIVE DEVELOPMENT PROCESS

FIGURE 1-1

Section 3 - Technology types and process types are screened, and those technologies considered to be feasible are combined into remedial alternatives (based on their effectiveness and implementability) for use in meeting the remedial action objectives for the site.

Section 4 - Remedial alternatives are subjected to a detailed analysis against the Superfund evaluation criteria and compared against each other using a scoring system. An alternative is selected and justification for selection is presented.

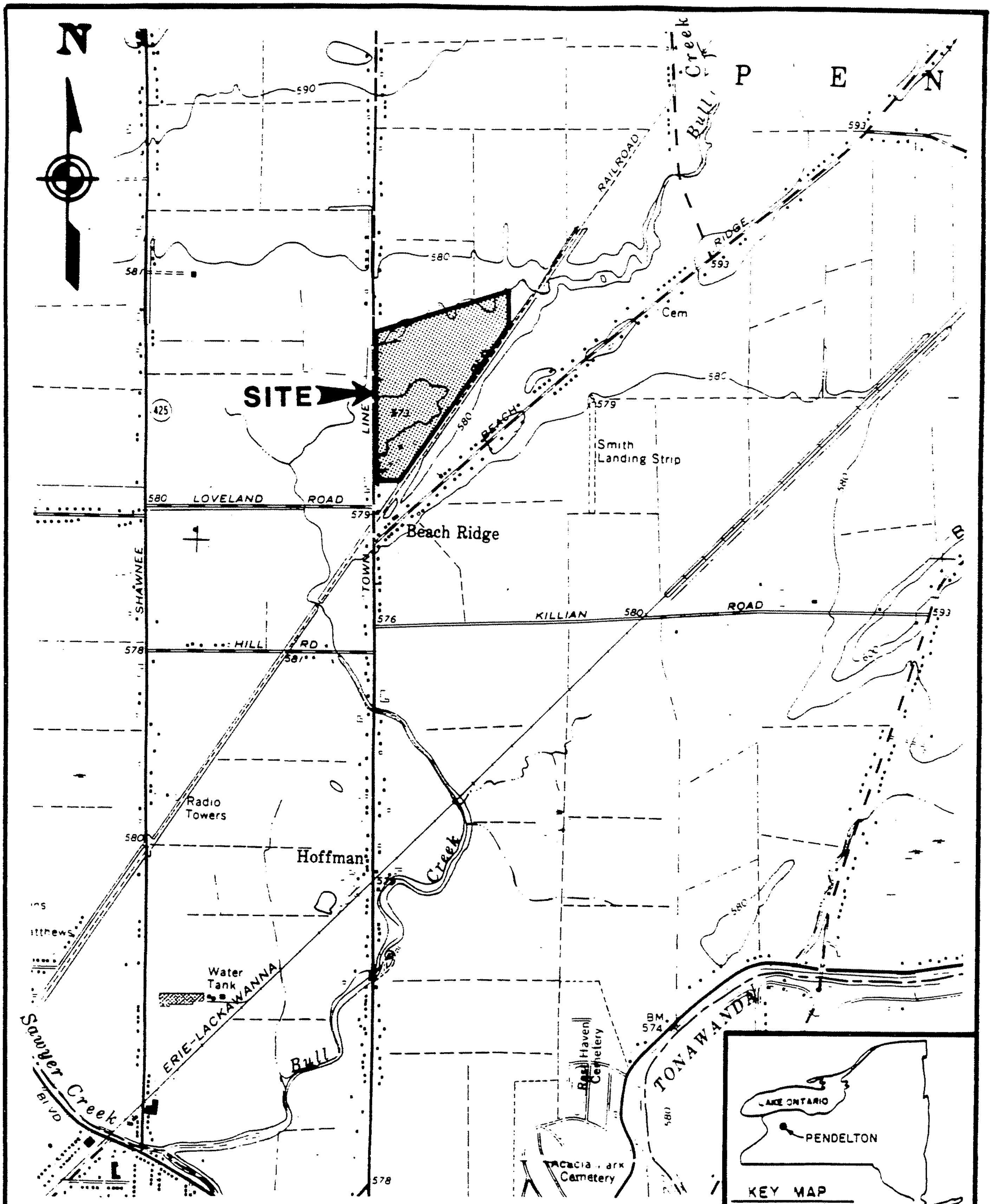
Section 5 - A conceptual design and preliminary cost estimate for implementation of the preferred alternative are presented. A list of additional studies required prior to or during the design phase of the remedial action is also included.

1.2 Background Information

The purpose of the RI was to collect data and to characterize the site in sufficient detail as to permit identification and evaluation of remedial alternatives as part of the Feasibility Study. Pertinent data from the RI include a detailed site description and history, the nature and extent of contamination at the site, and a baseline risk assessment. These findings from the RI, upon which the Feasibility Study is based, are summarized below.

1.2.1 Site Description and History

The Frontier Chemical-Pendleton Site is an approximately 75-acre tract of land located on Townline Road in the Town of Pendleton, County of Niagara, New York. The site location is shown in Figure 1-2, and a site plan in Figure 1-3. The roughly triangular site is bounded by Townline Road to the west, an abandoned railroad right-of-way to the southeast, and Bull Creek to the north. A lake approximately 15 acres in size (Quarry



SOURCE:
USGS TOPOGRAPHIC 7.5 MINUTE
QUADRANGLE, TONAWANDA EAST, N.Y. 1965

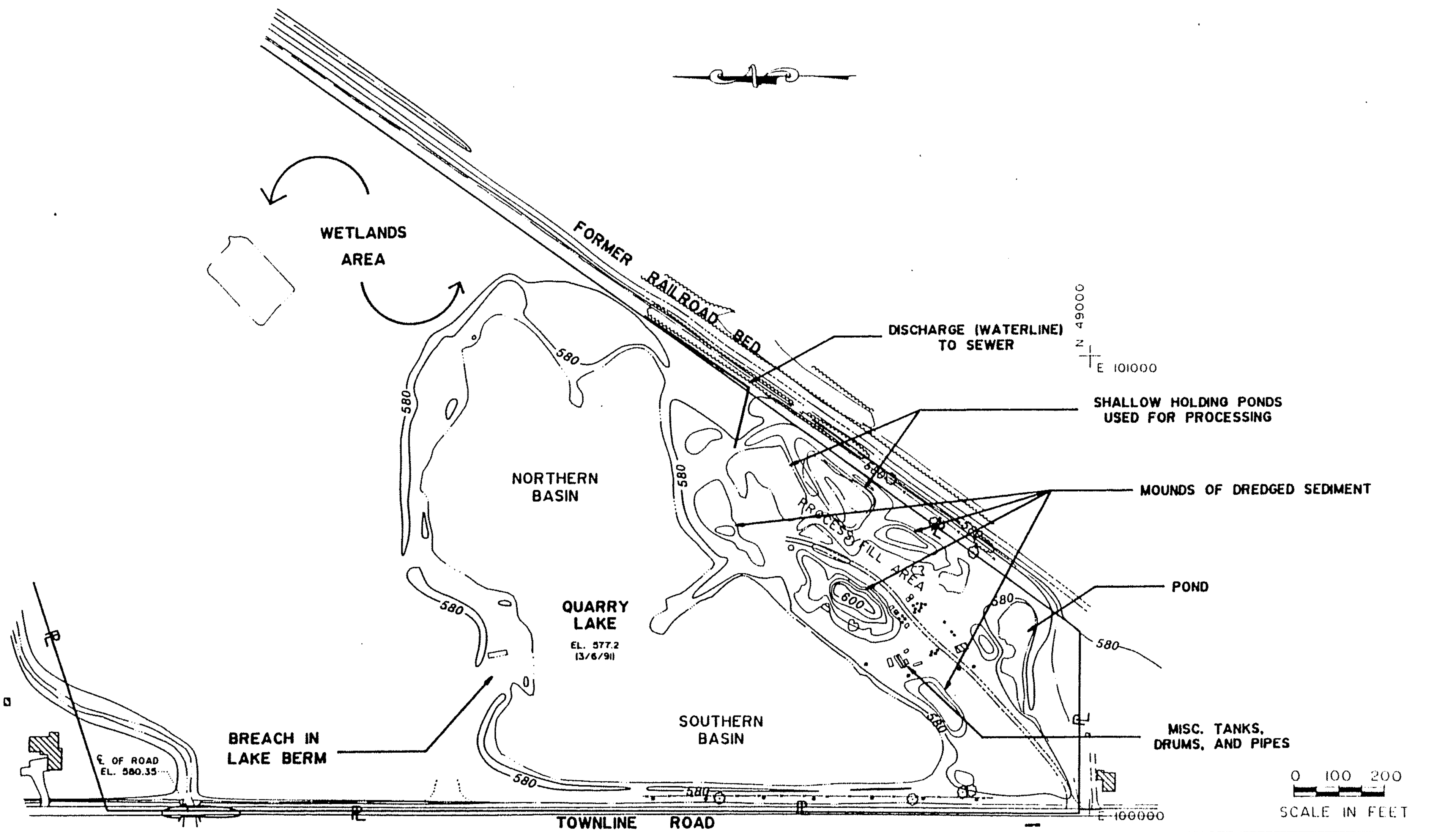
0 1000 2000 FT.

A-3222

URS CONSULTANTS, INC.

SITE VICINITY MAP

FIGURE 1-2



SITE FEATURES

URS CONSULTANTS, INC.

FIGURE I-3

Lake, a former clay quarry) occupies the south-central portion of the site. Spaced residential developments are found on the west, northwest, and southwest sides of the site. The nearest residences are located less than 100 feet from the site. The surrounding area is relatively flat and devoted to both agricultural and residential uses. Ground surface elevations in this area range from 577 to 582 feet. The surface elevation of the lake is approximately 577 feet.

The earliest industrial operation at this site was reportedly a clay brick and tile manufacturing facility. Much of the area that is now Quarry Lake appears disturbed in a 1938 aerial photograph, but only a small amount of standing water is visible.

Frontier Chemical Waste Process, Inc., obtained the property and operated the site as an industrial waste treatment facility from 1958 to 1974. The waste treatment is said to have involved lime neutralization of plating wastes, pickle liquors, and other liquid acid wastes from the plating and metal finishing industries. The treatment operation was carried out in the process area of the site, between Quarry Lake and the abandoned railroad. Resulting mixtures from the waste treatment process were discharged into Quarry Lake for settling of the neutralization products. Other operations performed at the site included chemical oxidation, chemical product recovery, incineration, and distillation. Various drummed and tanked wastes were stored on site for transfer.

Much of the process area was filled and graded following termination of the waste processing and treatment operations between 1974 and 1977.

In 1980, two retention ponds were constructed for the rehabilitation of Quarry Lake. This was accomplished by batch-treating lake water in the treatment ponds with a 50% caustic solution, and discharging (via a direct pipeline) the resultant liquid to the Town of Wheatfield Sewage Treatment Plant. The use of the ponds ceased in the mid-1980s. The lake was drained in May 1988 by breaching the dikes. This was done as part of a never completed effort to build a naturally clay-lined engineered landfill for deposition of metals sludges from Quarry Lake. Sludges from the southern basin were dredged and stockpiled along the shores in four distinct piles (see Figure 1-3) as excavation progressed until 1988, when an oily, chemical-smelling seepage from the area of the old brick plant began filling the excavation. Seepage was reduced by the construction of a temporary clay cutoff wall in July 1988. Groundwater also reportedly entered the excavation at up to 10 gal/min.

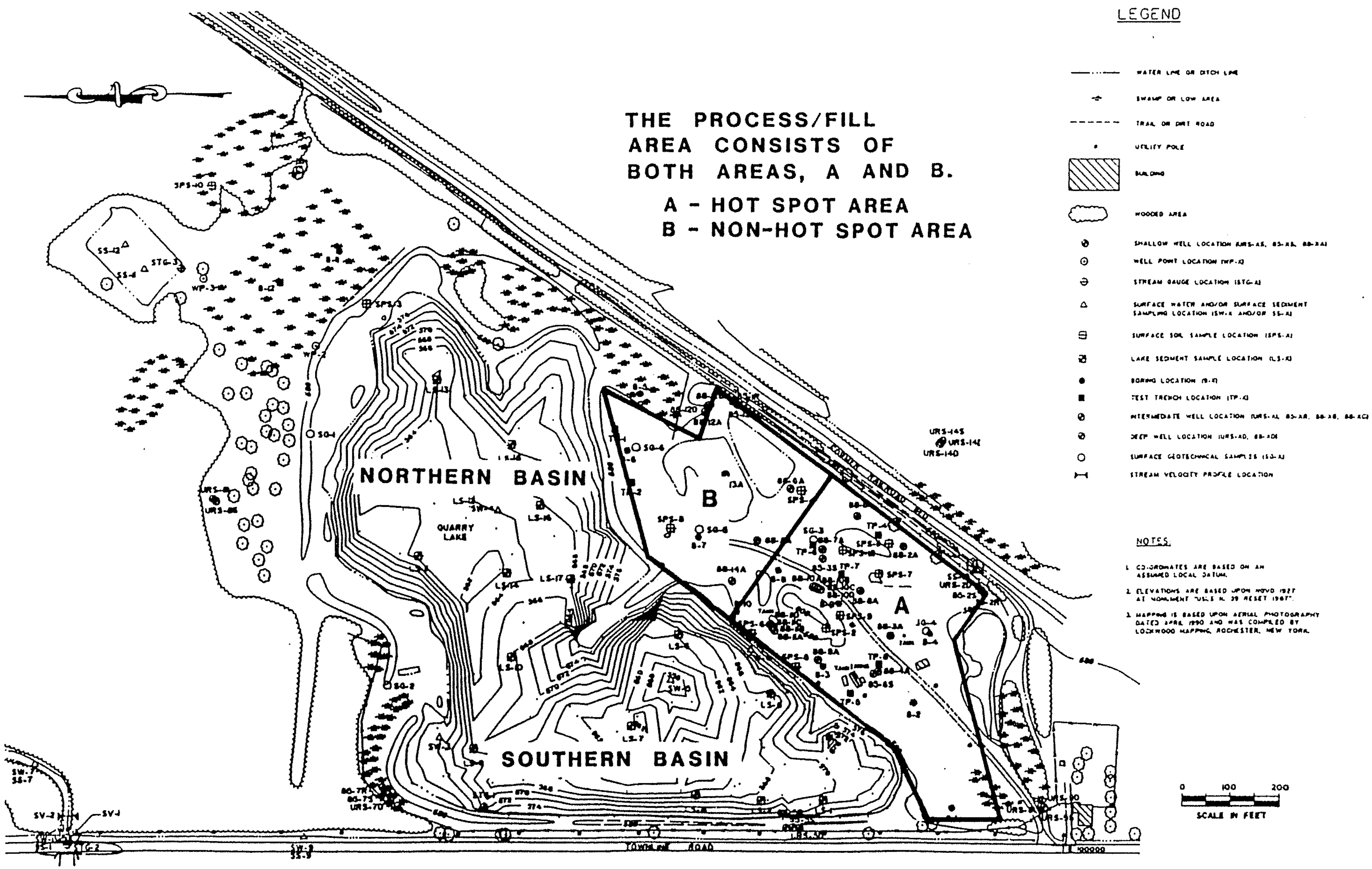
The process/fill area of the site covers roughly a 7.4-acre area to the southeast of Quarry Lake between the lake and the former railroad bed. Existing structures in this area include two earth berm retention (holding) ponds, one small building, two railroad tank cars, and other small tanks. Large stockpiles of lake bottom sediments, lime, and mixed debris are found near the shore of Quarry Lake in this area.

1.2.2 Nature and Extent of Contamination

This section summarizes the analytical data from the RI (Appendix A). Sampling locations are shown on Plate 1 of the RI Report (June 1991) and are reproduced in Figure 1-4 for relevant areas of the site. Each of the different areas on the site, such as the process/fill area, the lake, and the ponds, were found to have distinct areas of contamination. A determination of the extent of contamination is necessary to develop a remediation plan that adequately addresses all areas of contamination on the site.

The source of contamination appears to be the 7.4-acre process/fill area south of Quarry Lake (see Figure 1-4). As shown on Figure 1-4, this area can be divided into a hot-spot area (Area A, 4.8 acres) with the highest levels of contamination, and a not-hot-spot area (Area B, 2.6 acres) in which the contamination is sufficiently below levels that would

A-3776A



URS CONSULTANTS, INC.

REGIONS OF CONTAMINATION

FIGURE 1-4

raise any concern. Area A, where much of the processing occurred, contains piles of C&D refuse, metal sludge spoils, and black, dry, or sludge-like material mixed with partially intact drums. In addition to the fill, there are large containers, tanks, railroad cars, and pieces of equipment (see Figure 1-3 of RI). One railroad tank car appears to contain lime. One underground tank, possibly containing fuel oil, may be leaking. The remaining tanks, although empty, may have contained hazardous materials at one time and contributed to the contamination of the site. Also found here are two dumpsters and several drums containing soil. It is unknown whether any contained materials are contaminated.

The extent to which this contamination has affected other areas of the site is discussed in the following sections.

1.2.2.1 Soil/Fill Contamination

Both surface and subsurface soil investigations were undertaken. Nine samples were taken from the surface soil or waste at the site. Six of the samples were located in the area of known fill. Large numbers of contaminants of all types were detected in these samples, with the most contamination measured in samples SPS-5, SPS-6, and SPS-7, all located in the old process area along Quarry Lake. PAHs, benzene derivatives, and PCBs were the most prevalent groups of contaminants detected.

Volatile organic compounds were found in the highest concentrations in SPS-5 and SPS-6. Note that contaminated perched water or leachate was visible at the surface in this area. The highest concentration of PCBs (11,000 ppb) and polycyclic aromatic hydrocarbons (PAHs) (13,540 ppb) was found in samples SPS-7 and SPS-8, respectively. PCBs were detected in many of the soil/fill samples from the site. Relatively high concentrations were found for cadmium, calcium, and chromium, most of which were also found at elevated levels in Quarry Lake sediments. Sample SPS-7 also contained most of the elevated metals concentrations.

A total of five contaminants at relatively low levels were detected in the three samples taken from outside the process/fill area. Most of these were detected in sample SPS-3 (221 ppb total organics), taken from the berm along Quarry Lake.

Fifteen of the twenty subsurface samples (10 from borings, 5 from monitoring well borings, and 5 from test trenches) were taken from the process/fill area. Many different contaminant groups were found at high concentrations in this area. The most common and highly concentrated contaminants on site were usually chlorinated hydrocarbons or compounds belonging to the benzene, toluene, xylene (BTX) group. Other contaminants detected were phenols, PAHs, pesticides, and PCBs.

Chlorinated hydrocarbons and BTX compounds (associated with fuels) were generally concentrated in the center of the former process area. Test trench sample T-5, located adjacent to Quarry Lake, contained the highest concentrations, with 1,735,000 ppb of BTX compounds (mostly toluene) and 211,000 ppb of chlorinated hydrocarbons. Samples T-4, T-7, T-8, B-2, B-3, and B-8 were also highly contaminated with the same compounds. PAH compounds were more evenly distributed across the site than the other contaminants. Sample B-1, located in the southwest corner of the site, contained the highest concentration of PAHs, at 31,660 ppb. Samples B-2 and B-8 were also highly contaminated with PAHs. Metals in the fill measured at elevated levels were arsenic, cadmium, chromium, copper, lead, and mercury. Chromium concentrations were highest in the area where lake sediment/metals sludge spoils had been deposited in the center of the process area.

The five subsurface samples taken outside the process/fill area were found to be relatively uncontaminated, with only a few contaminants detected at relatively low levels. [URS-5D contained the highest concentration of total organics at 25 ppb. All were semivolatile organic compounds.]

In general, contamination is limited to the process/fill area, and has not spread appreciably to the surrounding soil. Based on soils analysis, the process/fill area between Quarry Lake and the former railroad bed may be divided into distinct sub-areas, depending on the level and type of contamination, as illustrated in Figure 1-4. The "hot-spot" area (Area A) in Figure 1-4 is the most heavily contaminated.

1.2.2.2 Quarry Lake Water

The preliminary results of the analysis of Quarry Lake water performed for this RI show that the lake water is relatively uncontaminated. In the Phase II sampling, only a few organic contaminants were detected, and these were detected at only low levels (e.g., 1,2-dichloroethene and toluene, both at 4 ppb). None of the organic contaminants in the lake (a Class D water body), exceeded Applicable or Relevant and Appropriate Requirements (ARARs). Metal concentrations are low, with only iron exceeding the ARARs for a Class D water body.

Quarry Lake is a water-filled, man-made excavation. The lake is underlain by a layer of low-permeability clay. In some areas the clay layer may be thin or nonexistent. Based on URS water balance calculations (Section 3.8, RI), the lake loses water on all sides except for the southeast, along the process area. Groundwater from the highly contaminated process/fill area is flowing into the lake at a rate estimated to be less than 200 gallons per day (gpd). This flow is small compared to the 37 million gallon volume of the lake. Also, the present flow from the groundwater into the lake is estimated to be only 0.5 percent of the influent flow from precipitation. Contaminants therefore are quickly diluted, which may explain why the organics were found at near detection limits. Contaminant levels would become significant if water levels in the lake were lower, resulting in an increased flow of contaminated groundwater and decreased dilution from the lake.

1.2.2.3 Quarry Lake Sediments

When sediments from Quarry Lake were analyzed as part of the RI, they were found to be contaminated with both organic and inorganic materials. The lake is divided by the remnants of a berm constructed in the mid-1980s, into northern and southern basins (Figure 1-4). The southern basin was dredged in 1988, and the dredge spoils, comprising mainly metal sludges and some natural clay, were deposited over the process/fill area.

Organic compounds, both volatile and semivolatile, were detected more frequently and at higher concentrations in the sediments of the southern basin. Samples LS-5 and LS-6, located in the sediment adjacent to the process/fill area, contained concentrations of total organic compounds of 686 ppb and 591 ppb, respectively. These were also the only two sediment samples to contain PCBs, with concentrations of 300 ppb in LS-5 and 120 ppb in LS-6. The higher level of organic contamination found in the southern basin is probably due to the proximity of the basin to the process area and to the continued leaching of organics from the process/fill area. When organic concentrations in the sediment were compared to sediment cleanup criteria, considered to be ARARs for the site sediments, Aroclor-1254 and benzo(a)pyrene were seen to exceed the acceptable levels. Both these contaminants were detected only in the southern basin, in samples LS-2, LS-5, and LS-6.

Unlike the pattern of organic contamination in Quarry Lake sediments, the metals contamination was found to be greatest in the northern basin. This is not surprising in view of the fact that the northern basin has not been dredged and still contains metal hydroxide sludges from past operations. Compared to background metals concentrations in the soil, only cadmium, chromium, and cyanide were present at significantly elevated levels in the northern basin. LS-16 contained the highest levels of cadmium and chromium, at 86.9 and 1,100 ppm, respectively.

1.2.2.4 Bull Creek and Pond Contamination

Limited sampling has been conducted on Bull Creek at the Frontier Chemical site. Two surface water and two sediment samples were collected from Bull Creek, a Class C stream. A total of seventeen organic compounds were found in the two surface water samples, thirteen of which were found only in the upstream sample. All compounds were detected at levels of 26 ppb, or less. Eleven organic compounds, mostly PAHs, were found in the sediment samples, eight of which were common to both samples. PAH concentrations were 2 to 5 times greater in the downstream samples than the upstream. Although these compounds were found on site, they may be attributed to a local source (i.e. Townline Road and RR ROW). When compared to ARARs calculated for the stream sediment, only benzo(a)pyrene (300 ppb) in the downstream sample exceeded the ARAR of 67 ppb. However, a benthic survey of the site, performed by URS during the RI, indicated that the overall impact of the site on the water quality of Bull Creek is negligible.

1.2.2.5 Groundwater Contamination

The three principal hydrologic units defined at the site include an upper water-bearing zone, a clay confining unit, and a lower aquifer. Within the process/fill area, the upper-water bearing zone includes both fill and the underlying weathered clay. Groundwater in the upper water-bearing zone is perched, and appears to flow in a radial pattern away from the process area, although horizontal flow is of low volume. The groundwater flow rate is low due to the presence of tight natural materials (clay) around the fill area. Flow through the clay confining unit is generally vertical and downward, as evidenced by the strong downward gradients between the upper water-bearing zone and the lower aquifer. Horizontal flow in the lower aquifer is generally to the southwest.

Fourteen samples were taken from the upper water-bearing zone, located in fill or weathered clay. Only those wells located in the process/fill area (Areas A and B in Figure 1-4) were found to contain any organic contaminants. The screened interval in most of these wells includes both fill and the underlying weathered clay. Wells outside the fill area were found to be free of organic contaminants. Numerous volatile and semivolatile contaminants were detected in the upper watering-bearing zone in the process/fill area. No pesticides or PCBs, however, have been found. The compounds of greatest significance, due to their frequency and concentration, were chlorinated hydrocarbons and BTX compounds. Sample 85-3S contained the highest toluene concentration (260,000 ppb) and the highest chlorinated hydrocarbons concentration (243,610 ppb).

Concentrations of many metals and cyanide were found to exceed groundwater ARARs. Concentrations of metals from onsite wells were found to greatly exceed metals concentrations in background wells. These metals include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, selenium, and zinc. Of these metals, antimony, iron, magnesium, and manganese also exceeded groundwater ARARs in the background wells.

Nine samples were analyzed from the confining clay unit. Eleven volatile organic contaminants and one semivolatile organic contaminant were detected at low levels in these samples. Samples 88-11B and 88-11C were the most contaminated, with total organics of 288.9 and 142 ppb, respectively. All other samples contained <20 ppb of organic contaminants. These contaminants may have migrated through the clay in the process area, or they may be migrating through the bottom of Quarry Lake.

As in the shallow groundwater, levels of antimony, iron, magnesium, and manganese exceed the groundwater ARAR limitations and background levels.

Six samples were taken from the lower aquifer. All organic compounds detected in these samples were volatiles. Samples URS-5D and URS-7D contained 250 ppb and 120 ppb of acetone, respectively. All other samples contained less than 14 ppb total organics. The acetones found in the deep aquifers could be the result of laboratory contamination. Several metals were also present at elevated levels. Antimony, iron, and magnesium exceeded ARARs. These metals, however, were also found in the background water samples at elevated levels. These results indicate that the deep aquifers are relatively clean.

The conclusion of the groundwater analyses is that all three units have been contaminated, with the most contamination being in the shallow aquifer within the process/fill area (Regions A and B on Figure 1-4). The water is apparently being contaminated either by direct migration of contaminants from the process/fill area, or by contaminants migrating through the bottom of Quarry Lake.

Most of the local residents are served by a municipal water supply system. The closest well used for drinking purposes is located more than 900 feet away from the site and has been tested by the NYSDOH and was found to be clean. The addition of an alternate water supply to area residents would not presently be necessary.

1.2.3 Baseline Health Risk Assessment

As part of the RI, a baseline health risk assessment was performed to determine the impact of contamination at the site in the absence of remedial measures.

Unacceptable risk probabilities for carcinogenic compounds, and hazard indexes for non-carcinogens have been identified for populations of nearby residents, trespassers, and future users as well as unacceptable hazard indices for non carcinogenic compounds for residents at the Frontier Chemical-Pendleton site. Estimates of the extent of exposure of potential receptors to chemicals were then developed according to USEPA Reasonable Maximum Exposure criteria.

The data suggest that groundwater in the upper water-bearing zone poses a carcinogenic risk to receptors. A receptor may be exposed to an unacceptable carcinogenic risk in shallow groundwater (when it lies on the surface of the site during certain parts of the year) by dermal contact. Onsite trespassers (hunters, etc.), nearby residents, and future recreational users of the site were considered as potential receptors. A summary of the risks is presented in Table 7-42 of the RI. The carcinogenic risk seems to be a function of two chemicals detected, namely Arochlor-1254 and benzene.

The data further suggest that contaminated soil presents an unacceptable chronic hazard index to residents and future uses. Contact may be made by inhalation of fugitive dust and by dermal contact with contaminated soil. Our analysis further suggests that this unacceptable chronic hazard index is a function of the concentrations of two metals, namely, chromium and cadmium.

1.3 Initial Remedial Action

The existing site conditions, characterizations, and preliminary risk assessment reveal several factors that may need to be addressed prior to the design and implementation of a long-term remedial action. At the present time, however, there is no immediate threat to humans or the environment from these factors. Therefore, no initial remedial action is warranted.

2. IDENTIFICATION OF GENERAL RESPONSE ACTIONS

2.1 Remedial Action Objectives

Remedial action objectives are based on both medium-specific and general requirements. Medium-specific remedial action requirements are based upon reducing the potential health risk associated with the site due to the presence or migration of contamination at the site. Contaminated media at the site include soil/fill, groundwater, surface water, and sediments. The following remedial action objectives have been established for the Frontier Chemical-Pendleton site:

1. Prevent human contact with contaminated soil.
2. Prevent the erosion of contaminated soil into Quarry Lake, Bull Creek, and the surrounding area.
3. Prevent migration of contaminants from the soil into the groundwater.
4. Prevent human contact with contaminated groundwater.
5. Prevent the migration of contaminated groundwater into Quarry Lake and off site.
6. Prevent human contact with potentially contaminated surface water.
7. Prevent the migration of potentially contaminated surface water from the site.
8. Prevent human contact with heavily contaminated sediment.
9. Prevent the migration of contaminants contained within the sediment.
10. Prevent human contact with fugitive dust.

2.2 General Response Actions

General response actions are, like remedial action objectives, medium-specific. These general response actions are categorical approaches to remediation into which fit various technologies and process options. The following general response actions have been identified for each of the contaminated media at the Frontier Chemical site.

1. Contaminated Soil/Waste/Fill

General response actions include: no action, institutional action, physical controls, containment, excavation and offsite disposal, excavation and onsite treatment, and in-situ treatment.

2. Groundwater

General response actions include: no action, institutional action, monitoring, containment, and collection and treatment.

3. Surface Water

General response actions include: no action, institutional action, diversion, and diversion with collection and treatment.

4. Sediments

General response actions include: no action, institutional action, containment, excavation and removal, excavation and treatment, and in-situ treatment (assuming that Quarry Lake has been drained).

5. Air

General response actions include: no action, institutional action, and others common to the response actions for contaminated soils/waste/fill that also address fugitive dust emissions.

Applicable remedial technologies and process options for each of the general response actions are identified and screened in Section 3.

2.3 Extent of Remediation

The extent of remediation is determined by the extent of contamination present at the site and from the remedial action objectives that were determined for the site. The extent of contamination at the site is primarily limited to the process area and Quarry Lake. All other areas north of the Lake, including the wetlands, are essentially free of contamination. The portions of the site to be remediated consist of soil, groundwater, surface water, and sediment, each of which is described in further detail below.

2.3.1 Soil

Analysis of soil samples at the Frontier Chemical site has determined that essentially all of the soil contamination present at the site is limited to the 7.4 acre process/fill area shown on Figure 1-4, between the lake and the former railroad bed. This area is predominantly contaminated with specific groups of compounds such as chlorinated hydrocarbons, BTX, PAHs, and metals. The process/fill area has been divided into two regions (Areas A and B) based on the type and level of contamination (Figure 1-4). The total volume of fill in the process area, most of which lies between the railroad bed and Quarry Lake, is estimated to be approximately 57,000 cubic yards, not including the four piles of previously dredged sediments.

Depending upon the health risk presented by certain groups or concentrations of chemicals present at the site, it may be possible to apply different remedial technologies to discrete areas of fill. The area of the highest contamination was found in Area A, designated as the "hot-spot" area. Area B was also contaminated, but at significantly lower levels. This is designated as the "non hot-spot" area.

2.3.2 Groundwater

As discussed in Section 1.2.2, groundwater in the upper water bearing zone is very contaminated while the deeper aquifer is comparatively clean.

2.3.3 Sediment

Analysis of sediment in Quarry Lake has shown that two distinct types of contamination are present in the lake sediments. The northern basin of the lake is contaminated primarily with metals, whereas the southern basin is contaminated primarily with organics. The southern basin, located adjacent to the process/fill area, contains many contaminants, of which PCBs and benzo(a)pyrene were found to exceed sediment ARARs. The total volume of contaminated sediments in the lake was estimated to be 20,000 cy. An additional 10,000 cubic yards of sediments/sludge was placed in four mounds in the process/fill area from previous dredging operations.

2.3.4 Surface Water

Recent analysis of water from Quarry Lake shows it to be relatively free of contamination, with only a few trace organics detected. Analysis of Bull Creek also showed no effect on the creek attributable to the Frontier site. The ponds located in the process area have not been analyzed.

2.3.5 Air

Inhalation of fugitive dust from the process/fill area by residents pose a chronic risk due to the presence of chromium and cadmium.

2.4 Applicable or Relevant and Appropriate Requirements (ARARs)

Applicable or Relevant and Appropriate Requirements (ARARs) considered for the site are discussed in Section 6 of the RI. In this report, the generic term ARAR is used to reference the following family of regulations; Federal ARARs, New York State Standards, Criteria, and Guidance (SCGs), and any other local laws and regulations. ARARs are divided into the following categories:

- Chemical-specific requirements - Health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or chemicals/contaminants. These limits may take the form of cleanup levels, discharge levels, and/or maximum intake levels (such as for drinking water and breathing air for humans).

- Action-specific requirements - Controls or restrictions on particular types of remedial activities in a related area, such as hazardous waste management or wastewater treatment.

- Location-specific requirements - Restrictions on remedial activities that are based on the characteristics of a site or its immediate environment. An example would be restrictions on wetlands development.

2.4.1 Chemical Specific Requirements

The standards identified for protection of water quality are listed in Table 6-2 of the RI. New York State ambient groundwater standards for chemicals on the Target Compound List (TCL) have been taken from the NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values, September 25, 1990 (TOGS 1.1.1, 9/25/90).

Protection of surface waters is accomplished through ambient water quality standards listed in TOGS 1.1.1, 9/25/90 for Classes C (Bull Creek) and D (Quarry Lake). These are extracted from Part 701 and 702 of Title 6 NYCRR (NYSDEC regulations). In the absence of a specified standard or guidance value for organic chemicals, a general ambient water quality value of 50 ug/L for a chemical may be applied. The Federal Clean Water Act (CWA) provides ambient water quality criteria for the protection of aquatic life. These standards are for the protection of aquatic life and will also be discussed under location-specific requirements. Ambient water quality standards are used to derive effluent standards for discharges to State groundwaters and surface waters. Effluent standards will be discussed under action-specific requirements.

Sediment cleanup criteria in New York State are discussed in "Cleanup Criteria for Aquatic Sediments" (NYSDEC, 1989). Cleanup criteria are developed through the method of equilibrium partitioning to calculate the equilibrium concentrations of non-polar organic chemicals in soil.

There are no chemical standards to apply to soil except for the tests to determine whether wastes must be characterized as hazardous. In New York State, either the EP Toxicity test or the newer Toxicity Characteristic Leaching Procedure (TCLP) may be applied to determine whether waste is hazardous. [TCLP has replaced EP Toxicity at the federal level (40 CFR Part 261) but NYSDEC has not yet promulgated this rule.]

For purposes of actual disposal, TCLP must be used, even in New York State.

To protect human health through direct contact with the site, health-based standards for surficial soils and shallow groundwater were developed from the health risk assessment (Section 7 of the RI). Acceptable maximum contaminant levels were back-calculated from the acceptable carcinogenic and chronic risks assumed in the RI. These health-based standards are considered to be ARARs for the site.

Contaminants of concern which presented individual carcinogenic risks greater than 1×10^{-6} or chronic risks greater than 1.0 were identified for each pathway examined in the health risk assessment. Ten of the eleven pathways had at least one contaminant each with an individual carcinogenic risk greater than 1×10^{-6} (Table 7-42 of the RI). One pathway had one contaminant with an individual chronic risk greater than 1.0. Working from assumed acceptable risks of 1×10^{-6} (carcinogenic) and 1.0 (chronic), back calculations were done using the pathways and models established in the health risk assessment to yield maximum acceptable contaminant concentrations. The contaminants identified and concentrations calculated are presented in Table 2-1. It must be recognized that lower acceptable risks may have to be assumed during remediation, for individual compounds, such that the cumulative risks from all compounds for each pathway and for sums of pathways also will be acceptable.

2.4.2 Location-Specific Requirements

The Frontier Chemical site is located in an area of State-regulated wetlands and classified surface waters. Bull Creek, the northern border of the site, is a Class C stream suitable for fishing and fish propagation, as well as for primary and secondary contact recreation. Quarry Lake is a Class D surface water, meaning that, due to natural

TABLE 2 – 1

HRA BASED ACCEPTABLE CONTAMINANT CONCENTRATIONS

MEDIA: COMPOUND: Contaminant Concentrations That Will Individually Produce Carcinogenic Risks of 1.00E–06 or Chronic Risks of 1.00E+00:

MEDIA	COMPOUND	PATHWAY: Residents – Ingestion (Soil)	Residents – Dermal Absorption (Soil)	Trespassers – Inhalation (Fugitive Dust)	Trespassers – Inhalation (Fugitive Dust)	Future Recreational Users – Ingestion (Soil)	Future Recreational Users – Dermal Absorption (Soil)
		Carc.	Carc.	Carc.	Chron.	Carc.	Carc.
Surface Soils	Benzo(a)anthracene	*	*	*	*	*	208.0
	Chrysene	*	*	*	*	*	208.0
	Benzo(b)fluoranthene	*	*	*	*	*	208.0
	Benzo(k)fluoranthene	*	*	*	*	*	208.0
	Benzo(a)pyrene	*	*	*	*	*	208.0
	Indeno(1,2,3–cd)perylene	*	*	*	*	*	208.0
	Aroclor–1254	1550.0	1710.0	*	*	3100.0	310.0
	Aroclor–1260	*	*	*	*	*	310.0
	Cadmium	*	*	41800.0	*	*	*
	Chromium	*	*	*	218000.0	*	*

MEDIA	COMPOUND	PATHWAY: Trespassers – Dermal Contact (Groundwater)	Future Recreational Users – Dermal Contact (Groundwater)
		Carc.	Carc.
Shallow Groundwater	Vinyl Chloride	610.0	314.0
	Chloroform	*	*
	1,2–Dichloroethane	15400.0	7940.0
	Trichloroethene	*	*
	Benzene	94.5	48.0

Carc. = Carcinogenic
Chron. = Chronic
All concentrations in ppb.

* = Does not have an individual risk greater than 1.00E–06 (carcinogenic) or 1.00E+00 (chronic) at the present environmental concentration.

conditions, the waters are suitable for fishing (but not for fish propagation) and for primary and secondary contact recreation. Other factors may limit the lake's use for these purposes.

A major portion of the site is covered by New York State-regulated Class II wetland, TE-6. In addition, all areas where Lakemont soil predominates are likely to be considered federal wetlands according to the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (U.S. Army Corps of Engineers, 1989). State wetlands and 100-foot buffer zones are protected as a matter of public policy by Parts 663 and 664 of Title 6 NYCRR, so that they may provide the benefits of storm and floodwater control, wildlife habitat, water supply, water quality, fisheries, food chain, recreation, open space, and education and scientific research opportunities. Federal Executive Order #11990 of 1977 provides policy guidance, in the furtherance of the National Environmental Policy Act of 1969 as amended, for the consideration of the benefits of wetlands when federal activities affect national wetlands. Activities such as draining, dredging, channelizing, filling, diking, impounding, and related activities are prohibited unless no practicable alternative exists.

According to the Natural Heritage Program of New York State, no federal or State endangered, threatened or special-concern species are known to exist within a two-mile radius or nine miles downstream of the site. No critical habitats are known to occur within this range, and none of the plant communities observed during the habitat-based assessment appears to be of limited range or threatened within New York State.

This site is partially located in a 100-year flood plain and a 500-year flood plain. Executive Order 11988 of May 24, 1977, and amendments, required federal actions to consider alternative measures to avoid adverse effects on 100-year flood plains, or to minimize potential harm to or within the flood plain.

RCRA regulations pertaining to the siting of hazardous waste TSD facilities are appropriate and relevant at Frontier. The remedial action chosen must identify the 100-year flood level and any other factors which must be considered in constructing and operating the facility to withstand washout from a 100-year flood (6 NYCRR 373-1, 361).

2.4.3 Action-Specific Requirements

Action-specific ARARs pertaining to remedial technologies at Frontier Chemical define the regulatory framework within which the technologies may be developed and executed. Federal regulations which must be considered in technology screening include CERCLA and its amendments under SARA, the Federal Clean Air Act and its amendments, the Clean Water Act and its amendments, and RCRA Subtitle C (40 CFR 264). The Hazardous and Solid Waste Amendments to RCRA, including Land Disposal Restrictions, provide an action-specific ARAR. New York State has promulgated the RCRA mandates through the State hazardous waste management system, 6 NYCRR Parts 370 through 374.

RCRA requirements include groundwater protection, general landfill standards, and standards for waste piles and surface impoundments. Specific ARARs of concern depend on the alternatives selected. Should wastes be transported off site, regulations applicable to transporters of hazardous waste (40 CFR 263) would be relevant. Transporters must obtain a USEPA identification number and comply with the manifest system, which documents shipment and delivery of hazardous waste.

Other action-specific requirements include discharge limitations applicable to groundwater treatment technologies. The New York State Pollution Discharge Elimination System (NYSPDES) provides for permitted discharges based on ambient water quality standards for classified streams.

Activities in wetlands will require complying with New York State wetland permit requirements (6 NYCRR Part 663) and U.S. Army Corps of Engineers regulations concerning construction activities affecting wetlands. Activities impacting the wetland may include filling or draining a portion to reclaim land for construction activities at the site during remediation. New York State standards for the issuance of permits (6 NYCRR 663.5) provide for the weighing of need for the activity against benefits lost with the loss of wetland area. These weighing standards for Class II wetlands require that the proposed activity be compatible with public health and welfare and be the only practical alternative to meet the project's objectives. The loss of Class II wetland area is acceptable only in the very limited circumstance in which "the proposed activity satisfies a pressing social or economic need that clearly outweighs the loss of or detriment to the benefit(s) of the Class II wetland." The regulations also provide for the possibility that the applicant's proposal calls for mitigation of serious impacts to wetlands.

Remedial activities on site may include capping, excavation and treatment, in-situ treatment, surface water erosion control, slurry walls, sediment dredging, and groundwater collection and treatment. Capping of wastes in place will not trigger applicability of RCRA requirements for landfills (40CFR 264.310(a)), but they may be relevant and appropriate. These requirements include: preventing migration of liquids through the cap; minimizing maintenance; minimizing erosion; preventing settling; permeability considerations; restricting access; maintaining benchmarks to locate cells; 30-year post-closure care and groundwater monitoring. In-situ treatment of wastes does not trigger RCRA applicability, since this is not considered placement (disposal) of waste. However, design and operating standards for the specific unit in which hazardous waste is treated may be relevant and appropriate (40 CFR 264.601, 264.601).

Surface water control must prevent run-on and collect runoff from a 24-hour 25-year storm in waste piles, land treatment facilities and landfills (40 CFR Parts 264.251 (c).(d), 264.273(c).(d), and 264.301(d).(d)), and prevent overtopping of surface impoundments.

Discharge of dredge or fill material into surface waters or wetlands is prohibited unless: there is no practical alternative, water quality standards are not violated, no significant degradation of water quality occurs, and appropriate steps to minimize adverse effects have been implemented (40 CFR 230, 33 CFR 320-33).

Onsite container storage of hazardous wastes not meeting small quantity generator criteria held for a temporary period lesser than 90 days is subject to RCRA requirements (40 CFR 264.171 through 264.178). Onsite container storage of hazardous wastes not meeting small quantity generator criteria held for a temporary period greater than 90 days is subject to RCRA requirements (40 CFR 264.171 through 264.178). Tank storage requirements are listed in 40 CFR 264.190 through 264.198.

Discharges to a POTW must not include pollutants which: create a fire or explosion hazard; cause corrosive damage; obstruct flow; or increase the temperature of wastewater so as to cause interference with the treatment plant. Discharges must also comply with local POTW pretreatment programs (40 CFR 403.5 and local POTW regulations).

Groundwater monitoring requirements are covered in 40 CFR 264, Subpart F.

Land Disposal Restrictions

Wastes from sites where remedial action is being conducted, such as Frontier Chemical, are subject to land disposal restrictions (LDRs) only if they are removed for treatment and/or disposal off-site. When the treatment and/or disposal occurs within the area of contamination (AOC), placement does not occur and the LDRs are not applicable.

Once removed for the off-site treatment/disposal, these wastes become newly generated for purposes of the Hazardous and Solid Waste Amendments (HSWA) of 1984, which require USEPA to limit the volume and toxicity of hazardous wastes for land disposal. The waste types that have been banned from land disposal without treatment are: reactives, ignitables, incompatible wastes, bulk liquids, and containerized liquids. All characteristic and listed hazardous waste, referred to as scheduled wastes, were divided into three parts: first-third (considered to be the most toxic), second-third, and third-third (the least toxic). To date, all scheduled and characteristic wastes are effectively regulated by the schedule established under HSWA, limiting the type of wastes that can be disposed of in a landfill.

A listed waste may be from specific sources (K codes under 40 CFR 361.32), non-specific sources (F code under 40 CFR 361.31), or from spill residues (P and U codes under CFR 261.33). If the waste fits one of these categories, it is a listed hazardous waste. The waste, if hazardous, must be assigned all listed and characteristic waste codes. At the Frontier site, it is known that wastewater from plating operations was treated and metal sludges were generated from this process. If it is determined that the wastewater came from electroplating operations, the sludge would be assigned an USEPA Hazardous Waste Number F006. Using the "by contact" rule, all contaminated waste would be classified as F006 waste. Per the third-third rule, F006 wastes are prohibited from land disposal without treatment. The technology standard for wastes listed for heavy metals content is solidification. Other waste classifications would depend upon documented past processes at the site, which may include fuel blending or solvent recovery, residues likely to result from such process, e.g. spent non-halogenated solvents and still bottoms (F001 through F005).

Another criterion by which the soil/waste may be classified is TCLP analysis. Two surface soil samples analyzed for TCLP exceeded regulatory levels of 0.7 ppm for tetrachloroethene (maximum 11.22 ppm) and 0.5 ppm for trichloroethene (maximum 5.92 ppm). As a result, the soil/waste would be assigned USEPA Hazardous Waste Number D039 (tetrachloroethene) and D040 (trichloroethene). Additional classifications may apply due to benzene (D018) and 1,4-dichlorobenzene (D027), which were found at significantly higher concentrations in areas not sampled for TCLP. A variance is in effect for "D" wastes until May 1992. However, since actual remediation of the site is not expected to be completed by May 1992, the soil/waste, if excavated for off-site treatment/disposal, will be subject to the land disposal restrictions.

3. IDENTIFICATION/SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

3.1 Identification of Remedial Technologies

The purpose of this section is to identify potential remedial technologies which are best suited to the Frontier Chemical-Pendleton site based on technical implementability. Remedial technologies are selected for each environmental medium and general response action, as presented in Table 3-1. Corresponding process options are also presented with each remedial technology.

3.1.1 Remedial Technologies for Soil/Fill/Waste

A. No Action

"No action" is included as required by the National Contingency Plan (NCP). This "technology" represents the conservation of existing conditions at the site, with current levels of maintenance and control and no additional remedial actions.

B. Institutional Action

Institutional actions for the prevention of direct human contact include consideration of permanent deed restrictions controlling the use and development of the site, and long-term monitoring of site contamination levels. Due to health risks associated with human exposure to contamination in the surficial soils and groundwater, site access has to be severely restricted.

C. Capping

Capping covers buried waste to prevent its exposure at the surface, enhance runoff, and minimize groundwater recharge. A variety of

TABLE 3-1

TECHNOLOGY SCREENING SUMMARY

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS
SOIL, WASTE, AND FILL	NO ACTION	NO ACTION	NO ACTION	NO ACTION
	PREVENT HUMAN CONTACT	INSTITUTIONAL ACTION	INSTITUTIONAL ACTION	DEED RESTRICTIONS
				LONG TERM MONITORING
		CONTAINMENT	CAPPING	RCRA CAP
				6 NYCRR PART 360 CAP
				MSG CAP
				SOIL CAP
	PREVENT EROSION OF ON-SITE SURFICIAL SOILS INTO LAKE AND BULL CREEK	PHYSICAL CONTROLS	EROSION CONTROLS	VEGETATION
				BERMS AND DITCHES
		CONTAINMENT	CAPPING	(see above)
	PREVENT MIGRATION OF CONTAMINANTS INTO GROUNDWATER	EXCAVATION AND TREATMENT	BIOLOGICAL TREATMENT	BIOLOGICAL TREATMENT
			PHYSICAL/CHEMICAL TREATMENT	SOLIDIFICATION/STABILIZATION
				SOIL WASHING
			THERMAL TREATMENT	INCINERATION
				LOW TEMPERATURE THERMAL DESORPTION
		IN-SITU TREATMENT	BIOLOGICAL TREATMENT	BIOLOGICAL INJECTION
			PHYSICAL/CHEMICAL TREATMENT	CHEMICAL TREATMENT
				IN-SITU SOLIDIFICATION
				IN-SITU VITRIFICATION
		CONTAINMENT	SECURE CELL	ON-SITE RCRA CELL MEETING 40 CFR 264, SUBPART N, REQUIREMENTS

TABLE 3-1

TECHNOLOGY SCREENING SUMMARY

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS
GROUNDWATER	NO ACTION	NO ACTION	NO ACTION	NO ACTION
	PREVENT HUMAN CONTACT	INSTITUTIONAL ACTION	INSTITUTIONAL ACTION	DEED RESTRICTIONS
				LONG TERM MONITORING
	PREVENT MIGRATION OF CONTAMINATED GROUNDWATER	CONTAINMENT	VERTICAL BARRIERS	SHEET PILING
				SLURRY WALL
		COLLECTION	GROUNDWATER COLLECTION	SUBSURFACE COLLECTION TRENCHES
				WITHDRAWAL WELLS
		TREATMENT	OFF-SITE TREATMENT	POTW
				COMMERCIAL FACILITY
			ON-SITE TREATMENT	SITE-SPECIFIC PROCESS OPTIONS
SURFACE WATER	NO ACTION	NO ACTION	NO ACTION	NO ACTION
	PREVENT HUMAN CONTACT	INSTITUTIONAL ACTION	INSTITUTIONAL ACTION	DEED RESTRICTIONS
				LONG TERM MONITORING
				RESIDENT RELOCATION
	PREVENT OFFSITE WATER FROM ENTERING SITE	DIVERSION OF RUNON	DIVERSION	TRENCHES
				BERMS
	PREVENT ONSITE WATER FROM LEAVING SITE	DIVERT/COLLECT RUNOFF	COLLECTION	DRAINAGE DITCHES
			CONTROL OVERFLOW	BERMS/V-NOTCH WEIR

TABLE 3-1

TECHNOLOGY SCREENING SUMMARY

ENVIRONMENTAL MEDIA	REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS
SEDIMENTS	NO ACTION	NO ACTION	NO ACTION	NO ACTION
	PREVENT HUMAN CONTACT	INSTITUTIONAL ACTION	INSTITUTIONAL ACTION	DEED RESTRICTIONS
				LONG TERM MONITORING
		CONTAINMENT	CELL CONSTRUCTION	DREDGE AND CONSTRUCT RCRA PART 360 CELL FOR SEDIMENT
	PREVENT MIGRATION OF CONTAMINANTS	DREDGING AND TREATMENT	PHYSICAL/CHEMICAL TREATMENT	SOIL WASHING
				CHEMICAL TREATMENT
				SOLIDIFICATION
			THERMAL TREATMENT	INCINERATION
		IN-SITU TREATMENT	PHYSICAL/CHEMICAL TREATMENT	IN-SITU CHEMICAL TREATMENT
				IN-SITU SOLIDIFICATION
				IN-SITU STABILIZATION
				IN-SITU VITRIFICATION
AIR	NO ACTION	NO ACTION	NO ACTION	NO ACTION
	PREVENT HUMAN CONTACT	INSTITUTIONAL ACTION	INSTITUTIONAL ACTION	DEED RESTRICTIONS
				LONG TERM MONITORING
				RESIDENT RELOCATION
	PREVENT INHALATION OF FUGITIVE DUST	CONTAINMENT	CAPPING	SEE PROCESS OPTIONS FOR SOIL/WASTE/FILL

capping systems is feasible for implementation in the process/fill area. Capping would meet the following objectives:

- A reduction of infiltration from precipitation through the process/fill area. The process/fill area presently releases contaminated groundwater to the lake.

- A reduction or elimination of contaminated surface water runoff from the fill area. Contaminated runoff at present flows into the lake.

- An elimination of direct human contact with contaminated surficial soil in the process/fill area. Health risks due to dermal contact and ingestion of contaminated soil/fill would be reduced or eliminated.

Capping options include:

- RCRA cap;
- 6 NYCRR Part 360 cap;
- multilayered cap with a synthetic geomembrane (MSG); and
- soil cap.

All capping options would include grading, vegetative cover, and surface water drainage provisions as part of the design.

D. Erosion Control

Several control methods are available to keep contaminated soil from leaving the site through erosion. Erosion control options include the addition of vegetation to the site, and berms and ditches. Capping systems, described in the previous section, would also reduce the amount of contaminated soil and fill that leaves the site by erosion, through careful grading, vegetative cover, and the addition of a surface water drainage system.

E. Excavation and Offsite Disposal

This technology involves the excavation, transportation, and offsite disposal of part or all of the contaminated soils, wastes, and fill present within the process/fill area. Wastes could be taken to a commercial secure landfill (i.e. RCRA facility) for disposal, or to a commercial treatment facility. This technology may be applied to either the waste piles or the subsurface fill material, or both, although if large quantities of material are involved, it may not be cost-effective. At present, these site soils and wastes are considered hazardous by TCLP criteria. Metal sludges will be considered hazardous wastes since they were derived from electroplating operations. Both soils and sludges will be subject to RCRA Land Disposal Restrictions and consequently cannot be disposed of off site without treatment. Excavation and offsite disposal will therefore not be considered further.

F. Excavation and Onsite Treatment

This technology involves excavation, treatment, and replacement of treated soils at the site. Examples of treatment are biological treatment, solidification, chemical treatment, and thermal treatment.

- Biological treatment technologies include mixing the excavated soil or waste in a "biological reactor." Contaminants are oxidized by microorganisms into harmless products, thereby reducing the toxicity of the waste.

- Solidification, stabilization, or fixation technologies include first excavation of the soil and/or waste, and then mixing with it additives in order to reduce the mobility of the contaminants. Mobility may be reduced to such an extent that contaminants cannot be released or leached from the resultant product.

- Chemical treatment generally refers to a type of soil-washing technology. The contaminated soil is excavated, crushed or pulverized, and screened (sieved) to remove large particles and debris. The soil then passes into a soil scrubber where it is sprayed with a washing fluid typically consisting of water with added surfactants and chemicals for pH adjustment. Contaminants in the fluid are then treated and the liquid is recycled back to the process.

- Thermal treatment technologies are generally synonymous with incineration, a process which destroys contaminants by controlled oxidation (combustion). Many different types of incinerators exist, including rotary kiln, fluidized bed, and infrared incinerators, each of which has various advantages and disadvantages. The contaminated waste is fed, along with auxiliary fuel, into the incinerator. Many incinerators have two stages of thermal treatment, the second generally being an after-burner for further treatment of the gas phase. The process oxidizes the waste, leaving byproducts of ash and gases. Ash generated from incineration would need testing and possibly treatment prior to onsite disposal. The combustion gases are treated with air pollution control units and the ash is disposed of appropriately. This technology offers essentially complete destruction of the original organic waste.

Another thermal process is low-temperature thermal desorption. In this process, the waste is heated to a temperature at which the volatile organic contaminants desorb from the waste. The desorbed contaminants are then collected and treated by an additional process such as fume incineration or vapor-phase carbon adsorption.

G. In-Situ Treatment

A number of in-situ treatment technologies are potentially applicable to the site. None involve wholesale excavation.

- Biological treatment involves the injection, collection, biological treatment, and reinjection of water across the site. The feasibility of this technology depends on the biodegradability of the contaminants and hydraulic gradients across the site.

- Chemical treatment involves the injection, collection, chemical treatment and reinjection of water across the site. Chemical treatment processes are effective for a wider range of contaminants than biological methods in that they can treat inorganic as well as organic contaminants.

- In-situ solidification involves the same principles as previously mentioned under excavation and treatment, except that a deep soil mixing technique is used for the direct application of the agents to the soil. This is accomplished with augers and mixers, which inject additives as the soil is mixed.

- The in-situ vitrification process converts contaminated soil into a chemically inert, stable, glass and crystalline product through extremely high temperatures created by electrical currents. During the process, organic compounds are destroyed by pyrolysis, and inorganics are retained in the soil. Upon cooling, the soil is transformed into a glass-like product which is left in place. This process works best at shallow depths above the water table.

- In-situ vacuum extraction is a process in which air flow is induced through the soil by using a series of extraction wells and vacuum pumps. Volatile organic contaminants in the soil and groundwater desorb and are carried out with the air stream for treatment. Vacuum extraction is applicable only to those contaminants above the water table in the unsaturated zone. Success of the technology also depends largely upon the permeability of the soil/fill present at the site.

H. Containment Within a Secure Landfill Cell

Containment through horizontal barriers would permanently and significantly reduce the mobility of contaminants. Since contamination has already integrated with the clay below the surface, a horizontal barrier below the waste/fill is not feasible. If all wastes however, were to be excavated, consolidated, and replaced in a cell with a horizontal and vertical barrier, contaminant mobility would be reduced or eliminated. Excavation of all waste material will be a very expensive approach, however, and horizontal barriers as part of a containment system will therefore not be considered further.

3.1.2 Remedial Technologies For Groundwater

A. No Action

"No Action" is included as required by the National Contingency Plan (NCP). This "technology" represents the conservation of existing conditions at the site, along with a groundwater monitoring program.

B. Institutional Action

With institutional action, future use of the site is possible, but the use of groundwater should be prohibited. To ensure this, permanent deed restrictions prohibiting groundwater use are included in the Institutional Action option. Since the groundwater table is near the ground surface and significant health risks exist with exposure to the contaminated groundwater, access to the site should be severely restricted. In addition, a long-term environmental monitoring program should be developed in conjunction with the appropriate regulatory agencies. An additional option is the relocation of local residents.

C. Vertical Barriers

Low-permeability vertical subsurface barriers would reduce or eliminate migration of contaminants from the site and/or reduce the amount of groundwater to be collected and treated by interrupting the inflow of water to the site. Available barrier options include sheetpiles (with or without partial or complete grouting), and slurry walls (soil-bentonite or cement-bentonite).

D. Groundwater Collection

Collection of contaminated groundwater is necessary to prevent the migration of contaminated groundwater off site. As indicated by the results of environmental sampling, contaminants are present on site in both the upper water bearing zone and lower aquifer. The contamination does not seem to have migrated off site, however. Onsite withdrawal of groundwater in areas where contamination is indicated may be applicable.

Collection of groundwater can be accomplished by several methods. One method is to install collection wells at appropriate intervals across the site. A system of subsurface groundwater collection trenches is another effective method for containing groundwater migrating from the site.

E. Groundwater Treatment

Groundwater collected from the contaminated areas of the site can be treated on-site, off-site or a combination of both. Complete onsite treatment for the parameters of concern will be required if the groundwater is to be discharged to a receiving surface water stream, i.e. Bull Creek. The groundwater can also be transported to a publicly owned treatment works (POTW) or a (Commercial) treatment facility permitted to accept aqueous waste from a hazardous waste site for treatment. Discharge to the POTW through the sewer may require that the groundwater be pretreated on-site to meet sewer discharge limits.

3.1.3 Remedial Technologies for Surface Water

A. No Action

"No Action" is included as required by the National Contingency Plan (NCP). No action represents conservation of existing conditions at the site, with current levels of maintenance and control.

B. Institutional Action

Institutional Action for the prevention of direct human contact includes permanent deed restrictions controlling the use and development of the site, and long-term monitoring of surface water contamination levels.

C. Diversion of Surface Water Runon From Off Site

Surface water runon from off-site contributes to an increase in the volume of contaminated surface water runoff from the site. Depending on the remedial technology chosen and the subsequent quantity of runon, a system of trenches and berms may be constructed for diversion purposes.

D. Collection of Runoff From the Site

Runoff which comes in contact with waste or fill may be potentially contaminated. Surface water runoff from the site mainly enters Quarry Lake and can discharge to Bull Creek via a ditch along the western side of the lake. Collection of this runoff prior to its entering the lake would involve the construction of a system of ditches around the site. Appropriate discharge of the runoff would depend on whether or not it came into contact with contaminated soil. When used in conjunction with a site cap, effective runoff controls will prevent off-site migration of contamination through runoff.

E. Control Overflow

The lake overflows to Bull Creek via a ditch along the eastern side of Townline Road. This overflow from the lake can be released at a controlled rate through the use of a V-notch weir or a spillway control.

3.1.4 Remedial Technologies for Sediments

A. No Action

"No Action" is included as required by the National Contingency Plan (NCP). No Action represents conservation of existing conditions at the site, with current levels of maintenance and control.

B. Institutional Action

Institutional Action for the prevention of direct human contact includes permanent deed restrictions controlling the use and development of the site, and long-term monitoring of site contamination levels.

C. Dredging and Offsite Disposal

Sediments at the site will be considered hazardous waste since they were derived from electroplating operations subject to the landban restrictions. Therefore, disposal at an offsite facility will not be possible without treatment.

D. Dredging and On-site Treatment

This technology involves dredging the bottom of the Lake, followed by treatment of all dredge spoils, including the four piles on the process/fill area, and placement of the treated sediments on site under a suitable cap. The sediments would be treated by one of the technologies discussed in Section 3.1.1.F for soils/fill/waste.

E. Cell Construction

This technology involves the dredging of contaminated sediments and disposal of all dredged sediments, including those already in piles over the process/fill area, into an on-site cell, meeting 40 CFR 264, Subpart N requirements. It may be possible to use a portion of the lake as the cell, since a confining clay layer already exists below the lake. Additional clay may be needed in areas where the clay layer is thin or non-existent due to past quarrying. This technology will be retained for further consideration.

3.1.5 Technologies for Air

A. No Action

"No Action" is included as required by the National Contingency Plan (NCP). No Action represents the conservation of existing conditions at the site, with current levels of maintenance and control.

B. Institutional Action

Institutional Action for the prevention of direct human contact includes permanent deed restrictions controlling the use and development of the site, long-term monitoring, and relocation of residents in the vicinity of the site.

C. Capping

The capping options presented earlier for soil/waste/fill will eliminate risks due to inhalation of fugitive dust from the contaminated areas by residents and trespassers.

3.1.6 Selection of Technologies

A preliminary identification of technologies and process options was presented in the preceding section. A summary of those considered feasible for the site based on results of the RI is presented below.

SOIL/WASTE/FILL

No action; institutional action; capping; erosion control; excavation and onsite treatment; in-situ treatment.

GROUNDWATER

No action; institutional action; vertical barriers; collection and treatment.

SURFACE WATER

No action; institutional action; diversion of surface water runon; collection of runoff; and lake overflow control.

SEDIMENTS

No action; institutional action; dredging; treatment; and placement under a cap.

AIR

No action; institutional action; and capping (see soils/waste/fill).

3.2 Screening of Remedial Technologies/Process Options

3.2.1 General

Criteria for the screening of remedial technologies/process options are predicated on seeking remedial actions that, in whole or in part, result in a permanent and significant decrease in the toxicity, mobility, or volume of hazardous substances, pollutants or contaminants to the maximum extent practicable. Preference is given to those remedial technologies/process options that provide permanent protection to human health and the environment from the risks posed by hazardous substances at the site. Specifically, the criteria to be used are based upon a hierarchy of remedial technologies, in which the order of preferable technologies (i.e. from most desirable to least desirable) is:

- Destruction - Irreversible destruction or detoxification of all or most of the hazardous waste to levels satisfying remedial action objectives and resulting in no residue containing unacceptable levels of hazardous constituents. This will achieve a permanent reduction in the toxicity of all or most of the hazardous waste.

- Separation/Treatment - Separation of the hazardous from the non-hazardous waste, resulting in two waste streams, one with an acceptable level of hazardous waste (namely in relation to the remedial action objectives) and the other a concentrated waste stream with high contaminant levels for treatment. This will achieve a permanent and significant reduction in the volume of waste mixed with hazardous waste.

- Solidification/Chemical Fixation - Significant and permanent reduction in the mobility of hazardous waste. This may or may not significantly reduce the toxicity or volume of hazardous wastes.

- o Control and Isolation - Significant reduction in the mobility of hazardous wastes, but with no significant reduction in toxicity or volume. This also includes physical barriers to control migration of leachate, and pumping and treatment of contaminated groundwater.

Preference will be given to those remedial technologies that have been successfully demonstrated on a full scale or a pilot scale under a SITE program; at a Federal or State Superfund site; at a Federal facility or at a PRP site overseen by a State environmental agency or USEPA, and/or currently operating under a RCRA Part B permit or a RCRA Research and Development permit. A remedial technology which has a documented history of successful treatment will also be given preference.

At this point, process options are screened to limit the number which represent each remedial technology. The criteria used to screen process options are effectiveness and implementability.

The evaluation of process options for effectiveness focuses upon:

- o Potential effectiveness in handling the estimated areas or volumes of media.
- o Meeting remedial action objectives.
- o Potential impacts on human health and the environment during the construction and implementation phases.
- o Estimated success and reliability when applied to the contaminants and conditions at the site.

3.2.2 Technology Screening for Soil/Waste/Fill

3.2.2.1 Soil Capping

A. RCRA Cap

The components of a USEPA RCRA cap include 24 inches of low-permeability clay, 20-mil minimum membrane liner, 12 inches of sand drainage layer, and 24 inches of soil. A RCRA cap would permanently and significantly decrease infiltration into the fill and in this way reduce the mobility of the hazardous substances at the site. A RCRA cap would also provide permanent protection to human health and the environment against the risks associated with contact with the contaminated soil and off-site migration of the hazardous substances. RCRA caps are recommended for hazardous waste landfills, as they are considered a proven and effective capping option. However, a RCRA cap would be the most expensive capping option and would also require the most intensive construction effort. In particular, the low-permeability (recompacted) soil layer must be constructed carefully and efficiently by experienced crews in order to meet the stringent QA/QC requirements applied to these layers. A RCRA cap is significantly more expensive than other capping options and the additional degree of protection provided by a RCRA cap would not justify its higher cost. For these reasons, a RCRA cap was rejected as a process option.

B. 6 NYCRR Part 360 Cap

A New York State Part 360 cap, considered to be a New York State SCG (Standard, Criteria, and Guidance), consists of a 12-inch gas-venting layer of sand or gravel, a minimum 18-inch low-permeability layer (or High-Density Polyethylene), a minimum 30-inch soil protection layer, and six inches of topsoil. In order to reduce the cap thickness, the gas-venting layer could consist of a geosynthetic capable of performing the function of 12 inches of sand. The total thickness of this cap would be approximately 4.5 feet.

With proper maintenance, the Part 360 cap would permanently and significantly decrease infiltration into the fill and thereby reduce the mobility of the hazardous substances at the site. This type of cap would also provide permanent protection to human health and the environment against the risks associated with contact with the contaminated soil and migration of the hazardous substances. A Part 360 cap is recommended by NYSDEC as an effective environmental control for landfills and is thus considered a proven capping option. However, as discussed earlier, low-permeability soil layers require an intensive construction effort to ensure that the required degree of impermeability is achieved, which increases the difficulty of implementing this option as well as the cost of construction compared to other capping options. Therefore, the Part 360 cap was also rejected.

C. Multilayered Cap with Synthetic Geomembrane Layer (MSG Cap)

A multilayered (MSG) cap consists of general fill as required for grading, low-permeability 60 mil HDPE liner, a 12-inch sand drainage layer, 6 inches of topsoil, and vegetative cover. When properly maintained, a MSG cap would permanently and significantly decrease infiltration into the fill and thereby reduce the mobility of hazardous substances at the site. This type of cap would also provide protection to human health and the environment against the risks associated with contact with the contaminated soil and reduces the migration of the hazardous substances. This cap is also thinner than the RCRA or Part 360 caps and could therefore be matched more closely to the existing grade. The HDPE is more quickly and easily installed compared to low-permeability soil layers and are also less expensive. The multilayered cap with synthetic geomembrane is a feasible option, and will be considered further.

D. Soil Cap

A soil cap consist of one (1) foot of compacted general fill, and 6 inches of topsoil with a vegetative cover. A soil cap with site regrading would provide protection to human health and the environment against the risks associated with contact with the contaminated soil and erosion of the contaminated soil. However, a soil cap would not provide sufficient impermeability to ensure that infiltration would be significantly and permanently reduced and would therefore be the least effective capping option in reducing migration of contaminants at the site. It would instead promote migration of the contaminants of concern, resulting in a long-term decline in the amount of toxics at the site. A soil cap may be more effective when used in conjunction with other technologies that provide treatment of the contaminated soils/waste. For these reasons, the soil cap option will be retained for further consideration.

3.2.2.2 Erosion Controls

The Frontier Chemical site is relatively flat, meaning that only minimal erosion control features such as topsoil, seeding and grass-lined ditches will be required. The slope of final cover will be about 5 percent. Construction of a ditch collection system with general fill will be necessary to create positive flow perimeter drainage from the cap. This will consist of a perimeter berm 6 feet high at its highest point, with an average height of 3 feet to create a drainage ditch which slopes 0.5 percent.

3.2.2.3 Excavation and On-site Treatment

A. Excavation and Biological Treatment

Excavation and biological treatment of part or all of the contaminated fill would permanently and significantly decrease the toxicity and volume of the contaminants. Volatile air emissions from the excavation would be of concern due to the proximity of residential homes. Many of the contaminants present are not readily biodegradable and would require a very long time to be treated completely. In addition, the inorganic elements of the site's contamination cannot be removed through biological treatment, and may even be toxic to the microorganisms. Since a large portion of the contamination at the site is due to chromium, biological treatment is not considered feasible for the treatment of soil, waste, and fill.

B. Excavation and Physical/Chemical Treatment

Excavation and physical/chemical treatment of part or all of the contaminated fill would permanently and significantly decrease the toxicity and volume of the contaminants. Two such physical/chemical processes have been identified for possible use at the Frontier Chemical site:

1) Solidification/Stabilization

The out-of-ground or ex-situ stabilization/solidification technology involves the excavation of contaminated soil/fill, treatment with solidifying agents, and replacement of the solidified material in the ground. Ex-situ stabilization/solidification has been widely developed and used for over fifteen years. This type of processing relies on a proven technology adapted from the chemical and commodities manufacturing industry. The solidification/stabilization process market is well developed and highly competitive. Many vendors are able to supply hardware and service capabilities to meet specific process needs.

Stabilization/solidification would significantly reduce the mobility of hazardous wastes at the Frontier Chemical site as well as provide permanent protection to human health and the environment against the risks associated with contact with the contaminated soil and the migration of the hazardous constituents. As of December 1990, sixteen Superfund sites and ten RCRA sites have utilized stabilization/ solidification as a remedial action. Of these, nine Superfund sites and six RCRA sites utilized stabilization/solidification to volatile organic compounds.

Stabilization/solidification, would require additional efforts for the excavation of the soil/fill and the control of volatile emissions that could impact cost. Ex-situ processing has the advantage, as compared to in-situ processing, of higher power input to achieve very efficient mixing, particle size reduction, and homogeneity. It also has high control of grout loading and other process variables which can affect the quality of the final product.

Solidification/stabilization seems to be feasible for either part or all of the contaminated soil. The feasibility of this option depends entirely on the selection of stabilizing additives that can neutralize those contaminants present. Treatability tests must be performed to determine waste characteristics and the presence of any contaminants which may adversely affect the integrity of the final treatment product. Based on available data from vendors on remediated sites, this process appears to be feasible for the soils at this site. Volatile air emissions would be of concern, as with all other options involving excavation. This technology will be retained for further consideration.

2) Soil Washing

Soil washing seems to be a feasible process option for either part or all of the contaminated soil. Feasibility depends largely on the formulation of a wash fluid which can remove all contaminants successfully. Additionally, contaminants must be easily removable from the cleaning fluid. Because of the additional requirements for handling and treating leachate from the washing process and treated soil, this option will not be considered further.

C. Excavation and Thermal Treatment

1) Incineration

The removal of contaminated soil/fill from the site and destruction is a very effective and permanent means of remediation. However, very few commercial operated hazardous waste incinerators are permitted. Only two vendors were identified for possible treatment of wastes from the Frontier Chemical site, one in Louisiana and one in South Carolina. Disposal costs at these two facilities are several times greater than the costs of other options, and is therefore not considered feasible for this site.

The onsite incineration option consists of the excavation of part or all of the contaminated fill and destruction of all organic constituents in the fill through high-temperature oxidation. The most common type of incinerator presently in use is the rotary kiln.

Nearly complete breakdown of all organics is possible with incineration. However, inorganics, such as metals, are not affected by incineration and the ash may require additional treatment. In addition, the presence of halogenated organics (including PCBs) requires higher destruction temperatures and more stringent air emissions control, making it more difficult obtain permits. Due to inherent problems with public acceptance, regulatory concerns, and relatively high costs, onsite incineration is not considered a viable option.

2) Low-Temperature Thermal Desorption

The onsite thermal desorption option consists of the excavation of part or all of the contaminated fill, desorption of the organics from the waste, destruction of all organics, and replacement of the treated soil. Several types of thermal desorption units are presently available, including thermal dryers and low-temperature thermal treatment (LT^3) units. Thermal desorption is a proven technology, having received several RCRA Part B permits, and is a very effective means for removing volatile and most semivolatile organic compounds.

Many of the problems that exist for onsite incineration also apply to thermal desorption processes. These are:

- o The possibility of volatile emissions during the excavation and stockpiling of contaminated wastes;
- o The treatment of metals, which are unaffected by thermal treatment options; and
- o High water content of the spoils and wastes, which may require special stockpiling and/or drying considerations.

Excavation and low-temperature thermal desorption of part or all of the contaminated fill would permanently and significantly reduce the toxicity of the contaminants. Thermal desorption would remove a large amount of the risk associated with contaminant transport off site. While political climate and community reaction are also of concern, these are not expected to be nearly as intense as is expected for a high-temperature incinerator. Thermal desorption units have generally been easier to permit, with more community acceptance than incinerators. For these reasons, low-temperature thermal desorption will be carried forward in the analysis of remedial alternatives.

3.2.2.4 In-Situ Treatment

A. Biological Treatment

In-situ biological treatment of part or all of the contaminated fill would permanently and significantly reduce the toxicity of the contaminants. This process involves the injection, collection, treatment, and reinjection of water across the contaminated area of the site. Well-defined upgradient and downgradient locations from which to withdraw and inject the water are required. Radial groundwater flow patterns have been identified at the site. With these flow patterns, injection of water may potentially add to the offsite migration of contaminants. In addition, the clay found at the site does not readily desorb contaminants. For these reasons biological in-situ treatment has not been deemed feasible.

B. Chemical Treatment

In-situ chemical treatment is similar to in-situ biological treatment except that the contaminants are removed and/or reacted with suitable chemicals added to the treatment water. This process is also not considered feasible for the same reasons as above.

C. Solidification

The in-situ stabilization/solidification process consists of the introduction and in-situ mixing of solidifying agents to the waste/fill, and encapsulation and chemical binding of the contaminants within the media. This process can treat soils and sludges to a depth of up to 30 feet. With new chemical additives to the solidifying agents, stabilization/solidification has become a very feasible option for the treatment of all types of hazardous wastes. With proper additives formulated for the contaminants of concern at this site, in-situ solidification of part or all of the contaminated fill would permanently and significantly reduce the mobility of the contaminants in the areas treated. It has the advantage of minimizing volatile emissions over excavation-intensive processes, such as incineration or out-of-ground stabilization techniques. While costs for stabilization are much less than those of incineration, stabilization does not achieve the destruction of hazardous waste as does incineration.

Solidification uses the same principles described in the section on excavation and solidification, except that deep soil mixing equipment is needed to efficiently treat the soil with appropriate chemicals. Dewatering of the site prior to solidification is not necessary. The saturated conditions of the soil would actually reduce the amount of water required from outside for processing. Currently available equipment is also provided with organic vapor treatment and dust collectors. This option is considered feasible and will be carried forward.

D. Vitrification

In-situ vitrification of part or all of the contaminated fill would permanently and significantly reduce the mobility of the contaminants. In this process, waste is converted into a stable glass and crystalline form, and the contaminants are held within this highly impermeable product. Due to the presence of volatile organic compounds that would volatilize before being destroyed, processes must be included to collect and treat off-gases. Dewatering of the site prior to vitrification would also be required. Due to its high cost relative to solidification, in-situ vitrification will not be retained further.

3.2.3 <u>Technology Screening for Groundwater</u>

3.2.3.1 <u>Vertical Barriers</u> (Slurry walls, sheetpiles)

A below-grade vertical cutoff barrier may be necessary due to fractures in the weathered clay which may locally increase the permeability of the layer. Below-grade vertical cutoff barriers can be constructed around the entire cap perimeter or by the lake along the more highly contaminated (hot spots) zone. The exact horizontal and vertical limits of the cutoff barrier will depend upon the required treatment of soil and groundwater and necessary containment areas. The depth of cutoff barrier is expected to be just below the weathered clay (average 15 feet), keying 5 feet into the underlying clay/silty clay.

Sheetpile and slurry wall barriers are both possible options, although sheetpile is preferred since it requires less working space than slurry wall operations. Also, sheetpiles can be driven closer to a property line or other boundary than the slurry wall which require berms to contain slurry. The sheetpile would be partially or fully grouted at the interlocks, in order to decrease overall permeability. Slurry wall installation would require excavation.

Adjacent to the lake, for about 500 linear feet, sheetpile can be driven along the top of the bank or into the lake sideslope itself. If it is required that clean fill be placed into the east slope of the lake to gain usable surface area, the sheetpile cutoff structure can also act as a vertical retaining wall for clean fill, thereby reducing the quantity of clean fill necessary in the lake sideslope area.

Vertical barriers would permanently and significantly reduce the mobility of the contaminants. This option will be carried forward in the analysis of remedial alternatives.

3.2.3.2 Groundwater Collection

Groundwater extraction on the Frontier-Pendleton site can be achieved by using withdrawal wells, stone-filled trenches, subsurface drains or combinations of all of the above.

- Withdrawal Wells
  To extract water from the weathered clay aquifer, a series of properly placed withdrawal wells would have to be installed. However, the effectiveness of the wells is questionable, considering the properties of the weathered clay. The clay layer's thickness and low permeability can result in an excessive number of wells needed to ensure the proper containment of the offsite flow. Also, the nature of flow in the weathered clay is more characteristic of the fractured flow. This could render the withdrawal well system ineffective, since the contaminated water moving through the fractures not in contact with the wells would not be intercepted.

- Subsurface Collection Trenches
  Subsurface trenches would effectively intercept the contaminated groundwater. The subsurface drainage system would consist of perforated pipes, surrounded by the stone bedding and geotextile filter fabric, and collection chambers equipped with pumps. The drains could be sloped and can be operated as force mains by maintaining the proper water elevation in the collection chambers.

Of the two groundwater extraction technologies discussed above, the subsurface collection trench is the most appropriate for the Frontier - Pendleton site. It offers both effectiveness in intercepting the entire offsite flow and sufficient capacity to convey it to the collection system.

3.2.3.3 Groundwater Treatment

A. Full On-site Groundwater Treatment

Processes required for full on-site treatment of the groundwater prior to discharge to Bull Creek include cyanide destruction, metals precipitation/sedimentation, air stripping, biological treatment and carbon adsorption. Whether all or only some of these processes are required depend on the degree to which each process can remove the contaminants of concern.

Cyanide destruction can be achieved with the use of a suitable oxidizing agent such as sodium hypochlorite. Precipitation, flocculation and sedimentation are required to remove metals from the groundwater prior to discharge. Air stripping is recommended since it is the simplest and most economical method of removing volatile organics. Due to the high concentrations of volatile organics in the groundwater, an air phase carbon adsorption unit or fume incinerator may be required to treat the off-gases of the air-stripper. Biological treatment will be required to meet BOD and TOC discharge limitations. A combination of air stripping and biological treatment would be more cost-effective than an air stripper alone. Carbon adsorption may be utilized as a polishing step to remove organics that are not effectively removed by the air stripper and biological treatment.

B. Pretreatment of Groundwater

The contaminated groundwater can be pretreated to a level where it could be accepted by a local POTW. The POTW closest to the Frontier Chemical site is the Niagara County Sewer District #1 Treatment Plant. Treatment operations at the facility consist of grit removal, activated sludge aeration, clarification, phosphate removal, polishing, chlorination, and finally discharge to the Niagara River. The plant has a design capacity of 14 MGD but presently operates at 4 to 5 MGD. Effluent limitations to the treatment plant from sources such as the Frontier Chemical site are determined on a case-by-case basis and were not available for the purpose of this feasibility study. Negotiations between NYSDEC and Niagara County Sewer District #1 will be necessary to determine the restrictions on discharge from the Frontier Chemical site. The actual treatment processes and design of the pretreatment facility would have to be based on these restrictions. Cyanide destruction is one such process that may or may not be required, depending upon the final effluent limitation.

The process train for pretreatment of the groundwater prior to discharge to the POTW is anticipated to include precipitation, flocculation, sedimentation, and air stripping. Certain other processes might have to be added, or modified depending on actual sewer discharge requirements.

C. Offsite Groundwater Treatment

Offsite treatment of contaminated groundwater collected by a groundwater extraction system could be accomplished by transporting groundwater to a publicly owned treatment works (POTW) or a commercial aqueous hazardous waste treatment facility. Alternately, the contaminated groundwater could be pretreated on site to meet local sewer discharge limits and then discharged into the sewer for further treatment at the POTW.

Cost depends not only upon the chemical nature and extent of pretreatment of the groundwater, but also upon the size, design, and operating conditions of the plant; the regulatory status of the plant regarding acceptance of extraneous waste streams; the owner of the facility generating the water (e.g., public or private); and, to some extent, the overall political and economic climate at the time of disposal. A local POTW might be able to treat groundwater from the Frontier Chemical site, provided that future institutional and regulatory concerns could be adequately addressed. Offsite disposal has the disadvantage of requiring transportation, that increases the possibility of exposure. Only offsite treatment of pretreated groundwater at a POTW will be retained at this time.

3.2.4 Technology Screening for Surface Water

3.2.4.1 Diversion of Runon From Off Site

By diverting surface water that enters the site through runon from off site, the volume of contaminated water that may leave the site is reduced. A series of trenches and/or berms to divert water entering the site would be feasible. However, due to the wetlands on the northern and eastern sides of the site, studies would have to be done to determine the effects of the diversion on the wetlands. Also, permits would have to be obtained for this diversion. Due to its potential feasibility, this option will be carried through.

3.2.4.2 Diversion/Collection of Onsite Runoff

Collection of surface runoff from the site would include the construction of collection trenches or troughs around the site. Whether the runoff is collected for treatment, or diverted (to the creek, for example) depends on the contact the water has had with contaminants. When used with a site cap, the diversion of surface runoff becomes very effective for the elimination of onsite water buildup. This option is feasible for this site.

3.2.4.3 <u>Control Overflow</u>

Currently, Quarry Lake is surrounded by berms and existing ground at elevation 580 feet, with gaps which permit both lake overflow and run-on into the lake. In order to control lake overflow, the gaps must be closed, and a control structure placed where needed. The site contains very wet areas on low-lying ground, but firm ground will be required to place and compact low permeability soil berm material.

Since the lake is adjacent to a drainage ditch along Townline Road, and since there appear to be no soft soil conditions in that area, a control structure can most efficiently be constructed there. The ditch adjacent to Townline Road is a preferred location for the control structure also because all ditches eventually drain to this point. Improvements to upstream ditches will therefore be minimized because the lake overflow would be routed directly to the furthest downstream point (Townline Road area), bypassing other ditches. Consideration can be given to a second control structure at the east end of the lake, adjacent to the former railroad bed, in case one control structure is not of sufficient capacity. A weir, spillway, or controlled-level stoplog type of control structure can be used, with a V-notch weir the preferred option. The outlet may be concrete or riprap-lined, with riprap-lined outlet channel. This option is feasible and will be carried forward.

3.2.5 Technology Screening for Sediments

3.2.5.1 Dredging of Sediments

Mechanical and hydraulic dredging are methods considered feasible. Mechanical dredging involves the use of excavation equipment such as backhoes, drag lines, clam shells and bucket ladder dredges and is usually associated with high sediment resuspension (turbidity), low production rates, and inability to remove the liquid phase of contaminated sediment. Hydraulic dredging is applicable to depths up to 60 feet, and may be performed in bodies of water with substantial current velocities. These methods do not generate high sediment resuspension and typically do not require hauling of the excavated material. Their main disadvantage is a high flow rate since they create slurries with only a 10-20 percent concentration of solids. Therefore, large areas are required for the sediment storage and dewatering.

Based on the differences between the two methods, hydraulic dredging using a portable dredge was assumed in the development of the cost estimates presented in Section 4.

3.2.5.2 Treatment of Dredge Spoils

The sediments in the northern basin of the lake are contaminated primarily by metals. Previously dredged sediments were piled in four mounds over the process/fill area. These sediments can be treated onsite and placed under a cap. Process options are similar to those described for contaminated soil/fill at the site in the sub-section titled: Excavation and On-Site Treatment. Solidification would be the most effective option due to the predominance of metal contamination in the sediments. This process option is considered feasible and will be carried forward.

3.3 Summary

The remedial technologies and corresponding process options selected for consideration in the development of alternatives are shown on Figures 3-1A through 3-1D for the various media of concern.

3.4 Development of Alternatives

The remedial alternatives are the site- and media-specific remedial technologies and associated process options which, when combined and implemented, will achieve the remediation goals for the site. The formulation of remedial alternatives from the remedial technologies is based specifically on the following criteria:

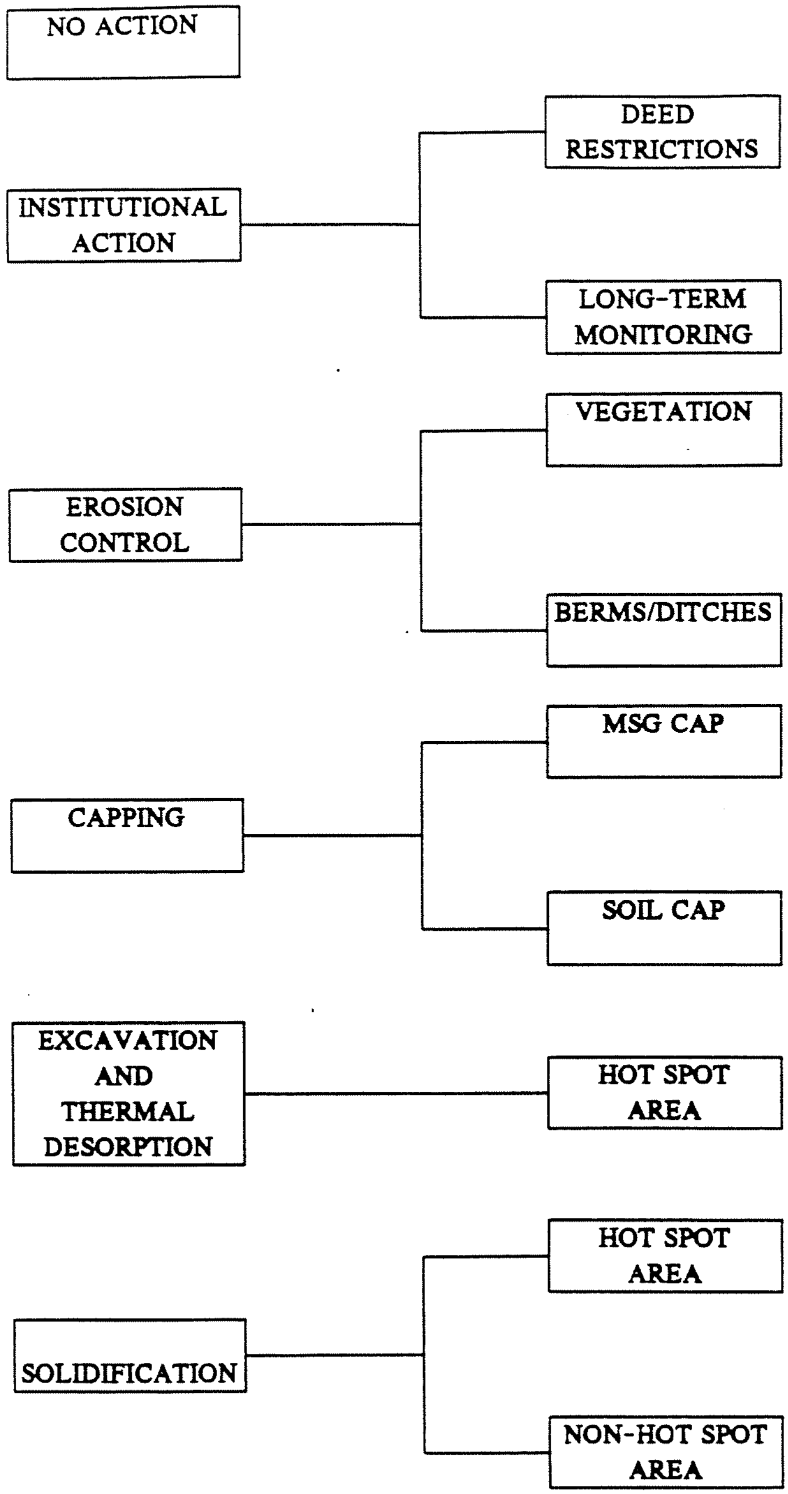
- Alternatives may include a range of general response categories, including no action, institutional action, containment, excavation/removal, physical controls, and groundwater collection/treatment.

- Alternatives must address all principal health and environmental remedial action objectives identified for the site, and specifically for the media.

Seven remedial alternatives were developed as shown in Figure 3-2. Five alternatives other than no action and institutional action were essentially driven by the specific technologies required for soil remediation. Elements common to these five alternatives include physical controls (diversion of run-on/run-off, control of lake discharge and berm closure), sediment dredging, additional monitoring wells, and long-term groundwater monitoring.

Alternatives 3A and 3B (which includes treatment of sediments) are the containment options. These options includes a multilayered cap with

A. SOILS / WASTE



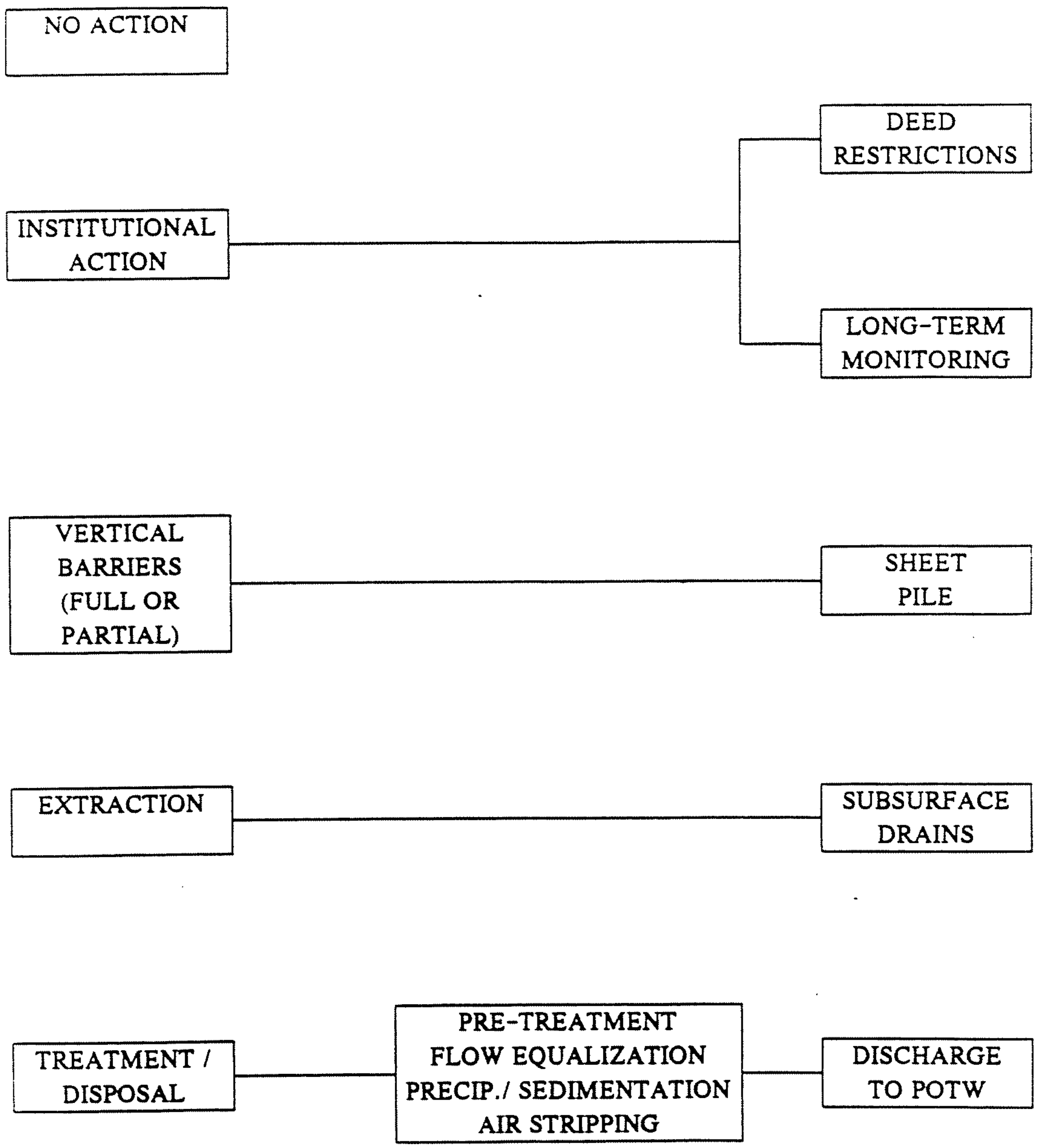
URS CONSULTANTS, INC

FRONTIER CHEMICAL - PENDLETON SITE
SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES

FIGURE 3-1A

A-3751

B. GROUNDWATER



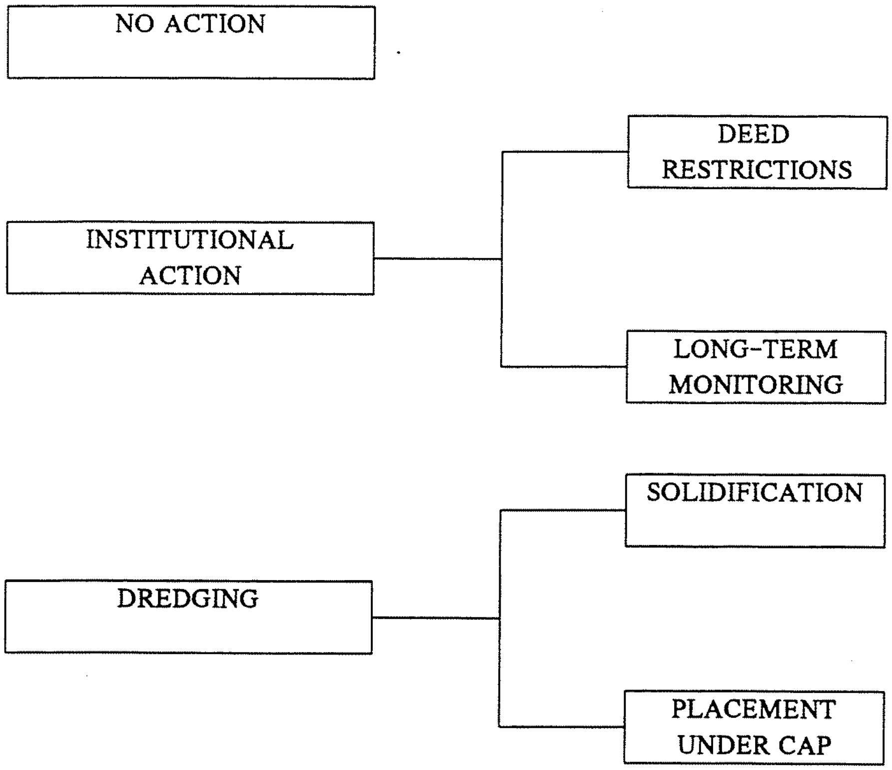
URS CONSULTANTS, INC

FRONTIER CHEMICAL - PENDLETON SITE
SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES

FIGURE 3-1B

A-3752

C. LAKE SEDIMENTS



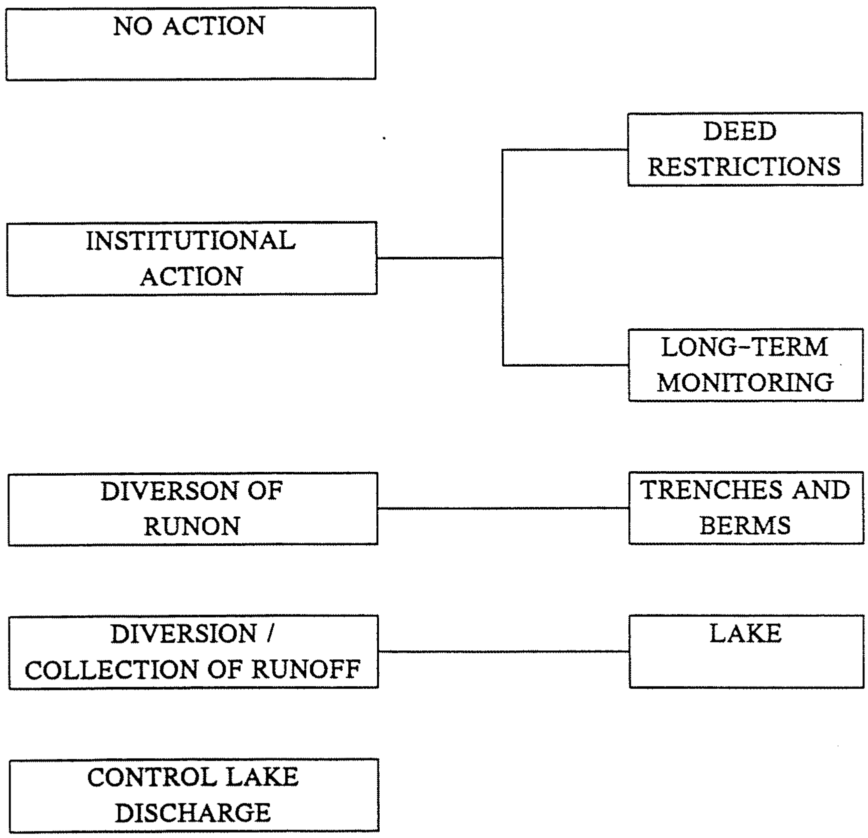
URS CONSULTANTS, INC.

FRONTIER CHEMICAL - PENDLETON SITE
SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES

FIGURE 3-1C

A-3753

D. SURFACE WATER



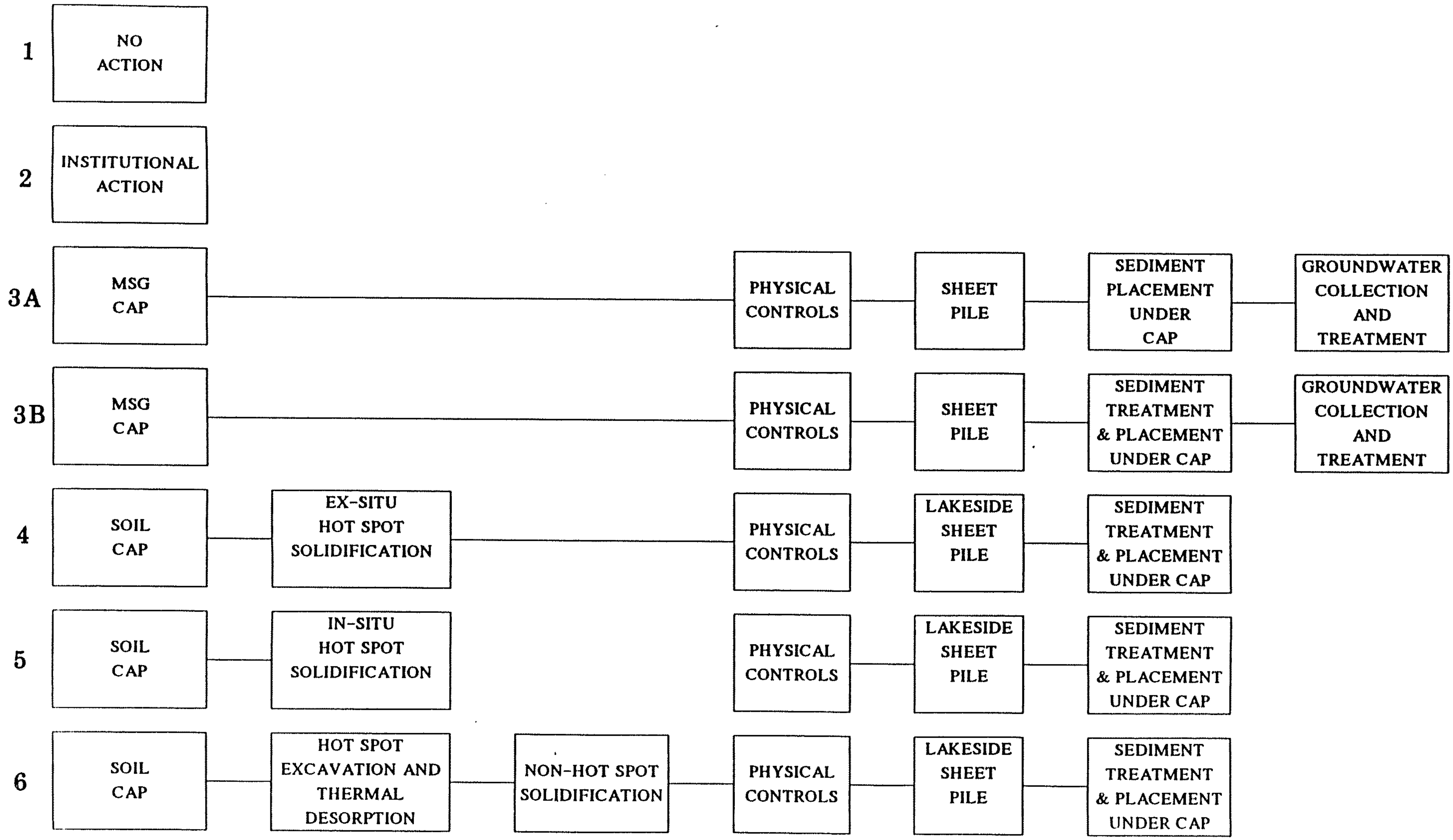
URS CONSULTANTS, INC.

FRONTIER CHEMICAL - PENDLETON SITE
SUMMARY OF SELECTED REMEDIAL TECHNOLOGIES

FIGURE 3-1D

A-3754

A-3755



URS CONSULTANTS, INC.

FRONTIER CHEMICAL - PENDLETON SITE
REMEDIAL ALTERNATIVES

FIGURE 3-2

a synthetic geomembrane (MSG cap) to adequately protect human health and the environment from contaminated surface soils and water, and a complete vertical barrier to prevent off-site migration of contaminants. Alternative 3B includes solidification of the sediments, while Alternatives 4, 5 and 6 include both sediment and soil/waste treatment. For Alternatives 4 and 5, highly contaminated soils and fill material in the "hot-spot" area (Area A in Figure 1-4) are treated using solidification. The contaminated materials are excavated and solidified ex-situ in Alternative 4, while Alternative 5 provides for in-situ solidification of the hot-spot area. Alternative 6 includes treatment of all contaminated areas by both solidification (non-hot spot areas) and thermal desorption (hot-spot areas). A soil cap is also included in Alternatives 4, 5, and 6.

Surface water, lake water controls, and erosion controls are included in all alternatives except the no action and institutional action. Retaining the lake for recreational use in the long term requires proper surface water control measures to alleviate flooding problems around the site. Erosion controls around the lake berm and uncapped areas of the site would help prevent lake overflow, ponding of water, and exposure of contaminated materials, if any.

Although the sediments in the lake are largely composed of metal hydroxide sludges from past processing of waste pickle liquor, it is not considered hazardous based on EP-Tox data. Due to public perceptions of potential health risks associated with chromium, PAH and PCB contamination, however, dredging the lake sediments is included in the five of the alternatives. In Alternative 3A, the dredged sediments are placed without treatment under the MSG cap. Sediments dredged during remediation and the piles of dredge spoils in the process/fill area, will be solidified ex-situ in Alternatives 3B, 4, 5, and 6. The treated sediments will be placed and graded over the process/fill area prior to the placement of a soil cap under Alternatives 4 and 5. For Alternative

6, the northern portion of the lake is converted into a containment cell to contain the solidified lake sediments excavated from this area, and other spoils treated on the site.

Groundwater at the site, contaminated with organics, requires extraction and treatment. Long-term treatment of groundwater is therefore included in Alternatives 3A and 3B. Groundwater treatment will not be required using the in-situ solidification option in Alternative 5 since contaminated groundwater within the fill will be incorporated within the solidified matrix. Temporary groundwater treatment would be required and/or provided under Alternatives 4 and 6 during excavation of the soil/fill for ex-situ solidification and/or thermal desorption. All alternatives except the no-action alternative will require long-term groundwater monitoring.

4. DETAILED EVALUATION OF ALTERNATIVES AND SELECTION OF A REMEDY

4.1 General

The alternatives developed in the previous section and summarized in Figure 3-6 are subjected to a detailed evaluation in this section to select the most appropriate and cost-effective remedy for the site.

These alternatives are described as follows:

Alternative 1 is the "No-Action" alternative involving no activities, short-term or long-term, at the site.

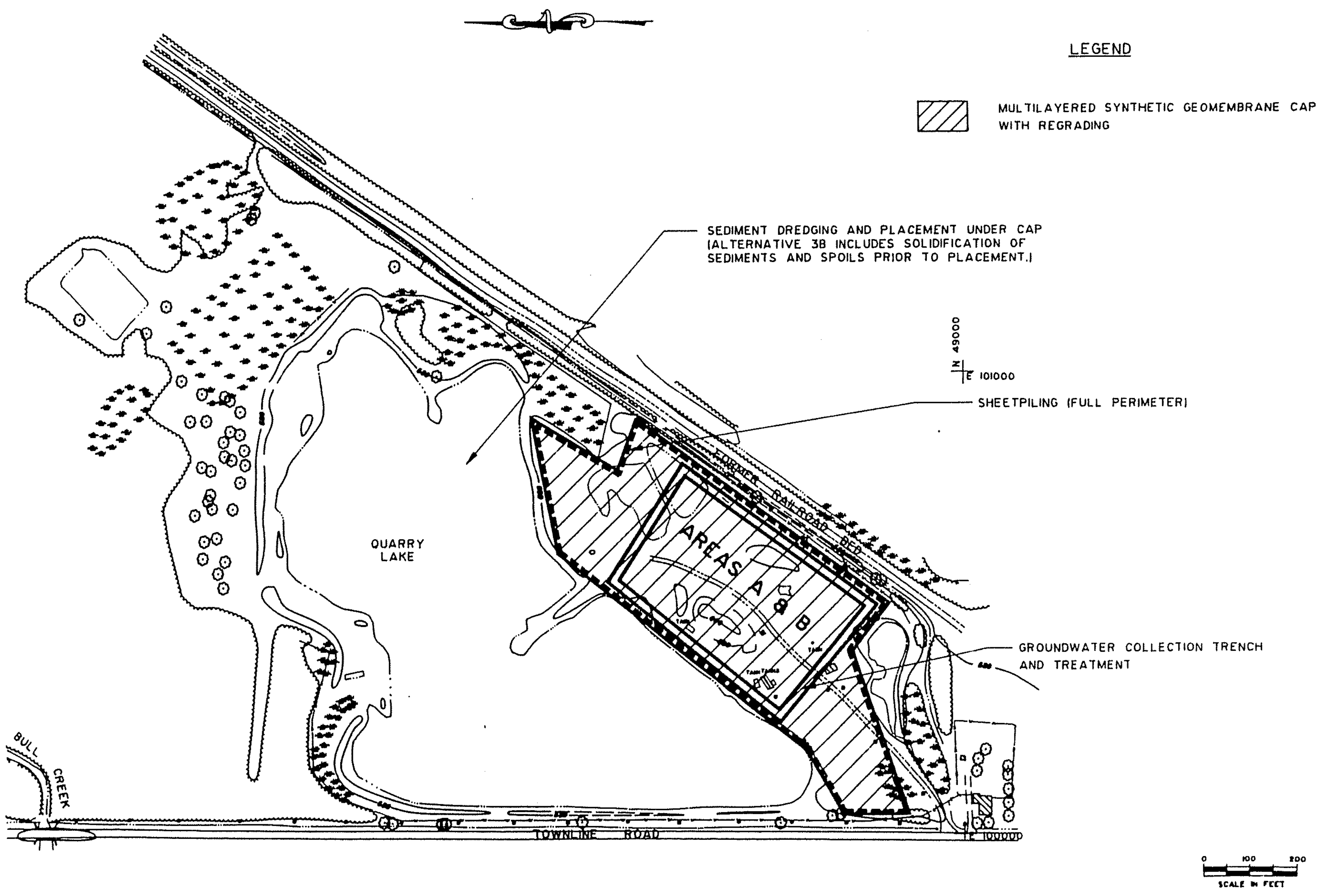
Alternative 2 is an "Institutional Action" alternative involving installation of additional monitoring wells, long-term groundwater monitoring, and site use/access restrictions. A permanent fence and hazard signs will be installed and maintained. This alternative provides a baseline against which other alternatives may be assessed.

Alternative 3A, a "Containment" alternative, provides for a multilayered synthetic geomembrane cap, sheetpile with grouting along the full perimeter of the contaminated process/fill area (as shown in Figure 4-1), placement of untreated dredge sediments over the contaminated fill area under the cap, installation of groundwater collection trenches, and groundwater treatment. Other elements common to Alternatives 3 through 6 include physical controls (diversion of runon/runoff, control of lake discharge, and berm closure), sediment dredging, additional monitoring wells, and long-term groundwater monitoring.

Alternative 3B, is the "Containment with Solidification of Sediments and Spoils" alternative. This alternative is identical to

AC-3781A

1:100 1/03/92



URS CONSULTANTS, INC.

FRONTIER CHEMICAL ALTERNATIVES 3A & 3B

FIGURE 4-1

Alternative 3A, except that dredged lake sediments and surface spoils piles will be solidified prior to placement under the cap.

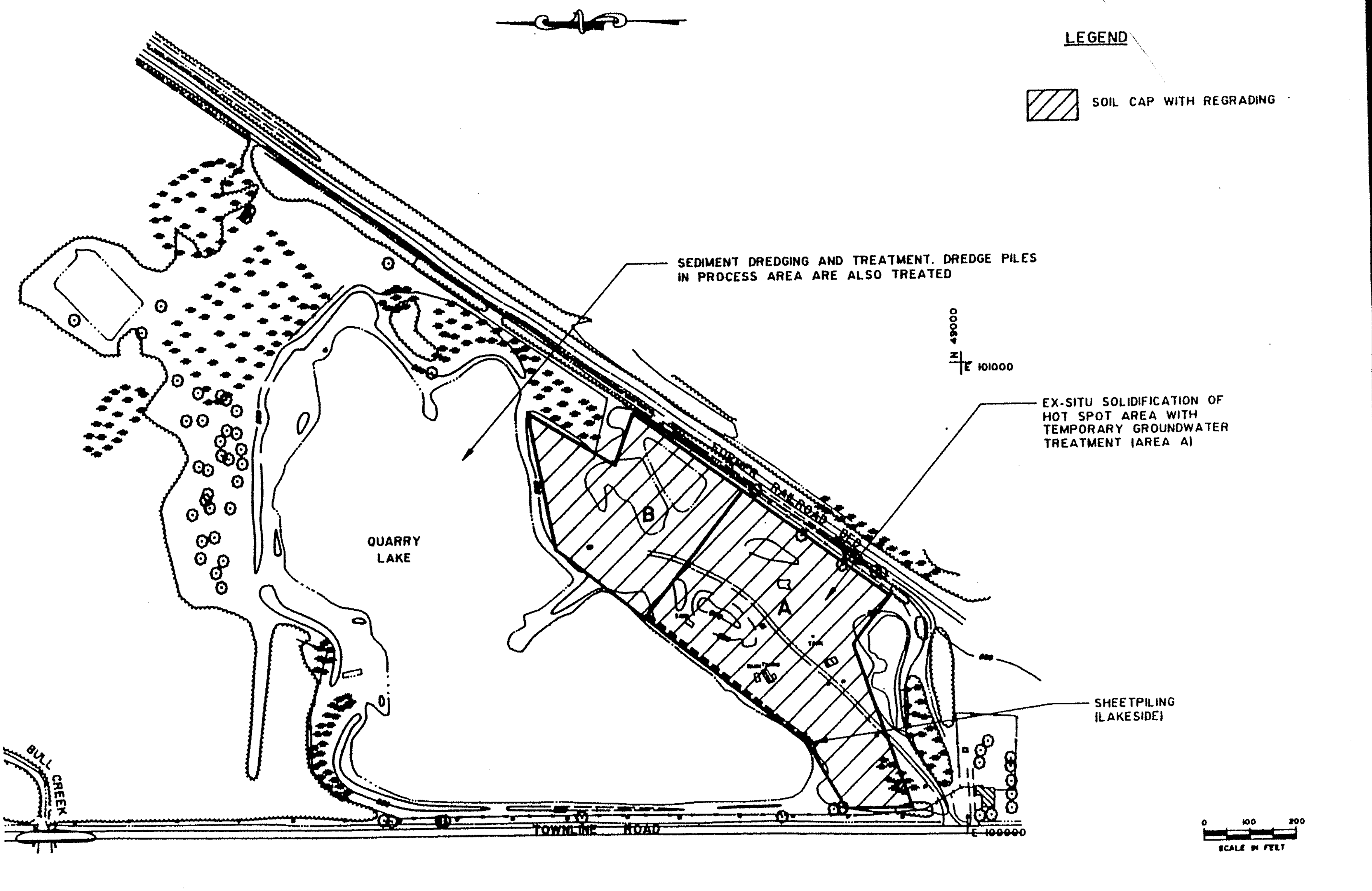
Alternative 4, is the "Hot Spot Treatment with Ex-situ Solidification" alternative. Contaminated soils, waste and fill are excavated from the hot spot area (Area A on Figure 1-4), and treated with lake sediments and dredge spoils in the process/fill area using the ex-situ solidification process. The treated soils, waste and sediments are placed and graded under a soil cap within the process/fill area as shown on Figure 4-2. Temporary treatment of groundwater generated from dewatering during excavation is also included. Physical controls, sediment dredging, additional monitoring wells, and groundwater monitoring are common elements.

Alternative 5 is the "Hot Spot Treatment with In-Situ Solidification" alternative. It provides for in-situ solidification of the hot-spot contamination area (Area A on Figure 1-4), treatment and placement of dredged sediments under regraded fill prior to installation of a soil cap in the process/fill area, as shown on Figure 4-3. A partial sheetpile along the lake by the process/fill area is also included. Physical controls, sediment dredging, additional monitoring wells, and groundwater monitoring are common elements.

Alternative 6 is the "Full Treatment with Solidification and Hot-Spot Thermal Desorption" alternative. It is a full soil/fill treatment option in which the hot-spot area is excavated and treated through thermal desorption, while the non-hot-spot area and the sediments undergo solidification. Re-placement of dredged sediments after solidification in a containment cell built in the northern section of the lake is included, as shown on Figure 4-4. Temporary treatment of groundwater generated from dewatering during excavation is also included. Elements common to the previous three

AC-3782

1:100 7/12/91



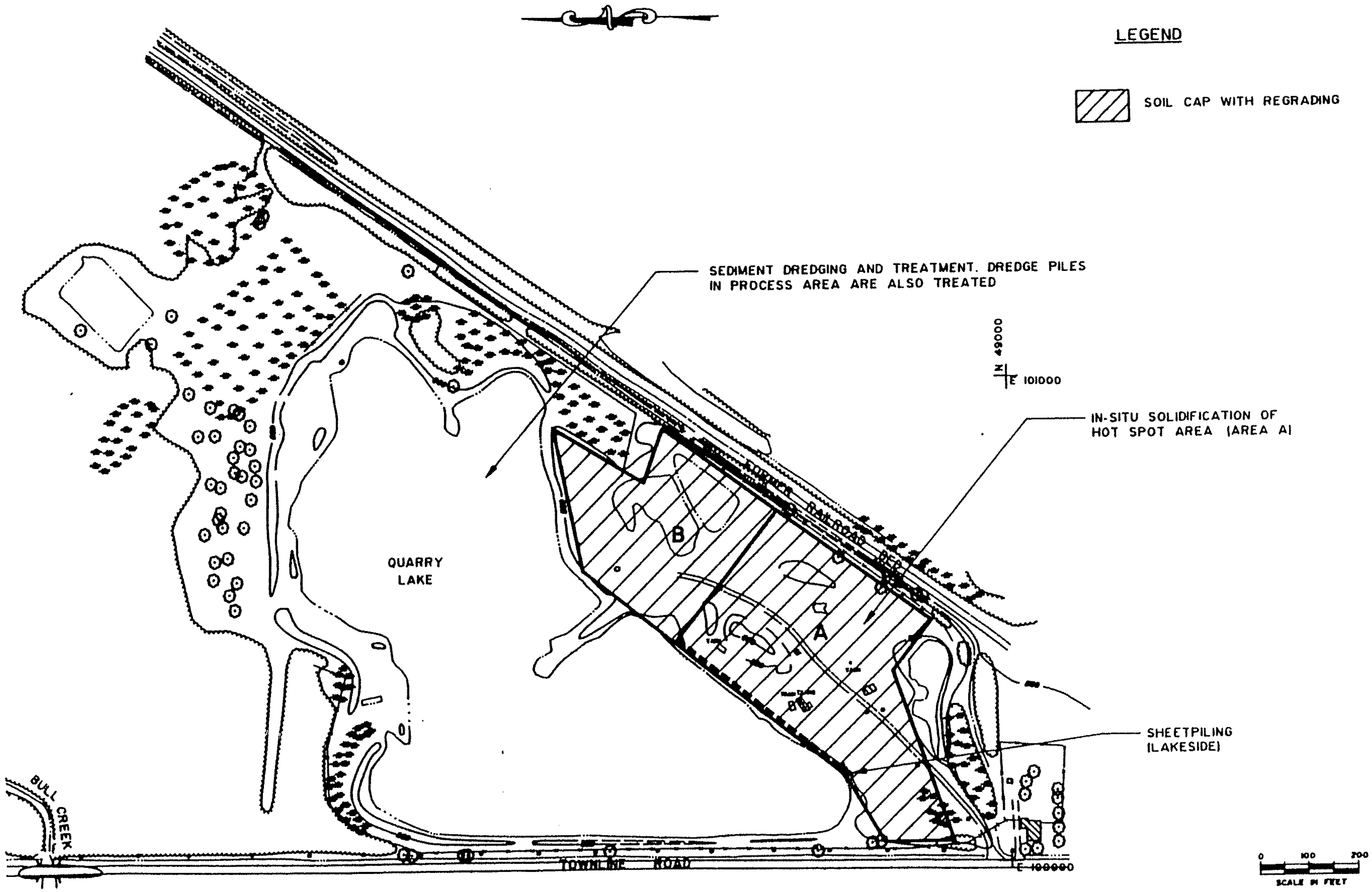
URS CONSULTANTS, INC.

FRONTIER CHEMICAL
ALTERNATIVE 4

FIGURE 4-2

AC-3912

1=100 7/12/91



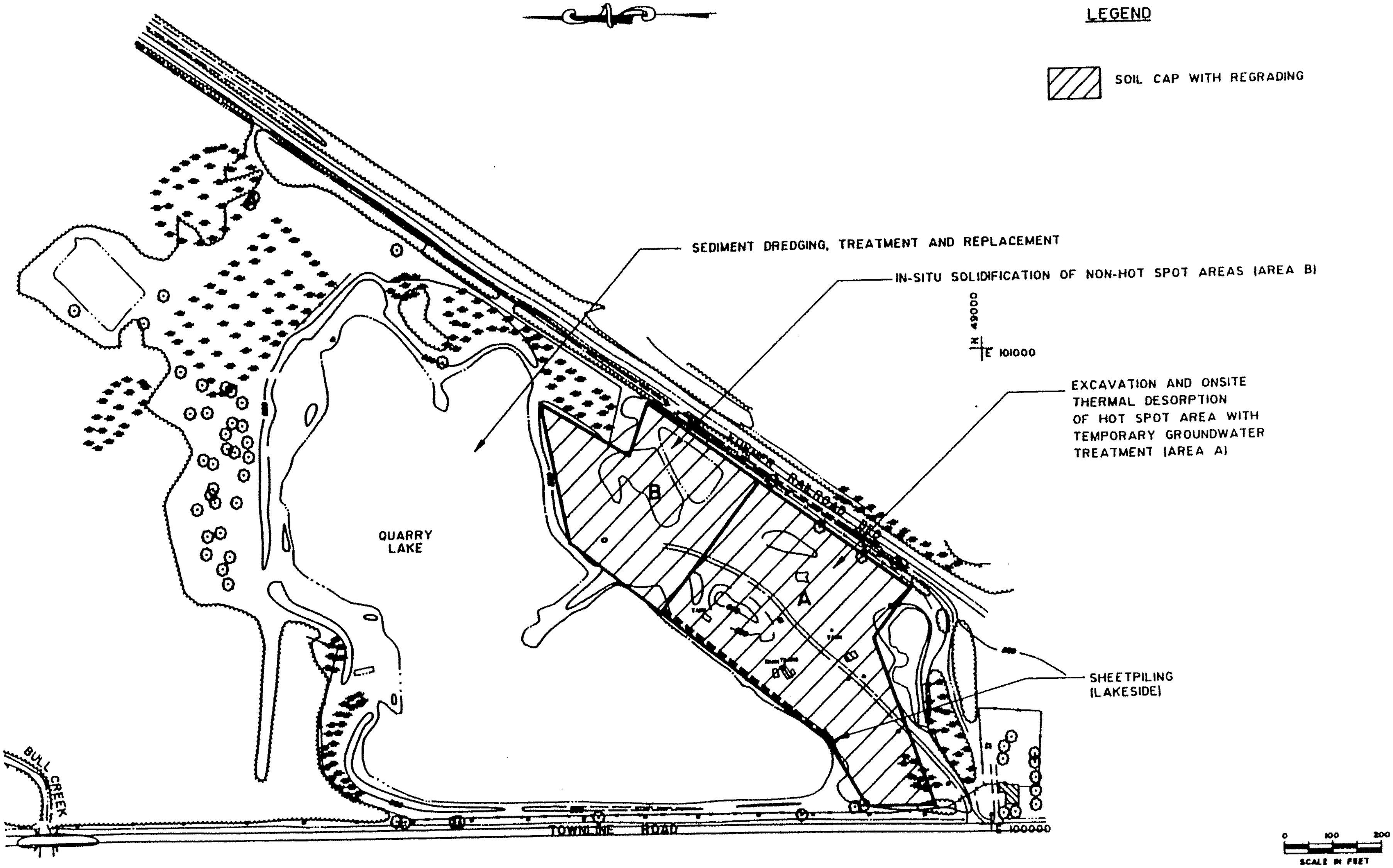
URS CONSULTANTS, INC.

FRONTIER CHEMICAL
ALTERNATIVE 5

FIGURE 4-3

AC-3784

1:100 7/12/91



URS CONSULTANTS, INC.

FRONTIER CHEMICAL
ALTERNATIVE 6

FIGURE 4-4

alternatives include physical controls, sediment dredging, additional monitoring wells, and long-term groundwater monitoring.

The detailed evaluation of alternatives consists of 3 steps. The first step involves a determination of an individual alternative's effectiveness in meeting NYSDEC requirements.

To make this determination, a NYSDEC-approved weighted-matrix scoring system is used to assign a numerical value to how well each alternative satisfies the NYSDEC criteria.

In the second step, the costs associated with the implementation and operation of each alternative are estimated.

In the third step, a comparative analysis is performed in which the alternatives are compared to each other using the results of the weighted-matrix scoring system and the cost estimates for each alternative. A recommended remedial alternative will be selected following the comparative analysis of alternatives.

4.2 Weighted-Matrix Scoring System

4.2.1 Procedure

The selection of a site remedy based upon a scoring system approach involves a quantitative evaluation of the alternatives using the following criteria, with weighing-factors and a simple, numerical scoring system:

- Short-term impacts and effectiveness;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume of hazardous waste;
- Implementability;
- Compliance with federal ARARs and NYS SCGs;

- Overall protection of human health and the environment; and
- Cost Effectiveness.

In the scoring system each alternative is numerically rated against the factors developed for each criterion. [The higher the number, the closer the match to the criterion.] This weighted-matrix scoring system is based on the NYSDEC Technical and Administrative Memorandum on Selection of Remedial Actions at Inactive Hazardous Waste Sites, dated September 13, 1989. The results of the weighted-matrix scoring analysis are presented in Table 4-1 and are discussed in detail below.

4.2.2 Alternative 1 - No Action

A. Short-term Impacts and Effectiveness - Score: 10 out of 10

Since no construction is required to implement this alternative, there are no associated risks to the community, environment, or workers. However, implementation of this alternative would mean a continuation of the current environmental and public health effects outlined in the baseline risk assessment (Section 7) of the RI.

B. Long-term Effectiveness and Permanence - Score: 2 out of 15

This alternative is neither an effective nor permanent remedy to the risks posed by the contaminants at the site. The current environmental and health effects may continue to worsen due to deterioration of the existing minimal onsite controls. Continued erosion of the uncovered waste piles would lead to increased exposure of deeper, more contaminated soils and waste fill. Although groundwater movement away from the site is extremely slow, highly contaminated groundwater will eventually reach Quarry Lake, significantly increasing

TABLE 4-1

WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

ALTERNATIVE 1:	No Action
ALTERNATIVE 2:	Institutional Action
ALTERNATIVE 3A:	Containment
ALTERNATIVE 3B:	Containment, with Solidification of Sediment and Spoils
ALTERNATIVE 4:	Hot Spot Treatment with Ex-Situ Solidification
ALTERNATIVE 5:	Hot Spot Treatment with In Situ Solidification
ALTERNATIVE 6:	Full Treatment with Solidification and Hot Spot Thermal Desorption

A. SHORT-TERM EFFECTIVENESS (Weight = 10)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Protection of community during remedial actions	- Are there significant short-term risks to the community that must be addressed? (if no, go to factor 2)	Yes - 0 No - 4	4	0	0	0	0	0	0
	- Can the risk be easily controlled?	Yes - 1 No - 0	-	1	1	1	1	1	1
	- Does the mitigative effort to control risk impact the community lifestyle?	Yes - 0 No - 2	-	2	2	2	1	2	1
2. Environmental Impacts	- Are there significant short-term risks to the environment that must be addressed? (If no, go to factor 3)	Yes - 0 No - 4	4	4	0	0	0	0	0
	- Are the available mitigative measures reliable to minimize potential impacts?	Yes - 3 No - 0	-	-	3	3	2	3	2
3. Time to implement the remedy	- What is the required time to implement the remedy?	<2 yr - 1 >2 yr - 0	1	1	1	1	0	0	0
	- Required duration of the mitigative effort to control short-term risk.	<2 yr - 1 >2 yr - 0	1	1	1	1	0	0	0
SUBTOTAL (MAXIMUM = 10)			10	9	8	8	4	6	4

TABLE 4-1
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

B. LONG-TERM EFFECTIVENESS AND PERMANENCE (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Permanence of the remedial alternative	- Will the remedy be classified as permanent in accordance with Section 2.1(a),(b) or (c) of the NYSDEC TAGM for the "Selection of Remedial Actions at Inactive Hazardous Waste Sites", Sept. 13, 1989? (if yes, go to factor 3)	Yes - 5 No - 0	0	0	0	0	0	0	5
2. Lifetime of remedial actions	- Expected lifetime or duration of effectiveness of the remedy	25-30 yr - 4 20-25 yr - 3 15-20 yr - 2 <15 yr - 0	0	0	4	4	4	4	-
3. Quantity and nature of waste or residual left at the site after remediation	i. Quantity of untreated hazardous waste left at the site	None - 3 <25% - 2 25-50% - 1 >50% - 0	0	0	0	0	2	2	3
	ii. Is there any treated residual left at the site? (if no, go to factor 4)	Yes - 0 No - 2	0	0	2	0	0	0	0
	iii. Is the treated residual toxic?	Yes - 0 No - 1	0	0	0	1	1	1	1
	iv. Is the treated residual mobile?	Yes - 0 No - 1	0	0	0	1	1	1	1
4. Adequacy and reliability of controls	i. Operation and maintenance required for a period of:	<5 yr - 1 >5 yr - 0	0	0	0	0	0	0	0
	ii. Are environmental controls required as a part of the remedy to handle potential problems? (if no, go to "iv")	Yes - 0 No - 2	2	2	0	2	2	2	2
	iii. Degree of confidence that controls can adequately handle potential problems	Moderate to very confident - 1 Somewhat to not confident - 0	-	-	1	-	-	-	-
	iv. Relative degree of long-term monitoring required (compare with other alternatives)	Minimum - 2 Moderate - 1 Extensive - 0	0	0	0	1	2	2	2
SUBTOTAL (MAXIMUM = 15)			2	2	7	9	12	12	14

TABLE 4-1

WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

C. REDUCTION OF TOXICITY, MOBILITY OR VOLUME (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Volume of hazardous waste reduced (reduction in volume or toxicity)	i. Quantity of hazardous waste destroyed or treated	100% - 10 80-99% - 8 60-80% - 6 40-60% - 4 20-40% - 2 <20% - 0	0	0	0	4	6	6	8
	ii. Are there any concentrated hazardous wastes produced as a result of (i)? (if no, go to factor 2)	Yes - 0 No - 2	2	2	2	2	2	2	2
(If subtotal = 12, go to factor 3)	iii. How is the concentrated hazardous waste stream disposed?	On-site land disposal - 0 Off-site secure land disposal - 1 On-site or off-site destruction or treatment - 2	-	-	-	-	-	-	-
2. Reduction in mobility of hazardous waste	i. Method of Reduction - Reduced mobility by containment - Reduced mobility by alternative treatment technology	 1 3	0	0	1	2	2	2	-
	ii. Quantity of wastes immobilized	<100% - 2 >60% - 1 <60% - 0	0	0	2	2	1	1	2
3. Irreversibility of the destruction or treatment of hazardous waste	- Completely irreversible - Irreversible for most of the hazardous waste constituents - Irreversible for only some of the hazardous waste constituents - Reversible for most of the hazardous waste constituents	3 2 1 0	0	0	0	1	1	1	2
SUBTOTAL (MAXIMUM = 15)			2	2	5	11	12	12	14

TABLE 4-1

WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

D. IMPLEMENTABILITY (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Technical Feasibility									
a. Ability to construct technology	i. Not difficult to construct. No uncertainties in construction	3	3	3	2	2	2	2	2
	ii. Somewhat difficult to construct No uncertainties in construction	2							
	iii. Very difficult to construct and/or significant uncertainties in construction	1							
b. Reliability of technology	i. Very reliable in meeting the specified process efficiencies or performance goals	3	3	3	3	3	2	2	2
	ii. Somewhat reliable in meeting the specified process efficiencies or performance goals	2							
c. Schedule of delays due to technical problems	i. Unlikely	2	2	2	1	1	1	1	1
	ii. Somewhat likely	1							
d. Need of undertaking additional remedial action, if necessary	i. No future remedial action may b anticipated	2	1	1	1	1	2	2	2
	ii. Some future remedial actions may be necessary	1							
2. Administrative Feasibility			2	2	1	1	1	1	1
a. Coordination with other agencies	i. Minimal coordination is require	2							
	ii. Required coordination is norma	1							
	iii. Extensive coordination is required	0							
3. Availability of Services and Materials									
a. Availability of prospective technologies	i. Are technologies under consideration generally commercially available for the site-specific application?	Yes - 1 No - 0	1	1	1	1	1	1	1
	ii. Will more than one vendor be available to provide a competitive bid?	Yes - 1 No - 0	1	1	1	1	1	1	1
b. Availability of necessary equipment and specialists	i. Additional equipment and specialists may be available without significant delay	Yes - 1 No - 0	1	1	1	1	1	1	1
SUBTOTAL (MAXIMUM = 15)			14	14	11	11	11	11	11

TABLE 4-1
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

E. COMPLIANCE WITH ARARS (Weight = 10)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Compliance with chemical-specific ARARs	Meets chemical-specific ARARs	Yes - 2.5 No - 0	0	0	0	1.0	2.5	0	2.5
2. Compliance with action-specific ARARs	Meets action-specific ARARs	Yes - 2.5 No - 0	0	0	2.5	2.5	2.5	2.5	2.5
3. Compliance with location-specific ARARs	Meets location-specific ARARs	Yes - 2.5 No - 0	1.0	1.0	2.5	2.5	2.5	2.5	2.5
4. Compliance with appropriate criteria, advisories and guidelines	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated	Yes - 2.5 No - 0	0	0	0	1.0	2.5	2.5	2.5
SUBTOTAL (MAXIMUM = 10)			1.0	1.0	5	7	10	7.5	10

F. PROTECTION OF HUMAN HEALTH & THE ENVIRONMENT (Weight = 20)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
1. Use of site after remediation	Unrestricted use of the land and water (if yes, go to end of table)	Yes - 20 No - 0	0	0	0	0	0	0	0
2. Human health and the environment exposure after the remediation	i. Is the exposure to contaminants via air route acceptable?	Yes - 3 No - 0	0	0	3	3	3	3	3
	ii. Is the exposure to contaminants via groundwater/surface water acceptable?	Yes - 4 No - 0	0	0	4	4	4	4	4
	iii. Is the exposure to contaminants via sediments/ soil acceptable?	Yes - 3 No - 0	0	0	3	3	3	3	3
3. Magnitude of residual public health risks after the remediation	i. Health risk ii. Health risk	<1 in 1,000,000 - 5 <1 in 100,000 - 2	0	0	2	2	2	2	3
4. Magnitude of residual environmental risks after the remediation	i. Less than acceptable ii. Slightly greater than acceptable iii. Significant risk still exists	5 3 0	0	0	5	5	5	5	5
SUBTOTAL (MAXIMUM = 20)			0	0	17	17	17	17	18

G. COST (Weight = 15)

FACTOR	BASIS FOR EVALUATION	WEIGHT	ALTERNATIVE NUMBER						
			1	2	3A	3B	4	5	6
Overall (MAXIMUM = 15)	Scored on a linear scale with 0 an 15 assigned to the highest and the least cost alternatives respectively.	Lowest - 15 Others - Relative	15	15	11	9	9	7	0

TABLE 4-1
WEIGHTED-MATRIX SCORING SYSTEM FOR REMEDIAL ALTERNATIVES

SUMMARY

CATEGORY	ALTERNATIVE NUMBER						
	1	2	3A	3B	4	5	6
A. SHORT-TERM EFFECTIVENESS (Weight = 10)	10	9	8	8	4	6	4
B. LONG-TERM EFFECTIVENESS AND PERMANENCE (Weight = 15)	2	2	7	9	12	12	14
C. REDUCTION OF TOXICITY, MOBILITY OR VOLUME (Weight = 15)	2	2	5	11	12	12	14
D. IMPLEMENTABILITY (Weight = 15)	14	14	11	11	11	11	11
E. COMPLIANCE WITH ARARS (Weight = 10)	1	1	5	7	10	7.5	10
F. PROTECTION OF HUMAN HEALTH & THE ENVIRONMENT (Weight	0	0	17	17	17	17	18
G. COST (Weight = 15)	15	15	11	9	9	7	0

TOTAL SCORE (Maximum = 100)	44	43	64	72	75	72.5	71

contaminant loadings. Fugitive dust emissions from the uncontrolled waste surface would also continue to be a health risk.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score: 2 out of 15

Since no onsite contaminants are destroyed or treated, the mobility and volume of the toxic contaminants will remain essentially unaltered under this alternative.

D. Implementability - Score: 14 out of 15

The no-action alternative is easily implemented compared to the other alternatives. Although it fails to provide a remedy, future remedial actions to supplement this no-action alternative may be instituted without interfering with existing onsite controls.

E. Compliance with Federal ARARs and NYS SCGs - Score: 1 out of 10

Implementation of this alternative would not result in compliance with chemical-specific ARARs or SCGs (groundwater regulations) nor any appropriate agency advisories, guidelines, or objectives. It would be in compliance with location-specific ARARs restricting activities in the wetlands but not other location specific ARARs. It does not address any of the action-specific ARARs or SCGs (i.e. technology standards).

F. Overall Protection of Human Health and the Environment - Score: 0 out of 20

This alternative provides no protection for human health or the environment, and the risks posed by the contaminants at the site would continue due to the lack of onsite controls.

G. Cost - Score: 15 out of 15

No cost is associated with this alternative.

TOTAL WEIGHTED SCORE - 44 out of 100

4.2.3 <u>Alternative 2 - Institutional Action</u>

A. Short-term Impacts and Effectiveness - Score: 9 out of 10

Since minimal construction would be required to implement this alternative (assuming that few additional groundwater monitoring wells would be required for the long-term monitoring program), there would be few associated risks to the community, environment, or workers. However, current environmental and public health effects will continue.

B. Long-term Effectiveness and Permanence - Score: 2 out of 15

This alternative is neither an effective nor permanent remedy to the risks posed by the contaminants at the site. The current environmental and public health effects outlined in the baseline health risk assessment will continue to exist over the long-term due to the lack of onsite controls.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score 2 out of 15

This alternative does not reduce the toxicity, mobility or volume of hazardous waste at the site since the onsite contaminants are neither destroyed nor treated.

D. Implementability - Score: 14 out of 15

This alternative can be implemented without difficulty, since no technical or administrative difficulties are posed by the continuation of the monitoring program. It however, fails to provide a reliable remedy to the problem. The need for future remedial action is not addressed by this alternative but may be implemented without interfering with the long-term groundwater monitoring.

E. Compliance with federal ARARs and NYS SCGs - Score: 1 out of 10

Implementation of this alternative would not result in compliance with chemical-specific ARARs, SCGs, or any appropriate agency advisories, guidelines, or objectives. Nor would it address any location or action-specific ARARs or SCGs regarding site controls to protect human health or the environment. Due to the lack of any remedial construction, however, the wetlands will be untouched.

F. Overall Protection to Human Health and the Environment - Score: 0 out of 20

If this alternative were implemented, the risks to human health and the environment posed by contaminants at the site would remain.

G. Cost - Score: 15 out of 15

This alternative has the lowest relative cost compared to the other alternatives, excluding no-action.

TOTAL WEIGHTED SCORE 43 out of 100

4.2.4 <u>Alternative 3A - Containment</u>

A. Short-term Impacts and Effectiveness - Score: 8 out of 10

Short-term risks concerning volatile and fugitive dust emissions during dredging must be addressed. The same risks are of concern during grading for the cap. The risks can be easily controlled, and control efforts would not impact community lifestyle. Mitigative methods are also available to minimize short term environmental risks during the installation of the sheet piling.

Both the remedial action and the efforts to control the aforementioned risks are expected to take less than two years.

B. Long-term Effectiveness and Permanence - Score: 7 out of 15

The remedy is not considered permanent in accordance with section 2.1 of the NYSDEC TAGM, September 18, 1989. No waste is treated for this remedy. Therefore, 100% of the waste is left onsite untreated, and no treated residues are left on site. However, the HDPE geomembrane would reduce infiltration through the waste fill to less than one percent of expected site precipitation. This reduction in infiltration, combined with a lowering of the water table within the containment area, would significantly reduce the mobility of the contaminants.

The expected lifetime or duration of effectiveness is 25 to 30 years. Operation and Maintenance (O&M) is required for 30 years. Extensive long-term monitoring is required, utilizing environmental controls with moderate to high degrees of confidence.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score: 5 out of 15

No portion of the hazardous waste is treated for a reduction in volume or toxicity. There are no concentrated hazardous wastes produced from any treatment. However, mobility is reduced by containment. The treatment of hazardous wastes at the site is reversible for most hazardous waste constituents.

D. Implementability - Score 11 out of 15

Construction of this alternative has some minor difficulties and uncertainties. The technologies are very effective in meeting their performance goals. Delays due to technical problems may be likely. Some future remedial actions may be necessary.

Coordination with other agencies is expected to be normal. The technologies, vendors, equipment, and specialists should all be readily available without significant delay.

E. Compliance with federal ARARs and NYS SCGs - Score: 5 out of 10

This alternative does not meet chemical-specific SCGs or all relevant and appropriate federal and State guidelines. It, however, meets action-specific SCGs and location-specific SCGs.

F. Overall Protection of Human Health and the Environment - Score: 17 out of 20

Land and water use must be restricted after remediation. Human exposure to contaminants via all routes (air, groundwater, surface water, and soil/sediment) are acceptable. The magnitude of residual public health risk is on the order of <1 in 100,000.

G. Cost - Score: 11 out of 15

Capital and annual operating and maintenance costs are not the lowest. Future capital costs may not be required. Also, future land value will decrease after remediation. Present worth is not the lowest.

TOTAL WEIGHTED SCORE - 64 out of 100

4.2.5 <u>Alternative 3B - Containment with Solidification of Sediment and Spoils</u>

A. Short-term Impacts and Effectiveness - Score: 8 out of 10

Short-term risks concerning volatile and fugitive dust emissions during dredging must be addressed. The same risks are of concern during grading for the cap. The risks can be easily controlled, and control efforts would not impact community lifestyle. Mitigative methods are also available to minimize short term environmental risks during the installation of the sheet piling.

Both the remedial action and the efforts to control the aforementioned risks are expected to take less than two years.

B. Long-term Effectiveness and Permanence - Score: 9 out of 15

The remedy is not considered permanent in accordance with section 2.1 of the NYSDEC TAGM, September 18, 1989. Sediments and groundwater are treated in this remedy. In addition, the HDPE geomembrane would reduce infiltration through the waste fill to less than one percent of expected site precipitation. This reduction in infiltration, combined with a lowering of the water table within the containment area and the solidification of sediments and spoils, would significantly reduce the mobility of the contaminants. The solidification of the sediments and spoils will also strengthen the subbase for the cap.

The expected lifetime or duration of effectiveness is 25 to 30 years. Operation and Maintenance (O&M) is required for 30 years. Long-term monitoring is required, utilizing environmental controls with moderate to high degrees of confidence.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score: 11 out of 15

The sediments and spoils, making up 42% of the solid waste on site, are treated to reduce the mobility of the contaminants. There are no concentrated hazardous wastes produced from any treatment. Mobility is reduced through containment and solidification. The treatment is considered to be irreversible for sediments and groundwater which is treated.

D. Implementability - Score 11 out of 15

Construction of this alternative has some minor difficulties and uncertainties. The technologies are very effective in meeting their performance goals. Delays due to technical problems may be likely. Some future remedial actions may be necessary.

Coordination with other agencies is expected to be normal. The technologies, vendors, equipment, and specialists should all be readily available without significant delay.

E. Compliance with federal ARARs and NYS SCGs - Score: 7 out of 10

This alternative does not fully meet chemical-specific SCGs or all relevant and appropriate Federal and State guidelines. It, however, meets action-specific SCGs and location-specific SCGs.

F. Overall Protection of Human Health and the Environment - Score: 17 out of 20

Land and water use must be restricted after remediation. Human exposure to contaminants via all routes (air, groundwater, surface water, and soil/sediment) are acceptable. The magnitude of residual public health risk is on the order of <1 in 100,000.

G. Cost - Score: 9 out of 15

Capital and annual operating and maintenance costs are not the lowest. Future capital costs may not be required. Present worth is not the lowest.

TOTAL WEIGHTED SCORE - 72 out of 100

4.2.6 Alternative 4: Hot Spot Treatment with Ex-Situ Solidification

A. Short-term Impacts and Effectiveness - Score: 4 out of 10

Intrusive activities such as hot-spot excavation will disturb areas of the site containing the highest concentrations of contaminants. Dust emissions and contaminant volatilization during these activities may potentially have a negative impact on both the environment and the community. However, available methods for controlling both dust and contaminant emissions should provide adequate control. This is an important factor considering the proximity of the residents to the site. The time required for full implementation of this remedy is longer than two years. This alternative may create short-term risks during construction, and may not be effective until full implementation is complete.

B. Long-term Effectiveness and Permanence - Score: 12 out of 15

As of December 1990, a total of 16 Superfund Sites and 10 RCRA Sites have utilized stabilization/solidification. The solidification of inorganic and "low" levels of organic waste is classified as a permanent remedy according to Section 2.1 of NYSDEC TAGM, September 13, 1989. Available information from the use of solidification at other sites demonstrates that the higher levels of contaminants in the hot-spot area can be permanently demobilized with the appropriate chemical additives. (However, solidification is not considered a permanent remedy for the purpose of scoring.)

Solidification would therefore provide long-term protection to human health and the environment against the risks associated with contact with the contaminated soil, and prevent migration of the hazardous substances.

While operation and maintenance may be required for a period greater than 5 years, environmental controls are not required, and long-term monitoring is moderate.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score: 12 out of 15

No hazardous waste is treated for a reduction in volume or toxicity. No concentrated hazardous wastes are produced. This technology is far more effective in reducing contaminant mobility than is the containment option. While all available data indicate that the treatment is permanent and irreversible, the data base is limited.

D. Implementability - Score 11 out of 15

Although no exceptional uncertainties are expected, usual delays can be assumed in construction scheduling. While treatment data are promising, bench-scale or pilot testing will be required to demonstrate that the technique will meet performance goals at this site. Once bench-scale testing is performed, delays due to technical problems will be less likely, and no future remedial action is anticipated. Normal coordination with other agencies is anticipated. The technologies for this option are available for site-specific applications. Other equipment and specialists should be available without significant delay.

E. Compliance with federal ARARs and NYS SCGs - Score: 10 out of 10

The alternative meets chemical-specific SCGs, action-specific SCGs, location-specific SCGs, and all relevant and appropriate federal and State regulations.

F. Overall Protection of Human Health and the Environment - Score: 17 out of 20

After remediation, groundwater and land use should be restricted. Exposure to contaminants via all routes (air, groundwater, surface water, and sediments/soil) are acceptable. Magnitude of public health risks is between <1 in 100,000 and <1 in 1,000,000, and the magnitude of environmental risk is less than acceptable.

G. Cost - Score: 9 out of 15

Capital and O&M costs are not the lowest and future capital costs are not expected. Future land value will remain unchanged after remediation. Present worth cost is not the lowest .

TOTAL WEIGHTED SCOPE - 75 out of 100.

4.2.7 Alternative 5 - Hot-Spot Treatment with Solidification

A. Short-term Impacts and Effectiveness - Score: 6 out of 10

In-situ treatment of the contaminated soil/fill at the Frontier Chemical site presents a minimal risk to the community due to the emissions and fugitive dust control systems inherent in the treatment process. Dredging, stockpiling and treatment of lake sediments produce a risk to the community which can be easily controlled with proper management and design. Risk to the environment during the remediation can be easily controlled. Remediation time is expected to exceed two years.

B. Long-term Effectiveness and Permanence - Score: 12 out of 15

The overall remediation of the site would not be considered permanent since only the hot-spot area is treated using in-situ solidification. In-situ solidification has been demonstrated to be effective in de-mobilizing metals and organics based on TCLP results from tests conducted as part of the EPA's SITE program. Although there are concerns about the effect of freeze-thaw on unconfined compressive strength, TCLP and permeability results were found to be equivalent in both weathered and unweathered samples. The soil cap would require periodic inspection and maintenance to ensure its continued integrity.

C. Reduction in Toxicity, Mobility and Volume of Hazardous Waste - Score: 12 out of 15

Recent developments in solidification and the implementation of this technology in a couple of SITE programs have demonstrated the effectiveness of this technology in demobilizing high concentrations of organics in waste/fill. This technology, however, does not reduce the volume or toxicity of the contaminated area since the contaminants are not destroyed nor are they removed.

A secondary benefit of in-situ solidification is that the groundwater associated with the soil/fill being treated is used as part of the process, and the contaminants in the groundwater are incorporated in the solidified matrix. Any contaminated groundwater outside the treated volume of soil/fill particularly in the weathered clay underlying the existing fill, is not expected to migrate off-site due to the highly impermeable clay/silty clay associated with this site.

The mobility of the low-level contaminants in the non-hot spot areas on the site will be reduced by containment under the soil cap. The combination of these treatments should reduce any threat to human health or the environment currently posed by the contamination present at the site.

D. Implementability - Score 11 out of 15

Implementation of the alternative could be affected by several factors. The most significant factor to consider is that intrusive activities are required in the area with the highest contamination. This work may require additional measures to control dust and volatile emissions and may result in some delays. The technologies are well established and commercially available through more than one vendor. Specialized equipment needed for the in-situ solidification is also available from several firms.

E. Compliance with federal ARARs and NYS SCGS - Score: 7.5 out of 10

The alternative is expected to meet all ARARs and all health or environmental standards associated with the site, with the exception of the chemical-specific areas for any contaminated groundwater in the weathered clay underlying the treated fill.

F. Overall Protection of Human Health and the Environment - Score: 17 out of 20

This alternative meets all specific remedial action requirements that were designed to reduce the potential health risk associated with the presence or migration of contaminants at the site. All the contaminated media at the site are addressed including soil/fill, groundwater, surface water, and sediments. Treatment of the soil/fill hot-spot area at the site should significantly reduce any contaminant release from the site. A soil cap over the area of contamination at the site will prevent human contact with contaminated soil. This combination of media-specific remedial technologies should stop almost all contaminant migration from the site. Deed restrictions will be needed in order to maintain the integrity of the components of this remedial action. Residual risk to health and environment will be minimal, and future use of the site is possible.

G. Cost - Score: 7 out of 15

Capital and annual operating and maintenance costs are not the lowest. Future capital costs may not be required. Also, future land value will decrease after remediation. Present worth is not the lowest.

TOTAL WEIGHTED SCORE - 72.5 out of 100

4.2.8 <u>Alternative 6 - Full Treatment with Solidification and Hot Spot Thermal Desorption</u>

A. Short-term Impacts and Effectiveness - Score: 4 out of 10

Several of the components of this remedial alternative, such as hot-spot excavation, thermal desorption and in-situ solidification, are intrusive activities that will disturb areas of the site with high concentrations of contaminants. These activities may potentially affect both the community and the environment, due to dust emissions or volatilization of contaminants during excavation or during soil mixing. Mitigative measures are available for controlling both dust and contaminants. However, many of them may not be completely reliable, particularly with excavation, and considering also the proximity of residents to the site, are of concern. A portion of the wetlands adjacent to the site may have to be reclaimed for use during construction, since very limited space is available on site. Implementation of this alternative and the mitigative efforts required to control short-term risks are expected to take more than two years.

B. Long-term Effectiveness and Permanence - Score: 14 out of 15

Excavation of hot-spot areas and thermal desorption of organic contaminants in the excavated waste fill would result in a permanent remediation of the highly contaminated material, since the desorbed organics would be further treated using carbon adsorption or incineration. Solidification of wastes in the non-hot-spot area does not reduce the toxicity or volume of the waste, but it does significantly reduce the mobility of the contaminants and therefore their ability to be exposed to environmental transport and uptake. Solidification of waste with low level organics is considered to be a permanent technology. However, it will have to be periodically monitored to ensure the integrity of the solidified waste.

The soil cap may require periodic repair. Although the soil cap has a relatively high permeability, infiltration will be limited due to the solidified material beneath the cap. The treated soil will minimize leaching of contaminants to the groundwater. All the contaminated media at the site are addressed, including soil/waste/fill, sediments, surface water and groundwater, thereby providing the most comprehensive remedial alternative compared to the other alternatives discussed herein.

C. Reduction in Toxicity, Mobility and Volume - Score: 14 out of 15

This alternative reduces the volume and toxicity of the most contaminated areas on site by excavating and treating them. Mobility of contaminants in the remaining areas of the site is reduced by treatment with in-situ solidification. This alternative, like the others, will significantly reduce the volume of contaminated groundwater migrating from the site, and the threats to human health and the environment posed by the contaminants.

D. Implementability - Score 11 out of 15

Implementation of the alternative could be affected by several factors. Problems may be created by the waste buried at the site, which includes drums and highly contaminated areas. Any intrusive work required in these areas may result in schedule delays. Monitoring will be required to assess the effectiveness of this alternative. With a comprehensive remedial action such as this, there will be no need for any future remedial action at the site.

E. Compliance with ARARs - Score: 10 out of 10

The alternative was designed to either meet or exceed all ARARs and all health or environmental standards associated with the site.

F. Overall Protection of Human Health and the Environment - Score: 18 out of 20

This alternative meets all specific remedial action requirements that were designed to reduce potential health risks associated with migration of contaminants from the site. This alternative addresses all contaminated media at the site including the soil/fill, groundwater, surface water, and sediments. Removal of hot-spots from the site and solidification of the remaining areas should essentially eliminate any further release of contaminants from the site. A soil cap is also placed on the site to help prevent human contact with and any erosion of the waste. Contaminated groundwater from the site is to be pumped and treated. Deed restrictions will be needed in order to maintain the integrity of the components of this remedial action. Residual risk to health and the environment will be minimal, and future use of the site is possible.

G. Cost - Score: 0 out of 15

Capital and annual operating and maintenance costs are not the lowest. Future capital costs may not be required. Also, future land value will decrease after remediation. Present worth is the highest.

TOTAL WEIGHTED SCORE - 71 out of 100

4.3 Economic Evaluation of Alternative

4.3.1 General

To facilitate the evaluation of the cost-effectiveness of the alternatives, preliminary capital and annual operation and maintenance (O&M) costs were developed for individual components (i.e. technologies and process options) selected for the alternatives. Total capital and O&M costs for each alternative are then determined by combining the costs of appropriate components.

Quantities associated with remedial activities as they relate to the media of concern (e.g. soil excavation, groundwater collection) are developed initially to serve as the basis for this economic evaluation. Specific aspects and quantities of each component used as the basis for the capital and annual O&M costs of the selected remedial technologies are discussed in detail under each technology. The capital and annual O&M costs for each component are presented on separate tables and accompany the discussions. The sources of the unit prices are referenced on the tables. These include Means (1990), Richardson (1990), past URS experience, and quotes from vendors. Several cost items are estimated as a percentage of the total cost based on past URS experience. They include the following: mobilization/demobilization (10%); construction administration and design engineering (25%); bonds and insurance (10%) to reflect construction at sites containing hazardous waste; escalation of 5% per year over four years to account for increased construction costs at the time construction is anticipated to occur (21.55%); contractor markups for overhead and profit (25%); and provisions for health and safety using different levels of protection (5% for Level D, 40% for Level C and 160% for Level B) depending on the type of activity.

For the evaluation of the alternatives for cost-effectiveness, the capital and annual O&M costs are converted to their equivalent present worth. A 30-year performance period with a 10 percent annual interest rate is used in the determination of the present worth of the cost of each alternative. The accuracy of the estimated costs lies within a range of -30% to +50% of actual construction costs.

4.3.2 Estimation of Quantities

A. Capping

Areas A (hot spot) and B (non-hot spot) shown on Figure 1-4 are approximately 4.8 and 2.6 acres respectively, totalling 7.4 acres for the process/fill area. The capping areas will be higher due to the slope requirements for drainage. Also, the limits of the two areas are subject to change during final remedial design or actual remediation of the site depending on the criteria applied to define these limits. To account for these factors, Areas A and B are assumed to be 5.9 and 3.1 acres respectively (9 acres total) for the cost estimates developed in this Feasibility Study.

During capping, the two ponds in Area B (Figure 1-4) that were previously used for processing will be drained and backfilled with existing berm materials surrounding the ponds and additional general fill if necessary. The physical volume of the ponds and the chemical characteristics of the water in the ponds has to be established to determine general fill requirements and the need for pond water treatment before draining.

B. Soil/Fill Excavation

It was determined during the RI that soil contamination is limited to the process/fill area between Quarry Lake and the abandoned railroad right-of-way (Figure 1-4). Fill volumes were calculated using the end average method and the thickness of fill. Fill volumes are shown in Figure 3-10 of the RI Report, and are summarized below:

Hot-Spot (Area A)	40,100 cubic yards
Non-Hot-Spot (Area B)	17,200 cubic yards
TOTAL	57,300 cubic yards

Not included in the above estimate is approximately 10,300 cubic yards of sediments and sludges placed on the process/fill area from previous dredging operations. Since excavation must extend beyond the limits of contamination, an additional volume of 30 percent was added to all excavation volumes for size and cost analysis. This was to ensure that all contaminated fill was removed. Therefore, soil quantities for use in this FS are as follows:

Hot-Spot (Area A)	52,000 cubic yards
Non-Hot-Spot (Area)	22,000 cubic yards
TOTAL	74,000 cubic yards

The volume of the contaminated soils and waste fill can increase by 10 to 50 percent when treated using commercially available solidification technologies. Based on results from SITE demonstration programs, in-situ solidification will be assumed to create a 20 percent increase in the treated volume of the soils/fill and a corresponding rise of the treated area above existing grade. A 30 percent volume increase is assumed for the ex-situ solidification option. The ex-situ thermal desorption process is expected to result in a net decrease of about 20 percent in the volume of the treated materials.

C. Groundwater Collection

Long-term pumping rates were calculated for the two cap options with and without a sheetpile vertical barrier. Contributions to the groundwater flow into the collection trench include infiltration through the cap, horizontal flow from off site, and flow through the bottom. In order to facilitate the calculations, two collection trenches were assumed within the process/fill area, one along the lake and one parallel to the old railroad embankment, as shown on Figure 4-1 for Alternative 3, which also includes two additional trenches to complete a full square around the highly contaminated area.

Infiltration values for MSG and soil caps were determined by HELP Model runs: 0.11 inches/year and 16.9 inches/year, respectively, out of a total 38 inches/year. Flow from off-site was evaluated for a withdrawal system alone and for a withdrawal system with sheetpile cutoff. Off-site flow was controlled by a maximum water elevation of 570 feet in the lakeside collection trench and a maximum water elevation of 573 feet in the railroad embankment-side collection trench. Flow from underneath the site was computed based on the following: hydraulic head elevation of about 575 feet in the silty sand aquifer, onsite groundwater elevation of 572 feet, and average clay thickness of 15 feet underneath the site, based on the data presented in the RI Report.

Based on the above assumptions and the calculations presented in Appendix B, a groundwater collection rate of 1 gpm was estimated with the MSG cap and sheetpile, and of 9 gpm with a soil cap and sheetpile. Inflow from off site contributed an additional 1 gpm without the sheetpile.

The required pumping rate for the groundwater collection system depends not only on the long-term groundwater flow rate into the collection trench but also on the volume of water that should be drained to lower the water table to the desired level. Treatment of the contaminated soils/fill in-situ or after excavation would significantly affect the magnitude of this initial drainage volume. In order to size and estimate costs conceptually, and facilitate an economic comparison, a groundwater collection rate of 5 gpm was assumed for long-term groundwater treatment Alternative 5 and for temporary groundwater treatment during excavation in Alternatives 4 and 6. Detailed calculations with the use of appropriate flow models would be necessary to more accurately reflect the effects of the assumptions and processes.

D. Sediment Dredging

The quantity of lake bottom sediments and sludges requiring removal during remediation is based on the results of sediment investigations described in the RI. It was determined that the in-situ volume of metal sludge and contaminated sediments is 20,000 cubic yards, based on a sediment thickness which varies from zero to 12 feet. Approximately 14,000 cubic yards is located in the northern basin and 6,000 cubic yards in the southern basin. Hydraulic dredge methods will create a dredged slurry with 10 to 40 percent solids content by wet weight. The lake can be drained prior to dredging in order to minimize the amount of water that will be contaminated with resuspended sediments and to facilitate the dredging operation itself. A 15 percent dredged slurry soils content was assumed for cost estimating purposes. In addition to the 20,000 cubic yards of sediments in the lake, it is estimated that an additional 10,300 cubic yards of metal sludge and mixed clay spoils that were placed on site in four mounds shown on Figure 1-3 from past dredging operations. Three of these four mounds (7,400 cubic yards) are located in Area A and the fourth (2,900 cubic yards) is in Area B adjacent to the lake. These spoils will be treated along with sediments. For design and cost estimating purposes, the total volume of all sediments/sludges for treatment will be assumed to be 39,000 cubic yards which include an additional 30 percent.

E. Quarry Lake Volume

Lake volumes were calculated using a CADD volume program for various lake levels and topographic mapping of the lake bottom. The topographic mapping was based on lake bottom soundings performed at an average frequency of about 7 per acre. At the current lake surface elevation of 577 feet, the total volume of water in the lake would be 37 million gallons. Reducing the lake level to 572 feet elevation in order to provide adequate volume for storm water storage and lake overflow control would require draining approximately 18 million gallons of water.

F. Sheetpile

The subsurface sheetpile barrier is required to seal off the top layers of soil/fill and weathered clay down to the clay/silty clay layer. The top of this layer represents the top elevation of sheetpile, since regraded waste fill will taper to zero thickness (above existing grade) around the site perimeter. A key-in length of 5 feet into the clay is assumed, resulting in a typical sheetpile wall length of 15 feet. The length of grout required to seal the joints between individual sheetpile sections is based on an assumed spacing of 1'4" between the interlocks.

4.4 Cost Estimates for Individual Technologies

Detailed cost estimates are presented below for individual technologies that compose the various alternatives being evaluated. A summary of design parameters required to estimate costs for each technology is included as Table 4-2.

A. Soil Cap

A soil cap is a two-layered system consisting of 12 inches of a general fill material placed over regraded site fill, and then an uppermost layer of 6 inches of topsoil with vegetative cover. Limits of the soil cap cover are shown in Figures 4-2 through 4-4 for Alternatives 4 through 6. The soil cap is the lowest-cost capping option by the very nature of its simple two-layer system. There should be no difficulty in

TABLE 4-2

FRONTIER CHEMICAL – PENDLETON SITE

SUMMARY OF DESIGN QUANTITIES

ITEM	UNITS	QUANTITY
MSG CAP AND SOIL CAP	HOT-SPOT AREA	5.9 ACRES
	NON HOT-SPOT AREA	3.1 ACRES
DRAINAGE DITCHES	LENGTH	3,000 LINEAR FEET
SHEET PILING (ALL)	LENGTH	3,000 LINEAR FEET
	AVG. DEPTH	15 FEET
GROUTING	LENGTH	34,000 LINEAR FEET
SHEET PILING (LAKESIDE)	LENGTH	500 LINEAR FEET
	AVG. DEPTH	15 FEET
GROUTING	LENGTH	5,700 LINEAR FEET
GROUNDWATER COLLECTION TRENCH	LENGTH	2,000 LINEAR FEET
	EXCAVATION VOLUME	3,000 CUBIC YARDS
SEDIMENT DREDGING	SEDIMENT VOLUME	26,000 CUBIC YARDS
	SLURRY PERCENT SOLIDS	20 %
SEDIMENT SPOILS IN THE PROCESS/FILL AREA	VOLUME OF SPOILS	13,000 CUBIC YARDS
TREATMENT OF SEDIMENTS	TOTAL VOLUME	39,000 CUBIC YARDS
TREATMENT OF CONTAMINATED SOILS/FILL	HOT SPOT VOLUME	52,000 CUBIC YARDS
	NON-HOT SPOT VOLUME	22,000 CUBIC YARDS
	TOTAL SOILS/FILL VOLUME	74,000 CUBIC YARDS
GROUNDWATER COLLECTION & TREATMENT	FLOW RATE	5 GPM

locating a borrow source for the general fill component since the general fill may be composed of a wide variety of material types.

A minimum slope of 4 percent will be required of the cover in accordance with Part 360 regulations. Given the total area of the site and volume of waste fill on site, the average slope will be about 5 percent (maximum 10 feet of fill above existing grade, over 200 feet of slope). Since Part 360 regulations permit slopes up to 33 percent, this site poses no special concerns regarding slope. Slopes will be affected, though, by several operations which can raise the height of fill and increase the slopes.

Capital costs are based on the following for the soil cap:

- o The grading of the 4 hazardous waste piles (13,000 cy) and dredged sediments (26,000 cy).
- o Clearing and grubbing of the 9 acres to be capped.
- o Placement, compacting, and grading of one foot of general fill
- o Placement of 6 inches of topsoil
- o Seeding, mulching, and fertilizing the cap for erosion control.

Additional items such as drainage ditches are considered separately. Table 4-3 presents a capital cost estimate for a soil cap. Cap O&M must be performed for 30 years. O&M costs include inspection of the cap, and maintenance and repair of the items enumerated above. Table 4-4 presents an annual O&M cost estimate for a soil cap.

B. Multilayered Cap With Synthetic Geomembrane (MSG):

The limits of the MSG cap are shown on Figures 4-1 for Alternative 3. The MSG Cap is a four-layered system which would consist of, in descending order, the following components:

- o Topsoil (6 inches) with vegetative cover
- o Sand drainage (12 inches)
- o Synthetic geomembrane (60 mils)
- o Subgrade for geomembrane (6 inches)

Capital costs are based on the following for an MSG Cap:

- o The grading of the 4 hazardous waste piles (10,000 cy), of dredged sediments (26,000 cy), and of the level excavated for the groundwater collection trench (3000 cy)
- o Clearing and grubbing of the 9 acres to be capped
- o Placement of a 60-mil HDPE fabric
- o Placement compaction, and grading of 0.5 feet of clay for the HDPE subgrade
- o Placement of a one-foot sand drainage layer
- o Placement of 6 inches of topsoil
- o Seeding, mulching, and fertilizing the cap for erosion control.

Additional items such as surface drainage ditches are considered separately. Table 4-3 presents a capital cost estimate for the MSG cap. Cap O&M must be continued for 30 years. O&M costs include inspection of the cap, and maintenance and repair of those items bulleted above. Table 4-4 presents an O&M cost estimate for the MSG Cap.

TABLE 4-3

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

MSG AND SOIL CAP

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST	
						A. MSG CAP	B. SOIL CAP
1	PLACE AND GRADE DREDGED SEDIMENTS	cy	39,000	$5.00	1	$195,000	$195,000
2	CLEAR AND GRUB	acre	9	$4,600	1	$41,000	$41,000
3	SUPPLY AND PLACE GENERAL FILL (1 ft.)	cy	15,000	$18.00	1	$0	$270,000
4	COMPACT/SMOOTH AND ROLL GENERAL FILL	acre	9	$600	1	$0	$5,000
5	60-mil HDPE	sf	400,000	$1.00	3	$400,000	$0
6	CLAY FOR HDPE SUBGRADE (0.5 ft.)	cy	8,000	$30.00	1	$240,000	$0
7	SAND DRAINAGE LAYER (1 ft.)	cy	15,000	$22.00	1	$330,000	$0
8	SUPPLY AND PLACE TOPSOIL (0.5 ft.)	cy	8,000	$28.00	2	$224,000	$224,000
9	SEED, MULCH, AND FERTILIZE	acre	9	$3,300	2	$30,000	$30,000
	SUBTOTAL					$1,460,000	$765,000

Mobilization/Demobilization (10%)	$146,000	$77,000
Contractor Markup for Overhead and Profit (25%)	$365,000	$191,000
Construction, Administration, and Design Engineering (15%)	$219,000	$115,000
Level "C" Health and Safety Requirements (40%) (Applies to items 1 through 6)	$350,000	$204,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$315,000	$165,000
Bonds and Insurance (10%)	$146,000	$77,000
TOTAL	**$3,001,000**	**$1,594,000**

SOURCES:
1 - Estimate from Means, 1990
2 - URS Estimate
3 - Vendor Quote

CAPCAP.WK1

12 Jul 91

TABLE 4-4

FRONTIER CHEMICAL - PENDLETON SITE
ANNUAL O & M COST ESTIMATE

MSG AND SOIL CAP

COMPONENT	ITEM	UNITS	QUAN.	UNIT COST	SOURCE	TOTAL COST	
						A. MSG CAP	B. SOIL CAP
1. INSPECTION	Inspection of Cap	hr	30	$25	1	$1,000	$1,000
2. MAINTENANCE	Maintain Vegetative Cover and Topsoil	hr	200	$30	1	$6,000	$6,000
3. REPAIR CAP BREAKTHROUGHS	a. Excavation, Removal and Disposal of Damaged Cap	cy	20	$400	2	$8,000	$8,000
	b. Replacement of Clay, or General Fill	cy	20	$30/ $18	1	$600	$300
	c. Replacement of HDPE Liner	sf	250	$1	1	$200	$0
	d. Replacement of Sand Drainage Layer	cy	10	$22	1	$200	$0
	e. Replacement of Topsoil	cy	10	$28	1	$300	$300
	F. Revegetate	ac	1	$3,300	1	$3,000	$3,000
SUBTOTAL						**$19,000**	**$19,000**
Mobilization/Demobilization (10%)						$2,000	$2,000
Contractor Markup for Overhead and Profit (25%)						$5,000	$5,000
Construction, Administration, and Design Engineering (15%)						$3,000	$3,000
Level "C" Health and Safety Requirements (40%)						$8,000	$8,000
Escalation to Midpoint of Construction (5% per year over 4 years)						$4,000	$4,000
Bonds and Insurance (10%)						$2,000	$2,000
TOTAL						**$43,000**	**$43,000**

SOURCES:
1 - URS Estimate
2 - Quote from CECOS International

CAPO&M.WK1

11 Jul 91

C. Sheetpile

A below-grade vertical cutoff barrier (sheetpile) can be constructed around the entire cap perimeter (3,000 linear feet) or by the lake (500 lineal feet) along the more highly contaminated (hot-spots) zone. The partial sheetpile along the lake is required for Alternatives 4 (Figure 4-2), 5 (Figure 4-3) and 6 (Figure 4-4), while the full-perimeter sheetpile is required for Alternatives 3A and 3B (Figure 4-1). The depth of the cutoff barrier is expected to be just below the weathered clay (average 15 feet), keying 5 feet into the underlying clay/silty clay. Spacing between the sheetpile interlocks is assumed to be 1'4" to estimate grouting requirements.

Capital cost estimates are presented in Table 4-5 for the sheetpile vertical barrier around the entire cap perimeter, or by the lake along the hot-spot area. O&M costs are expected to be minimal.

D. Physical Controls

On-site physical controls include berm closure, a concrete weir for overflow control, and surface drainage ditches. Capital cost estimates are presented in Table 4-6.

E. Groundwater Collection

Measures to control groundwater include groundwater collection trenches. A 2-foot wide stone-filled trench drain with collection pipe will be placed around the areas of medium to high contamination inside the cutoff wall (2,000 feet) as shown in Figure 4-1 for Alternative 3. The trench will extend down to the bottom of the weathered clay. A capital cost estimate for the groundwater collection system is presented in Table 4-7. The annual O&M costs for the collection trench is expected to be

TABLE 4-5

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

SHEET PILE CUTOFF WALL

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST	
						A. LAKE SIDE	B. ALL
1A	SHEET PILING (LAKESIDE)	sf	7,500	$15.70	1	$118,000	-
1B	SHEET PILING (ALL)	sf	45,000	$15.70	1	-	$707,000
2A	PRESSURE GROUTING (LAKESIDE)	lf	5,700	$10.00	1	$57,000	-
2B	PRESSURE GROUTING (ALL)	lf	34,000	$10.00	1	-	$340,000
	SUBTOTAL					**$175,000**	**$1,047,000**

Mobilization/Demobilization (10%)	$18,000	$105,000
Contractor Markup for Overhead and Profit (25%)	$44,000	$262,000
Construction, Administration, and Design Engineering (15%)	$26,000	$157,000
Level "C" Health and Safety Requirements (40%)	$70,000	$419,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$38,000	$226,000
Bonds and Insurance (10%)	$18,000	$105,000
TOTAL	**$389,000**	**$2,321,000**

SOURCES: 1 - Recent Vendor Quotation

TABLE 4-6

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

PHYSICAL CONTROLS

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	BERM CLOSURE					
1A	Supply, Place, and Grade Select Fill	cy	630	$19	1	$12,000
1B	Supply, Place, and Grade Topsoil	cy	150	$21	1	$3,000
1C	Seed, Mulch, and Fertilize	acre	0.5	$3,300	1	$2,000
2	CONCRETE WEIR	each	1	$5,000	1	$5,000
3	SURFACE DRAINAGE DITCHES					
3A	Grass-lined Drainage Ditches	lf	3000	$20	1	$60,000
	SUBTOTAL					$82,000

Mobilization/Demobilization (5%)	$4,000
Contractor Markup for Overhead and Profit (25%)	$21,000
Construction, Administration, and Design Engineering (15%)	$12,000
Level "C" Health and Safety Requirements (40%)	$33,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$18,000
Bonds and Insurance (10%)	$8,000

TOTAL **$178,000**

SOURCES: 1 - Estimate from Means, 1990

PHYSICAL.WK1

11 Jul 91

TABLE 4-7

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

GROUNDWATER COLLECTION TRENCH

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	EXCAVATE, LAY PIPE AND FILTER FABRIC, BACKFILL WITH STONE	lf	2,000	$40	1	$80,000
2	PRECAST CONCRETE CLEANOUT	ea	20	$3,000	1	$60,000
3	PUMP STATIONS	ea	4	$10,000	1	$40,000
4	PUMPS (inc. installation)	ea	4	$5,000	1	$20,000
5	PLACE & GRADE EXCAVATED SOIL	cy	3000	$5	1	$15,000

SUBTOTAL **$215,000**

Mobilization/Demobilization (10%)	$22,000
Contractor Markup for Overhead and Profit (25%)	$54,000
Construction, Administration, and Design Engineering (15%)	$32,000
Level "C" Health and Safety Requirements (40%)	$86,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$46,000
Bonds and Insurance (10%)	$22,000

TOTAL **$477,000**

SOURCES: 1 - Estimate from Means, 1990

minimal and is included as part of the O&M for the groundwater pretreatment system.

F. Dredging of Lake Sediments

It is assumed that the lake sediments will be dredged using hydraulic means. The volume of dredged sediments is estimated to be 26,000 cy. Capital cost estimates are presented in Table 4-8.

G. Ex-situ Solidification

Ex-situ stabilization/solidification costs are variable depending on the type and amount of chemical additives required to process the wastes/soil. Capital and O&M cost estimates are presented in Table 4-9 for the ex-situ solidification of contaminated soil/fill in Area A (hotspot) under Alternative 4. Costs for the solidification media and processing of the wastes are shown separately based on discussions with vendors. A detailed breakdown of the capital cost estimate for air emissions control is discussed separately.

URS has placed OHM Corporation under contract to perform a treatability study to determine feasible solidification media, addition ratios, and costs for ex-situ solidification. Costs used in Tables 4-9 and 4-11 are based on the preliminary results from this ongoing study.

H. In-situ Solidification

Since stabilization/solidification processes are highly labor-and material-intensive, fixed costs have a nominal effect on unit costs. In-situ stabilization/solidification costs are still highly variable, depending on the vendor, contractor, additives, and soil-mixing techniques. Costs range from $25 to $150 per cubic yard. Since the maximum depth to which waste would be solidified at the Frontier Chemical

TABLE 4-8

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

DREDGING OF SEDIMENTS AND SLUDGES

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	HYDRAULIC DREDGING	cy	26,000	$8.00	1	$208,000
2	STOCKPILING	cy	26,000	$4.00	1	$104,000

SUBTOTAL **$312,000**

Mobilization/Demobilization (10%)	$31,200
Contractor Markup for Overhead and Profit (25%)	$78,000
Construction, Administration, and Design Engineering (15%)	$46,800
Level "C" Health and Safety Requirements (40%)	$124,800
Escalation to Midpoint of Construction (5% per year over 4 years)	$67,000
Bonds and Insurance (10%)	$31,200

TOTAL **$691,000**

SOURCES: 1 - Estimate from Means, 1990

TABLE 4-9

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

EX-SITU SOLIDIFICATION/STABILIZATION
HOT SPOT CONTAMINATION AREA

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	CLEAR AND GRADE	acre	4.8	$2,000	1 & 2	$10,000
2	EXCAVATE	cy	52,000	$3.00	1	$156,000
3	HAUL AND STOCKPILE	cy	52,000	$4.00	1 & 2	$208,000
4	SOLIDIFICATION MEDIA	ton	10,000	$10.00	3	$100,000
5	MEDIA TRANSPORTATION	truck	2,000	$50.00	2	$100,000
6	SOLIDIFICATION	cy	52,000	$25.00	3	$1,300,000
7	BACKFILL TREATED SOIL	cy	67,600	$5.00	3	$338,000

SUBTOTAL **$2,212,000**

Mobilization/Demobilization (Vendor Quote)	$88,000
Contractor Markup for Overhead and Profit (25%)	$553,000
Construction, Administration, and Design Engineering (15%)	$332,000
Level "B" Health and Safety Requirements (160% applied to items 2 and 3)	$582,000
Level "C" Health and Safety Requirements (40% applied to items 1, 6, and 7)	$659,000
Escalation to Midpoint of Construction (5% over 4 years)	$477,000
Bonds and Insurance (10%)	$221,000

TOTAL **$5,124,000**

SOURCES:
1 - Estimate from Means, 1990
2 - URS Estimate
3 - Vendor Quote (OHM Corporation)

EXSLDHI.WK1 06-Jan-92

site is 15 feet, the cost range may be narrowed to $50 to $100 per cubic yard. Processing capacities also vary from 60 to 300 cubic yards per ten-hour day.

Table 4-10 presents capital cost estimates for the in-situ stabilization/solidification of hot-spot and non-hot-spot areas identified in Figure 1-4. Capital costs for ex-situ solidification of dredged sediments and sludges are presented in Table 4-11. Total capital cost for the in-situ solidification of all contaminated areas would be the sum of the individual costs for the two areas. Different amounts of chemical additives may be added to the solidifying agents depending on the amount and type of organic contaminants present in the waste. The costs are based on the use of high-density fixating agents. Treatability testing would be required to determine whether lower-cost medium-density fixating agents would provide adequate treatment.

I. Excavation and Thermal Desorption

Excavation and onsite thermal desorption of the hot-spot contamination as shown on Figure 4-4 is included in Alternative 6. The volume of soil/fill for excavation and treatment is estimated to be 52,000 cy. Generally fixed costs (plans, permitting, mobilization/ demobilization, startup, and trial burn) total approximately $2 million. Depending on the quantity of waste treated, unit costs for the thermal desorption process can vary from $100 to $220 per cubic yard. Additional cost items include excavation, stockpiling, dewatering, treated soil replacement, and additional fill. A unit cost of $175 per cubic yard is assumed for cost estimating purposes.

Table 4-12 presents a capital cost estimate for the thermal desorption of all hot spot contamination areas.

TABLE 4-10

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

IN-SITU SOLIDIFICATION/STABILIZATION
HOT SPOT / NON-HOT SPOT CONTAMINATION AREA

ITEM NO.	ITEM	UNITS	QUANTITY		UNIT COST	SOURCE	TOTAL COST	
			HOT-SPOT	NON HOT-SPOT			HOT-SPOT	NON HOT-SPOT
1	CLEAR AND GRUB	acre	4.8	2.6	$2,000	2	$10,000	$5,000
2	SOLIDIFICATION MEDIA	ton	10,000	4,231	$400	2	$4,000,000	$1,692,000
3	MEDIA TRANSPORTATION	truck	2,000	846	$50	1	$100,000	$42,000
4	SOLIDIFICATION	cy	52,000	22,000	$50	2	$2,600,000	$1,100,000
	SUBTOTAL						**$6,710,000**	**$2,839,000**

Mobilization/Demobilization (10%)	$671,000	$284,000
Contractor Markup for Overhead and Profit (25%)	$1,678,000	$710,000
Construction, Administration, and Design Engineering (15%)	$1,007,000	$426,000
Level "C" Health and Safety Requirements (40% applied items 1 & 3)	$1,044,000	$442,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$1,446,000	$612,000
Bonds and Insurance (10%)	$671,000	$284,000
Air Emissions Control (including air monitoring)	$500,000	$500,000
TOTAL	**$13,727,000**	**$6,097,000**

SOURCES:
1 - URS Estimate
2 - Vendor Cost Estimate (OHM Corporation)

SOLIDNON.WK1

06-Jan-92

TABLE 4-11

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

EX-SITU SOLIDIFICATION/STABILIZATION
SEDIMENTS AND SLUDGES

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	HAUL AND STOCKPILE	cy	13,000	$4.00	1 & 2	$52,000
2	SOLIDIFICATION MEDIA	ton	14,000	$30.00	3	$420,000
3	MEDIA TRANSPORTATION	truck	2,800	$50.00	2	$140,000
4	SOLIDIFICATION (SEDIMENT)	cy	26,000	$36.00	3	$936,000
5	SOLIDIFICATION (SPOILS)	cy	13,000	$32.00	3	$416,000
6	PLACE UNDER CAP	cy	50,700	$5.00	1 & 2	$254,000

SUBTOTAL **$2,218,000**

Mobilization/Demobilization (Included in Table 4-9)	NA
Contractor Markup for Overhead and Profit (25%)	$555,000
Construction, Administration, and Design Engineering (15%)	$333,000
Level "C" Health and Safety Requirements (40% applied to all items)	$887,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$478,000
Bonds and Insurance (10%)	$222,000

TOTAL **$4,693,000**

SOURCES:
1 - Estimate from Means, 1990
2 - URS Estimate
3 - Vendor Quote (OHM Corporation)

TABLE 4-12

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

EXCAVATION AND ON-SITE THERMAL DESORPTION
HOT SPOT CONTAMINATION AREA

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	CLEAR AND GRADE	LS	-	$10,000	1	$10,000
2	EXCAVATE	cy	52,000	$3.00	1	$156,000
3	HAUL AND STOCKPILE	cy	52,000	$4.00	1	$208,000
4	DEWATER	LS	-	$250,000	1	$250,000
5	THERMAL DESORPTION	cy	52,000	$175.00	2	$9,100,000
6	HAUL AND BACKFILL TREATED SOIL	cy	41,600	$5.00	1	$208,000
7	FURNISH AND DELIVER FILL	cy	10,400	$15.00	1	$156,000
8	BACKFILL AND GRADE FILL	cy	10,400	$2.00	1	$21,000

SUBTOTAL **$10,109,000**

Mobilization/Demobilization (10%)	$1,011,000
Contractor Markup for Overhead and Profit (25%)	$2,527,000
Construction, Administration, and Design Engineering (15%)	$1,516,000
Level "B" Health and Safety Requirements (160% applied to items 2 and 3)	$582,000
Level "C" Health and Safety Requirements (40% applied to items 1 and 4)	$104,000
Level "D" Health and Safety Requirements (5% applied to items 6 and 7)	$18,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$2,178,000
Bonds and Insurance (10%)	$1,011,000

TOTAL **$19,056,000**

SOURCES:
1 - Estimate from Means, 1990
2 - URS Estimate

DESRPHOT.WK1

06-Jan-92

J. Containment Cell in Lake

The containment cell located within the northern segment of the lake is provided in Alternative 6 for the replacement of dredged and treated sediments. Any excess volume resulting from the regrading of the process area after treatment will also be placed in this containment cell. A berm will be placed across the middle of the lake to separate the two segments and to drain the northern half. The existing clay layer in the bottom of the cell will be implemented with additional clay where necessary to provide the required minimum bottom liner thickness. An average of 2 feet of additional clay across an area of 6 acres is assumed.

Capital cost estimates for the on-site cell is provided in Table 4-13.

K. Air Emissions Control

Excavation of contaminated soils/fill in Alternatives 4 and 6 for ex-situ treatment will require extensive air emissions control to minimize health risks to onsite workers, nearby residents and the environment. Major components of on-site air emissions control during remediation include a building, foam suppressants, tarpaulins and air quality monitoring equipment. Such extensive controls will not be required for Alternative 3 which does not involve intrusive work, and for Alternative 5 in which the in-situ solidification process has a built-in air emissions collection and treatment system. However, Alternatives 3 and 5 may need air quality monitoring at a minimum. Detailed capital cost estimates for air emissions control were therefore developed and are presented as Table 4-14.

TABLE 4-13

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

LAKE CELL

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	FURNISH, DELIVER, AND INSTALL CLAY FOR BERM	cy	7,407	$5.00	1	$37,000
2	DRAIN CELL PORTION OF LAKE	LS	-	$20,000	1	$20,000
3	FURNISH, DELIVER, AND INSTALL CLAY FOR BOTTOM LINER	cy	19,360	$18.00	1	$348,000
4	RE-PLACEMENT OF TREATED SEDIMENTS	cy	50,700	$5.00	1	$254,000
5	SOIL CAP	acre	6	$97,000	2	$582,000

SUBTOTAL $1,241,000

Mobilization/Demobilization (10%)	$124,000
Contractor Markup for Overhead and Profit (25%)	$310,000
Construction, Administration, and Design Engineering (15%)	$186,000
Level "C" Health and Safety Requirements (40%) (Applies to items 4 and 5)	$334,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$267,000
Bonds and Insurance (10%)	$124,000

TOTAL **$2,586,000**

SOURCES:
1 - Estimate from Means, 1990
2 - See Table 4-3

CELL.WK1

11 Jul 91

TABLE 4-14

FRONTIER CHEMICAL - PENDLETON SITE
CAPITAL COST ESTIMATE

AIR EMISSIONS CONTROL

ITEM NO.	ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
1	PRE-ENGINEERED STEEL BUILDING (50' x 50')	sq ft	2500	$10	1	$25,000
2	INDUCED DRAFT FAN	ea	1	$8,000	1	$8,000
3	BAGHOUSE	ea	1	$10,000	1	$10,000
4	AIR MONITORING	test	240	$700	3	$168,000
5	VAPOR SUPPRESSANT FOAM CONCENTRATE	gal	700	$15	3	$10,500
6	FIRE TRUCK - RENTAL	day	120	$300	3	$36,000
7	FIRE TRUCK - LABOR	man-day	240	$300	2	$72,000
8	REAL TIME AIR MONITORING - EQUIPMENT	day	120	$150	3	$18,000
9	REAL TIME AIR MONITORING - LABOR	man-day	120	$300	2	$36,000
10	TARPAULINS - MATERIAL	sq yd	1800	$2	1	$3,600
11	TARPAULINS - LABOR	man-day	30	$300	2	$9,000

SUBTOTAL $396,100

Mobilization/Demobilization (5%)	$19,805
Contractor Markup for Overhead and Profit (25%)	$99,025
Construction, Administration, and Design Engineering (15%)	$59,415
Escalation to Midpoint of Construction (5% over 4 years)	$85,360
Bonds and Insurance (10%)	$39,610

<u>TOTAL</u> <u>(All components)</u> **<u>$699,000</u>**

<u>TOTAL</u> <u>(Item 4, Air monitoring only)</u> **<u>$297,000</u>**

SOURCES:
1 - Estimate from Means, 1990
2 - URS Estimate
3 - From actual URS work invoices, Delaware Sand and Gravel Superfund Site, 1991

AIREMIT.WK1

12 Jul 91

L. Groundwater Treatment

In order to establish a basis for design, the groundwater data presented in the RI Report were utilized to develop design influent concentrations for the contaminants expected to be present in groundwater flowing into the treatment system. The design concentration for each parameter is assumed to be equal to the maximum concentration detected in the shallow aquifer. However, in cases where the maximum concentration detected is significantly greater than the average concentration, this assumption would result in an overly conservative basis for equipment sizing and costs. In such cases, the design concentration is assumed to be the maximum concentration or four times the average concentration, whichever is smaller. The design concentrations are presented in Table 4-15. The long-term groundwater collection rate is assumed to be 5 gpm for Alternative 3A and 3B. The same rate is also assumed for a temporary treatment system that will be required in Alternatives 4 and 6 when the site is dewatered during excavation.

It is assumed that the treated water can be discharged to the local POTW, which is the Niagara County Sewer District #1 Treatment Plant. Treatment operations at the facility consist of grit removal, activated sludge aeration, clarification, phosphate removal, polishing, chlorination, and finally discharge to the Niagara River. The design capacity of the plant is 14 MGD but the plant presently operates at 4 to 5 MGD. Negotiations between the NYSDEC and Niagara County Sewer District #1 will be necessary to determine the restrictions to be placed on discharge from the Frontier Chemical site. The actual treatment processes and design of the treatment facility would have to be based on these restrictions. With the level of treatment provided herein, it may even be possible to discharge the treated water to Bull Creek.

The process train for the pretreatment facility would consist of equalization, precipitation/flocculation/sedimentation, air stripping, and

TABLE 4-15

Summary of Groundwater Treatment Design Data

Parameter	Type	Units	Design Concentration (Influent)
Vinyl Chloride	VOC	µg/L	800
Methylene Chloride	VOC	µg/L	5,600
Acetone	VOC	µg/L	20,400
1,1-Dichloroethane	VOC	µg/L	400
1,2-Dichloroethene (Total)	VOC	µg/L	21,000
Chloroform	VOC	µg/L	800
1,2-Dichloroethane	VOC	µg/L	88,700
2-Butanone	VOC	µg/L	70
1,1,1-Trichloroethane	VOC	µg/L	1,900
Trichloroethene	VOC	µg/L	13,500
Benzene	VOC	µg/L	3,300
4-Methyl-2-Pentanone	VOC	µg/L	3,100
Tetrachloroethene	VOC	µg/L	3
Toluene	VOC	µg/L	92,800
Chlorobenzene	VOC	µg/L	60
Ethylbenzene	VOC	µg/L	150
Total Xylenes	VOC	µg/L	1,200
Phenol	SEMI	µg/L	6,700
bis(2-Chloroethyl)ether	SEMI	µg/L	60
1,4-Dichlorobenzene	SEMI	µg/L	5
Benzyl Alcohol	SEMI	µg/L	90
1,2-Dichlorobenzene	SEMI	µg/L	5
2-Methylphenol	SEMI	µg/L	500
4-Methylphenol	SEMI	µg/L	1,700
Nitrobenzene	SEMI	µg/L	200
Isophorone	SEMI	µg/L	30
2,4-Dimethylphenol	SEMI	µg/L	40
Benzoic Acid	SEMI	µg/L	500
Bis(2-chloroethoxy)methane	SEMI	µg/L	70
1,2,4-Trichlorobenzene	SEMI	µg/L	5
Naphthalene	SEMI	µg/L	80
4-Chloroaniline	SEMI	µg/L	8
2-Methylnaphthalene	SEMI	µg/L	6
Phenanthrene	SEMI	µg/L	5
Di-n-butylphthalate	SEMI	µg/L	5
Fluoranthene	SEMI	µg/L	5
Pyrene	SEMI	µg/L	5
Butylbenzylphthalate	SEMI	µg/L	5
bis(2-Ethylhexyl)phthalate	SEMI	µg/L	40
Total Volatiles	*VOC*	*µg/L*	*253,783*
Total Semivolatiles	*SEMI*	*µg/L*	*10,064*
Total Organics		*µg/L*	*263,847*

TABLE 4-15

Summary of Groundwater Treatment Design Data

Parameter	Type	Units	Design Concentration (Influent)
Aluminum	MCP	µg/L	4,000
Antimony	MCP	µg/L	40
Arsenic	MCP	µg/L	30
Barium	MCP	µg/L	200
Cadmium	MCP	µg/L	10
Calcium	MCP	µg/L	430,000
Chromium	MCP	µg/L	77,900
Cobalt	MCP	µg/L	30
Copper	MCP	µg/L	80
Iron	MCP	µg/L	12,500
Lead	MCP	µg/L	10
Magnesium	MCP	µg/L	947,000
Manganese	MCP	µg/L	1,000
Nickel	MCP	µg/L	200
Potassium	MCP	µg/L	63,200
Selenium	MCP	µg/L	3
Sodium	MCP	µg/L	1,450,000
Vanadium	MCP	µg/L	200
Zinc	MCP	µg/L	80
Cyanide	MCP	µg/L	1,000
Phenols	MCP	mg/L	30
Bicarbonate	MISC	mg/L	500
BOD	MISC	mg/L	900
COD	MISC	mg/L	1,200
Chloride	MISC	mg/L	900
Hardness	MISC	mg/L	5,400
Ammonia, as N	MISC	mg/L	20
Total Kjeldahl Nitrogen, as N	MISC	mg/L	40
Alkalinity	MISC	mg/L	500
Acidity	MISC	mg/L	400
Nitrate-Nitrogen	MISC	mg/L	1
Oil and Grease	MISC	mg/L	20
TOC	MISC	mg/L	900
TSS	MISC	mg/L	2,000
TDS	MISC	mg/L	8,000
Sulfate	MISC	mg/L	4,300
pH Units	MISC	mg/L	7

Ph adjustment (Figure 4-5). Major equipment items required for the pretreatment system are summarized in Table 4-16. Conceptual sizing of the equipment and the basis upon which the equipment was sized are also shown in this table. The capital cost estimate for the 5-gpm pretreatment system is presented in Table 4-17. The basis for the estimation of annual O&M costs for groundwater collection and pretreatment is presented in Table 4-18, while annual O&M costs are included in Table 4-19.

M. Groundwater Monitoring

For the purpose of developing cost estimates, it is assumed that only 4 additional wells must be installed and used for annual monitoring in conjunction with six existing wells. These may be modified when the final remedy is in place. Capital and annual O&M cost estimates are developed in Tables 4-20 and 4-21, respectively.

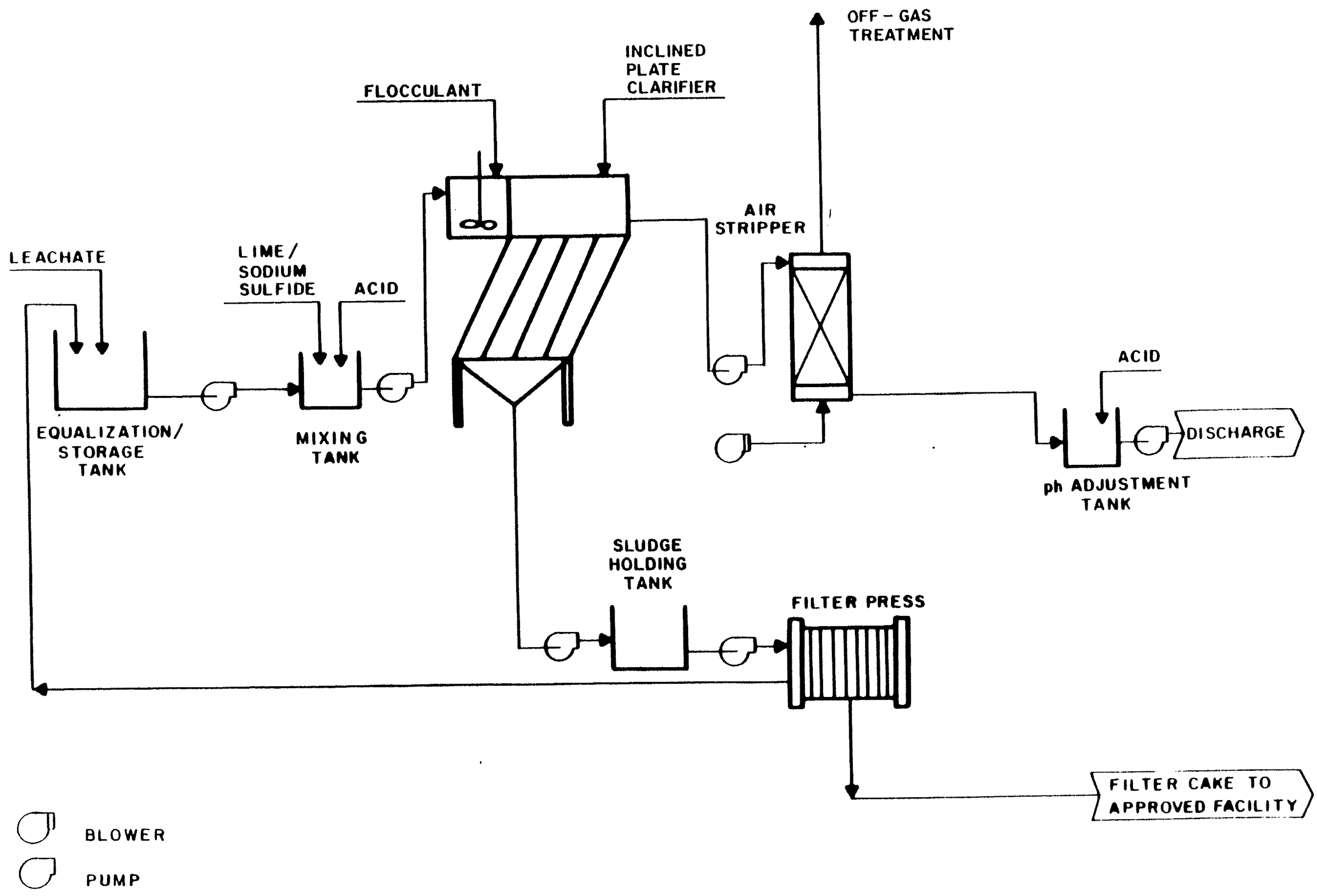
4.5 Cost Estimates for Alternatives

Table 4-22 summarizes the capital and annual O&M costs for each alternative based on the component costs given previously. For the economic evaluation of alternatives, the total cost (i.e. capital and annual O&M costs) for an alternative is converted to its present worth based on a performance period of 30 years and a 10 percent interest rate. The present worth of costs of each alternative are also presented in Table 4-22. These costs are discussed below.

4.5.1 Alternative 1 - No Action

The No-Action alternative has no cost associated with it.

A– 3759



URS CONSULTANTS

GROUNDWATER TREATMENT SYSTEM
(PRETREATMENT OPTION)

FIGURE 4–5

TABLE 4-16

EQUIPMENT SIZING & DESIGN CRITERIA

GROUNDWATER TREATMENT (5 gpm)

Equipment Description	Design Criteria	Size
Equalization/Storage Tank	24 Hour Retention Time	7,500 gal
Equalization Tank Agitator	0.15 HP per 1,000 gallon	1.5 HP
Mixing Tank	30 Minute Retention Time	200 gal
Mixing Tank Agitator	2 HP per 1,000 gallon	0.5 HP
Inclined Plate Clarifier	Overflow Rate = 0.25 gal/ft²	20 ft²
Sludge Tank	Sludge Flow Rate = 0.25 gpm 1 Week Retention Time	3,000 gal
Filter Press	Suspended Solids = 1000 mg/L 40% Solids in Filter Cake Cake Density = 70 lb/ft³ Sludge Dewatered 1 time per week	15 ft³
Air Stripper	Water Temperature = 55°F Air to Water Ratio = 60:1	Column Diameter = 1 ft Column Height = 15 ft
Blower	Same as Above	40 cfm
Vapor Phase Carbon Adsorption		
pH Adjust Tank	10 Minute Retention Time	50 gal
pH Adjust Tank Agitator	3 HP per 1,000 gallon	0.15 HP
8 Process Pumps *		5 gpm
2 Sludge Pumps *		0.25 gpm
2 Sludge Pumps *		2 gpm
8 Chemical Metering Pumps *		0.5 gpm

* - It is assumed that standby pumps are installed.

TABLE 4-17

CAPITAL COST ESTIMATE

GROUNDWATER TREATMENT (5 gpm)

Item	# Of Items	Unit Cost	Source	Total Cost
EQUIPMENT COSTS				
Equalization/Storage Tank	1	$7,800	2	$7,800
Equalization Tank Agitator	1	$4,000	2	$4,000
Mixing Tank	1	$798	2	$798
Mixing Tank Agitator	1	$2,088	2	$2,088
Inclined Plate Clarifier	1	$35,000	3	$35,000
Sludge Tank	1	$8,000	2	$8,000
Filter Press with Feed Pumps	1	$20,250	2	$20,250
Air Stripper with Blower	1	$21,675	3	$21,675
Vapor Phase Carbon Adsorption	1	$145,000	3	$145,000
pH Adjust Tank	1	$400	3	$400
pH Adjust Tank Agitator	1	$798	2	$798
Process Pumps	8	$1,400	2	$11,200
Sludge Pumps	2	$575	1	$1,150
Metering Pumps	8	$800	2	$6,400
SUBTOTAL EQUIPMENT				$264,559
ADDITIONAL DIRECT COSTS				
Equipment Installation (50% of Equipment)				$132,280
Instrumentation and Controls (20% of Equipment)				$52,912
Piping (60% of Equipment)				$158,735
Electrical (10% of Equipment)				$26,456
Buildings (40% of Equipment)				$105,824
Service Facilities and Yard Improvements (20% of Equipment)				$52,912
TOTAL DIRECT COSTS				$793,677

Contractor Markup for Overhead and Profit (25% of Direct)	$198,419
Construction, Administration, and Design Engineering (15% of Direct)	$119,052
Change Order Contingencies (10% of Direct)	$79,368
Escalation to Midpoint of Construction (5% per year over four years)	$171,037
Level "C" Health Protection (40% of Equipment Installation) (For Level "B" Protection Use 160%, Level "D" use 5%)	$52,912
TOTAL	$1,414,465
say	$1,410,000

SOURCES:

1 - Richardson, 1990
2 - Means, 1990
3 - Vendor Quotation

TABLE 4-18

O & M COST ESTIMATE BASIS

GROUNDWATER COLLECTION AND TREATMENT (5 gpm)

Item	Basis	Unit Cost
Operating and Maintenance Labor	1 man 8 hrs per day 5 days per week	$31.60 per hour
Maintenance	3% of Capital Costs	3% of Capital Costs
Insurance and Taxes	1% of Capital Costs	1% of Capital Costs
Maintenance Reserve and Contingency Costs	1% of Capital Costs	1% of Capital Costs
Granulated Activated Carbon	N/A	$1.25 per lb
Energy		
-Electricity	HP x .747 x hrs of operation	$0.10 per kWhr
Chemicals		
-Calcium Hydroxide (Lime)	250 mg/l	$60.00 per Ton
-Sulfuric Acid	250 mg/l	$96.00 per Ton (100% Basis)
-Polymer	1 mg/l	$1.25 per lb
Filter Cake Disposal	2000 mg/l sludge 40% solids in cake Cake Density = 70 lb per ft^3	$350.00 per yd^3
Monitoring Costs		
-Conventional Parameters	Monthly	$300
-HSL Parameters	Quarterly	$1350
Sewer Use Charge		
-Flow	5 gpm	$0.05 per 1000 gal

TABLE 4–19

ANNUAL O & M COST ESTIMATE

GROUNDWATER COLLECTION AND TREATMENT (5 gpm)

Item	Units	Quantity	Unit Cost	Total Cost 5 gpm
O & M Labor	hrs	2,080	$31.60	$65,728
Maintenance			3%	$42,300
Insurance and Taxes			1%	$14,100
Maintenance Reserve and Contingency Costs			1%	$14,100
Granular Activated Carbon	lb	17,600	$1.25	$22,000
Energy				
-Electricity	kwh	327,186	$0.10	$32,719
Chemicals				
-Calcium Hydroxide	lb	5,479	$0.03	$164
-Sulfuric Acid	lb	5,479	$0.048	$263
-Polymer	lb	22	$0.09	$2
Filter Cake Disposal	yd^3	29	$350	$10,147
Monitoring Costs				
-Conventional Parameters	ea	12	$300	$3,600
-HSL Parameters	ea	4	$1,500	$6,000
Sewer Use Charge				
-Flow	kgal	2,628	$1.43	$3,769
TOTAL O & M COST				**$215,000**

TABLE 4-20

FRONTIER CHEMICAL
CAPITAL COST ESTIMATE

GROUNDWATER MONITORING

ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
Mobilization/ Demobilization	task	1	$500	1	$500
Drilling	ft	240	$25	1	$6,000
4" S.S Riser Installed	ft	216	$30	1	$6,500
4" S.S. Screen Installed	ft	40	$70	1	$2,800
Protective Casing	Ea	8	$200	1	$1,600
Drums for Residuals	Ea	20	$70	1	$1,400
Standby Time	hrs	16	$150	1	$2,400
Pressure Grouting (for deep well)	ft	80	$10	1	$800

SUBTOTAL **$22,000**

Mobilization/Demobilization (10%)	$2,000
Contractor Markup for overhead and Profit (25%)	$6,000
Construction, Administration, and Design Engineering (15%)	$3,000
Change Order Contingencies (10%)	$2,000
Escalation to Midpoint of Construction (5% per year over 4 years)	$5,000
Bonds and Insurance (10%)	$2,000

TOTAL **$42,000**

NOTE: Estimate for the installation of four (4) well pairs.

SOURCES: 1 Actual subcontractor invoice costs (1988) for Weston Mills Hazardous Waste Site, pro-rated for 1991. Includes Level "C" Protection.

TABLE 4–21

FRONTIER CHEMICAL
ANNUAL O & M COST ESTIMATE

GROUNDWATER MONITORING

ITEM	UNITS	QUANTITY	UNIT COST	SOURCE	TOTAL COST
Sampling					
-Labor	mandays	10	$375	1	$3,750
-Equipment	misc	-	$250	1	$250
Analyis					
-TCL	sample	24	$1,500	2	$36,000
Data Validation	sample	24	$400	1	$9,600

SUBTOTAL **$50,000**

Administration, Engineering (15%)	$8,000
Change Order Contingencies (10%)	$5,000
Bonds and Insurance (10%)	$5,000

TOTAL ANNUAL COSTS **$68,000**

NOTE: Involves annual sampling and analysis of twenty (20) shallow and deep wells for the TCL list. An additional 20% is added for QA/QC.

SOURCES:
1 - URS estimate. Includes Level "C" Protection.
2 - Recent laboratory quote

TABLE 4–22

FRONTIER CHEMICAL – PENDLETON SITE
COST ESTIMATES FOR REMEDIAL ALTERNATIVES

ITEM	ALT. 1	ALT. 2	ALT. 3A	ALT. 3B	ALT. 4	ALT. 5	ALT. 6
CAPITAL COSTS							
1. MSG CAP			3,001,000	3,001,000			
2. SOIL CAP					1,594,000	1,594,000	1,594,000
3. EXCAVATION AND THERMAL DESORPTION (HOT SPOT)							19,056,000
4. IN–SITU SOLIDIFICATION (HOT SPOT)						13,727,000	
5. IN–SITU SOLIDIFICATION (NON–HOT SPOT)							6,097,000
6. EX–SITU HOT SPOT SOLIDIFICATION					5,124,000		
7. PHYSICAL CONTROLS			178,000	178,000	178,000	178,000	178,000
8. SHEET PILING (ALL)			2,321,000	2,321,000			
9. SHEET PILING (LAKESIDE)					389,000	389,000	389,000
10. SEDIMENT DREDGING			691,000	691,000	691,000	691,000	691,000
11. SEDIMENT TREATMENT (EX–SITU SOLIDIFICATION)				4,693,000	4,693,000	4,693,000	4,693,000
12. LAKE CELL							2,586,000
13. AIR EMISSIONS CONTROL			297,000	297,000	699,000	297,000	699,000
14. GROUNDWATER COLLECTION			477,000	477,000			
15. GROUNDWATER TREATMENT			1,410,000	1,410,000	1,410,000		1,410,000
16. GROUNDWATER MONITORING WELLS		42,000	42,000	42,000	42,000	42,000	42,000
TOTAL CAPITAL COST	**$0**	**$42,000**	**$8,417,000**	**$13,110,000**	**$14,820,000**	**$21,611,000**	**$37,435,000**
OPERATIONS AND MAINTENANCE COSTS							
1. GROUNDWATER MONITORING		68,000	68,000	68,000	68,000	68,000	68,000
2. MSG CAP			43,000	43,000			
3. SOIL CAP					43,000	43,000	43,000
4. GROUNDWATER TREATMENT – LONG TERM (30 YRS.)			215,000	215,000			
5. GROUNDWATER TREATMENT – TEMPORARY (2 YRS.)					215,000		215,000
TOTAL ANNUAL O & M COST	**$0**	**$68,000**	**$326,000**	**$326,000**	**$326,000**	**$111,000**	**$326,000**
PRESENT WORTH OF O & M COST	**$0**	**$642,000**	**$3,079,000**	**$3,079,000**	**$1,478,000**	**$1,048,000**	**$1,478,000**
PRESENT WORTH OF TOTAL COST (CAPITAL PLUS O & M)	**$0**	**$684,000**	**$11,496,000**	**$16,189,000**	**$16,298,000**	**$22,659,000**	**$38,913,000**

NOTE: Present worth analysis for Alternative 3 is based on a 30–year performance period at 10% interest per year.
Present worth analysis for Alternatives 4 and 6 is based on a 2–year operation of groundwater treatment and a 30–year performance period for other O&M at 10% interest per year.

CAPSUM.WK1

06–Jan–92

4.5.2 Alternative 2 - Institutional Action

The Institutional Action alternative has monitoring well installation and long-term groundwater monitoring (i.e. sampling and analysis) costs associated with it. Total capital cost for Alternative 2 is estimated to be $42,000; annual O&M cost is $68,000. The total present worth of the costs for this alternative is $684,000.

4.5.3 Alternative 3A - Containment

The capital costs associated with this alternative include installation of groundwater monitoring wells, sediment dredging and placement, construction of sheetpile barrier, an MSG cap, groundwater collection and pretreatment facilities, and physical controls. The total capital cost amounts to $8,417,000. The annual O&M costs amounting to $326,000 for this alternative cover groundwater monitoring, MSG cap repair and maintenance, and groundwater collection and treatment. The total present worth of Alternative 3A is $11,496,000.

4.5.4 Alternative 3B - Containment with Solidification of Sediment and Spoils

The capital costs associated with this alternative include the installation of groundwater monitoring wells, sediment dredging, solidification of dredged sediments and spoils and placement of treated wastes under an MSG cap, construction of a sheetpile barrier, groundwater collection and treatment, and physical controls. The total capital cost amounts to $13,110,000. The annual O&M costs amounting to $326,000 include costs for groundwater monitoring, MSG cap repair and maintenance, and groundwater collection and treatment. The total present worth for Alternative 3B is $16,189,000.

4.5.5 Alternative 4 - Hot Spot Treatment With Ex-situ Solidification

The capital costs for the alternative include the installation of groundwater monitoring wells, ex-situ solidification of hot spot contaminated waste/fill, sediment dredging and treatment, installation of lakeside sheetpile, construction of a soil cap, and a temporary groundwater treatment facility. Most of the capital costs will be expended on the ex-situ solidification process. The total capital cost amounts to $14,820,000. The annual O&M costs for this alternative are associated with groundwater monitoring, cap repair and maintenance, and groundwater collection and pretreatment. The total annual O&M cost is $326,000. The total present worth of the costs for Alternative 4 is $16,298,000.

4.5.6 Alternative 5 - Hot-Spot Treatment with In-Situ Solidification

The capital costs for this alternative include the installation of groundwater monitoring wells, in-situ solidification of hot-spot contamination areas, sediment dredging and treatment, installation of lakeside sheetpile, and construction of a soil cap. Solidification represents the bulk of the capital cost. The total capital cost amounts to $21,611,000. The annual O&M cost of $111,000 for this alternative covers groundwater monitoring, and cap repair and maintenance. The total present worth of Alternative 5 is $22,659,000.

4.5.7 Alternative 6 - Full Treatment with Solidification and Hot-Spot Thermal Desorption

The capital cost of $37,435,000 for Alternative 6 includes groundwater monitoring wells, ex-situ thermal desorption of hot spot, in-situ solidification of non-hot spot, sediment dredging and treatment, installation of lakeside sheetpile, construction of a soil cap, and a temporary groundwater treatment facility. The annual O&M cost of $326,000 for the alternative covers groundwater monitoring, soil cap repair and maintenance, and groundwater collection and pretreatment. The estimated total present worth of Alternative 6 is $38,913,000.

4.6 Comparison of Alternatives

This analysis involves a comparative evaluation amongst the alternatives to determine which alternative best meets the objectives of this feasibility study. Specifically, the results of the previous two analyses (namely, the weighted-matrix scores and cost estimates) are used.

Alternatives 1 and 2 are considered to be totally ineffective since the contaminants and their associated risks would remain unchanged following implementation of either alternative.

Alternatives 3 through 6 would eliminate the risk to human health posed by contact with the soil at the site and would, in conjunction with the physical controls, prevent erosion of surficial soils. Also, dredging the lake sediments would alleviate any concerns over the future use of the lake.

Alternative 3A, is the containment option. It does not alter the toxicity or volumes of hazardous waste within the site. It does decrease the mobility of the contaminants by minimizing infiltration through the use of a multilayered synthetic geomembrane cap. Alternatives 3A, 3B, 4 and 5 are mostly similar to one another except for the difference in the caps and the solidification of waste/fill in the area of maximum contamination (hot spot). Treatment of the hot-spot area immobilizes almost all contaminants at the site, thereby preventing the migration of these contaminants through the groundwater. The soil cap in Alternatives 4 and 5 would provide adequate protection against human contact. Complete treatment of all contaminated materials is provided for in Alternative 6.

With a combination of two different treatment techniques for the hot-spot and non-hot spot areas, Alternative 6 would be a permanent remedy for the site.

In terms of implementability of the remedial action, Alternatives 1 and 2 would be the least difficult. Short-term risks to the community or environment are also minimal, since there are no contamination activities involved.

Physical controls and sheetpile installation are relatively easy. Excavation of contaminated waste/fill, or dredging of contaminated sediments, would create short-term risks to the community and the environment. The risks are lower with in-situ treatment of the waste/fill. In any event additional efforts are required to control risks from these technologies from the standpoint of constructability, and the soil cap is easier to implement than the MSG cap, which requires the installation of a geomembrane. Overall, Alternatives 3A, 3B, 4 and 5 would be more readily implemented then Alternative 6.

Examination of the present-worth values of the preliminary total capital and annual O&M costs for the five alternatives in Table 4-22 (based on a 30-year performance period and a 10 percent annual interest rate) reveals that the range of costs is from no cost for Alternative 1 (No Action) to $38,913,000 for Alternative 6, which provides the most comprehensive remedy. Alternative 2 (Institutional Action) has a minimal cost of $684,000, while Alternative 3A (Containment) has the second lowest cost ($11,496,000). However, both these alternatives do not meet the overall objectives for remediation of the site and have the lowest weighted-matrix scores. Between Alternatives 3B, 4, 5 and 6, Alternative 3B (Containment with Solidification of Sediments and Spoils) has the lowest cost ($16,189,000) although all four have similar weighted-matrix scores and are comparable in meeting the remedial objectives. Alternative 5 (Hot Spot Treatment with In-Situ Solidification) has the second highest cost ($22,659,000) amongst these three alternatives). Annual O&M costs are the same for Alternatives 3A, 3B, 4, and 6 since groundwater monitoring, collection, and treatment are assumed to be the same for these four alternatives. However, groundwater treatment is provided over the long-term in Alternative 3A and 3B and only during excavation in Alternatives 4 and 6.

The present worth of the costs for the alternatives vary significantly because of the wide differences in the remedial approach and selected technologies. Costs are also subject to change as a result of future investigations or developments. For example, future developments may require that full groundwater treatment be implemented over a pretreatment system for extracted groundwater, or treatability studies may require that the proposed conceptual design for the selected technologies be revised. From the standpoint of cost, Alternative 3A appears to be the most favorable, followed by Alternative 3B.

4.7 Selection of Preferred Alternative

Based on the evaluation of alternatives, the recommended remedial approach for the Frontier Chemical-Pendleton site is Alternative 3B. This alternative provides for dredging of the lake sediments, ex-situ solidification of all lake sediments including the existing mounds of dredged sediments/spoils, installation of a sheetpiling around the contaminated area, installation of groundwater collection trenches and a long-term groundwater treatment plant, installation of an MSG cap, groundwater monitoring, diversion of runon/runoff, lake overflow control, and berm closure.

Alternative 3B was selected for several reasons. The largest source of short-term risk to workers and the community is posed by disturbing the soils/fill in the process (hot-spot) area. Alternatives 4, 5 and 6 would each disturb the hot-spot soils to some extent, which would lead to the possible release of fugitive dust and/or volatile emissions. Secondly, contamination has not migrated far from contaminant sources, due to the low permeability of surrounding soils. Because of this low permeability, there is little justification for the additional costs required to solidify the soils/fill in the process area, as in Alternative 4 and 5. Alternative 3B will also be easier to implement than Alternatives 4, 5, or 6. Alternative 3B will also achieve the remedial objectives specified in Section 2.

5. CONCEPTUAL DESIGN AND PRELIMINARY COST ESTIMATES FOR PREFERRED ALTERNATIVE

5.1 Conceptual Design

5.1.1 Physical Controls

A. Diversion of Runon/Runoff

A series of berms shall be constructed around the site perimeter and the surface grading of the cap area will be such that surface water runon from off-site is eliminated. Proper contouring of the ground surface will allow surface water from precipitation on to the site to drain to the lake or into the ditch along the former railroad bed. With the placement of treated sediments below the MSG cap, runoff from the site will not require treatment.

B. Berm Closure

At present, the dike along the perimeter of the lake is not continuous. There are some breached sections. All the damaged or eroded diked area will be repaired to provide, in conjunction with the sheet piling at the process area, a complete enclosure of the lake. The top of dike will be at least 2 feet higher than the maximum expected water level in the lake.

C. Control of Lake Discharge

In the case of excessive rainfall there is a possibility of water overflowing the banks of the lake. In order to control such overflow and avoid possible flooding of Bull Creek, a concrete overflow weir with stop log will be constructed in the northwest corner of the lake in the vicinity of Bull Creek. Use of this type of weir will permit the discharge from the lake to increase as the level increases. Rip rap will also be placed around the overflow section to prevent erosion of the ground surface. A second control structure will be located at the east end of the lake near the former railroad bed in the event one overflow weir is not sufficient. A channel will be constructed up to Bull Creek to facilitate the flow. Since the surface water is expected to be clean, no treatment is required before discharge.

5.1.2 Sheet Piling

Prior to sediment dredging and treatment, a "z" type sheet pile barrier wall will be driven to sufficient depth, around the entire perimeter of the contaminated area, into the clay layer as close as possible to the water's edge along the southeast portion of the lake, as shown in Figure 4-3. The sheet piling will limit lake water and other groundwater from entering the capped area. Sheetpiles will also prevent contaminated groundwater from entering the lake from the capped area. The interlocks between individual sheet piles will be grouted. In order to support the additional weight of the sediments and the MSG cap, a berm may be required on the water side of the sheetpile. If required, it will be constructed of rip rap or granular fill. The sheetpile will be left in place after the sediment placement and cap construction.

5.1.3 Sediment Dredging

The sediments will be removed from the lake bottom either by dredging or by excavating. In order to avoid treating a large volume of water during the dredging operation, the lake will be dewatered by pumping water out of the lake. The lake water does not need any treatment before being discharged into the local drainage ditch or to Bull Creek. Dewatering of the lake will be carefully monitored so that there is no movement of sediment during dewatering. To facilitate the removal of wet sediment it may be mixed with sand so that excavation equipment can move around and the sediment can be removed easily. The sediments will be taken to the non-hot spot area for solidification. The contaminated sediment removed from the lake bottom will be treated on site and placed over the process/fill area as described below.

5.1.4 Sediment Treatment (Ex-Situ Solidification)

An estimated 26,000 cubic yards of contaminated sediments and sludges will be dredged from the two segments of the lake and treated ex-situ by solidification. An additional 13,000 cubic yards of previously dredged sediments now existing in four piles in the process/fill area will also be processed with any newly dredged sediments.

The successful application of solidification to immobilize contaminants in the soil/fill is dictated by the type and amount of chemical additives. Cement, flyash, sodium silicate, bentonite and other such inorganic chemicals are typically used in the process with proprietary chemicals that bind or encapsulate organic and inorganic contaminants. Water may be needed during mixing to meet minimum moisture levels in the waste being treated. Equipment to mix the waste with the chemical additives are usually specific to each vendor. The following components will be included for sediment treatment:

- Sediment storage and feed systems
- Chemical reagent storage and feed systems
- Waste homogenizer
- Process mixer with air emission controls
- Treated sediment storage
- Treated sediment transport and placement
- Instrumentation for measurement and control

The treated material will be treated in batches so that each batch can be tested before placement. The treated sediment will be tested more frequently in the beginning to ensure that the contaminants are immobilized and treatment requirements are adequately met.

5.1.5 Placement of Treated Sediments

The estimated 39,000 cubic yards of treated sediments will increase in volume by an amount that depends on the type of sediments or sludges being treated and the type and amount of chemical additives. Assuming a 30 percent increase by ex-situ solidification, the volume of treated sediments will be approximately 51,000 cubic yards. The treated sediments will be placed in such a way as to minimize the increase in ground surface relative to the surrounding and provide a uniform topography across the site.

After placement of the treated sediments, the process/fill area will be regraded in accordance with a subgrade grading plan with adequate slopes to promote surface runoff and minimize erosion.

5.1.6 Multilayed Cap with Synthetic Geomembrane

The MSG cap will consist of 12 inches of general fill, a 60-mil HDPE fabric, 6 inches of clay, a 12 inch sand drainage layer, and 6 inches of topsoil. The MSG cap will be constructed over the hot spot and non-hot spot areas (Areas A and B in Figure 1-4), including the areas over which the treated sediments are placed. The subgrade grading plan will closely match the contours of the final grading plan so as to minimize the amount of general fill needed to obtain the required slopes. There will be a high ridge in the center of the cap, and gradually sloped from there.

After regrading and before placing the general fill, a filter fabric or a drainage net will be laid across the cap area to differentiate between the regraded surface and the cap components. General fill will then be placed, followed by the other components listed above. Finally, the site will be seeded to prevent the erosion of topsoil from the site.

5.1.7 Groundwater Monitoring Wells

To monitor groundwater quality at the site, four well pairs (four wells for the upper aquifer and four wells for the bedrock aquifer) will be installed and sampled along with six existing well pairs. Samples will be analyzed for the TCL compounds in accordance with the NYSDEC Analytical Services Protocol (ASP). QA/QC samples will be collected as per the ASP requirements. The depths for the wells will be determined during installation.

5.1.8 Groundwater Collection and Treatment

Groundwater collection will be accomplished by construction of a perimeter trench, filled with crushed stone and containing a perforated collection pipe, around the hot spot area. At 300 foot intervals, a submersible pump will be provided to transfer the collected groundwater to a force main and thence to the treatment system. Those pumps will operate to maintain the groundwater within the contaminant area at a level at least two feet below that of the surroundings, thus avoiding possible outward flow to the environment.

An onsite facility will be constructed to provide appropriate pre-treatment for the collected groundwater prior to transfer to a local POTW.

5.2 Preliminary Cost Estimate

The total capital cost (escalated to the midpoint of construction, 1995) required for the implementation of this remedy is $13,110,000. The total annual O&M cost is $326,000. The 1991 present worth of the total cost (capital plus O&M) using a 30-year performance period and 10 percent annual interest rate is $16,189,000. A breakdown of the capital and annual O&M costs are provided in Table 4-22 under Alternative 3B.

The capital and annual O&M costs were developed in Section 4, therefore, reference should be made to that section for additional details. Those estimates were prepared by making numerous assumptions which could be subject to change pending future investigations or developments. The most significant component of the total capital cost is the solidification of the sediments. Solidification media requirements depend on the type of contaminants and the waste being treated. Since these chemical additives are usually proprietary, the costs will vary from vendor to vendor. Bench or pilot scale tests, which are presently being performed, will establish solidification media requirements, so that total costs can be developed with a higher degree of accuracy.

5.3 Implementation Schedule

Implementation of the proposed alternative will involve a phased approach and is expected to require two complete construction seasons. The order of remedial activities at the site, with some overlap, may be as follows:

- Prepare site for remediation
- Clear site of all miscellaneous debris such as drums, tanks, etc.
- Install sheetpiling around contaminated area, grout interlocks, and construct berm (if necessary)
- Move surface piles to non-hot spot area for processing
- Construct groundwater collection system
- Construct forcemain to transport groundwater
- Construct permanent onsite treatment plant
- Drain lake for sediment dredging
- Dredge sediments from the lake

- Rebuild berm around lake perimeter
- Construct lake overflow weir
- Solidify all sediments and spoils, place over the process/fill area and regrade site
- Place general fill; compact, smooth, and roll
- Place clay subgrade
- Place HDPE fabric
- Place sand drainage layer
- Place topsoil
- Seed, mulch, and fertilize
- Install new monitoring wells
- Install pavement
- Create site access restrictions