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FEASIBILITY STUDY

PHASES I, II and III
PLANT NO. 1
VAN DER HORST CORPORATION SITE
SITE NO. 9-05-008
OLEAN, CATTARAUGUS COUNTY

VOLUME I OF II

JANUARY 1992

SUBMITTED TO:

DIVISION OF HAZARDOUS WASTE REMEDIATION
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233

SUBMITTED BY:

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ERM-Northeast

ERM-Northeast

FEASIBILITY STUDY
VAN DER HORST CORPORATION PLANT NO. 1 SITE

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EXECUTIVE SUMMARY

ERM-Northeast (ERM) completed a Phase I (Development of Alternatives), Phase II (Preliminary Screening of Alternatives) and Phase III (Detailed Analysis of Alternatives) Feasibility Study (FS) for the New York State Department of Environmental Conservation (NYSDEC) at the Van Der Horst Corporation Plant No. 1 chrome plating facility in Olean, New York. The Feasibility Study was conducted in general accordance with: 1) " United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA", October 1988; and 2) the May 15, 1990 NYSDEC TAGM entitled, "Selection of Remedial Actions at Inactive Hazardous Waste Sites".

The initial phase involved the identification of broadly defined general response actions, where a response is deemed necessary to protect public health or the environment based on the Remedial Investigation (RI) risk assessment. Technologies for each general response action were identified and preliminarily screened solely on the basis of their effectiveness and technical feasibility. The technologies that were retained through this initial screening process were then used to develop media-specific remedial alternatives for the Plant No. 1 site.

The second phase screening involved evaluating these media-specific remedial alternatives primarily on the basis of effectiveness and implementability. Those alternatives passing this second phase of screening were assembled into ten (10) comprehensive remedial alternatives for the contaminated media at the site. A laboratory Treatability Study was then conducted to better identify those alternatives that would be effective in treating the actual soil and ground water at the site. Based on the results of the Treatability Study, three of the ten comprehensive alternatives were found to be ineffective in addressing the site-specific soil conditions (i.e., those alternatives involving soil washing). The remaining seven (7) comprehensive alternatives then underwent a detailed evaluation during the Phase III FS.

During the Phase III FS, the potential remedial alternatives were subjected to a detailed quantitative evaluation which considered: 1) Overall protection of human health and the environment; 2) Compliance with New York State Standards, Criteria and Guidance (SCGs); 3) Long-term effectiveness and performance; 4) Reduction of toxicity, mobility, and volume; 5) Short-term effectiveness; 6) Implementability; and 7) Cost. Alternatives were then compared to select the most environmentally sound and cost-effective remedial action for the Van Der Horst Plant No. 1 site. State and Community acceptance of the results of the Phase

III FS, and the potential for combining some aspects of the remedial technologies at the two separated plants (i.e., Nos. 1 and 2), will be evaluated prior to the NYSDEC's Record of Decision (ROD).

The remedial costs associated with each alternative were estimated based on vendor information, conventional cost estimating guides, generic unit costs and prior experience. The total 1991 present worth costs for each alternative were estimated using a 5 percent discount rate per year for the time period associated with implementation of the specific alternative, not to exceed 30 years.

The Phase III FS included an evaluation and comparison of the seven comprehensive alternatives using both the NYSDEC-TAGM scoring tables and a Cost-Effectiveness analysis. Both the results of the NYSDEC-TAGM scoring tables and the Cost-Effectiveness analysis were similar and resulted in the selection of the recommended alternative described below.

Recommended Alternative

The primary components of the recommended alternative are: 1) building decontamination followed by demolition/dismantling; 2) sediment dredging and storm sewer cleaning; 3) excavation of chromium contaminated soil on and near the site; 4) solidification/

stabilization and backfilling of treated soil/sediment; 5) site restoration and monitoring; and 6) ground water extraction, carbon adsorption pre-treatment, followed by discharge to the POTW.

Once the soil with chromium concentrations greater than 50 ppm is excavated, and the sediment dredged/removed, it will then be solidified/stabilized on-site. The treatability study indicated that a mixture of lime and ferrous sulfate provides the most favorable results with respect to reducing the leaching potential of the soil. The properties of this treated mixture include a 25% volume increase over the original soil/sediment, and the leachability of the material is reduced to a level below the TCLP limit for chromium. Since the TCLP limits for inorganics are based on drinking water standards, it appears that the treated highly chromium contaminated soil as well as the less contaminated soil would not be a source to ground water and could be back-filled on-site. The increase in the site's elevation will be a function of the volume increase resulting from the treatment process (i.e., approximately 25%) and a 1 foot thick topsoil layer to support vegetation.

There are three contingencies associated with this remedial alternative. The first contingency is the addition of an on-site conventional precipitation treatment plant to treat the contaminated ground water. This plant would need to be constructed at Van Der Horst Plant No. 2, due to space limitations at Plant No.1. The treated water would be discharged to Olean Creek or Two-mile Creek. Note that this option was not selected due to the higher cost of operating such a facility (i.e., $3,500,000 per year) when compared to discharge to the POTW ($2,200,000 per year). This contingency would be implemented if POTW discharge was considered unacceptable by the agencies involved. However, recent discussions with the POTW have indicated that the POTW is interested in receiving the ground water from Plant No. 1 provided appropriate upgrades to its system are made to handle the increased volume.

The second contingency involves off-site landfilling of the soil most highly contaminated with chromium. This contingency would be implemented if post-remediation pilot testing indicates that the treated soil is still a source to ground water. Based solely on the limited results (i.e., small scale) of the treatability study, the treated soil with the high levels of chromium would not be considered a source to ground water.

The third contingency involves backfilling the treated soil from Plant No. 1 at Van Der Horst Plant No. 2. This contingency would be implemented based on the compatibility of this option with the selected alternative for Plant No. 2 and the potential aesthetic problems with the topography at Plant No. 1 due to backfilling.

The fourth contingency involves treatment of the highly contaminated soil below the water table. The results of the Pre-Remediation Investigation (see Section 6.0) should provide sufficient data for evaluating specific technologies that are applicable for this area. Some possibilities include in-situ stabilization and dewatering followed by excavation.

1.0 INTRODUCTION

1.1 Feasibility Study Overview

This report summarizes the findings of ERM-Northeast's (ERM) Phase I (Development of Alternatives), Phase II (Preliminary Screening of Alternatives) and Phase III (Detailed Analysis of Alternatives) Feasibility Study (FS) for the New York State Department of Environmental Conservation (NYSDEC) at the Van Der Horst Plant No. 1 chrome plating facility in Olean, New York. During the Phase I and II FS we were assisted by our subcontractor, YEC, Inc. of Valley Cottage, New York, who prepared a report for our use entitled "Identification of Potential Remedial Action Alternatives for Van Der Horst Plant No. 1 Site RI/FS". ERM provided oversight during the preparation of the YEC report and utilized it in preparation of this ERM report for NYSDEC.

The following two guidance documents were used as the basis for the FS: 1) " United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA", October 1988; and 2) the May 15, 1990 NYSDEC TAGM entitled, "Selection of Remedial Actions at Inactive Hazardous Waste Sites". These two documents were in general agreement; however, the NYSDEC TAGM stated that cost should <u>not</u> be considered as an evaluation criteria in the Screening of

Technologies (Phase I FS) or the Preliminary Screening of Alternatives (Phase II FS). In preparation of this FS report, ERM followed the NYSDEC TAGM relative to this issue.

This report identifies general response actions, evaluates remedial technologies, and formulates and evaluates potential remedial action alternatives. Finally, this report presents a conceptual design of the recommended remedial alternative (Task VII of the RI/FS).

The initial phase involved the identification of broadly defined general response actions, where a response is deemed necessary to protect public health or the environment based on the Remedial Investigation (RI) risk assessment. Technologies for each general response action were identified and preliminarily screened on the basis of their effectiveness and technical feasibility. The technologies that were retained through this initial screening process were used to develop media-specific remedial alternatives for the site.

The second phase screening involved evaluating these media-specific remedial alternatives primarily on the basis of effectiveness and implementability. Those alternatives passing the second phase of screening were assembled into comprehensive remedial alternatives addressing contaminated media at the site. It is these comprehensive alternatives that underwent a detailed evaluation during the Phase III FS.

During the Phase III FS, the potential remedial alternatives were subjected to a detailed quantitative evaluation which considered: 1) Overall protection of human health and the environment; 2) Compliance with New York State Standards, Criteria and Guidance (SCGs); 3) Long-term effectiveness and performance; 4) Reduction of toxicity, mobility, and volume; 5) Short-term effectiveness; 6) Implementability; and 7) Cost. Alternatives were then compared to select the most environmentally sound and cost-effective remedial action for the Van Der Horst Plant No. 1 site. State and Community acceptance of the results of the Phase III FS will be evaluated prior to the NYSDEC's Record of Decision (ROD).

1.2 Purpose of Feasibility Study

The purpose of this feasibility study is to evaluate and identify remedial action alternatives which cost-effectively limit the risks to human health and the environment resulting from contamination at the Van Der Horst Plant No.1 Site. Additionally, the Phase I and II FS were used to identify data needs early on in the RI/FS process so that appropriate information would be collected during the Phase II and III RIs.

1.3 Report Organization

The information contained in this FS report is in general accordance with the NYSDEC and USEPA requirements and the format is in general accordance with USEPA Guidance for Conducting RI/FS Under CERCLA (Table 6-5 EPA/540/G-89/004, October, 1988). The organization of this report is as follows:

Section 1 - Introduction

Section 2 - Identification and Screening of Technologies

Section 3 - Development and Screening of Alternatives

Section 4 - Treatability Studies

Section 5 - Detailed Analysis of Alternatives

Section 6 - Conceptual Design of Recommended Alternative

Section 7 - Limitations and Use of Report

Section 8 - References

Appendix A - Screening Evaluation Forms

Appendix B - Treatability Study Data

Appendix C - Detailed Analysis Evaluation Summaries

Appendix D - Basis and Cost Estimation Summaries

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

This section discusses the identification and screening of the remedial technologies and process options applicable to the Van Der Horst Plan No. 1 Site. Initially, this section summarizes the findings of the RI as it applies to the FS program. This summary is followed by a discussion of the remedial action objectives and general response actions for each of the various media (i.e., soil, sediment, ground water, surface water and structures/vats). Finally, feasible technologies/process options are identified and screened to provide a basis for the subsequent development of the remedial alternatives (Section 3.0).

2.2 Summary of Contaminated Media

A complete discussion of the RI including sampling locations and procedures, contaminant levels, physical conditions of the study area, indicator chemicals, potential sources of contamination and extent of contamination is found in the RI report. The purpose of this section is to summarize the contaminated media in the study area that appear (based upon the findings of the baseline risk assessment and the RI) to: 1) be the result of past site disposal activities; and 2) require a remedial response for protection of human health or the environment. These contaminated media are summarized below:

- Surface soil in the vicinity of the site containing elevated chromium, lead and arsenic concentrations. This condition appears to represent an unacceptable carcinogenic risk to human health via fugitive dust and is also a potential source of contamination to ground water. The surface soil cleanup level developed during the RI is 50 ppm for total chromium. The surface area delineated by the chromium cleanup level generally includes the soil with elevated concentrations for the other analytes of concern.

- Subsurface soil below and in the immediate vicinity of the plant with elevated chromium concentrations (i.e., greater than 50 ppm total chromium). Portions of this area appear to be a source of ground water contamination and should be addressed prior to any ground water remediation efforts. The subsurface soil cleanup level developed during the RI is 50 ppm for total chromium. The subsurface area delineated by the chromium cleanup level generally includes the soil with elevated concentrations for the other analytes of concern.

- Ground water in the study area contaminated with chromium, lead, cadmium, copper, arsenic and tetrachloroethene (PCE). Although no active public supply wells have been identified in the vicinity of the site, this condition should be remediated to limit potential risks caused by contaminant migration or future supply well installations. The ground water cleanup level developed during the RI is 50 ppb for total chromium. The ground water area delineated by the chromium cleanup level generally includes the ground water with elevated concentrations for the other analytes of concern.

- Sediment within the storm sewer system between the site and outfalls at Olean Creek. Residual chromium contamination in this storm sewer appears to be a source of the chromium measured in the surface waters and sediment of Olean Creek. The surface water chromium levels, which are a result of the contaminated sediment, exceed proposed New York State criteria and may be impacting benthic and aquatic life. The sediment cleanup level is 26 ppm for chromium which is the NYSDEC regulatory limit for chromium in sediment.

- Olean Creek sediment in the vicinity of the Brookview storm sewer outfall. This sediment has elevated chromium levels, and also appears to be contributing to surface water contamination in Olean Creek during storm events. The sediment cleanup level is 26 ppm for chromium which is the NYSDEC regulatory limit for chromium in sediment.

- Asbestos and surface contamination within the plant. The asbestos and surface contamination on the structures and vats within the plant need to be removed prior to demolition.

2.3 Remedial Action Objectives

General remedial goals were guided by 40 CFR 300.68 (Code of Federal Regulations 1987), which specifies that the objective of every remedial action is to "mitigate and minimize damage to and provide adequate protection of public health, welfare or the environment". The following site-specific remedial goals were developed for the Van Der Horst Corporation Plant No. 1 site, based on the RI:

Soil

- Limit migration of on-site fugitive dust containing chromium that would result in an excess cancer risk of greater than 10^{-4} to 10^{-7}.
- Limit releases of chromium, lead, cadmium, copper, arsenic and PCE to ground water that would exceed NYSDEC drinking water criteria or result in a potential future excess cancer risk of greater than 10^{-4} to 10^{-7}.

Ground Water

- Limit potential future ingestion of ground water having chromium, lead, cadmium, copper, arsenic and PCE that would exceed NYSDEC drinking water criteria or result in an excess cancer risk of 10^{-4} to 10^{-7}.

Sediment

- Limit releases of hexavalent chromium from sediments that would result in surface water levels impacting benthic and aquatic life.

Surface Water

- Restore surface water hexavalent chromium levels to background levels.

Structures/Vats

- Limit direct contact or migration of contaminants on the surface of the plant building or within vats and pits inside the plant building.
- Demolish and remove the plant buildings to: 1) provide access to contaminated soil below the plant; 2) remove residual contamination and asbestos associated with the plant building; and 3) enhance implementation of remedial measures.

2.4 General Response Actions

General response actions describe those actions that satisfy the remedial action objectives. Based on information gathered during the RI, general response actions, or classes of actions, are identified for each media of concern. The response actions are considered applicable if they generally address the site problems identified in the previous section.

Table 2-1 summarizes the general response actions for each media of concern which are presented in the form of conceptual

TABLE 2-1

SUMMARY OF GENERAL RESPONSE ACTIONS

Media	Contamination Concern	General Response Actions
Soil.	Surface, Subsurface, and Air Contamination.	No Action. Institutional Action. Containment. Partial Removal. Complete Removal. On-Site or Off-Site Disposal. On-Site or Off-Site Treatment. In-Situ Treatment.
Ground Water.	Horizontal Movement of Contaminated Ground Water Off-Site.	No Action. Institutional Action. Containment. Ground Water Recovery. On-Site or Off Site Treatment. On-Site or Off-Site Disposal. In-Situ Treatment.
Sediment.	Surface and Subsurface Contamination.	No Action. Institutional Action. Containment. Partial Removal. Complete Removal. On-Site or Off-Site Disposal. On-Site or Off-Site Treatment. In-Situ Treatment.
Structures/Vats.	Surface, Subsurface, and Air Contamination.	No Action. Institutional Action. Containment. Partial or Complete Removal. Off-Site Disposal. On-Site Treatment.

alternatives. General response actions considered include the "no action" alternative, which will serve as a baseline against which other remedial measures can be compared. The "no action" alternative is mandated to be included by the Superfund Amendments and Reauthorization Act (SARA). Additionally, potential remedial technologies are identified for each general response action.

2.4.1 General Response Actions for Soil

The general response actions for soil, presumably contaminated by the improper disposal of waste chromic acid, address the pathways of leaching and air transport. Institutional actions such as deed restrictions and fencing are possible responses to contamination in the soil. Containment would reduce leaching from percolation and limit the transport of contaminants by air. Excavation, treatment, and disposal of soil would immobilize or separate soil contaminants and would remove the source of contamination.

2.4.2 General Response Actions for Ground Water

General response actions appropriate for ground water contamination are: 1) monitoring; 2) containment; and 3) ground water recovery, treatment, and disposal. These actions would limit contaminated plume migration, remove the contaminants from the ground water, and provide data on ground water quality.

2.4.3 General Response Actions for Sediment

Remedial actions for contaminated sediments generally involve sediment removal and subsequent treatment and disposal. Sewer lines are cleaned of sediments by various methods of pipe cleaning, while the process of removing bottom sediments from a water body is commonly known as dredging. After the collected contaminated sediments are dewatered, they can then be treated either independently or with the contaminated soil. Thus, for purposes of remedial action, the contaminated soil on the site and the sediment can be considered as a single medium. The contaminated water generated during dewatering generally contains hazardous constituents which may be treated together with the ground water.

The general response actions for sediment include: 1) drainage control measures; and 2) sediment removal, disposal, and/or treatment. Drainage control measures would limit further contamination of creek sediments. Removal, disposal or treatment would remove or immobilize contaminated sediment.

2.4.4 General Response Actions for Surface Water

It appears that the hexavalent chromium in the surface water is the result of migration from the sediments. Thus, addressing the sediment problem appears to address the surface water conditions. Consequently, surface water general response actions are covered under the sediment general response actions.

2.4.5 General Response Actions for Structures/Vats

General response actions identified for structures/vats are containment, partial or complete removal, off-site disposal, and on-site treatment. These actions would limit direct contact with receptors, reduce leaching resulting from percolation, remove the source of contamination, and decontaminate structure surfaces for disposal.

2.5 Identification of Applicable Remedial Technologies

Table 2-2 lists the general response actions and potentially applicable remedial technologies for each medium of concern. The applicable remedial technologies, which are discussed below, include the wide range of technologies available within each of the general remedial response actions identified above. These

TABLE 2-2

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Applicable Remedial Technology	Process Options
Soil/Sediment		
No Action/ Institutional Actions.		
No Action.	No Action.	
Access Restrictions.	Fencing. Deed Restrictions.	
Containment.	Surface Capping.	Clay Cap. Synthetic Membrane. Multilayer. Asphalt. Concrete.
	Vertical Barriers.	Slurry Wall. Sheet Piling. Grout Curtain. Vibrating Beam.
	Horizontal Barriers.	Grouting. Bottom Sealing.
	Surface Controls.	Grading. Diversion/ Collection. Soil Stabili-zation.
	Sediment Control Barriers.	Coffer Dams. Silt Curtains. Channel Diversion.
Partial or Complete Removal.	Excavation and Removal Sediment Dredging.	Solids Excavation. Mechanical Dredging. Hydraulic Dredging. Pneumatic Dredging.

TABLE 2-2 (CONTINUED)

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Applicable Remedial Technology	Process Options
Partial or Complete Removal. (continued)	Storm Sewer Cleaning.	Mechanical Scouring. Hydraulic Scouring. Bucket Machines. Suction Devices.
On-Site or Off-Site Disposal.	On-Site Secure Landfill. Off-Site Secure Landfill.	Solids Excavation and Disposal. Solids Excavation and Disposal.
On-Site or Off-Site Treatment.	Pretreatment.	Dewatering Centrifuge. Gravity Thickener. Filtration. Solids Separation Screens and Sieves. Spiral Classifier. Cyclone and Hydroclone. Settling Basin.
	Thermal Treatment.	Liquid Injection. Rotary Kiln. Multiple Hearth. Fluidized Bed. Pyrolysis.
	Chemical Treatment.	Immobilization Soil Washing. Detoxification.
	Physical Treatment.	Solidification/ Stabilization. Encapsulation. Volatilization.

TABLE 2-2 (CONTINUED)

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Applicable Remedial Technology	Process Options
In-Situ Treatment.	In-Situ Treatment.	Bioreclamation. Heating. Soil Flushing. Vitrification.
Ground Water		
No Action/ Institutional Actions.	No Action. Access Restrictions. Alternate Water Supply.	Deed Restrictions. City Water Supply. New Community Well.
	Monitoring.	Ground Water. Monitoring.
Containment.	Surface Capping.	Clay & Soil Cap. RCRA Composite Cap. Concrete. Bituminous Concrete/Asphalt. Spray Asphalt.
	Vertical Barriers.	Slurry Wall. Sheet Piling. Grout Curtain. Vibrating Beam.
Containment	Horizontal Barriers	Grouting. Bottom Sealing.

TABLE 2-2 (CONTINUED)

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Applicable Remedial Technology	Process Options
Ground Water Recovery.	Pumping. Plume Removal.	Extraction Wells. Extraction/Injection Wells.
	Subsurface Drains.	Interceptor Trenches.
On-Site or Off-Site Treatment (for ground water, process water, seepage and decontamination water).	Biological.	Activated Sludge. Rotating. Biological Discs. Fixed Film Bioreactor. Aerobic/Anaerobic Fluidized Bed. Sequencing Batch Reactor. Aerated Lagoon.
	Physical/Chemical	Activated Carbon. Precipitation/Flocculation/Sedimentation. Ion Exchange. Resin Sorption. Filtration. Reverse Osmosis. Neutralization. Gravity Separation Air Stripping. Steam Stripping. Chemical Oxidation. Chemical Reduction.
	Physical/Chemical/Biological.	Powdered Activated Carbon Treatment (PACT).
	Thermal Destruction.	Liquid Injection. Rotary Kiln. Multiple Hearth. Fluidized Beds. Pyrolysis.

TABLE 2-2 (CONTINUED)

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

General Response Action	Applicable Remedial Technology	Process Options
On-Site or Off-Site Treatment (for ground water, process water, seepage and decontamination water). (continued)	Off-Site Treatment.	POTW. RCRA Facility.
Ground Water Disposal.	Off-Site Disposal.	POTW. Surface Water Discharge.
	On-Site Disposal.	Reinjection Deep Well Injection.
In-Situ Treatment.	Bioreclamation.	
<u>Structures/Vats</u>		
No Action/Institutional Action.		
No Action.	No Action.	
Access Restrictions.	Fencing. Deed Restrictions. Closure.	
Containment.	Encapsulation/ Enclosure.	Plaster. Epoxy Resins. Concrete Casts. Painting and Coating.
Partial or Complete Removal.	Demolition and Removal. Dismantling and Removal.	Demolition. Dismantling.

TABLE 2-2 (CONTINUED)

SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

On-Site Treatment.	Solids Processing/ Treatment.	Grit Blasting. Hydroblasting/ Water Washing. Scarification. Solvent Washing. Steam Cleaning. Vapor-Phase Solvent Extraction. Photochemical Degradation.
On-Site or Off-Site Disposal.	Incineration Landfill.	

technologies have been divided, for the purpose of this discussion, into three groups: 1) Soil/Sediment; 2) Ground Water; and 3) Structures/Vats.

2.5.1 Soil/Sediment Remedial Technologies

Contaminated soil/sediment remedial technologies are used to contain, remove, or treat the soil/sediment in the study area. The following soil/sediment remedial technologies are initially considered for the Van Der Horst Corporation Plant No. 2 site.

No Action

The no action alternative was considered for comparison purposes.

Institutional Actions

Institutional Actions involve Access Restrictions. This alternative would include deed restrictions and fencing off areas of contaminated soil/sediment.

Surface Capping

Capping techniques utilize materials such as synthetic membranes, asphalt, concrete, clay, and soil. In general, capping is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards and/or unrealistic costs. Clay and Soil, Concrete, Bituminous Concrete/Asphalt, Clay, and RCRA Composite Cap represent commonly used single and multi-layered cap designs.

Vertical and Horizontal Barriers

Subsurface barriers are installed below ground to contain, capture, or redirect ground water flow in the vicinity of a site. The most commonly used subsurface barriers are slurry walls, grouting, sheet piling, vibrating beams, grout curtains, and bottom sealing. These barriers can be used both to redirect the ground water flow upgradient of the site, and to contain ground water leaving the site on the downgradient side.

Surface Controls

Diversion/Collection, Grading, and Soil Erosion Control limit the infiltration and erosion by establishing continuous surface grades, diversion ditches, and collection ditches to limit the ponding of surface water.

Sediment Control Barriers

Sediment control barriers such as cofferdams and curtain barriers are used in some contaminated sediment areas. These technologies provide hydraulic isolation of sediments so that dewatering followed by dry excavation may be implemented, or so that hydraulic dredging may be conducted in a contained environment.

Dust Control

Dust control plays an important role in the soil remediation, although the technology is very simple and easy to implement. Typical dust control measures include Revegetation, Capping and Watering.

Excavation and Removal

Excavation and removal followed by land disposal, reclamation or treatment are implemented extensively in hazardous-waste site remediation. This technology includes excavating, lifting, loading, hauling, dumping, and grading soil and waste material. This technology involves the use of conventional heavy construction equipment.

Sediment Dredging

The process of removing bottom sediments from a water body is commonly known as dredging. Potential dredging methods include Mechanical Dredging, Hydraulic Dredging and Pneumatic Dredging. These technologies are typically used in conjunction with sediment control technology to limit sediment transport during dredging.

Storm Sewer Cleaning

Cleaning of sewers, or other pipelines, helps to remove sediment or debris which has built up in the line. When the cleaning is taking place, care should be taken to limit transport of deposits into downstream lines. Collected deposits should be removed, treated and disposed of. The most common methods of sewer cleaning are briefly described in the paragraphs below.

Mechanical scouring techniques include the use of power rodding machines ("snakes"), which pull or push scrapers, augers,and brushes through the pipelines. "Pigs", bullet shaped plastic balls lined with scouring strips, are hydraulically propelled at high velocity through sewer mains to scrape the interior pipe surface.

Hydraulic scouring is achieved by running high pressure hoses into sewer lines through manholes and flushing out sections of the sewer. This technique is often used after mechanical scouring devices have cleared the line of solid debris or loosened sediments that coat the inner surface of the pipe.

A bucket machine can be used to dredge grit or contaminated soil from a sewer line. Power winches are set up over adjacent manholes with cable connections to both ends of a collection bucket. The bucket is then pulled through the sewer until loaded with debris. The same technique can be used to pull "sewer balls" or "porcupine scrapers" through obstructed pipes.

Suction devices such as pumps or vacuum trucks may be used to clean sewer lines. Manholes and fire hydrants provide easy access for the set-up and operation of such equipment.

On-Site Disposal

On-site disposal of contaminated soils and sediments involves the construction of a new landfill which must comply with RCRA landfill facility standards under 40 CFR Part 264.

Off-Site Disposal

Off-site disposal of contaminated soil/waste involves the hauling of excavated soil/waste to a commercial sanitary or secure landfill for disposal.

Pretreatment

On-site or off-site treatment of contaminated soils may require pretreatment such as dewatering and solids separation. Dewatering processes include centrifugation, gravity thickening and filtration. The contaminated water generated during dewatering generally contains hazardous constituents, which would require additional treatment and could be treated together with ground water. Solid separation methods include

Screens and Sieves, Spiral classifiers, Cyclones and Hydroclone and Setting Basins.

Thermal Treatment

Thermal Treatment can be used to destroy organic contaminants in liquid, gaseous and solid waste streams. The most common incineration technologies include Liquid Injection, Rotary Kiln, Multiple Hearth, Fluidized Bed and Pyrolysis.

Chemical Treatment

Generally, organic and inorganic contaminants can be immobilized, mobilized for extraction, or detoxified by using chemical treatment.

Immobilization methods, which include precipitation, chelation, and polymerization, are designed to render contaminants to be bound and less mobile, limit leaching of the contaminants from the soil matrix, and limit contaminant movement from the areas of contamination.

Soil Washing extracts contaminants from soil matrices using an extracting solution. The washing fluid may be composed of water, organic solvents, chelating agents, surfactants, acids or bases, depending on the contaminant to be removed. The waste types that can be removed include heavy metals (e.g., lead, zinc), halogenated solvents (e.g., TCE, trichloroethane), aromatics (e.g., benzene, toluene, phenol), gasoline, fuel oils and PCBs.

Chemical detoxification techniques include neutralization, hydrolysis, oxidation/reduction, enzymatic degradation, and installation of permeable treatment beds. Operation involves the injection of chemicals into the ground to destroy, degrade, or reduce the toxicity of contaminants. A collection system should be incorporated to limit migration of the reagents and contaminants which are not successfully treated.

Physical Treatment

A number of methods are currently being developed which involve physical manipulation of the soil in order to immobilize or detoxify waste constituents. These technologies include solidification/stabilization, encapsulation, and volatilization.

Solidification/Stabilization involves mixing the wastes directly with a solidifying agent (e.g. portland cement). Solidification produces a monolithic block with high structural integrity. The contaminants do not necessarily interact chemically with the solidification agent, but are mechanically located within the solidified matrix. Stabilization methods usually involve the addition of chemicals in order to limit the solubility or mobility of waste constituents. This technology is well suited for solidifying soils containing heavy metals, organics (generally no more than 20% by volume), and solidified plastic. However, some constituents may interfere with the use of cement-based methods, such as fine particles, silt, clay, and lignite. The advantages of cement-based methods include their low cost and the use of readily available mixing equipment.

Encapsulation methods physically microencapsulate wastes by sealing them in an organic binder or resin. These methods can be used for both organic and inorganic waste constituents. The major advantage of encapsulation is that the waste material is essentially isolated from leaching solutions. The major disadvantage is that the processes are energy intensive and relatively costly.

Volatilization can be accomplished through thermal treatment or mechanical aeration. The direct heat rotary dryer is a proven thermal treatment unit and has been used for many years by the asphalt industry. This unit is best suited for use with free flowing granular solids.

In-Situ Treatment

In-Situ Treatment, a substitutive alternative to waste excavation and removal, entails the use of chemical or biological agents or physical manipulations which degrade, remove, or immobilize contaminants. In-situ treatment processes include bioreclamation, in-situ heating, soil flushing, and vitrification.

Bioreclamation is a technique for treating zones of contamination by microbial degradation. The technology involves enhancing the natural biodegradation process by injecting nutrients, oxygen, and cultured bacterial strains. Bioreclamation can provide substantial reduction in organic contaminant levels in soils, without the cost of soil excavation. The technique is well suited for soil contaminated by petroleum by-products. A number of site-specific factors, such as site geology, soil characteristics, and aquifer characteristics, are critical in evaluating the implemetability of this technology.

In-Situ Heating is a method to destroy or remove organic contaminants in the subsurface through thermal decomposition, vaporization, and distillation. Methods of in-situ heating are steam injection and radio frequency heating.

In-Situ Soil Flushing is a process applied to unexcavated soils using a ground water extraction/reinjection system. In-situ soil flushing consists of injecting a solvent or surfactant solution to enhance the contaminant solubility, resulting in an increased recovery of contaminants in the leachate or ground water. The system includes extraction wells, reinjection wells and a wastewater treatment system.

In-Situ Vitrification involves electric melting of contaminated soil, converting it into durable glass. The advantages of vitrification processes are: (1) the limited amount of oxidation products and air emissions; and (2) the reduced leachability of inorganic materials, such as heavy metals.

2.5.2 Ground Water Remedial Technologies

Ground water remedial technologies can be applied to contain, collect, divert, or remove the ground water in the study area, in an effort to prevent further migration of contaminants from the site and manage the migration that has already occurred.

No Action

A no action response is typically retained as a baseline against which to judge alternatives. The no action alternative is used to assess other alternatives' effectiveness in reducing impacts, meeting objectives, and cost.

Institutional Actions

Institutional actions include Deed Restrictions, City Water Supply, Extension of New Community Well and Ground Water Monitoring.

Surface Capping

Surface capping has been previously discussed under Soil/ Sediment Remedial Technologies, Section 2.5.1.

Vertical/Horizontal Barriers

Vertical and horizontal barriers are discussed under Soil/Sediment Remedial Technologies, Section 2.5.1.

Ground Water Recovery

Extraction Wells or Extraction/Injection Wells, ground water pumping techniques, involve the active manipulation and management of ground water in order to: (1) contain or remove a plume; or (2) adjust ground water levels to limit the formation of a plume. Pumping methods are most effective at sites where underlying aquifers have high intergranular hydraulic conductivities and contaminants move readily in water. When used in conjunction with a barrier wall and a cap, hydrologic isolation of a site can essentially be achieved. Plume removal implies a complete purging of the ground water system. Removal techniques are often suitable when contaminant sources have been removed and aquifer restoration is desired.

Interceptor trenches include any type of buried conduit used to convey and collect aqueous discharges by gravity flow. They function like a line of extraction wells and can be used to contain or remove a plume, or to lower the ground water table to limit contact of water with waste material. One of the biggest drawbacks to the use of interceptor trenches is that they are generally limited to shallow depths.

Biological Ground Water Treatment

The function of biological treatment is to remove organic matter/chemicals from the waste stream through microbial degradation. Biological treatment processes which may be applicable to the treatment of aqueous wastes from hazardous waste sites include Activated Sludge, Rotating Biological Discs, Fixed Film Bioreactor, Aerobic/Anaerobic Fluidized Bed, Batch Reactor and Aerated Lagoon.

Physical/Chemical Treatment

Physical and chemical treatment processes are utilized to treat both inorganic and organic hazardous wastes which are either nonbiodegradable or resistant to biodegradation.

Several physical/chemical treatment processes are summarized in the following paragraphs.

Activated carbon is well suited for removal of mixed organics from aqueous wastes. The process has been successfully demonstrated on volatile organics, organic nitrogen compounds, and chelated heavy metals.

Precipitation/Flocculation/Sedimentation is applicable for the removal of soluble metallic ions and certain anions. The performance of the process is affected by chemical interactions, temperature, pH, solubility variances and mixing effects. Organic compounds may interfere with precipitation by forming organo-metallic complexes.

Ion exchange is a well established technology for removal of heavy metals and hazardous anions from dilute solutions. This process involves the substitution of innocuous cations and anions, such as hydrogen and hydroxide, for more toxic cations and anions, such as cadmium and cyanides.

Resin Sorption involves the use of sorptive resins for removal of organics. In this process, the contaminant is transferred from a dissolved state in an aqueous solution to the surface of a resin.

Filtration is frequently installed ahead of biological or activated carbon treatment units to reduce the suspended solids load, the potential for biological growth, and clogging. Filtration could also be used as part of a polishing unit to remove residual floc from the effluent of a precipitation, flocculation, and sedimentation process.

Reverse Osmosis involves using high pressure to force water through a synthetic membrane,leaving the contaminants behind the membrane. To avoid membrane plugging, it is important to remove suspended solids and oils with pretreatment. The application of membrane processes must be carefully evaluated on a pilot-scale basis, because of the potential for the chemical to react with the membrane.

Neutralization consists of adding acid or base to a waste in order to adjust the pH. The selection of neutralizing agents should take into account the type, buffer capacity, and concentration of the waste.

Gravity Separation is used to treat two-phased aqueous wastes, solid/liquid or liquid/liquid. Oil separation, centrifugation, and dissolved air flotation have been used for this purpose. Immiscible oily liquids, suspended solids, and hydrophobic chemicals can be treated with this technology.

However, dissolved contaminants will not be removed by this process.

Air Stripping is typically applied to ground water or wastewater contaminated with low levels of volatile organics. It is often followed by another process such as biological treatment or carbon adsorption .

Steam Stripping is effective in the removal of high concentrations of organics dissolved in water. Those organic compound such as volatile organics, phenols, ketones, and phthalates ranging from 1 to 20 percent can be removed by using steam stripping.

Chemical Oxidation can be used for detoxification of arsenic cyanide and for treatment of dilute waste streams containing oxidizable organics. Aldehyde, benzene, mercaptans, phenols, benzidine, unsaturated acids, and certain pesticides have been treated by this method. Common commercially available oxidants include potassium permanganate, hydrogen peroxide, calcium or sodium hypochlorite, ozone, and chlorine gas.

Chemical Reduction is well demonstrated for the treatment of lead, mercury, chromium (VI), PCBs, and unsaturated hydrocarbons. Narrow pH ranges need to be maintained to achieve optimum reaction rates. Common commercially available reducing agents include ferrous ions, sulfur dioxide, and sodium bisulfite. The reduced heavy metals would be treated in the precipitation/ flocculation /sedimentation treatment stage.

Sulfide Precipitation involves the use of hydrogen sulfide or soluble sulfide salts to precipitate heavy metals. Since most metal sulfides are even less soluble than metal hydroxides at alkaline pH levels, heavy metal removal can be more readily accomplished through the use of sulfide rather than hydroxide as a chemical precipitant prior to sedimentation.

Physical/Chemical/Biological Treatment (PACT)

Powdered Activated Carbon Treatment (PACT) process is one of the most popular physical/chemical/biological treatment methods. PACT has been shown to upgrade effluent quality in conventional activated sludge plants. Pilot studies are necessary to evaluate process feasibility on specific wastes. Settled sludge from PACT may contain elevated levels of organics or heavy metals.

Thermal Destruction

Thermal destruction has been previously discussed under Soil Remedial Technologies in section 2.5.1 Thermal Treatment.

Off-Site Treatment

Off-site treatment involves transferring the liquid wastes at the site to either a Publicly Owned Treatment Works (POTW) or a RCRA-facility for treatment and/or disposal.

Publicly Owned Treatment Works (POTW) technology involves the discharge of water to the nearby City of Olean Wastewater Treatment Plant for final treatment and disposal with or without pretreatment.

Surface Water Discharge involves the discharge of treated ground water to a nearby surface water body (Two Mile Creek).

On-Site Disposal

Deep Well Injection is a method frequently used for disposal of highly contaminated or very toxic wastes not easily treated or disposed of by other methods. Deep well injection is limited to on-site geological conditions. There must be a substantial and extensive impervious caprock strata, overlying a porous strata which is not used as a water supply or for other withdrawal purposes.

Reinjection to Ground Water involves the injection of treated ground water into the aquifer from which it was withdrawn. This approach can be used to help direct the flow of contaminated ground water toward the extraction wells or recovery trenches.

In-Situ Treatment

In-situ treatment entails the use of chemical or biological agents or physical manipulations which degrade, remove, or immobilize contaminants. The most promising technology is bioreclamation.

Bioreclamation is a technique for treating zones of contamination by microbial degradation. The basic concept involves altering environmental conditions to enhance microbial catabolism of organic contaminants, resulting in the breakdown and detoxification of those contaminants. The bioreclamation method that has received the most attention, and is the most feasible for in-situ treatment, is aerobic bioreclamation which has been previously discussed.

Other methods for ground water in-situ treatment include Chemical Treatment, Physical Treatment, and Permeable Treatment Bed.

2.5.3 Structures/Vats Remedial Technologies

Abandoned building control technologies are used to enclose, remove, dispose, or treat the building on the site. These technologies are summarized below.

No Action

A no action response is typically retained as a baseline against which to evaluate other alternatives.

Institutional Actions

Institutional actions include access restrictions such as Closure, Fencing and Deed Restrictions.

Containment

Contaminants or contaminated structures are physically separated from building occupants and the ambient environment by a barrier. An encapsulating or enclosing physical barrier may take different forms; among these are plaster, epoxy resins, and concrete casts and walls. Acting as a shield, a barrier keeps contaminants inside and away from clean areas, thereby alleviating the hazard. Painting and coating techniques may also be classified under encapsulation.

Partial or Complete Removal

Demolition is the total destruction of a building, structure, or piece of equipment. Specific demolition techniques include burndown, controlled blasting, wrecking with balls or backhoe-mounted rams, rock splitting, sawing, drilling, and crushing. The potentially contaminated debris from demolition may require handling as a hazardous waste.

Dismantling refers to the physical removal of selected structures (such as contaminated pipes, tanks, vats and other process equipment) from buildings or other areas. Dismantling can be the sole activity of decontamination efforts (e.g., removal of contaminated structures from an otherwise clean building), or it can be used in the initial stage of a more complex building decontamination effort (e.g., removal of structures prior to flaming, demolition, or other cleanup techniques).

On-Site Treatment

There are several technologies that are applicable for the treatment of contaminated buildings. These include gritblasting, hydroblasting/water washing, scarification, solvent washing, steam cleaning, vapor-phase solvent extraction, and photochemical degradation.

Gritblasting is a surface removal technique in which an abrasive material is used for uniform removal of contaminated surface layers from a building or structure. The mixture of contaminated surface debris and spent abrasive material can be thermally decontaminated (e.g., by kiln incineration) before disposal.

Hydroblasting/Water Washing involves a high pressure (3,500 to 350,000 kPa) water jet used to remove contaminated debris from surfaces. The debris and water are then collected and thermally, physically, or chemically decontaminated. At present, hydroblasting is applicable to explosives, heavy metals, and radioactive contaminants. This method can be used on contaminated concrete, brick, metal, and other materials. It is not applicable to wooden or fiberboard materials.

Scarification is capable of removing up to 2.5 cm of surface layer from concrete or similar materials. The scarifier tool (Scrabbler) consists of pneumatically operated piston heads that strike the surface, causing concrete to chip off. Scarification is potentially applicable to most contaminants except highly toxic residues (e.g., asbestos, dioxins) or highly sensitive explosives. This method is applicable to concrete (not concrete block) and cement.

Solvent Washing involves an organic solvent circulated across the surface of a building to solubilize contaminants. Spent solvent is either thermally or chemically treated to remove contaminants, and recycled if no degradation of the solvent occurs during treatment. The hot solvent soaking process has been shown to be effective in decontamination of PCB-contaminated transformers. It has not yet achieved widespread use, although it is beginning to be used in the decommissioning of nuclear facilities.

Steam Cleaning physically extracts contaminants from building materials and equipment surfaces. The steam is applied by hand-held wands or automated systems, and the condensate is collected for treatment.

Vapor-Phase Solvent Extraction involves an organic solvent with a relatively low boiling point (such as acetone) heated to vaporization and allowed to circulate in a building. The vapors permeate into porous building materials, where they condense, solubilize contaminants, and diffuse outward. The contaminant-laden liquid solvent is collected in a sump and treated to allow recycling of the solvent.

Photochemical Degradation uses intense ultraviolet (UV) light which is applied to a contaminated surface for some period of time. This process is not effective on contaminants imbedded in dense particulate matter (such as deep soil or thick carpet) because UV light cannot penetrate through these surfaces.

On-Site or Off-Site Disposal

Potential on-site or off-site disposal of demolished/ dismantled building materials includes landfilling and incineration. In certain cases, it may be cost-effective to decontaminate the building materials prior to final disposal. These disposal technologies, Off-Site RCRA Landfilling and

Incineration, were previously discussed under Soil Remedial Technologies, Section 2.5.1.

2.6 Screening of Technologies

An initial screening of potentially applicable remedial technologies for the Van Der Horst Corporation Plant No. 1 site was completed based on technical implementability (i.e., cost criteria were not considered in this evaluation). The results of this screening are presented on Table 2-3. Technical implementability, as per USEPA/540/G-89/004, involves an evaluation of each technology based on the following:

- o Site conditions and characteristics;
- o Physical and chemical characteristics of contaminants to evaluate the effectiveness of various technologies; and
- o Performance, reliability, and operating problems.

This initial screening process eliminated those remedial technologies which are unproven, or not expected to achieve an acceptable level of performance. Remedial technologies which could

TABLE 2-3
PROCESS OPTIONS PRELIMINARY SCREENING

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
SOIL SEDIMENT				
No action	None	Not Applicable	No action	Required for consideration by NCP
Institution Actions	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence would include deed restrictions	Potentially applicable
		Fencing	Fence off areas of contaminated soil	Potentially applicable
		Spray Asphalt	Spray application of asphalt over contaminated area	Not durable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Containment	Capping	Clay & Soil	Compacted clay covered with soil over areas of contamination	Potentially applicable
		Concrete	Installation of a concrete slab over contaminated area	Potentially applicable
		Bituminous Concrete/ Asphalt	Installation of asphalt pavement over contaminated area	Potentially applicable
		Composite Liner	Clay & geomembrane covered with soil over contaminated area	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comment
Containment (continued)	Vertical Barriers	Slurry Wall	Trench around contaminated area is filled with soil or cement/bentonite slurry	Not feasible as there is no shallow geologic confining layers at the site
		Sheet Piling	Ground water barrier made of wood, precast concrete or steel	Not feasible for on-site geologic conditions
		Grout Curtain	Pressure injection of group in a regular pattern of drilled holes	Not feasible for on-site geologic conditions
		Vibrating Beam	Vibrating force to advance beams with injection of grout as beams are removed	Not feasible for on-site geologic conditions

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Containment (continued)	Horizontal Barriers	Grouting	Injection of grout into a rock or soil mass	Difficult to implement
		Bottom Sealing	Horizontal barrier beneath the site	Difficult to implement
	Surface Controls	Diversion/ Collection	Surface water diversion and collection to limit infiltration	Potentially applicable
		Grading	Changing topography of site to reduce migration of contaminants	Potentially applicable
		Soil Stabilization	Revegetation or compaction to reduce erosion	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Containment (continued)	Sediment Control Barriers	Cofferdams	Small barriers to limit movement of suspended solids during treatment	Potentially applicable
		Curtain Barriers	Silt curtains used to limit migration of suspended solids	Potentially applicable
	Dust Controls	Revegetation	Reseeding of contaminated surface soils susceptible to erosion	Potentially applicable
		Capping	See under "Capping" above	
		Watering	Loose contaminated soils are watered during other remedial actions	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Partial or Complete Removal	Excavation	Solids Removal	Excavate contaminated soils with a mechanical device	Potentially applicable
	Sediment Removal/ Dredging	Mechanical Dredging	Excavate contaminated sediment with a mechanical device	Potentially applicable
		Hydraulic Dredging	Excavate contaminated sediment in the form of a slurry	Potentially applicable
		Pneumatic Dredging	Excavate contaminated sediment using a pump and compressed air	Potentially applicable
	Storm Sewer Cleaning	Mechanical Scouring	Clean storm sewers by use of power rodding machines and scrapers	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Partial or Complete Removal (continued)	Storm Sewer Cleaning	Hydraulic Scouring	Clean Storm Sewers by use of high pressure water	Not feasible. Generates excess amount of waste water
		Bucket Machine	Clean Storm Sewers with power winches attached to a collection bucket	Potentially applicable
		Suction Devices	Clean Storm Sewers with vacuum trucks or pumps	Not feasible. Lines too small for human entrance
Treatment	In-Situ Treatment	Bioreclamation	Treating zones of contamination by microbial degradation	Not feasible for heavy metals. Dif-ficult to implement
		Heating	Destroy or removes contaminants through thermal decomposition, vaporization and distillation	Not applicable for heavy metals. Dif-ficult to implement

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (continued)	In-Situ Treatment (continued)	Soil Flushing	Injecting a solvent to enhance the solubility of contaminants	Potentially applicable
		Vitrification	Electric melting of soil	Potentially applicable
	Pretreatment - Dewatering	Centrifuge	Rotating auger that separates coarse material from centrate	Potentially applicable
		Gravity Thickener	Circular tank used to concentrate slurries	Potentially applicable
		Filtration	Solids are separated from aqueous by mechanical filtering process	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (continued)	Pretreatment - Solid Separation	Screens and Sieves	Mechanical Filters used to segregate soils	Potentially applicable
		Spiral Classifier	Rotating screens used to wash adhering clay and silt from sand & gravel	Potentially applicable
		Cyclone and Hydroclone	Separated solids that are heavier than water by centrifugal force	Potentially applicable
		Settling Basin	Allows solids to settle out by gravity	Potentially applicable
	Aqueous Waste Treatment for By-Products of Solids Treatment	See "Ground Water Treatment" Options		

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (continued)	Thermal Treatment	Liquid Injection	Refractory lined combustion chamber(s) incinerate pumpable waste	Not feasible for inorganics
		Rotary Kiln	Incinerates all forms of wastes	Not feasible for inorganics
		Multiple Hearth	Series of solid flat hearths incinerate all forms of waste, particularly sludges	Not feasible for inorganics
		Fluidized Bed	Waste injected into an agitated bed of sand where combustion occur	Not feasible for inorganics

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (continued)	Thermal Treatment (continued)	Pyrolysis	Thermal conversion of waste into solid, liquid and gas components	Not feasible for inorganics
	Chemical Treatment	Immobilization	Render contaminants insoluble and limit leaching of the contaminants	Potentially applicable
		Soil Washing	Extracts contaminants from soil using solvents	Potentially applicable
		Detoxification	Destroy, degrade or otherwise reduce the toxicity of contaminants	Potentially applicable

TABLE 2-3 (CONTINUED) SOIL/SEDIMENT

General Response Action	Remedial Technology	Process Options	Descriptions	Screening Comments
Treatment (continued)	Physical Treatment	Solidification /Stabilization	Contaminants are mechanically located within a solidified matrix	Potentially applicable
		Encapsulation	Sealing the wastes in an organic binder or resin	Potentially applicable
		Volatilization	Thermal treatment or mechanical aeration	Not applicable for heavy metals
Disposal	On-Site Land Disposal	On-Site Landfill	Construction of a landfill	Not applicable for on-site conditions
	Off-Site Land Disposal	Landfilling	Dispose of waste in an off-site facility	Potentially applicable

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
<u>GROUND WATER</u>				
No Action	None	Not Applicable	No Action	Required for consideration by NCP
Institutional Actions	Access Restrictions	Deed Restrictions	Supply well usage in the area of influence would include deed restrictions	Potentially applicable
	Alternate Water Supply	City Water Supply	Extension of existing municipal water system to serve residents in area of influence	Municipal water already used by majority of residents
		New Community Well	New supply well to serve residents in area of influence	Municipal water system appears to be adequate
	Monitoring	Ground Water Monitoring	Monitoring of existing wells	Potentially applicable

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comment
Ground Water (continued)	Extraction	Extraction Wells	System of well(s) to extract contaminated ground water	Potentially applicable
		Extraction/ Injection Wells	Inject uncontaminated water to increase flow to extraction well(s)	Potentially applicable
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches to collect contaminated ground water	Difficult to implement due to on-site geologic conditions
On-Site/Off-Site Treatment	Biological	Aerobic	Degradation of organics in the presence of oxygen	Not feasible for on-site organics
		Anaerobic	Degradation of organics in the absence of oxygen	Potentially applicable for PCE and TCE

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off-Treatment (continued)	Physical/ Chemical	Activated Carbon	Adsorption of contaminants onto activated carbon	Potentially applicable for PCE sand TCE
		Precipitation/ Flocculation/ Sedimentation	Removal of soluble metallic ions	Potentially applicable
		Ion Exchange	Toxic ions are exchanged with harmless ions held by ion exchange material	Potentially applicable
		Resin Sorption	Contaminant is transferred from dissolved state to the surface of the resin	Potentially applicable

TABLE 2-3 (CONTINUED) GROUNDWATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off Treatment (continued)	Physical/ Chemical	Filtration	Suspended solids are removed by passing through a bed of filter media	Potentially applicable
		Reverse Osmosis	Use of high pressure to force water through the membrane leaving contaminants behind	Potentially applicable
		Neutralization	Adding acid or base in order to adjust the pH	Potentially applicable
		Gravity Separation	Separate two-phased aqueous waste	Not feasible for soluble organics

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off-Site Treatment (continued)	Physical/ Chemical	Air Stripping	Mixing air with water in a packed column to promote transfer of VOCs to air	Potentially applicable for TCE and PCE
		Chemical Oxidation	Addition of an oxidizing agent	Not applicable
		Chemical Reduction	Addition of a reducing agent	Potentially feasible for Cr(VI) reduction
		Sulfide Precipitation	Hydrogen sulfide or sodium sulfide used to precipitate heavy metals	Potentially applicable
	Physical/ Chemical/ Biological	Powdered Activated Carbon Treatment (PACT)	Addition of carbon to the aeration basin	Potentially applicable for TCE and PCE

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off-Site Treatment (continued)	Thermal Destruction	Liquid Injection	Refractory lined combustion chamber(s) incinerate pumpable waste	Potentially applicable for TCE and PCE
		Rotary Kiln	Incinerates all forms of wastes	Potentially applicable for organics
		Multiple Hearth	Series of solid flat hearths incinerate all forms of waste, particularly sludges	Potentially applicable
		Fluidized Bed	Waste injected into an agitated bed of sand where combustion occurs	Potentially applicable for organics

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off Treatment (continued)	Thermal Destruction (continued)	Pyrolysis	Thermal conversion of waste into solid, liquid and gas components	Potentially applicable for organics
	Off-Site Treatment	POTW	Extracted ground water discharge to Olean Waste Water Treatment Plant	Potentially applicable
		RCRA Facility	Extracted ground water transported to RCRA facility for treatment	Potentially applicable
	In-Situ Treatment	Bioreclamation	Treating zones of contamination by microbial degradation	Applicable for organics

TABLE 2-3 (CONTINUED) GROUND WATER

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
On-Site/Off-Treatment (continued)	In-Situ Treatment (continued)	Chemical	Immobilization soil flushing and detoxification used to decontaminate soil	Potentially applicable
		Physical	Heating, vitrification and ground freezing to demobilize contaminants	Potentially applicable
		Permeable Treatment Beds	Downgradient trenches filled with activated carbon or lime to treat contaminants	Not feasible due to site geologic conditions
Ground Water Disposal	Off-Site Disposal	POTW	Extracted water discharged to Olean Waste Water Treatment Plant	Potentially applicable

TABLE 2-3 (CONTINUED) GROUND WATER, STRUCTURES/VATS

General Response Actions	Remedial Technology	Process Options	Description	Screening comments
Ground Water Disposal (continued)	Off-Site Disposal	Surface Water	Discharge to Olean Creek following pretreatment	Potentially applicable
	On-Site Disposal	Deep Well Injection	Extracted water discharged to deep well system	Not applicable for on-site conditions
		Reinjection to Ground Water	Discharge to ground water following treatment	Potentially applicable
<u>STRUCTURES/VATS</u> No Action	None	Not applicable	No Action	Required for consideration by NCP

TABLE 2-3 (CONTINUED) STRUCTURE/VATS

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Institutional Actions	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence would include deed restrictions	Potentially applicable
		Fencing	Fence off areas of contaminated soil	Potentially applicable
		Closure	Board-up on-site structures	Potentially applicable
Containment	Encapsulation/ Enclosure	Containment	Protective coating acting as a shield from contaminated surfaces	Potentially applicable
Partial or Complete Removal	Demolition and Removal	Demolish Structures	Includes burn down, controlled blasting, drilling, crushing and sawing	Potentially applicable

TABLE 2-3 (CONTINUED) STRUCTURES/VATS

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Partial or Complete Removal (continued)	Dismantling and Removal	Physical Removal	Removal of contaminated structures	Potentially applicable
	Solid/ Aqueous Waste Removal	Mechanical	Excavate wastes from on-site structures with a mechanical device	Potentially applicable
		Hydraulic	Excavate wastes from on-site structures using hydraulics	Potentially applicable
		Pneumatic	Excavate wastes from on-site structures using a pump and compressed air	Potentially applicable

TABLE 2-3 (CONTINUED) STRUCTURES/VATS

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment	On-Site Treatment	Grit Blasting	Abrasive material is used for uniform removal of contaminated surface layers	Potentially applicable to specific surfaces
		Hydroblasting/ Water Washing	A high pressure water jet is used to remove contaminated debris	Potentially applicable to specific surfaces
		Scarification	Pneumatically operated piston heads strike the surface, causing concrete to chip off	Potentially applicable to concrete floor
		Solvent Washing	Organic solvent is used to solubilize contaminants	Technology under development

TABLE 2-3 (CONTINUED) STRUCTURES/VATS

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Treatment (continued)	On-Site Treatment	Steam Cleaning	Use high pressure steam to clean up residual contaminants	Potentially applicable
		Vapor-Phase Solvent Extraction	Organic solvent is heated to vaporize and allowed to circulate in a building	Difficult to implement
		Photochemical Degradation	Intense ultra violet light is applied to a contaminated surface	Difficult to implement
Disposal	On-Site Land Disposal	On-Site Landfill	Construction of a landfill	Not applicable to on-site conditions

TABLE 2-3 (CONTINUED) STRUCTURES/VATS

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
Disposal (continued)	Off-Site Disposal	Landfilling	Dispose of waste in an off-site facility	Potentially applicable
		Incineration	See "Incineration of Soil" above	Not applicable for inorganic contaminants

be extremely difficult to implement were also discarded. The technologies with the greatest potential for applicability to the site characteristics and constituents of concern have been retained and are evaluated further in the subsequent sections of this report.

2.7 Evaluation of Process Options

The technology processes considered to be implementable were evaluated in greater detail in this section. These remedial technologies or process options were evaluated on the basis of effectiveness and implementability. A relative cost comparison was also completed; however, cost was not used as the sole criteria to screen out any of the technologies. Table 2-4 summarizes the screening process and Table 2-5 summarizes the process options that were subsequently retained for further consideration. A discussion of each of the evaluation categories is presented below.

Effectiveness

Effectiveness refers to the degree to which a technology achieves the remedial objectives. As this evaluation pertains to technologies rather than overall remedial alternatives, a technology need not achieve the remedial objective in its entirety

TABLE 2-4 EVALUATION OF PROCESS OPTIONS

Process Options	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
<u>SOIL/SEDIMENT</u>				
No Action.	Does not achieve remedial action objectives.	Not acceptable to local government/ public.	None.	Yes.
Fencing.	Effective in limiting contact with contaminated soil. Does not achieve remedial action objectives.	Readily implementable.	Negligible.	No. Fails effectiveness criteria.
Deed Restrictions.	Effective in restricting the land use. Does not achieve remedial action objectives.	Depends on legal requirements and authorities.	Negligible.	No. Fails effectiveness criteria.
Clay & Soil Capping.	Effective in limiting contact with contaminated soil. Susceptible to cracking. No contaminant reduction.	Implementable. Restriction on future land use.	Low capital, moderate O & M.	No. Fails effectiveness criteria.
Concrete Capping.	Effective in limiting contact with contaminated soil. Susceptible to weathering and cracking. No contaminant reduction.	Implementable. Restrictions on future land use.	Moderate capital, moderate O & M.	No. Fails effectiveness criteria.
Bituminous Concrete/ Asphalt clay Capping.	Effective in limiting contact with contaminated soil. Susceptible to weathering and cracking. No contaminant reduction.	Easily implemented with plant building in place. Restrictions on future land use.	Low capital, moderate O & M.	No. Fails effectiveness criteria.

TABLE 2-4 (CONTINUED) SOIL/SEDIMENT

Process Options	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Composite Capping.	Effective in limiting contact with contaminated soil. Least susceptible to cracking. No contaminant reduction.	Implementable. Restrictions on future land use, Difficult to construct if plant building remains in place.	Moderate capital, low O & M.	Yes.
Diversion/Collection.	Effective in limiting infiltration of surface water in contaminated area. Supplements other options (i.e. capping options).	Implementable.	Low capital, low O & M.	Yes.
Grading.	Effective in limiting infiltration of surface water in contaminated areas. Supplements other options (i.e. excavation/capping).	Implementable.	Low capital, low O & M.	Yes.
Soil Erosion Control.	Effective in reducing erosion of contaminated soil. Supplements other options.	Implementable.	Low capital, low O & M.	Yes.
Cofferdams.	Effective in limiting movement of suspended solids during treatment. Supplements other options.	Implementable.	Moderate capital.	Yes.
Curtain Barriers.	Effective in limiting movement of suspended solids during dredging. Supplements other options.	Readily implementable.	Moderate capital.	Yes.

TABLE 2-4 (CONTINUED) SOIL/SEDIMENT

Process Options	Effectiveness	Implementability	Cost	Retain Action/ Screen Comment
Revegetation/ Restoration.	Effective in reducing erosion of contaminated soil. Supplements other options(i.e. excavation, capping).	Readily implementable.	Low capital, Low O & M.	Yes.
Watering.	Effective in reducing fugitive dust during implementation of other remedial options. Supplements other options (i.e., excavation).	Readily implementable.	Negligible.	Yes.
Solids Excavation.	Effective in removing contaminated soils.	Implementable with proper health and safety measures.	Moderate capital.	Yes.
Mechanical Dredging.	Effective in removing contaminated sediments. Used with sediment control. Should be done during low flow conditions.	Implementable with proper health and safety measures and sediment controls.	Moderate capital.	Yes.
Hydraulic Dredging.	Effective in removing contaminated sediments. Does not require channel rerouting.	Implementable. Requires disposal/treatment option.	Moderate capital.	Yes.
Pneumatic Dredging.	Effective in removing contaminated sediments. Does not require channel rerouting.	Not a common technology in the U.S. Requires disposal/ treatment option.	High capital.	No. Fails implementability criteria.
Mechanical/Hydraulic Scouring	Effective in removing contaminated sediment from storm sewer	Implementable. Requires cooperation of local officials.	Moderate capital.	Yes.
Off-Site Landfill.	Effective in removing contaminants from the site.	Implementable. Requires transport and handling.	High capital, no O & M.	Yes

TABLE 2-4 (CONTINUED) SOIL/SEDIMENT

Process Options	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Centrifugation.	Effective for separation of soils.	Implementable.	Moderate capital, low O & M.	Yes.
Gravity Thickening.	Effective with other options for concentration of slurries.	Implementable.	Moderate capital low O & M.	Yes.
Screens & Sieves.	Effective for segregation of soils. Supplements other options.	Implementable.	Moderate capital, high O & M.	Yes.
Spiral Classifier.	Effective for separation of coarse soils from fines.	Implementable.	High capital, moderate O & M.	Yes.
Cyclone and Hydroclone.	Effective for separation of solids heavier than water.	Implementable.	High capital, low O & M.	Yes.
Settling Basin.	Effective for separation of suspended solids from liquids.	Implementable. Takes longer than other solids separation processes.	Moderate capital, low O & M.	Yes.
Immobilization.	Effective for limiting solubility of contaminants.	Difficult to Implement. Insufficient field test information.	Moderate capital, no O & M.	No. Fails implementability criteria.
Soil Washing.	Effective in extraction of contaminants from soil.	Implementable. May require site-specific treatability study.	Moderate capital, moderate O & M.	Yes.
Detoxification.	Effective in reducing the toxicity of contaminants	Implementable. May introduce other pollutants.	Moderate capital, no O & M.	No. Fails implementability criteria.

TABLE 2-4 (CONTINUED) GROUNDWATER

Process Options	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Solidification/ Stabilization.	Effective for limiting leaching of wastes. No contaminant reduction.	Implementable. May require site-specific treatability study.	Moderate capital, no O & M.	Yes.
Encapsulation.	Reduces leaching potential. Improves handling.	Implementable.	High capital, no O & M.	Yes.
In-Situ Soil Flushing.	Effective in extraction of contaminants from soil.	Difficult to Implement.	Moderate capital, moderate O & M.	No. Fails implementability criteria.
Vitrification.	Potentially leaves contaminated soil on perimeter of treated area.	Difficult to Implement. Insufficient field test information.	Very high capital, no O & M.	No. Fails effectiveness criteria.
<u>GROUNDWATER</u>				
No Action.	Does not achieve remedial action objectives.	Not acceptable to local government/public.	None.	Yes.
Deed Restrictions.	Effective in restricting the land use. Does not achieve remedial action objectives.	Depends on legal requirements and authorities.	Negligible.	No. Fails effectiveness criteria.
Extension of City Water Supply.	Effective in limiting use of contaminated ground water. No contaminant reduction.	Municipal water system already in place in area of influence.	Negligible.	No. Fails effectiveness criteria.
Groundwater Monitoring.	Useful for documenting conditions. No contaminant reduction.	Alone, not acceptable to local government/ public.	Low capital, low O & M.	Yes.

TABLE 2-4 (CONTINUED) GROUNDWATER

Process Option	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Capping.*	See above under "Soil/Sediment".			
Extraction Wells.	Useful if used in conjunction with other options.	Implementable. May pull in contaminants from off-site sources.	Moderate capital, moderate O & M.	Yes.
Extraction/Injection Wells.	Probably will not increase extraction process due to lack of confining layers.	Potentially implementable in overburden.	Moderate capital moderate O & M.	No. Fails effectiveness criteria.
Anaerobic Treatment	Potentially effective to treat VOCs.	Difficult to implement at site due to the low organic waste concentration.	Moderate capital, high O & M.	No. Fails implementability and cost criteria.
Activated Carbon.	Proven technology for treating VOCs and Cr(VI).	Readily implementable.	Moderate capital, high O & M.	Yes.
Precipitation/ Flocculation/ Sedimentation.	Effective and reliable. Requires sludge disposal.	Readily implementable.	Low capital, moderate O & M.	Yes.
Ion Exchange	Effective for removal of metals/organics from groundwater.	Readily implementable.	Moderate capital, moderate O & M.	Yes.
Resin Sorption	Effective for removal of metals/organics from groundwater.	Readily implementable.	Moderate capital, moderate O & M.	Yes.
Filtration.	Effective for removing suspended solids. Can be used as pretreatment to other options.	Readily implementable.	Moderate capital, moderate O & M.	Yes.

Note: Capping is addressed under Soil/Sediment.

TABLE 2-4 (CONTINUED) GROUNDWATER

Process Option	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Reverse Osmosis.	Effective for removal of charged ions (EQ): Cr(VI), some organics and metals.	Difficult to Implement. Requires pretreatment.	Moderate capital, high O & M.	No. Fails implementability criteria.
Neutralization.	Effective for pH adjustment. Used as pretreatment options.	Readily implementable.	Low capital, low O & M.	Yes.
Air Stripping.	Proven effective technology for treating PCE & TCE. Results in VOC air emissions.	Readily implementable.	Moderate capital, moderate O & M.	Yes
Steam Stripping.	Not effective for waste types at the site.	Implementable.	Very high O & M cost.	No. Fails effectiveness criteria.
Chemical Reduction.	Effective for reduction of Cr(VI) to Cr(III) by using reducing agents.	Readily implementable.	Moderate capital, moderate O & M.	Yes.
Sulfide Precipitation.	Effective for precipitation of heavy metals.	Readily implementable.	Moderate capital, moderate O & M.	Yes.
Powdered Activated Carbon Treatment (PACT).	Not effective for low level organics and/or inorganics.	Readily implementable.	High capital, high O & M.	No. Fails effectiveness criteria.
Disposal/Treatment at RCRA Facility.	Effective.	Implementable.	Very high capital.	Yes.
In-Situ Treatment Bioreclamation.	Effective for organics, but not effective for inorganics.	Difficult to implement due to low levels of organics.	Moderate capital.	No. Fails effectiveness and implementability criteria.

TABLE 2-4 (CONTINUED) GROUNDWATER

Process Option	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
In-Situ Chemical Treatment.	Effective method for treating soils which also addresses ground water.	Difficult to implement. Not a proven technology.	Moderate capital, moderate O & M.	No. Fails implementability criteria.
In-Situ Physical Treatment.	Effective for organics and immobilizing contaminants. Does not lower contamination levels.	Difficult to implement.	High capital, high O & M.	No. Fails effectiveness and implementability criteria.
Discharge to POTW.	Effective and reliable method.	Implementable. Discharge permits required.	Low capital, low O & M.	Yes.
Discharge to Surface Water.	Effective and reliable method. requires extensive pretreatment.	Implementable. Discharge permits required.	Low capital, low O & M.	Yes.
Reinjection to Groundwater.	Potentially effective. Requires pretreatment.	Implementable. May impact municipal supply wells.	Moderate capital, moderate O & M.	Yes.

TABLE 2-4 (CONTINUED) STRUCTURES/VATS

Process Option	Effectiveness	Implementability	Cost	Retain Action/ Screen Comment
STRUCTURES/VATS				
No Action.	Does not achieve remedial action objectives.	Not acceptable to local public/government.	None.	Yes.
Closure.	Effective for limiting vandalism and access to structures. Does not achieve remedial objectives.	Implementable.	Low capital, low O & M.	No. Fails effectiveness criteria.
Fencing.	Effective in limiting contact with wastes. No contaminant reduction. Does not achieve remedial objectives.	Currently in place. Fencing could be upgraded to limit vandalism and trespassing.	Negligible.	No. Fails effectiveness criteria.
Deed Restrictions.	Effectiveness depends on continued future implementation. Does not achieve remedial objectives.	Depends on legal requirement and authorities.	Negligible.	No. Fails effectiveness criteria.
Containment (Encapsulation/ Enclosure).	Effective in limiting direct contact with contaminants. No contaminant reduction.	Implementable.	Low capital, moderate O & M.	No. Fails effectiveness criteria.
Demolition and Removal (Complete Removal).	Effective for breaking down structures and improving handling of debris.	Implementable if buildings are adequately decontaminated prior to demolition.	High capital.	Yes.

TABLE 2-4 (CONTINUED) STRUCTURES/VATS

Process Option	Effectiveness	Implementability	Cost	Retain Action/ Screen Comments
Dismantling and Removal.	Effective for removal of structures.	Implementable if buildings are adequately decontaminated prior to dismantling.	High capital.	Yes.
Grit Blasting.	Effective for removing contaminants from specific surfaces.	Implementable.	Moderate capital.	Yes.
Scarification.	Only effective for removing residual contaminants from masonry surfaces.	Implementable.	Moderate capital.	Yes.
Steam Cleaning.	Effective for removing residual contaminants on structures.	Implementable. Requires containment of water generated during cleaning.	Low capital.	Yes.
On-Site RCRA Facility.	Effective storage of waste. Achieves remedial objectives.	Difficult to implement. Public/local government concerns.	Very high capital, moderate O & M.	No. Fails implementability criteria.
Off-Site Landfill Disposal.	Effective for limiting contamination at site.	Implementable. Requires demolition, transportation and handling.	High capital.	Yes.

TABLE 2-5 SUMMARY OF APPLICABLE TECHNOLOGIES

Type of Media	Applicable Technologies
Soil/Sediment.	No Action. Composite Capping. Diversion/Collection. Grading. Soil Erosion Control. Cofferdams. Curtain Barriers. Revegetation/Restoration. Watering. Solid Excavation. Mechanical/Hydraulic Dredging. Mechanical/Hydraulic Scouring Off-Site Landfill. Centrifugation. Gravity Thickening. Screens and Sieves. Settling Basin. Spiral Classifier. Cyclone and Hydroclone. Soil Washing. Solidification/Stabilization. Encapsulation.
Groundwater.	No Action. Groundwater Monitoring. Extraction Wells. Carbon Adsorption. Conventional Precipitation. Ion Exchange using Resin Sorption. Filtration. Neutralization. Air Stripping. Chemical Reduction. Sulfide Precipitation. Discharge to POTW. Discharge to Surface Water. Reinjection to Groundwater. Disposal/Treatment at RCRA Facility.
Structures/Vats	No Action. Demolition/Dismantling and Removal. Steam Cleaning. Off-Site Landfill Disposal. Scarification. Grit Blasting

to be considered effective. Effective technologies may be combined with other complementary technologies, if required, to form effective alternatives which address the remedial objectives. This evaluation therefore is based upon the effectiveness of each technology at its intended function.

Implementability

Implementability encompasses both the technical and administrative feasibility of implementing a technological process. As discussed in Section 2.6, technical implementability is used to initially screen process options and to eliminate those that are clearly ineffective or unworkable at a site. Therefore, this subsequent, more detailed evaluation of process options places greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for off-site actions, the availability of treatment, storage and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology.

Cost

Relative capital and O & M costs were estimated during this stage of the screening process. The cost estimates were made on the basis of published unit costs and vender estimates, and each process option is evaluated as to whether costs are high, medium or low relative to other process options of the same technology type.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Preliminary screening of potentially applicable technologies/ process options was discussed in Section 2.0. This Section addresses the combination of the most feasible technologies/process options into remedial alternatives, and the subsequent screening of these alternatives for each of the three media previously identified (i.e., soil/sediment, ground water and structures/vats). In general, the alternatives discussed herein for each of the media include the no action/limited action alternative, and other alternatives which exceed, achieve, or do not achieve appropriate levels of remediation, as defined by the remedial action objectives.

Finally, this section presents the comprehensive remedial alternatives which, based on the screening process, appear to be the most feasible for the site. These alternatives are evaluated in more detail in Section 5.0, the Phase III FS (Task VI-Detailed Analysis of Alternatives).

3.1 Development of Alternatives

3.1.1 Summary of Alternatives for Contaminated Soil/Sediment Remediation

Alternatives for contaminated soil/sediment remediation are summarized below. Alternatives 1 through 10 address on-site soils and the sediment within Olean Creek. Alternative 11 addresses the residual contaminated sediment present in the storm sewer system.

- Alternative 1: No Action/Limited Action
- Alternative 2: Capping of Contaminated Soils; Removal of Sediments
- Alternative 3: Excavation and Off-Site Landfill Disposal
- Alternative 4: Soil Washing
- Alternative 5: On-Site Solidification/Stabilization
- Alternative 6: Off-Site Disposal of Heavily Chromium Contaminated Soil and On-Site Solidification/Stabilization of Less Contaminated Soil
- Alternative 7: Off-Site Disposal of Less Contaminated Soil and On-Site Washing (Reclamation) of Heavily Chromium Contaminated Soil

- o Alternative 8: On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil
- o Alternative 9: Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment
- o Alternative 10: Encapsulation
- o Alternative 11: Sewer Cleaning using Mechanical/Hydraulic Scouring Techniques

Each of these alternatives is summarized in the following paragraphs.

Alternative 1: No Action/Limited Action

The no action/limited action alternative would limit access to contaminated areas identified during the RI/FS. This alternative would include site fencing, monitoring and deed restrictions. The no action/limited action alternative is presented here as a baseline against which to evaluate other alternatives.

Alternative 2: Capping of Contaminated Soils; Removal of Sediments

The capping alternative includes a composite cap over the site and improvement of site drainage (e.g., grading, diversion/collection, soil erosion control, revegetation, etc.). For this alternative to be effective the plant building must be removed to allow complete closure of the site. If feasible (i.e., the quantity of the contaminated soil is not excessive) contaminated soil/sediment from off-site may be consolidated on-site or in one area of the site, and then capped. Capping would reduce the movement of contamination via air, surface water and ground water (i.e., by reducing infiltration). Surface capping at the Van Der Horst site would also limit direct contact with the contaminated soils by humans or animals entering the site area.

Capping would also enhance other technologies (e.g., ground water collection) by mitigating the impacts of infiltration or isolating the source of contamination. However, with regard to public health and the environment, removal of the sources of contamination is generally preferable to capping or any other form of containment. Nevertheless, capping offers a less expensive option.

Sediment would be removed by constructing a cofferdam or silt curtain around the contaminated area of the creek and dredging the sediments. Dredged sediments would be dewatered and disposed of at an off-site disposal facility or on-site.

Alternative 3: Excavation and Off-Site Landfill Disposal

Excavation and off-site disposal is a proven technology for remediation of waste sites where waste quantities are not excessive and the excavated material can be disposed of at a local off-site landfill. Watering and other dust control measures would be implemented during excavation. Soil excavation can be accomplished by a wide variety of conventional equipment ranging in size from a 220 cubic yard dragline down to the 1/4 cubic yard backhoe. These basic types of excavation machinery fall into the following general categories:

- Backhoes;
- Cranes and attachments (draglines and clamshells); and
- Dozers and loaders.

Sediment would be removed by constructing a cofferdam or silt curtain around the contaminated area of the creek and dredging the sediments. Dredged sediments can be dewatered and taken off-site with the contaminated soil.

Alternative 4: Soil Washing

Under this alternative, contaminated soil would be excavated and washed on-site with a liquid medium for removal of contaminants. Sediment would be removed by constructing a cofferdam or slit curtain around the contaminated area of the creek and dredging the sediments. Dredged sediments would be dewatered and washed on-site together with the contaminated soil. Decontaminated soil/sediment would be backfilled following delisting while the washing solution would be reclaimed, sold or treated for removal of the contaminants via the following treatment/disposal technologies:

- Chromium Reduction;
- Neutralization;
- Precipitation/Flocculation;
- Sedimentation;
- Filtration;
- Granular Activated Carbon Adsorption;
- pH Adjustment;

- o Belt Filter Press (for sludge dewatering); and
- o Off-Site Disposal of Dewatered Sludge.

A schematic flow diagram of a typical soil washing treatment train is presented in Figure 3-1. Additionally, soil segregation methods (e.g., centrifugation, gravity thickening, screens and sieves, spiral classifier, cyclone, hydroclone, and settling basins) may be used to separate the soils into various particle sizes prior to the washing process.

Alternative 5: On-Site Solidification/Stabilization

Under this alternative, contaminated soil/sediment would be excavated/dredged and solidified/stabilized on-site. There are various types of solidification/stabilization processes such as cement solidification, silicate-based processes, sorbent materials processes, and thermoplastic techniques. The objectives of the solidification treatment process are to:

- o Improve the handling and physical characteristics of the waste;
- o Decrease the surface area across which transfer or loss of pollutants can occur;

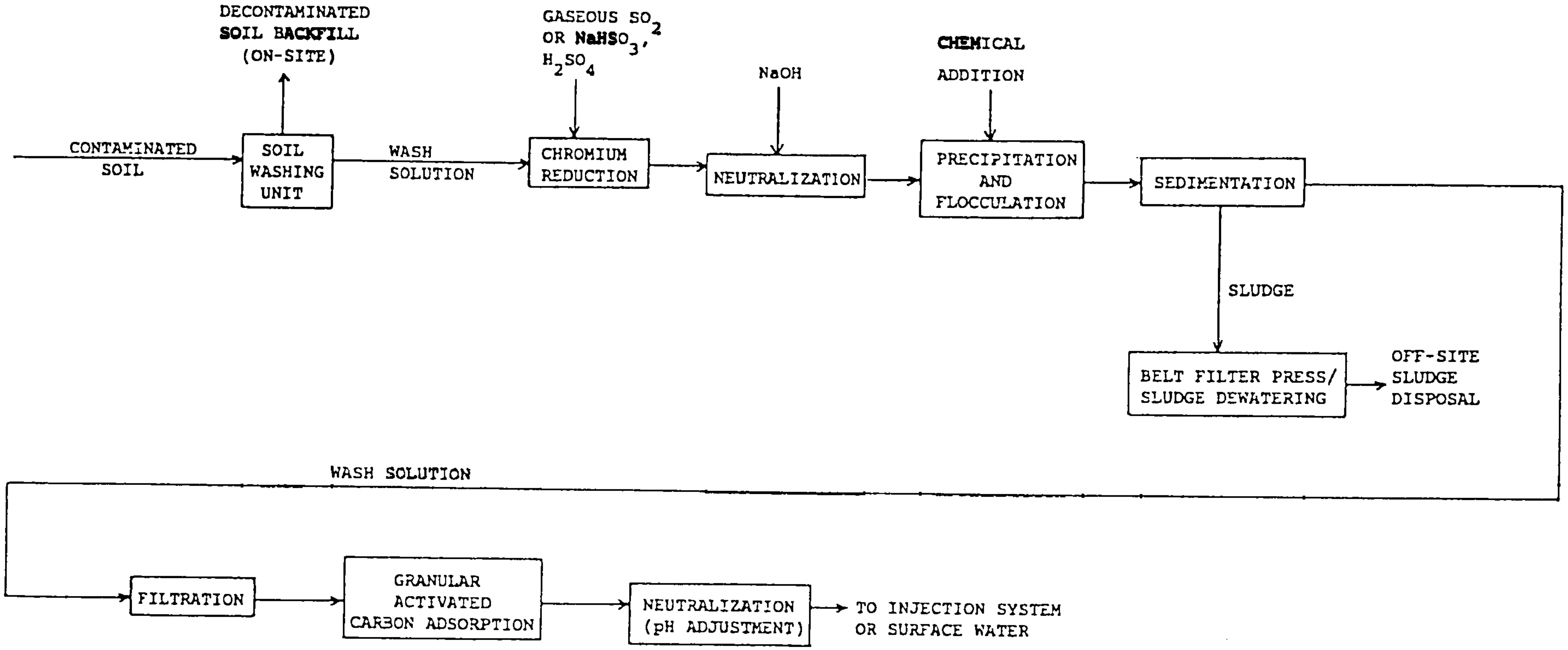


Figure 3-1 : TYPICAL SOIL WASHING TREATMENT PROCESS TRAIN

Source: YEC, INC.

- o Limit the solubility of metal contaminants in the waste; and
- o Make the soil less hazardous.

The success of this technology would depend primarily upon two factors: (1) the site-specific waste characteristics; and (2) the chemicals/binding reagents to be applied to the soil.

Alternative 6: Off-Site Disposal of Heavily Chromium Contaminated Soil and On-Site Solidification/Stabilization of Less Contaminated Soil

This alternative combines soil/sediment alternatives 3 and 5. The contaminated soil near MW-5, MW-3 and MW-17, which is considered to be heavily contaminated with chromium (i.e., greater than 1,000 ppm total chromium), would be excavated and hauled to an off-site RCRA landfill facility for disposal (Alternative 3), while the less contaminated soil/sediment (i.e., less than 1,000 ppm total chromium) would be treated on-site using solidification/stabilization techniques (Alternative 5).

Alternative 7: Off-Site Disposal of Less Contaminated Soil and On-Site Soil Washing of Heavily Chromium Contaminated Soil

This alternative combines soil/sediment alternatives 3 and 4. Under this alternative the heavily chromium contaminated soil near MW-5, MW-3 and MW-17 would be excavated and soil washed. The effluent could then be potentially recycled and the residual soils either backfilled, or disposed of with the less contaminated soil/sediment at an off-site landfill facility.

Alternative 8: On-Site Soil Washing of Heavily Chromium Contaminated Soil Followed by Site Capping

This alternative combines soil/sediment alternatives 2 and 4. The heavily contaminated soil would be washed and either backfilled, after delisting, or disposed of at an off-site landfill. The remaining less contaminated soil would be consolidated, if possible, and then covered with a cap to limit any further dust migration of the soil, and to limit the infiltration of surface water through the soil. The sediment would be dredged, dewatered and consolidated with the soil or disposed of in an off-site landfill.

Alternative 9: Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment

This alternative combines soil/sediment alternatives 2 and 3. The heavily chromium contaminated soil would be excavated and disposed of at an off-site landfill. The remaining soil/sediment would be consolidated, if feasible, and capped to limit any further dust migration and to limit surface water infiltration.

Alternative 10: Encapsulation

This alternative would involve excavating the contaminated soil and encapsulating it in an organic binder or resin followed by on-site or off-site disposal. One of the following three methods of microencapsulation would be used: 1) high-density polyethylene jacket developed by Environmental Protection Polymers; 2) high density polyethylene overpack developed by the USEPA; and 3) Envirostone Cement ™ developed by United States Gypsum. All these methods appear to be effective for isolating and immobilizing chromium contaminated soils at Van Der Horst Plant No. 1.

Alternative 11: Sewer Cleaning using Mechanical/Hydraulic Scouring Techniques

This alternative uses either a power rodding machine ("snake") to push or pull scrapers through the sanitary sewer or a high pressure water wash to dislodge contaminated sediment and debris. The sediments are then vacuumed from the downstream manholes using vacuum trucks. This material would then be taken to an off-site landfill or to the site to be treated and disposed of with the other soil/sediments.

3.1.2 Summary of Alternatives for Ground Water Migration Control

The following four (4) alternatives have been identified for control of ground water contaminant migration:

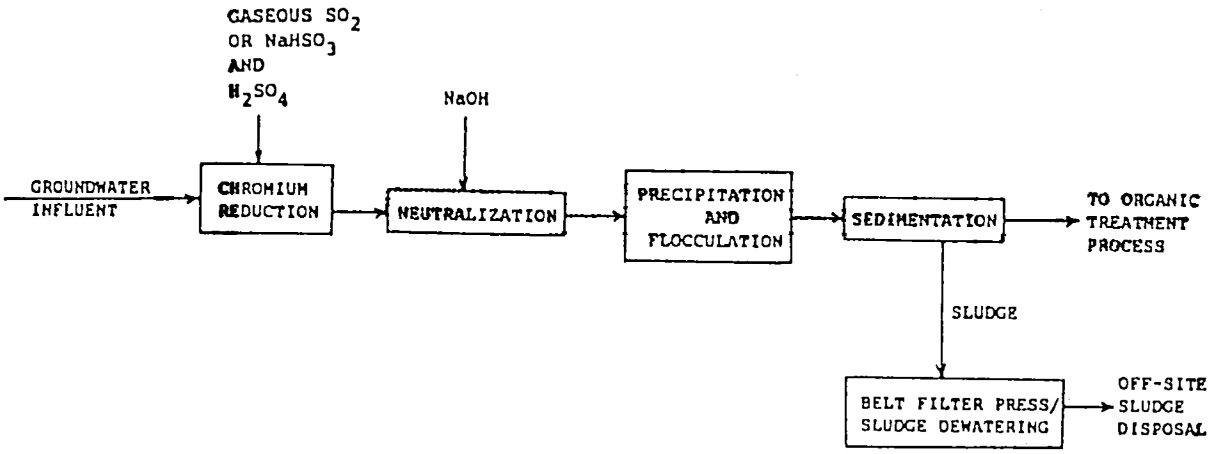
- Alternative 1: No Action/Limited Action
- Alternative 2: Ground Water Extraction, Treatment, and Discharge to Surface Water
- Alternative 3: Ground Water Extraction, Pretreatment, if necessary, and Discharge to POTW
- Alternative 4: Ground Water Extraction, Treatment, and Reinjection

Alternatives 2, 3 and 4 potentially involve on-site treatment of contaminated ground water. Therefore, potential treatment options are discussed independently.

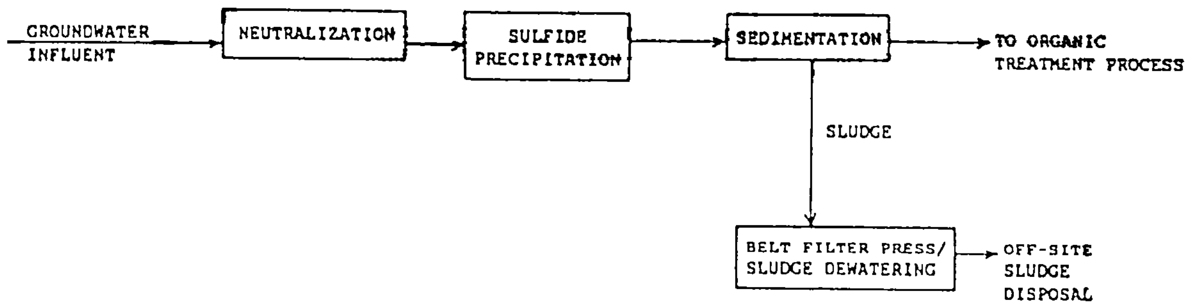
Since both inorganic (e.g., hexavalent chromium) and organic (e.g., PCE) contaminants are of concern, the following two groups of treatment options were evaluated:

1. Metal Treatment Options (Figure 3-2):
   a. Conventional Chemical Precipitation,
   b. Sulfide Precipitation; and
   c. Ion Exchange.
   d. Activated Carbon Adsorption (Figure 3-3)
2. Organic Chemical Treatment Options (Figure 3-3):
   a. Activated Carbon Adsorption;
   b. Air Stripping and Off-Gas Treatment by Carbon Adsorption; and
   c. Air Stripping followed by Carbon Adsorption.

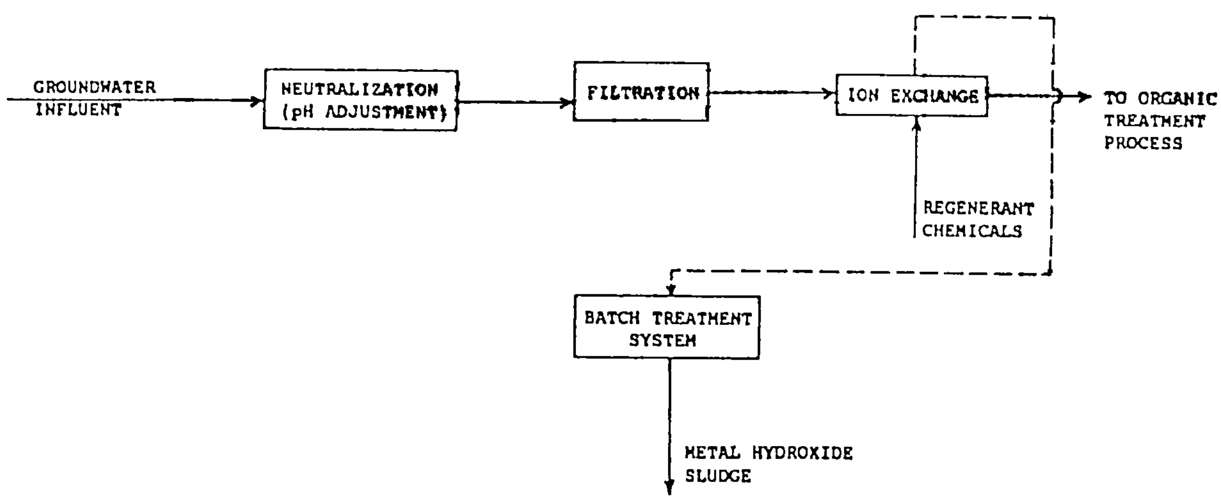
Note that Carbon Adsorption is included as a treatment option under metals due to its effectiveness in treating hexavalent chromium.



A. METAL TREATMENT OPTION 1



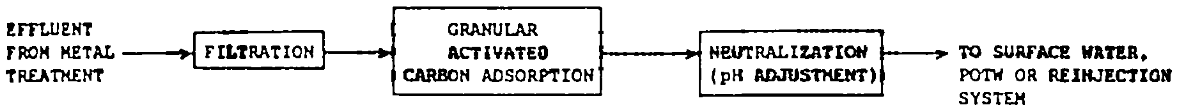
B. METAL TREATMENT OPTION 2



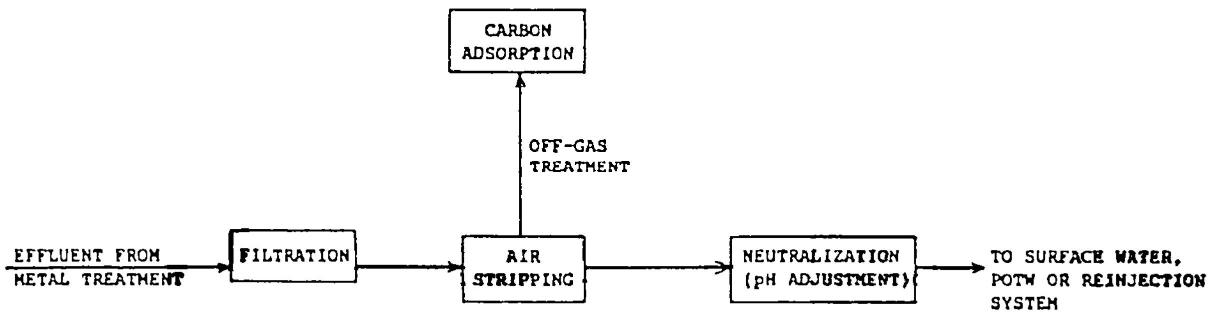
C. METAL TREATMENT OPTION 3

Source: YEC, INC.

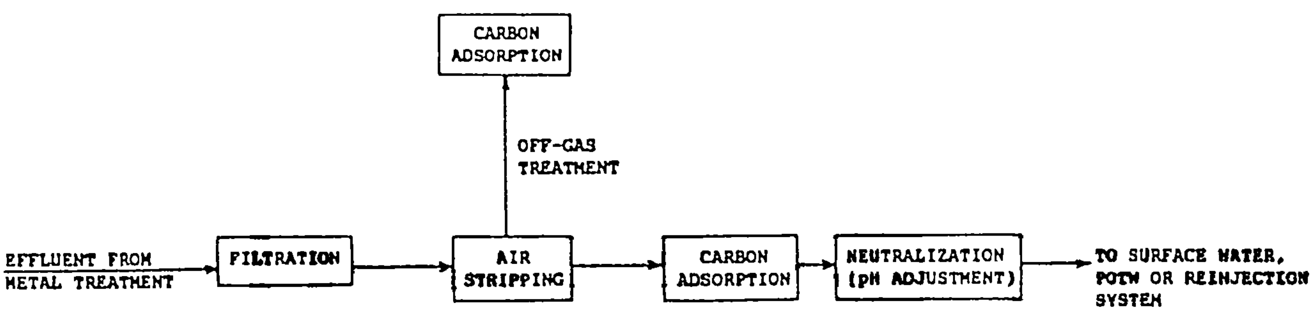
Figure 3-2 : METAL TREATMENT OPTIONS



A. ORGANIC TREATMENT OPTION 1



B. ORGANIC TREATMENT OPTION 2



C. ORGANIC TREATMENT OPTION 3

Figure 3-3 : ORGANIC TREATMENT OPTIONS

Source: YEC, INC.

Alternative 1: No Action/Limited Action

This alternative includes monitoring and land use restrictions. The monitoring wells and downgradient supply wells would be sampled and tested for contaminants periodically. No treatment or disposal actions would be taken relative to ground water remediation. Restrictions on the use of supply wells within the area of influence would be implemented by local government.

Alternative 2: Ground Water Extraction, Treatment and Discharge to Surface Water

This alternative would involve extraction of ground water through a pumping system in the vicinity of the site, followed by on-site treatment to remove metal and organic contamination. The objective of the treatment system would be to meet Class C stream standards, for eventual discharge to surface water.

Ground water pumping and treatment is feasible, given the nature of the aquifer and the level and type of metal and organic contamination. Surface water discharge may also be practical, so long as the volume of water does not produce localized flooding problems. A State Pollutants Discharge

Elimination System (SPDES) permit would be required under this alternative.

Alternative 3: Ground Water Extraction, Pretreatment, and Discharge to City of Olean Wastewater Treatment Plant

This alternative is basically the same as alternative 3, with the exception that ground water (pretreated, if necessary) would be discharged to a Publicly Owned Treatment Works (POTW). The nearest POTW is operated by the City of Olean and is serviced by an activated sludge treatment plant.

This treatment plant consists of a main pumping station (which includes mechanical screens, influent pumps and aerated grit chambers), primary clarifiers, aeration tanks, secondary clarifiers, and a chlorine contact tank. The treated wastewater is discharged to the Allegheny River.

This plant has a design capacity of 7 MGD and is currently operating at 4.5 MGD with an additional 1 MGD of capacity reserved for use by surrounding communities. Table 3-1 lists the current limits of contaminants that are allowed in discharges to the City of Olean sanitary sewer system. Based on ground water samples collected during the Phase I, II and III RIs the ground water at the site presently meets these

TABLE 3-1

LIMITS OF TOXIC SUBSTANCES IN SEWAGE DISCHARGE*

Contaminant	24 Hour Composite
Chromium, Hexavalent	5.5 mg/1
Copper (Total)	2.1.mg/1
Cadmium (Total)	1.0 mg/1
Cyanide (D)	0.2 mg/1
Zinc (Total)	20.0 mg/1
Nickel (Total)	0.9 mg/1
Arsenic (D)	0.02 mg/1
Lead (Total)	18.0 mg/1
Mercury (D)	0.7 mg/1
Silver (D)	10.2 mg/1
Trichlorethylene	1.0 mg/1

(D) - Dissolved- amenable to chlorination

*From City of Olean Sewer Use Ordinance.

limits except for hexavalent chromium concentration from the wells close to the site. Thus, it appears that the ground water extraction system could discharge a majority of the ground water pumped directly to the sewer system without pretreatment, pending final approval from the POTW and modifications to the POTW to increase its capacity.

Alternative 4: Ground Water Extraction, Treatment and Reinjection

This alternative includes extraction, treatment and reinjection of the treated ground water. A ground water treatment system would probably have to treat the extracted ground water down to acceptable drinking water standards. The reinjection system would require more engineering and equipment than disposal to the POTW.

3.1.3 Summary of Alternatives for Structures/Vats Remediation

Remedial alternatives for contaminated structures/vats are summarized below:

- Alternative 1: No Action/Limited Action
- Alternative 2: Demolition/Dismantalling and Off-Site Landfill Disposal

o Alternative 3: Decontamination of Structure Surfaces

Alternative 1: No Action/Limited Action

This alternative would include restricting access to contaminated structures by boarding-up the on-site structures and upgrading fencing around the site. The no action/limited action alternative is presented here as a baseline against which to judge other alternatives. This alternative may be unacceptable in terms of environmental impact, public health, and/or regulatory restriction concerns.

Alternative 2: Demolition/Dismantalling and Off-Site Landfill Disposal

The objective of this alternative is to remove or decontaminate the source of the contaminated structures/vats and to demolish the plant. The disposal of the materials would be at an off-site construction and demolition (C&D) landfill. This alternative consists of: 1) decontaminating the structure using various methods (e.g., steam cleaning, scarification, grit blasting); 2) demolition/dismantling of structures, which can be done using a variety of methods previously discussed; and 3) transporting the debris to a landfill. Some of the materials may require additional decontamination prior to landfilling in a C&D landfill.

Alternative 3: Decontamination of Surfaces

Steam cleaning, grit blasting and scarification can be used to remove the contaminants from the structural surfaces. As previously discussed this alternative involves the use of technologies which would be selected for use based upon the specific contaminant and surface characteristics.

3.2 Screening of Remedial Alternatives (Phase II FS)

In this section, remedial alternatives discussed in Section 3.1 for soil/sediment, ground water and structures/vats are screened on the basis of effectiveness and implementability. The objective of the screening is to narrow the list of potential alternatives that will be evaluated in detail during Task VI. Pursuant to the May, 1990 NYSDEC TAGM, cost was not used as an evaluation criteria. The evaluation forms for effectiveness and implementability from the above mentioned TAGM are included in Appendix A. A summary of the results of these evaluations can be found in Tables 3-2 and 3-3.

TABLE 3-2 PRELIMINARY SCREENING OF SOIL REMEDIATION ALTERNATIVES

Alternatives	Short Term/Long Term Effectiveness									Implementability				Total
	1	2	3	4	5	6	7	8	Sum	1	2	3	Sum	Score
1. No Action	4	0	1	0	0	0	0	0	**5**	9	2	3	**14**	**19**
2. Capping and Grading.	3	3	2	0	0	3	0	1	**12**	8	0	3	**11**	**23**
3. Excavation & Off-Site Landfill Disposal.	3	3	2	0	0	3	5	4	**20**	10	1	3	**14**	**34**
4. On-Site Soil Washing.	3	3	2	3	3	0	4	3	**21**	6	1	2	**9**	**30**
5. On-Site Solidification.	3	3	2	3	3	0	4	3	**21**	7	1	3	**11**	**32**
6. Off-Site Disposal of Heavily Chromium Contaminated Soil & On-Site Solidification/ Stabilization of Less Contaminated Soil.	3	3	2	0	0	3	5	4	**20**	10	1	3	**14**	**34**
7. Off-Site Disposal of Less Contaminated Soil and On-Site Washing of Heavily Chromium Contaminated Soil.	3	3	2	3	3	0	4	3	**21**	6	1	2	**9**	**30**

TABLE 3-2 PRELIMINARY SCREENING OF SOIL REMEDIATION ALTERNATIVES CONT'D

Alternatives	Short Term/Long Term Effectiveness									Implementability				Total
	1	2	3	4	5	6	7	8	Sum	1	2	3	Sum	Score
8. On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil.	3	3	2	3	3	0	4	3	**21**	6	1	2	**9**	**30**
9. Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment.	3	3	2	0	0	3	5	4	**20**	10	1	3	**14**	**34**
10. Encapsulation.	3	3	2	3	3	0	5	1	**20**	7	1	1	**9**	**29**
11. Storm Sewer Cleaning.	4	3	2	3	3	0	4	4	**23**	10	2	3	**15**	**38**

TABLE 3-3 PRELIMINARY SCREENING OF GROUNDWATER REMEDIATION ALTERNATIVES

Alternatives	Short Term/Long Term Effectiveness									Implementability				Total
	1	2	3	4	5	6	7	8	Sum	1	2	3	Sum	Score
1. No Action	4	0	1	0	0	0	0	0	5	9	2	3	14	19
2. GW Extraction, Treatment, & Discharge to Surface Water.	4	4	1	3	3	0	4	2	21	6	0	3	9	30
3. GW Extraction, Pretreatment, & Discharge to POTW.	4	4	1	1	3	0	4	2	19	8	0	3	11	30
4. GW Extraction, Treatment, & Reinjection.	4	4	1	3	3	0	3	1	19	6	0	3	9	28

3.2.1 Evaluation of Soil Remediation Alternatives

Alternative 1: No Action/Limited Action

The no action/limited action alternative has been retained to provide a baseline condition against which other alternatives can be compared. As the title states, this alternative involves no remedial action, except fencing the site and land use restrictions. This would leave the site in its present condition.

Effectiveness

No action/limited action is not considered effective, because environmental and public health risks (due to the contamination at the site) would not be alleviated by this alternative. The magnitude of risks would remain the same and any reduction in risk would be due to natural cleanup with the passage of time. The contaminated soils/sediments would continue to be subjected to surface water percolation and run-off as well as lateral and vertical seepage, which could cause additional ground water and surface water contamination. Additionally, hexavalent chromium could potentially migrate via fugitive dust.

Implementability

There would be no significant technical difficulty associated with the implementation of this alternative. Land use restrictions associated with this alternative would require minor coordination activities between NYSDEC and the local government.

Alternative 2: Capping of Contaminated Soils; Removal of Sediments

This alternative involves capping the site, or a portion of it, with a composite cap and grading the surrounding area. Capping of the soils would limit fugitive dust migration. It would also limit surface water infiltration thereby controlling contaminated ground water migration. Contaminated sediments from Olean Creek would be dredged, dewatered and disposed of landfill or consolidated with the on-site soils prior to capping.

Effectiveness

A properly installed and maintained cap would be effective in limiting exposure and fugitive dust migration, since the contaminated soil would be physically isolated.

This alternative would satisfy the remedial action objectives and would alleviate the short-term risks to human health once the cap is in place. However, potential for long-term risks would still exist, since the source of contamination would remain beneath the cap.

Dredging and subsequent management of contaminated sediments is a viable alternative for handling contaminated sediments. The remedial action objectives for sediment would be satisfied under this alternative.

Implementability

Capping technology is reliable and well demonstrated. The materials, equipment, and labor to grade and cap the site are readily available. The composite cap presents a fairly durable, weather resistant surface; however, it is susceptible to cracking and settling if not properly maintained. The capping option is particularly attractive if the plant building is removed. If present, the configuration of the plant building makes the installation of the cap very difficult.

Capping the site would require restricting its future use. The site would need to be securely fenced to prevent damage to the cap. Capping and fencing the site would preclude using the site as a residential area.

Mechanical dredging could resuspend contaminated sediment, thereby increasing the potential for downstream contaminant migration. This potential problem can be controlled by dredging during periods of low flow, and through the use of turbidity controls (e.g., silt curtains).

Alternative 3: Excavation and Off-Site Landfill Disposal

This alternative includes excavation of contaminated soil, dredging of contaminated sediments, and disposal of both soil and sediments in an off-site landfill. Excavation of the contaminated soils/sediments would require a field mobilization program which may include construction of the following:

- A haul road to provide stabilized access to the site;
- A decontamination pad for decontaminating excavation equipment; and
- A staging area for dewatering and temporary storage of excavated soils.

Remedial action for the contaminated sediments under this alternative would be the same as described for soil/sediment Alternative 2.

Effectiveness

This alternative relies on established technologies for removal and disposal of contaminated soil. Additionally, remedial action objectives for the soil/sediment would be met. The possibility of human health risks from on-site inhalation would be limited, although the potential for future contaminant migration from the off-site landfill would still potentially exist. In addition, the potential for ground water or surface water contamination from the soil would be reduced.

The effectiveness evaluation for remediation of the contaminated sediment was previously discussed under soil/sediment Alternative 2.

Implementability

Under this alternative, it will be necessary to locate a landfill to accept the contaminated soil and sediments.

Treatment may be required at the site, prior to landfilling, to meet landfill acceptance criteria.

Alternative 4: Soil Washing

As previously discussed, inorganic contaminants can be washed from contaminated soils/sediments by means of an extraction process termed "soil washing". This process extracts contaminants from the soil/sediment matrix using a liquid medium as the washing solution. This washing solution is then treated for removal of the contaminants via conventional wastewater treatment technologies. Solutions with the greatest potential for use in soil washing fall into the following classes:

- o Acids-bases;
- o Complexing and chelating agents; and
- o Certain reducing/oxidizing agents.

Water alone can be used to leach water-soluble or water-mobile organics and inorganics. However, for most inorganics, including lead, chromium, and copper, adjusting the pH with dilute solutions of acids or bases will enhance inorganic solubilization and removal.

Desirable soil washing fluid characteristics are listed below:

- o Favorable separation coefficient for extraction;
- o Low volatility;
- o Low toxicity;
- o Safety and ease of handling;
- o Recoverability; and
- o Treatability of washing fluid.

Effectiveness

Soil washing is an extracting process with a number of variations that range from experimental to full scale. Acids, bases, and chelating and/or solvent solutions have been used to extract the metals from soil. The extracting solutions are treated to recover or concentrate the metals. Although the treated soil could theoretically be backfilled if delisted, concentrated metal sludge must be disposed of as a hazardous waste.

The effectiveness of this technology at the Van Der Horst site would be related to the soil type, extracting agent, and other factors. A pilot study is needed to evaluate the chemicals required and the efficiency of the soil washing system.

Implementability

Soil washing systems typically experience some problems related to soil/liquid separation. These problems were encountered subsequent to the washing phase, due to the high percentage of silt or clay in the soil material. In general, if the contaminated soil contains more than 50% clay material, soil washing is not an effective remedial technology. However, if the contaminated soil contains more than 50% sand and gravel materials, soil washing may provide a cost-effective solution.

Review of the characteristics of the unconsolidated strata (0 to 60 ft.) at the Van Der Horst site indicates the soil is primarily gravel and sand with occasional cobbles. Thus, soil washing appears to be a feasible remedial alternative for this site.

Alternative 5: On-Site Solidification/Stabilization

Under this alternative, contaminated soil would be excavated and contaminated sediment would be dredged. The contaminated soil and sediment would be solidified/stabilized on-site. The treated media would then be backfilled on-site or disposed of off-site in a landfill. The method of excavation or dredging would be the same as described for Alternative 3.

A cement-based or thermoplastic solidification process appears feasible for the Van Der Horst site, since this technique has proven effectiveness in treating soils contaminated with heavy metals and low-level organics. However, bench-scale and pilot-scale studies are needed to evaluate the optimum solidification/stabilization process. Factors to be considered include leachability, volume increase, and strength of the solidified material.

Solidification of the contaminated soil and sediment is expected to result in an increase in volume of approximately 25%. The actual increase in volume would be evaluated by bench- and pilot-scale studies. Although solidification of the contaminated soil and sediment would reduce the potential for direct contact with heavy metals, it appears the treated soil may still be classified as a RCRA-listed hazardous waste.

Effectiveness

Excavation/dredging and landfilling are both established technologies. Solidification/stabilization techniques have been effective in immobilizing organic and inorganic contaminants in a solid monolith, thereby limiting their release to the environment and the possibility of direct contact with potential receptors. Thus, under this remedial alternative the remedial action objectives for the soil and sediment appear to be satisfied.

The major issue regarding solidification is its long term performance. Studies may be conducted during the bench-scale and pilot-plant testing to evaluate long-term leaching potential of the solidified material. By disposing of the solidified material in a RCRA-compliant hazardous waste landfill, adequate protection of human health and the environment would be addressed.

Implementability

During implementation of this alternative, the solidified material would be placed in lined dump trucks or trailers and transported to the closest available hazardous waste landfill. Thus, prior to implementing an on-site solidification/ stabilization technology, a preliminary bench-scale study will be needed to evaluate the suitability of this technology relative to off-site transport.

Alternative 6: Off-Site Disposal of Heavily Chromium Contaminated Soil and On-Site Solidification/Stabilization of Less Contaminated Soil

Remedial action under this alternative includes: 1) excavation of heavily chromium contaminated soil and dredging of contaminated sediment followed by off-site landfill disposal; and 2) excavation of the less contaminated soil and solidification/stabilization on-site. The method of excavation and disposal in a landfill would be the same as described for soil/sediment Alternative 3. The method of solidification/stabilization would be the same as described for soil/sediment Alternative 5.

Effectiveness

The effectiveness of this alternative has been previously discussed in terms of the effectiveness of Alternative 3 (i.e., excavation and off-site disposal in a landfill) and Alternative 5 (i.e., solidification/stabilization). This combined alternative appears to satisfy the remedial action objectives.

Implementability

This alternative would be technically implementable, as discussed for soil/sediment Alternatives 3 and 5.

Alternative 7: Off-Site Disposal of Less Contaminated Soil and On-Site Washing (Reclamation) of Heavily Chromium Contaminated Soil

This alternative includes the same methods as described for Alternative 6 except the heavily chromium contaminated soil would be washed and the less contaminated soil would be landfilled.

Effectiveness

This alternative appears to satisfy the remedial action objectives, as discussed for soil/sediment Alternatives 3 and 4.

Implementability

This alternative would be technically implementable, as discussed for soil/sediment Alternatives 3 and 4.

Alternative 8: On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil

Remedial action under this alternative would include the same methods as described for soil/sediment Alternatives 2 and 4. In this case the heavily chromium contaminated soil would be excavated, soil washed, and then backfilled when delisted. Uncovered areas would then be capped as outlined for Alternative 2.

Effectiveness

This alternative would appear to satisfy the remedial action objectives, as discussed for soil/sediment alternatives 2 and 4.

Implementability

This alternative would be technically implementable, as discussed for soil/sediment Alternatives 2 and 4.

Alternative 9: Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment

Remedial action under this alternative would include the same methods as described for soil/sediment Alternatives 2 and 3. In this case the heavily chromium contaminated soil would be excavated and then landfilled off-site. Less contaminated areas would then be consolidated and capped as outlined for Alternative 2. Sediment would be brought to the site, consolidated with the less contaminated soil and capped.

Effectiveness

This alternative would appear to satisfy the remedial action objectives, as discussed for soil/sediment Alternatives 2 and 3.

Implementability

This alternative would be technically implementable, as discussed for soil/sediment Alternatives 2 and 3.

Alternative 10: Encapsulation

Alternative 10 would involve excavation and staging of the contaminated soil. The contaminated sediments from the storm sewer and Olean Creek would also be dredged/removed and staged at the site. The soil/sediment would then be encapsulated on-site using one of the three previously mentioned encapsulation processes. The encapsulated soil would then be landfilled.

Effectiveness

This alternative would satisfy the remedial action objectives because it would immobilize the on-site contaminants in the soil. However, this alternative would only be feasible if encapsulated soil could remain on-site. Since the majority of the soil at the Van Der Horst plant #1 site would be accepted in a sanitary landfill without any pretreatment, encapsulation offers little to no benefit unless it allows for on-site disposal.

Implementability

Implementability of this alternative would be difficult due to the energy and skilled labor requirements. Consequently, this alternative would have to show substantial benefits over other alternatives that produce similar results (e.g., soil washing, solidification/stabilization) to be selected.

Alternative 11: Storm Sewer Cleaning

This alternative would involve the use of mechanical and hydraulic sewer cleaning methods to remove sediment from the storm sewer lines between Van Der Horst Plant #1 and Olean Creek. The sediment will then be dewatered. The resulting liquids will be discharged to the local sanitary sewer system and the dewatered sediment will be treated and/or disposed of by one of the alternatives applicable to soil/sediment.

Effectiveness

This alternative satisfies the remedial action objectives for the storm sewer because it removes any past deposits of contamination and limits the potential future sources of contamination in the storm sewer. The effectiveness of the treatment of the sediment can be found in that particular alternative.

Implementability

This alternative would be readily implementable. The hydraulic and mechanical cleaning techniques are available and have been utilized extensively in the past. The equipment and techniques for collecting the sediment and dewatering it are also tried and available methods.

3.2.2 Evaluation of Ground Water Migration Control Alternatives

Four (4) ground water alternatives are discussed in this section. These alternatives, except for the no action/limited action alternative, involve pumping, treatment and disposal of contaminated water.

The preliminary screening of treatment technologies was discussed in Sections 2.6 and 2.7. Based on this preliminary technology screening, five metal treatment options and three organic chemical treatment options were selected. Section 3.2.2.1 discusses the screening of these treatment options and the incorporation of the selected options into the alternatives. Screening of the ground water alternatives is then addressed in Section 3.2.2.2.

3.2.2.1 Treatment Option Screening

The objective of ground water treatment is to reduce the concentrations of hexavalent chromium and PCE in the ground water to appropriate clean-up standards. These clean-up standards are established during the Phase III FS (Task VI). These treatment processes can be implemented by installing or mobilizing the equipment at the site or by transporting the water to an off-site facility.

Metal Treatment Option 1: Conventional Chemical Precipitation

Chemical precipitation (i.e., precipitation/flocculation/sedimentation) is the most common technique for the removal of heavy metals from wastewaters. The chemicals most frequently used for precipitation of metals are lime, caustic soda, and sodium carbonate. Although most heavy metals are precipitated readily without pH adjustment, hexavalent chromium is highly soluble and does not precipitate out of solution at any pH. Consequently, treatment for chromium usually consists of a two-stage process. First, the hexavalent chromium is reduced to the trivalent form (i.e, chemical reduction). Second, the trivalent chromium is precipitated out of solution and the water is neutralized prior to discharge.

Reducing agents most commonly employed are gaseous sulfur dioxide or a solution of sodium bisulfite. Since the reduction proceeds rapidly at low pH, an acid (for example, sulfuric acid or hydrochloric acid) is usually added to keep the wastewater pH between 2 and 3. The reduced chromium waste stream is then treated in the neutralization/precipitation stage for removal of heavy metals.

Metal Treatment Option 2: Sulfide Precipitation

Since most metals form stable sulfides, removals can be attained by sulfide precipitation. Sulfide precipitation yields lower residual metal concentrations than hydroxide precipitation, and metal sulfides usually settle faster and can be dewatered more readily than hydroxide sludges.

Sulfide precipitation processes currently used for wastewater treatment fall into two broad categories: 1) the soluble sulfide process (SSP); and 2) the insoluble sulfide process (ISP). In the SSP, the sulfide is added in the form of a water-soluble reagent, such as sodium sulfide. In the ISP process, developed by Permutt Co., a fresh prepared slurry (made by reacting ferrous sulfate and NaHS) serves as the source of sulfide ions. Sulfide and ferrous ions reduce hexavalent chromium to the trivalent state, thereby eliminating the need to treat the chromium wastes separately.

Metal Treatment Option 3: Ion Exchange

Ion exchange is a stoichiometric and reversible chemical reaction, wherein an ion from solution is exchanged for a similarly charged ion attached to an immobile solid particle. Although there are numerous inorganic materials possessing ion exchange capability, the synthetic organic sorptive resins are the predominant type used today because their characteristics can be tailored to specific applications.

Wastewater pretreatment requirements consist of pH adjustment to ensure that pH is within the operating range of the resin, and filtration to remove suspended solids that would foul the resin bed. A major drawback of ion exchange is that the resin must be regenerated after it has exhausted its exchange capacity. This problem complicates the operation of the system considerably. Additionally, conversations with vendors of ion exchange treatment systems have indicated that this method would be impractical due to relatively high anion concentration in the waste stream. Hence, this treatment option is <u>not</u> retained for further evaluation.

Organic Chemical Treatment Option 1: Activated Carbon Adsorption

Hexavalent chromium and PCE have been found to be readily adsorbed onto activated carbon, due to its low solubility in water and its high affinity towards activated carbon. Most applications involve the use of adsorption units which contain granular activated carbon (GAC) and operate in a downflow series mode. This method has been found to be cost-effective and produces the lowest effluent concentrations relative to other carbon absorber configurations (e.g., downflow in parallel, moving bed, upflow-expanded).

Activated carbon can be implemented into more complex treatment systems. The process is well suited to mobile treatment systems as well as to on-site construction. Space requirements are small, start-up and shut-down are rapid, and there are numerous contractors who are experienced in operating mobile units.

Organic Chemical Treatment Option 2: Air Stripping

Air stripping is a mass transfer process in which volatile contaminants in water are transferred to gas. Air stripping is used to remove volatile organics from aqueous waste streams. Generally, components with Henry's Law constants of greater than 0.003 can be removed by air stripping.

An important factor in the consideration of whether to utilize the air stripping technology for the removal of volatile contaminants, is the air pollution implications of air stripping. The gas stream generated during air stripping treatment may require collection and subsequent treatment or incineration. Hence, this option alone is not retained for further evaluation.

Organic Chemical Treatment Option 3: Air Stripping followed by Carbon Adsorption

Stripping of contamination by means of air has high removal efficiencies with chlorinated hydrocarbons. However, it is difficult to achieve the stringent NYS drinking water standards by air stripping alone. Air stripping followed by carbon adsorption (as a polishing unit) is considered as a viable option. However, small distribution and the relatively low concentrations of organics at the site do not justify the addition of air stripping. Carbon adsorption alone is sufficient for the organics at the site. Hence, this option is not retained for further evaluation.

3.2.2.2 Screening of Ground Water Migration Control Alternatives

Alternative 1: No Action/Limited Action Alternative

Under this alternative, no remedial actions would be taken to contain or treat the ground water. However, periodic monitoring of the concentrations of contaminants in monitoring wells and downgradient supply wells, if present, would be implemented.

Effectiveness

This alternative would not be effective in meeting the remedial action objectives. It would help in keeping track of the extent and migration patterns of contamination with the passage of time. Initial contamination found in the aquifer may remain as residual contamination after the implementation of this alternative. Any reduction in the level of contamination would be due to natural processes, assisting cleanup.

Implementability

No technical difficulties would be associated with implementation of this alternative. However, the no action/limited action alternative may be strongly opposed by the public due to concern over environmental conditions at the site.

Alternative 2: Ground Water Extraction, Treatment and Discharge to Surface Water

This alternative would include extraction of ground water, pretreatment using either conventional precipitation followed by carbon adsorption or sulfide precipitation followed by carbon adsorption and discharge of the treated ground water to surface water. This alternative would require a SPDES permit. The treatment system would be designed to attain or nearly attain Class C stream standards. It is anticipated such a permit would likely be granted.

Effectiveness

Although the exact hydrogeological behavior of contaminants cannot be predicted, this alternative appears to satisfy ground water remedial objectives for the site.

Implementability

No significant barriers to implementation are expected for this alternative. However, under this alternative ground water would require substantially more treatment than Alternative 3. As noted above, a SPDES permit would be required. The remedial scheme would require land area to locate the treatment units and land use restrictions would be necessary at the location of the treatment units for the duration of remediation.

Alternative 3: Ground Water Extraction, Pretreatment and Discharge to POTW

This alternative would include extraction of ground water, pretreatment, if necessary to meet the City of Olean Sewer Use Ordinance, followed by disposal to the

POTW. Pretreatment may involve using either carbon adsorption alone, conventional precipitation followed by carbon adsorption <u>or</u> sulfide precipitation followed by carbon adsorption.

<u>Effectiveness Evaluation</u>

Although the exact hydrogeological behavior of contaminants cannot be predicted, this alternative appears to satisfy ground water remedial objectives for the site.

<u>Implementability</u>

To implement this alternative, a Sewer Use Ordinance permit may be needed. It is anticipated that this permit can be obtained with limited effort.

<u>Alternative 4: Ground Water Extraction, Treatment and Reinjection</u>

This alternative would include extraction of ground water, pretreatment using either conventional precipitation followed by carbon adsorption <u>or</u> sulfide precipitation followed by carbon adsorption. Treated water would then be discharged into the aquifer using injection wells.

Effectiveness

This alternative is effective and appears to satisfy the ground water remedial objectives.

Implementability

A discharge to ground water permit would be necessary to implement this alternative. The injection system would require substantial engineering design and the injection of ground water would have to be done off-site to limit the effects on the capture zone of the extraction system. This alternative would require treatment to more stringent requirements (Class GA) than ground water Alternative 3. Thus this alternative is not retained for further evaluation because it provides no benefit over Alternatives 2 and 3 and results in substantially more potential implementation problems and costs.

3.2.3 Evaluation of Structure/Vats Alternatives

Alternative 1: No Action/Limited Action

Under this alternative, no remedial actions would be taken to clean or remove the structures/vats. However, securing the site by locking entrances and boarding windows will take place. This, along with the perimeter fence system, will help deter persons from coming into contact with the structures/vats.

Effectiveness

This alternative would not be effective in meeting the remedial action objectives. It would assist in keeping unwanted persons from contacting any potential contaminated surfaces, but it would not reduce the amount of contamination present.

Implementability

No technical difficulties would be associated with implementation of this alternative. However, the no action/limited action alternative may be strongly opposed by the public.

Alternative 2: Demolition and Off-Site Landfill Disposal

This alternative includes demolition of the structure, removal of the vats and disposal of the materials in an off-site landfill. Prior to the demolition and removal, the grossly contaminated structures/vats would be washed or cleaned using methods applicable to the particular material (e.g., steam cleaning, grit blasting, scarification, etc.) to make disposal in a sanitary or C&D landfill possible. If enough gross contamination is removed, the possibility of a scrap dealer, instead of a landfill, receiving some of the materials is possible.

Effectiveness

This alternative appears to satisfy the remedial objectives for this site.

Implementability

This alternative uses technologies that are currently available. There should be no difficulty in implementing this alternative.

Alternative 3: Decontamination of Surfaces

Under this alternative the structure/vats would be decontaminated using various cleaning techniques. The wastes from the cleaning would be contained either treated on-site with the soil/sediment or taken to an off-site facility. After cleaning, the structure would be readied for occupation.

Effectiveness

This alternative would be effective in meeting the remedial action alternatives if the contamination is just on the surface. However, if contamination is imbedded in the building materials, decontamination may not be effective. Also, since contamination was found beneath the building floor, the structure appears to need demolition. Thus this Alternative is not retained for further evaluation, since it restricts implementation of the overall site remediation program.

Implementability

This alternative uses proven technology that is readily available and therefore would be highly implementable if just surface contamination is encountered.

3.3 Summary of Screening

Eleven (11) alternatives for soil/sediment, two (2) alternatives and two (2) treatment process options for ground water, and three (3) for structures/vats passed the screening and appear to be the most feasible. These alternatives are summarized in this section.

3.3.1 Soil/Sediment Remediation Alternatives

The eleven (11) soil/sediment remediation alternatives that appear to be the most feasible, based on the screening process, are summarized below. Each alternative provides a distinctly different and effective (except Alternative 1) approach to addressing soil/sediment remediation in the study area.

- Alternative 1: No Action/Limited Action
- Alternative 2: Capping of Contaminated Soils; Removal of Sediment
- Alternative 3: Excavation and Off-Site Landfill Disposal
- Alternative 4: Soil Washing
- Alternative 5: On-Site Solidification/ Stabilization

- Alternative 6: Off-Site Disposal of Heavily Chromium Contaminated Soil and On-Site Solidification/Stabilization of Less Contaminated Soil
- Alternative 7: Off-Site Disposal of Less Contaminated Soil and On-Site Washing (Reclamation) of Heavily Chromium Contaminated Soil
- Alternative 8: On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil
- Alternative 9: Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment
- Alternative 10: Encapsulation of Chromium Contaminated Soil/Sediment
- Alternative 11: Sewer Cleaning Using Mechanical/ Hydraulic Scouring

3.3.2 Ground Water Migration Control Alternatives

Ground water Alternatives 2 and 4, which involved treatment followed by discharge to surface water and ground water, respectively, did not appear as feasible as Alternative 3 based on the screening process. As previously discussed, they involved treatment to more stringent water quality levels, which was not as implementable as discharging to the POTW. Since discharge to surface water appears more feasible then reinjection, Alternative 2 was retained as a contingency in the event that POTW discharge is denied. The ground water alternatives and treatment options retained for detailed analysis are summarized below:

- Alternative 1: No Action/Limited Action
- Alternative 2: Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation followed by Activated Carbon Adsorption and Discharge to City of Olean Wastewater Treatment Plant
- Alternative 3: Ground Water Extraction, Pretreatment, if necessary, using Sulfide Precipitation followed by Activated Carbon Adsorption and

Discharge to City of Olean
Wastewater Treatment Plant

3.3.3 Structures/Vats Remediation Alternatives

Structures/Vats Remediation Alternative 2, which involves decontaminating the structure, demolishing/dismantling it and landfilling the debris appears to be the only feasible alternative for structures/vats. This alternative along with the no action/limited action alternative is summarized below:

- Alternative 1: No Action/Limited Action
- Alternative 2: Demolition/Decontamination
  Note that Decontamination will include grit blasting, steam cleaning and scarification depending on contaminant type and surface to be cleaned.

3.3.4 Comprehensive Remedial Alternatives

The following range of comprehensive alternatives were developed for the Van Der Horst Plant No. 1 site by combining the media-specific alternatives for soil/sediment, ground water and structures/vats. From these media-specific alternatives ten (10) overall remedial alternatives were formulated and are further evaluated during the Treatability Study (Section 4.0) and the Detailed Analysis of Alternatives (Section 5.0).

Alternative 1:
(1) No Action/Limited Action
(2) Monitoring of Ground Water

Alternative 2:
(1) Capping the Site (or a specific area of the site)
(2) Removal of Sediments and Off-Site Landfill Disposal or Consolidation On-Site
(3) Monitoring of Ground Water
(4) Demolition/Decontamination of Plant Building
(5) Storm Sewer Cleaning

Alternative 3:

(1) Excavation of Soil/Sediment and Off-Site Landfill Disposal

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 4:

(1) Excavation of Soil/Sediment and Soil Washing

(2) Ground Water Extraction, Pretreatment, if necessary, using Sulfide Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 5:

(1) Excavation of Soil/Sediment, On-Site Solidification/Stabilization

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 6:

(1) Excavation of Soil/Sediment and Off-Site Landfill Disposal of Heavily Chromium Contaminated Soil and On-Site Solidification/Stabilization of Less Contaminated Soil

(2) Ground Water Extraction, Pretreatment, if necessary, using Sulfide Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 7: (1) Excavation of Soil/Sediment and Off-Site Landfill Disposal of Less Contaminated Soil and On-Site Washing and Reclamation of Heavily Chromium Contaminated Soil

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 8: (1) On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil

(2) Ground Water Extraction, Pretreatment, if necessary, using Sulfide Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 9:
(1) Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment
(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water
(3) Monitoring of Ground Water
(4) Demolition/Decontamination of Plant Building
(5) Storm Sewer Cleaning

Alternative 10:
(1) Encapsulation of Chromium Contaminated Soil
(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water
(3) Monitoring of Ground Water
(4) Demolition/Decontamination of Plant Building
(5) Storm Sewer Cleaning

4.0 TREATABILITY STUDIES

4.1 Introduction

Treatability studies were carried out in order to: 1) provide preliminary data for further development of treatment alternatives; 2) to screen out selected technologies that do not appear to be applicable due to specific site conditions; and 3) to reduce the cost and performance uncertainties associated with some of the treatment alternatives presented in Section 3.0. The information presented in this section is based upon the results of the February 12, 1991 "Van Der Horst Treatability Study" report prepared by General Testing Corporation (GTC), Rochester, New York, which is included as Appendix B.

4.2 Scope and Methodology of the Studies

This section describes the general scope of the laboratory screening treatability studies conducted by GTC. Prior to completing the treatments, three original samples (i.e., water from MW-5D, highly-contaminated soil from near MW-5, and less contaminated soil from near MW-3) were analyzed to establish baseline parameters for subsequent comparisons with the treatment results. The testing protocols can be found in Appendix B.

Carbon Adsorption

Removal of hexavalent chromium from the ground water sample with activated carbon was attempted. The following different variations were used: 1) carbon isotherms that varied the amount of carbon added; 2) varying the contact time at a selected carbon to water ratio; 3) using either a glass or membrane filter to filter carbon out of the solution; and 4) precipitation followed by carbon treatment.

Reduction

Three reducing agents, sodium metabisulfite, ferrous sulfate and sulfur dioxide, were added to the ground water sample to monitor their effects on the reduction of hexavalent chromium. Beakers of sample water were first adjusted to a pH of 2.5 using concentrated sulfuric acid. The agents were then added to the water, first at their theoretical levels and then at increased levels, to assess the amount of reducing agent needed. The treated water was then analyzed to measure the effectiveness of the various agents.

Precipitation

In this portion of the study, lime and sodium hydroxide were separately added to samples of ground water that were first treated with doses of the aforementioned reducing agents. This treatment was run to assess how well combinations of reducing agents and precipitation agents removed the metals from the ground water samples, and to ascertain the volume and toxicity of the sludge that is generated from this process. Additionally, the use of sodium hydroxide and lime, without a previous reduction step, and using sodium sulfide as a reducing agent prior to adding the precipitation agents was tested.

The study was carried out by first adjusting the pH of the untreated ground water sample to 2.5, using sulfuric acid. An optimum amount of one of three reducing agents, identified in the earlier reduction study, or sodium sulfide was then added. The pH of this mixture was then adjusted to approximately 10 using one of the two precipitation agents (i.e., sodium hydroxide or lime). After the resulting sludge had settled, it was filtered, collected and analyzed for metals and for TCLP. The treated water was analyzed to see how well the treatment removed the metals. The above procedure was also carried out with no reduction agent added, using only the lime and sodium hydroxide precipitation agents.

Soil Washing

This study evaluated the removal of metal contaminants from the heavily contaminated soil found near MW-5 using soil washing. Four (4) wash solutions, the TCLP extraction fluid, a 5% ethylenediaminetetraacetic acid (EDTA) solution, a 5% nitric acid solution and a 2:1 EDTA/nitric acid solution were chosen based upon their probability to remove the metals and their ease of handling. Additionally, the 5% EDTA solution was used to wash a separate sample twice. A deionized water wash solution was also chosen to set a baseline against which the other solutions would be judged.

Each of the solutions was added to a measured amount of soil, and agitated. The solids were then separated from the liquids and both mediums were analyzed.

Solidification/Stabilization

In the solidification/stabilization (SS) study, samples of both the highly contaminated soil and the less contaminated soil were treated with lime, a 1:1 lime to ferrous sulfate mix and a 3:1 lime to fly ash mix. Three different ratios of soil to additive weight were attempted (approximately 2:1, 3:1 and 4:1) with an equal amount of water added each time (100 ml) to activate the reaction. After allowing the material to cure, samples from the stabilized materials were analyzed for TCLP and total metals. The lime and fly ash were also analyzed to see if there were any trace contaminants that could have impacted final concentrations of the treated soils.

4.3 Results from the Treatability Studies

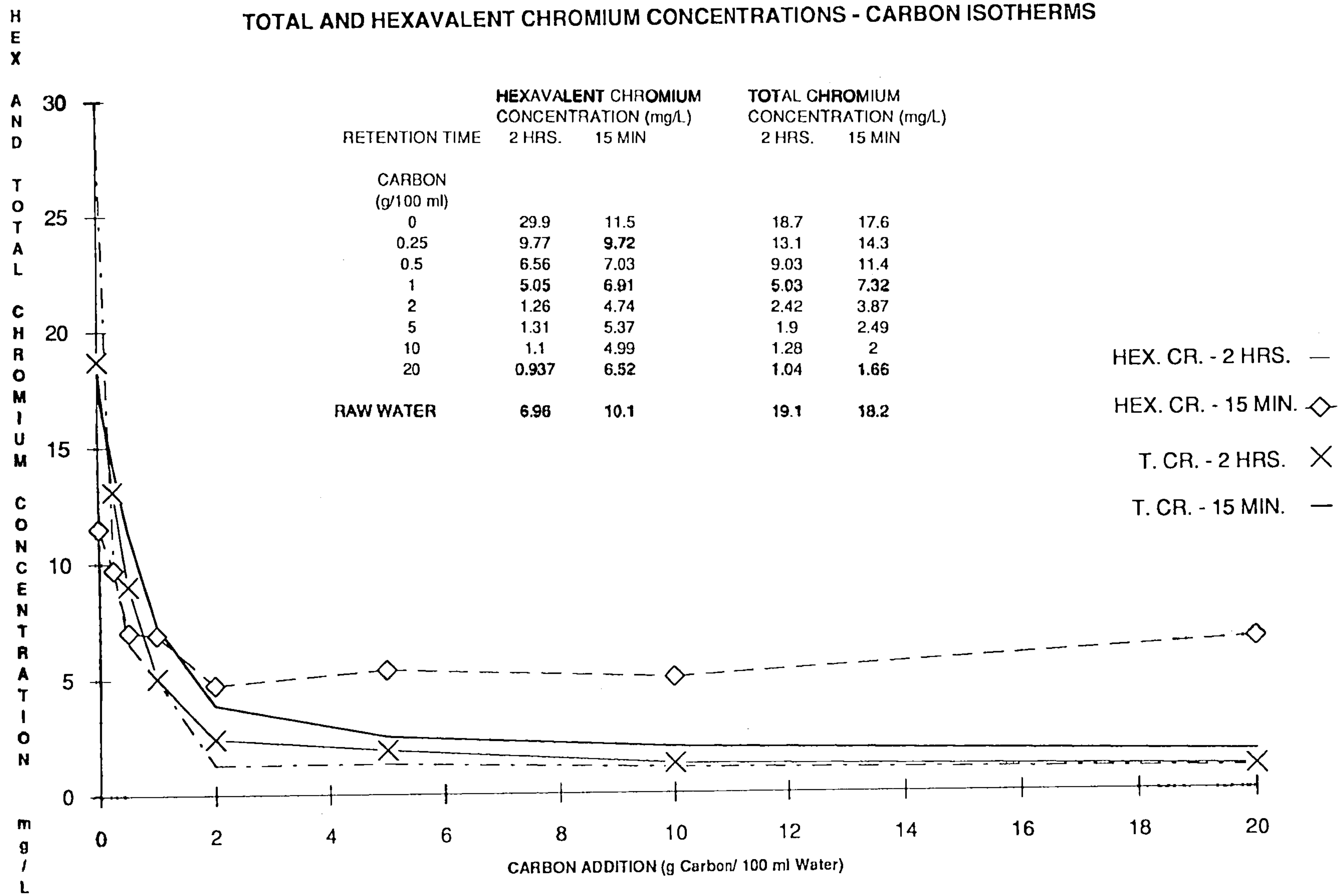
Carbon Adsorption

Various isotherms were attempted using Calgon WPX pulverized carbon added to ground water samples to evaluate the chromium removal efficiency of the carbon. As shown in Figure 4-1, hexavalent chromium can be reduced to below the City of Olean POTW levels of 5.5 mg/L using carbon. The figure shows that the hexavalent chromium that was treated for 15 minutes at 20 g carbon/100 ml ground water was reduced to 1.66 mg/l total chromium from an initial total chromium concentration of 19.1 mg/L. Note that although hexavalent chromium analysis is somewhat unreliable, the total chromium concentration for that sample was only 1.66 mg/L, and this

FIGURE 4-1

TOTAL AND HEXAVALENT CHROMIUM CONCENTRATIONS - CARBON ISOTHERMS

RETENTION TIME	HEXAVALENT CHROMIUM CONCENTRATION (mg/L) 2 HRS.	HEXAVALENT CHROMIUM CONCENTRATION (mg/L) 15 MIN	TOTAL CHROMIUM CONCENTRATION (mg/L) 2 HRS.	TOTAL CHROMIUM CONCENTRATION (mg/L) 15 MIN
CARBON (g/100 ml)				
0	29.9	11.5	18.7	17.6
0.25	9.77	9.72	13.1	14.3
0.5	6.56	7.03	9.03	11.4
1	5.05	6.91	5.03	7.32
2	1.26	4.74	2.42	3.87
5	1.31	5.37	1.9	2.49
10	1.1	4.99	1.28	2
20	0.937	6.52	1.04	1.66
RAW WATER	6.96	10.1	19.1	18.2



total contains the hexavalent fraction.

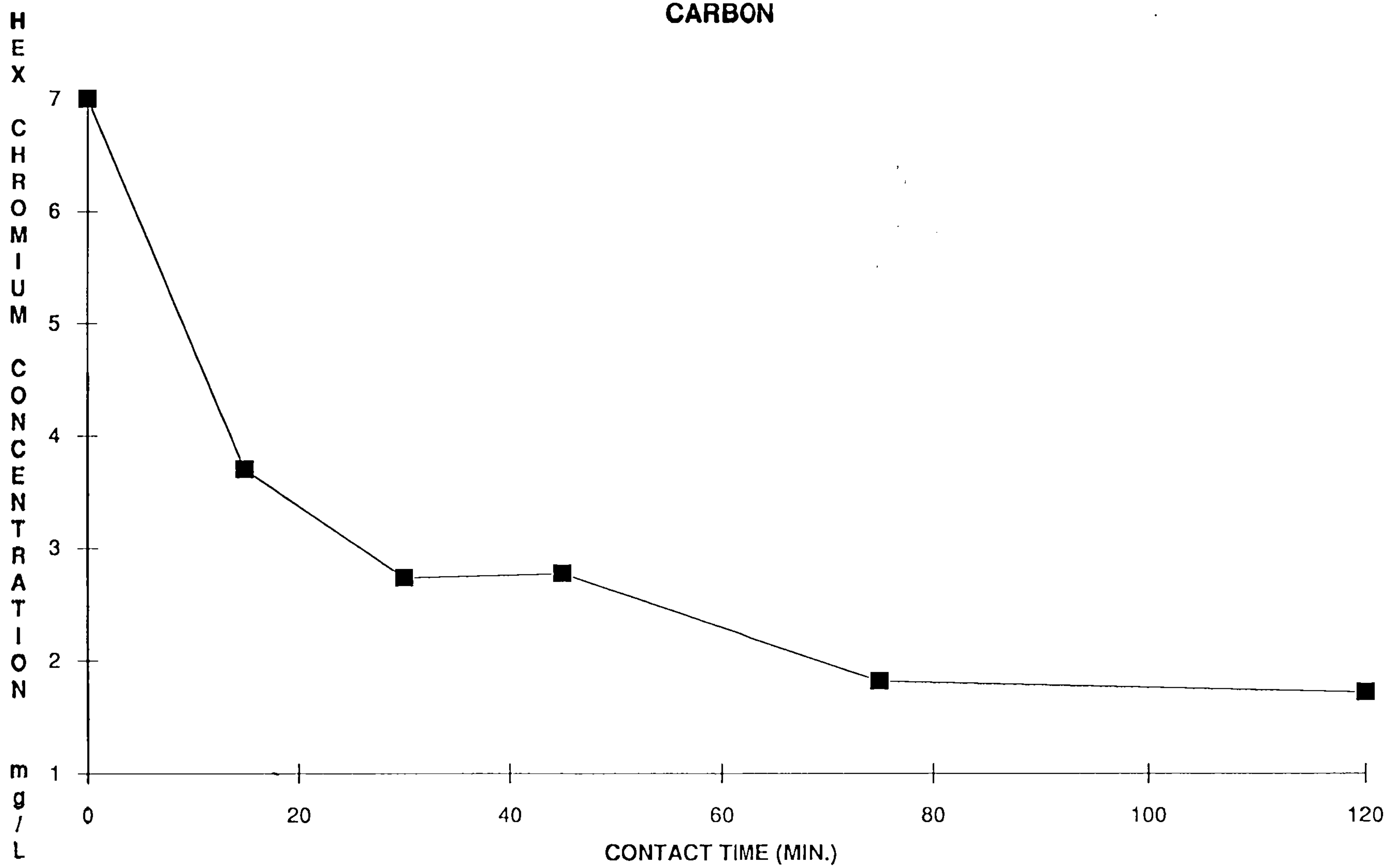
Figure 4-1 shows that the chromium is removed and reduced significantly up to 2 g/100 ml of carbon addition. Above this addition of carbon, reduction/removal still takes place but at a much slower rate. Approximately 87% of the total chromium is removed using 2 g/100 ml of carbon with very little additional percentage removed at increasing amounts of carbon. It also appears from this graph that the longer a sample is allowed to come into contact with the carbon the greater the effectiveness of the treatment.

The next stage of the activated carbon treatment was to evaluate whether there is an optimum contact time. This was done by adding 2 g carbon/100 ml water and varying the contact time with the water. As shown on Figure 4-2, there appears to be a significant reduction of chromium with increasing time up until the 75 minute range. Reduction of the chromium still appears to be taking place after this time; however, at a much slower rate.

Two other screenings were conducted using the carbon including: 1) varying the filter (i.e., glass filter vs. membrane filter) to see if this had an impact on the results and; 2) attempting a simple precipitation prior to carbon

FIGURE 4-2

HEXAVALENT CHROMIUM CONCENTRATION AFTER BEING TREATED WITH 2 g/100ml OF CARBON



treatment. It appears that neither of these variations had a major impact on the efficiency of the carbon treatments.

An article, published by the Polaroid Corporation on hexavalent chromium treatment using activated carbon (see Appendix B), shows the effective use of activated carbon on a waste stream containing chromium. After further discussions with the Calgon Corporation it was determined that: 1) carbon could possibly treat the total chromium to a level as low as non-detectable and; 2) that while the isotherms that were run during the laboratory screening showed relative treatment to each other, dynamic testing can and should be performed to see the actual removal efficiencies and loadings under conditions that would be similar to the proposed actual operating conditions (i.e., on scale model columns).

Reduction

The hexavalent chromium reductions, using sodium metabisulfite and ferrous sulfate, were first attempted using 100%, 150% and 175% of the theoretical amount of reducing agent needed to reduce the chromium. After varying the reaction times between 15 and 30 minutes, this first run produced little to no reduction in hexavalent chromium as evidenced by analytical results. A second attempt was made to reduce the hexavalent chromium, this time using color change as an indicator of the reduction. The ferrous sulfate and the sodium metabisulfite reducing agents were able to reduce the hexavalent chromium down to less than 10 parts per billion (ppb). The minimum amount of these reducing agents needed appeared to be 10 to 24 times greater than the theoretical amounts or 0.4 mg/L and 2.4 mg/L for the sodium metabisulfite and the ferrous sulfate, respectively.

Gaseous sulfur dioxide was also used as a reducing agent. The sulfur dioxide (116 ml/L maximum) was only able to reduce the hexavalent chromium to approximately 50 ppb, which is near the Class GA standard of 11 ppb.

Precipitation

As the data in table 4-1 show, sodium metabisulfite and lime, sulfur dioxide and lime, and sodium sulfide and lime can reduce the concentrations of listed metals in the ground water down to approximately class "GA" ground water standards. The other treatment methods did not reduce the total chromium to approximately 0.05 ppm or increased the iron content (i.e., the two samples treated with ferrous sulfate).

Table 4-1
ANALYSIS OF RAW AND TREATED WATER/TWO STEP PRECIPITATION

Reducing Agent	Raw	Class "GA"	Na2S2O5	Na2S2O5	FeSO4	FeSO4	SO2	SO2	Na2S	Na2S	----	----
Precipitation Agent	**Water**	**Standards**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**
Volume	NA	NA	1700 ml	1700 ml	2000 ml	2000 ml	2000 ml	2000 ml	1700 ml	1700 ml	2000 ml	2000 ml
pH	7.5	6-9	10.1	10.1	10	10	10.3	10	10.4	10.2	9.9	10
Suspended solids	24.6	NA	89	90.6	27.4	3	131	59.8	2.5	55.5	6.3	4.3
Hex Cr	6.96	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	9.8	2.82
As	<0.005	0.05	----	----	----	----	----	----	----	----	----	----
Ba	0.075	1	<0.10	<0.10	0.2	<0.10	<0.10	<0.10	0.16	<0.10	<0.10	<0.10
Cd	<0.005	0.01	----	----	----	----	----	----	----	----	----	----
Cr	20.8	0.05	0.051	7.6	0.052	0.029	0.022	6.5	0.043	12.4	17.3	15.4
Pb	<0.50	0.05	----	----	----	----	----	----	----	----	----	----
Hg	<0.0002	0.002	----	----	----	----	----	----	----	----	----	----
Se	<0.005	0.01	----	----	----	----	----	----	----	----	----	----
Ag	0.21	0.05	<0.010	<0.010	<0.010	<0.010	0.023	0.017	0.02	0.012	<0.010	<0.010
Fe	1.62	0.3	<0.050	<0.050	1.33	1.39	0.06	0.11	<0.05	0.15	<0.05	<0.05

NOTE:
1) EXCEPT WHERE NOTED, UNITS ARE IN mg/L.
2) TWO STEP PRECIPITATION PROCESS REFERS TO HEXAVALENT CHROMIUM REDUCTION FOLLOWED BY PRECIPITATION.

Treatment levels could probably be reduced more if the metal was precipitated out at a more optimum pH. All of the precipitations were carried out at a pH of approximately 10 to maintain consistency, and according to some literature values, the solubility of chromium hydroxides are lowest at a pH of approximately 8-9. Also, the treatments were preformed on water collected from well MW-5D, the Phase I/II RI monitoring well with the highest chromium concentration.

The sludge resulting from the treatment was collected weighed and, where there was sufficient sample, analyzed for total and TCLP metals. In some cases, mainly the samples using sodium hydroxide as the treatment agent, not enough sludge sample was generated to run all the parameters. This did not cause a major data gap because the samples that had an insufficient sludge volume, except for the sample treated with sodium sulfide and lime, were associated with a treated water sample that did not approximately meet class "GA" standards. Additionally, the sodium sulfide and lime sludge probably would not pass the test for reactivity due to the presence of sulfides.

Of the four samples that had sufficient sludge volume to run TCLP parameters, the ferrous sulfate/sodium hydroxide treated sample failed the TCLP criteria for chromium (Table 4-

2). The three remaining sludges that passed the TCLP criteria (i.e., those that would be classified as non-hazardous) are the samples from the water treated with: 1) sodium metabisulfite and lime; 2) ferrous sulfate and lime; and 3) sulfur dioxide and lime. Of these three, the ferrous sulfate and lime treated water sample had a high level of iron in it and the sulfur dioxide and lime generated almost three times the amount of sludge generated by the sodium metabisulfite and lime. Thus, it is felt that the most efficient overall ground water precipitation treatment method, taking into account water treatment, sludge volume and sludge toxicity, is the sodium metabisulfite and lime treatment.

Soil Washing

Of the four soil washing solutions used (i.e., the TCLP extraction fluid, a 5% EDTA solution, a 5% nitric acid solution and a 2:1 EDTA/nitric acid solution) the one with the greatest chromium removal efficiency was the 5% nitric solution. However, this solution was only able to reduce the total chromium from 11,800 ppm to 960 ppm which is substantially above the proposed cleanup level of 50 ppm (Table 4-3). The highest levels of removal of the other metals in the soil was achieved using the 5% EDTA solution.

TABLE 4-2
TOTAL METALS ANALYSIS OF SLUDGE FROM TWO STEP PRECIPITATION

Reducing Agent	Na2S2O5	Na2S2O5	FeSO4	FeSO4	SO2	SO2	Na2S	Na2S	----	----
Precipitation Agent	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**
Volume	12.9 g	0.52 g	23.8 g	13.4 g	34.4 g	0.02 g	5.71 g	0.07 g	2.55 g	0.47 g
Hex Cr	<1.0	----	<1.0	<1.0	40.4	----	----	----	----	----
As	5.1	----	<5.0	<5.0	<0.5	----	<8.0	<0.5	<0.5	15
Ba	39	80	20.7	<10	50	----	523	72	<10	203
Cd	2.4	----	1.4	1.1	<0.5	----	----	<0.5	<0.5	<0.5
Cr	2400	----	1290	2510	938	----	341	98	1.7	3.2
Pb	<5.0	----	<5.0	4.94	<5.0	----	<71	<5.0	<5.0	<10
Hg	<0.10	----	<0.10	<0.10	<0.1	----	----	<0.1	----	----
Se	<0.5	----	<0.50	<0.50	<0.5	----	<10	<0.5	<0.5	<1.0
Ag	3.5	<1.0	<1.0	<1.0	----	----	----	----	----	----

TCLP ANALYSIS OF SLUDGE FROM TWO STEP PRECIPITATION

Reducing Agent	TCLP	Na2S2O5	Na2S2O5	FeSO4	FeSO4	SO2	SO2	Na2S	Na2S	----	----
Precipitation Agent	**LIMITS**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**	**Lime**	**NaOH**
As	5.0	<0.5	----	<0.5	<0.5	<0.5	----	----	----	----	----
Ba	100.0	2.8	----	0.86	2.1	0.89	----	----	----	----	----
Cd	1.0	<0.1	----	<0.1	<0.1	<0.1	----	----	----	----	----
Cr	5.0	<0.1	----	0.49	8.8	1.1	----	----	----	----	----
Pb	5.0	<0.1	----	<0.1	<0.1	<0.1	----	----	----	----	----
Hg	0.2	<0.002	----	<0.002	<0.002	<0.002	----	----	----	----	----
Se	1.0	<0.5	----	<0.5	<0.5	<0.5	----	----	----	----	----
Ag	5.0	0.22	----	0.22	<0.1	----	----	----	----	----	----

NOTE:

1) EXCEPT WHERE NOTED, UNITS ARE IN ppm.

2) TWO STEP PRECIPITATION PROCESS REFERS TO HEXAVALENT CHROMIUM REDUCTION FOLLOWED BY PRECIPITATION.

TABLE 4-3
TOTAL METALS LEFT IN SOIL AFTER WASHING

All units in ppm unless specified

TEST	Original Characterization	Original TCLP	DI WATER	TCLP FLUID	2:1 EDTA/HNO3	5% HNO3	5% EDTA	DUAL WASHING 5% EDTA
% SOLIDS	78.4	NA	NA	NA	NA	NA	NA	73.4
Hex Chromium	943	NA	200	190	100	150	43	40
Arsenic	23.2	<0.5	17.9	16.5	13.9	14.6	13.6	0.214
Barium	3280	3.91	115	160	925	1900	125	1670
Cadmium	<0.5	<0.1	NA	NA	NA	NA	NA	NA
Chromium	11800	0.717	7530	9260	8850	960	8380	6170
Lead	8960	39.2	5910	6850	4830	4430	3380	2520
Mercury	0.363	<0.002	<0.02	<0.02	<0.02	<0.02	<0.02	0.569
Selenium	<0.5	<0.5	NA	NA	NA	NA	NA	NA
Silver	<1	<0.1	NA	NA	NA	NA	NA	NA

% SOLIDS - DATA EXCEEDS TCLP LIMITS
NA - NOT ANALYZED

Solidification/Stabilization

Solidification/Stabilization (SS) was attempted on both the less and highly contaminated soils. The Treatability Study analyses of the soils indicate that the less contaminated soil was non-hazardous (i.e., it passed the TCLP) and the highly contaminated soil was hazardous, due to the presence of lead. Note that other samples tested from the MW-5 area during the Phase I RI did not pass TCLP for chromium, indicating that the MW-5 area also contains soil that exceeds the TCLP limit for chromium.

Table 4-4 presents the data from the laboratory screening study including the additive, the ratio of the soil to the additive, and the hexavalent chromium and TCLP metals data from the treated samples. In the less contaminated soils, treatment of the hexavalent chromium was used as the main evaluation parameter because the raw soils were already determined to be non-hazardous. The most efficient hexavalent chromium treatment was the lime/ferrous sulfate mixture. This additive reduced the hexavalent chromium from 66.4 ppm in the raw soil to <1.0 ppm with a 2:1 and 4:1 mixture. The mercury showing up in the 2:1 mixture appears to be an anomaly, due to the fact that all the other samples as well as the original soil had <0.002 ppm of leachable mercury.

TABLE 4-4

TCLP AND HEXAVALENT CHROMIUM DATA FROM SOLIDIFIED/STABILIZED SOILS

units are in ppm unless otherwise stated

TCLP AND TOTAL HEXAVALENT CHROMIUM DATA OF SOLIDIFIED/STABILIZED LESS CONTAMINATED SOIL (MW-3)

	Original	Original	Lime			Lime/Ferrous Sulfate			Lime/Flyash		
TEST	Characterization	TCLP	2:1.1	3:1.1	4:1.1	2:1	3:1	4:1	2:1.2	3:1.2	4:1.2
% SOLIDS	93	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hex Chromium	66.4	NA	5.3	6.2	8.7	<1.0	5	<1.0	10	3.7	7.9
Arsenic	8.77	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Barium	149	2.63	1.7	2.2	2.7	0.22	0.31	0.34	2	1.6	2.6
Cadmium	2.4	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	392	0.107	<0.10	0.11	0.16	<0.10	<0.10	<0.10	0.22	0.15	<0.10
Lead	258	0.206	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	0.19	<0.10	<0.10
Mercury	0.229	<0.002	<0.002	<0.002	<0.002	0.008	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium	<0.5	<0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	1.48	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA

TCLP AND TOTAL HEXAVALENT CHROMIUM DATA OF SOLIDIFIED/STABILIZED HIGHLY CONTAMINATED SOIL (MW-5)

	Original	Original	Lime			Lime/Ferrous Sulfate			Lime/Flyash		
TEST	Characterization	TCLP	2:1.1	3:1.1	4:1.1	2:1	3:1	4:1	2:1.2	3:1.2	4:1.2
% SOLIDS	78.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hex Chromium	943	NA	360	360	360	14	21	10	170	320	450
Arsenic	23.2	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Barium	3280	3.91	1.8	1.6	1.4	0.8	0.83	1	1.3	0.99	0.99
Cadmium	<0.5	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	11800	0.717	23	22	31	1.8	2.1	1.6	14	17	18
Lead	8960	38.2	30	23	5.6	<0.10	<0.10	<0.10	13	<0.10	<0.10
Mercury	0.363	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Selenium	<0.5	<0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	<1	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA

TEST - DATA EXCEEDS TCLP LIMITS

NA - NOT ANALYZED

TCLP LIMITS	ppm
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0

The greatest drop in hexavalent chromium concentrations was achieved using the 2:1 soil to lime/ferrous sulfate mixture. The 4:1 mixture also met TCLP limits; and, although it leached 0.12 ppm more barium than the 2:1 mixture, it increased the sample volume by only 25%. Thus, since a 50% volume increase occurred in the 2:1 sample, the 4:1 mixture should be used for the treatment of the less contaminated soil.

In the highly contaminated soils the 4:1 soil to lime/ferrous sulfate mixture appeared to be the most effective SS agent. The other two mixtures exceeded the TCLP limits for chromium and, in the case of the 2:1.2 soil to lime/flyash mixture, also exceeded the TCLP limits for lead. Although some metals were detected, the lowest levels, for the TCLP metals (except barium) were from the 4:1 soil to lime/ferrous sulfate mixture. This SS agent would also give the smallest increase in volume and; therefore, is the apparent choice among the SS methods for the highly contaminated soil. Note that the consistency of all the dry soil mixtures was generally a crumbly solid.

4.4 Treatment Recommendations

The following conclusions and recommendations have been made based on a review of the data and results from the laboratory screening studies carried out by GTC and from a review of the relevant publications cited:

1) The carbon adsorption technology appears to be applicable to hexavalent chromium removal and should be considered for use as the pretreatment method for ground water prior to discharge to the POTW. Note that ground water currently meets the City of Olean POTW requirements except for hexavalent chromium, which could be removed by the carbon pre-treatment.

2) Due to the overall lack of effectiveness in meeting the proposed cleanup requirements, mainly chromium and lead, soil washing should be eliminated from the list of applicable technologies for soil remediation.

3) Stabilization/solidification of both the highly contaminated soils and the less contaminated soils appears to be effective using a 4:1:1 soil to additive to water weight ratio. The most effective additive appears to be a 1:1 mixture of lime and ferrous sulfate. The ferrous sulfate reduces the hexavalent chromium while the lime appears to stabilize the metals. The consistency of this mixture after dying is a crumbly solid.

4) If conventional precipitation is needed for ground water treatment (i.e., the City of Olean POTW will not accept discharge or if the permit discharge levels are lowered), the conventional treatment method that appears to be most effective is reduction/precipitation method using sodium metabisulfite and lime.

The following are the range of comprehensive alternatives that remain based on data generated during the laboratory screening studies for the Van Der Horst site. Note that monitoring of ground water wells and downgradient supply wells is common to all 7 alternatives. These remedial alternatives will be further evaluated in Section 5 of this FS report.

Alternative 1: (1) No Action/Limited Action

(2) Monitoring of Ground Water

Alternative 2: (1) Capping the Site (or a specific area of the site)

(2) Removal of Sediments and Off-Site Landfill Disposal or Consolidation On-Site

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 3: (1) Excavation of Soil/Sediment and Off-Site Landfill Disposal

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 4:

(1) Excavation of Soil/Sediment, On-Site Solidification/Stabilization

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 5:

(1) Excavation of Soil/Creek Sediment, On-Site Solidification/Stabilization of Less Contaminated Soil and Off-Site Landfill Disposal of Highly Contaminated Soil

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 6: (1) Off-Site Disposal of Highly Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

Alternative 7: (1) Excavation and Encapsulation of Chromium Contaminated Soil

(2) Ground Water Extraction, Pretreatment, if necessary, using Conventional Precipitation and/or Carbon Adsorption and Discharge to POTW or surface water

(3) Monitoring of Ground Water

(4) Demolition/Decontamination of Plant Building

(5) Storm Sewer Cleaning

5.0 DETAILED ANALYSIS OF ALTERNATIVES

The seven (7) potential comprehensive alternatives developed for the Van Der Horst site are outlined in the previous section, and are summarized in Table 5-1. These remedial alternatives undergo a more detailed evaluation in this section.

The detailed evaluation of alternatives includes an individual analysis of the alternatives relative to criteria described in USEPA 540/6-89/004, and a comparative analysis of the relative performance of each of the alternatives. Completed evaluation forms for each alternative (adapted from the May 1990 NYSDEC TAGM for criteria 1 through 6) are included in Appendix C. The comparative analysis identifies the relative advantages and disadvantages of each alternative and includes a measure of remediation and cost-effectiveness. Ultimately, the comparative analysis leads to the selection of the recommended alternative.

5.1 Individual Analysis of Alternatives

The seven (7) remedial alternatives represent a range of distinct waste management strategies which, to a varying degree, address human health and environmental concerns associated with the site. Although the selected alternative will be further refined as

TABLE 5-1
SUMMARY OF ALTERNATIVES

MEDIA	Technologies	Alternative 1	2	3	4	5	6	7
Ground Water	Monitoring/Institutional Actions	●	●	●	●	●	●	●
	Extraction			●	●	●	●	●
	Carbon Absorption and Discharge to POTW or Conventional Precipitation			●	●	●	●	●
Soil/Sediment	Capping		●				●	
	Excavation		●	●	●	●	●	●
	Off-Site Disposal (Sediment)		●			●	●	
	Off-Site Disposal (Less Contaminated)			●				
	Off-Site Disposal (Highly Contaminated)		●	●		●	●	
	Solidification/Stabilization				●			
	Solidification/Stabilization (Less Contaminated)				●	●		
	Storm Sewer Cleaning/Dredging		●	●	●	●	●	●
	Encapsulation							●
Structures/Vats	Building Decontamination/Demolition/Dismantling		●	●	●	●	●	●

necessary during the predesign phase, these alternatives reflect the fundamental components of the various alternative hazardous waste management approaches being considered for this site. These alternatives are evaluated with respect to seven (7) of the nine (9) criteria recommended in USEPA 540/G-89/004. The seven (7) criteria are summarized in the following paragraphs. State acceptance and community acceptance, the remaining two (2) criteria, are not dealt with herein but will be addressed in the Record of Decision (ROD), once public/community comments have been received on the RI/FS report.

1) Overall Protection of Human Health and the Environment - The evaluation of each alternative with respect to the overall protection of human health and the environment provides a summary of how the alternative reduces the risk from potential exposure pathways through treatment, engineering or institutional controls. This criteria also evaluates whether alternatives pose unacceptable short-term or cross-media impacts. Pursuant to NYSDEC's request for this project, the risks associated with each alternative were evaluated qualitatively as opposed to a quantitative evaluation.

2) Compliance with SCGs - The applicable or relevant and appropriate New York State Standards, Criteria and Guidelines (SCGs) are applied to each alternative. The ability of each alternative to meet the SCGs or the need to justify a waiver is noted for each. The SCGs used include the following:

- Air
  - National Ambient Air Quality Standards (NAAQS)
  - New York State Ambient Guideline Concentrations (AGCs)

- Soil/Sediment
  - U.S. EPA Interim Guidance Cleanup Level for Lead in Soil
  - NYSDEC Chromium Limit for Sediment

- Ground Water
  - U.S. EPA Maximum Contaminant Levels (MCLs)
  - NYSDOH MCLs
  - NYSDEC Ground Water Quality Standards (September 1990)

- Surface Water
  - U.S. EPA Ambient Water Quality Criteria for the Protection of Human Health (Ingestion of Fish)
  - NYSDEC Water Quality Standards and Guidance Values (September 1990)

3) **Long-Term Effectiveness and Permanence** - Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage remaining waste (i.e., untreated waste and treatment residuals) over the long-term. Alternatives that have the highest degree of long-term effectiveness and permanence are those that leave little or no waste remaining at the site, such that long-term maintenance and monitoring are unnecessary and reliance on institutional controls is limited.

4) **Reduction of Toxicity, Mobility, or Volume Through Treatment** - Evaluation of reduction of toxicity, mobility, or volume through treatment addresses the anticipated performance of the treatment technologies. This evaluation relates to the statutory preference for selecting a remedial action that uses treatment to reduce the toxicity, mobility, or volume of hazardous substances. Aspects of this criteria include: 1) the amount of waste treated or destroyed; 2) the reduction of toxicity, mobility, or volume; 3) the irreversibility of the treatment process; and 4) the type and quantity of residuals resulting from any treatment process.

5) **Short-Term Effectiveness** - Evaluation of alternatives with respect to short-term effectiveness takes into account: 1) protection of workers and the community during the remedial action; 2) environmental impacts from implementing the action; and 3) the time required to achieve the cleanup goals.

6) **Implementability** - Implementability deals with the administrative and technical feasibility of implementing the alternatives as well as the availability of necessary goods and services. This evaluation includes such items as: 1) the ability to obtain services, capacities, and equipment; 2) the ability to construct and operate components of the alternative; 3) the ability to monitor the performance and the effectiveness of the technologies; and 4) the ability to obtain the necessary approvals and permits from other agencies.

7) **Costs** - Costs are divided into capital and operation and maintenance (O&M) costs. Capital costs include those expenditures required to implement a remedial action (i.e., both direct and indirect costs are considered). Direct capital costs include construction costs or expenditures for equipment, labor, and materials required to implement a remedial action. Indirect capital costs include those associated with engineering, permitting (as required),

construction management, and other services necessary to carry out a remedial action.

Annual O&M costs include labor, maintenance materials, energy, and purchased services. The O&M costs include costs incurred even after the initial remedial activity is complete. The 1991 present worth costs are estimated using a 5 percent discount per year for the time period associated with implementation of the specific alternative, not to exceed 30 years. Tables summarizing the basis for each cost and the actual cost estimate summaries are included in Appendix D.

The cost estimates presented herein are order-of-magnitude estimates; these costs are based on vendor information, conventional cost estimating guides, generic unit costs and prior experience. The feasibility study cost estimates shown have been prepared for guidance in project evaluation from the information available at the time of the estimate. The real costs of the project at the time of implementation will depend on real labor and material costs, site conditions, competitive market conditions, final project scope, the implementation schedule, and other variable factors both anticipated and unforseen. An uncertainty that would affect the cost is actual volumes of contaminated soil, sediment and ground water. The accuracy of these "study estimate" costs are expected to be in the range of +50 percent to -30 percent based on assumed site conditions and other variables as mentioned above.

Sensitivity analyses were not conducted on the individual costs. This analysis was considered to be of limited value for this site since the primary parameters that have a large degree of uncertainty associated with them (e.g., contaminated soil and water volumes) have a similar impact on the costs of Alternatives 3 through 7. The costs of the remaining two alternatives are substantially lower than Alternatives 3 through 7. Thus, a sensitivity analyses will not change the relative ranking of the alternatives with respect to cost. However, Section 6.0 includes a sensitivity analysis that was conducted on the selected alternative to estimate the needed contingency or reserve funds.

5.1.1 Common Components

Alternatives 1-7

Alternatives 1-7 have the following two (2) common components: 1) supply well restrictions; and 2) ground water monitoring. Descriptions of these components are below and the evaluation of these alternatives is included with the assessment of Alternative 3.

- **Supply well restrictions** - The local government or agencies will be requested to oversee well installation and use in the area that is, or is expected to be, within the affected area. This oversight may include a local regulation requiring a review/permit for all proposed ground water well installation and use plans. This regulation would prohibit installing or using wells in contaminated areas of the aquifer until ground water meets NYSDEC water quality standards.

- **Ground water monitoring** - Ground water monitoring is a method of evaluating the long-term performance of the selected remedial alternative by reviewing the contaminant concentrations within the ground water over time. Ground water monitoring of indicator parameters within the existing monitoring wells would be done periodically, until the parameter levels are below the SCG levels. This periodic monitoring program would continue beyond the cessation of remediation (for a limited time) to verify that contamination has been removed from the local ground water.

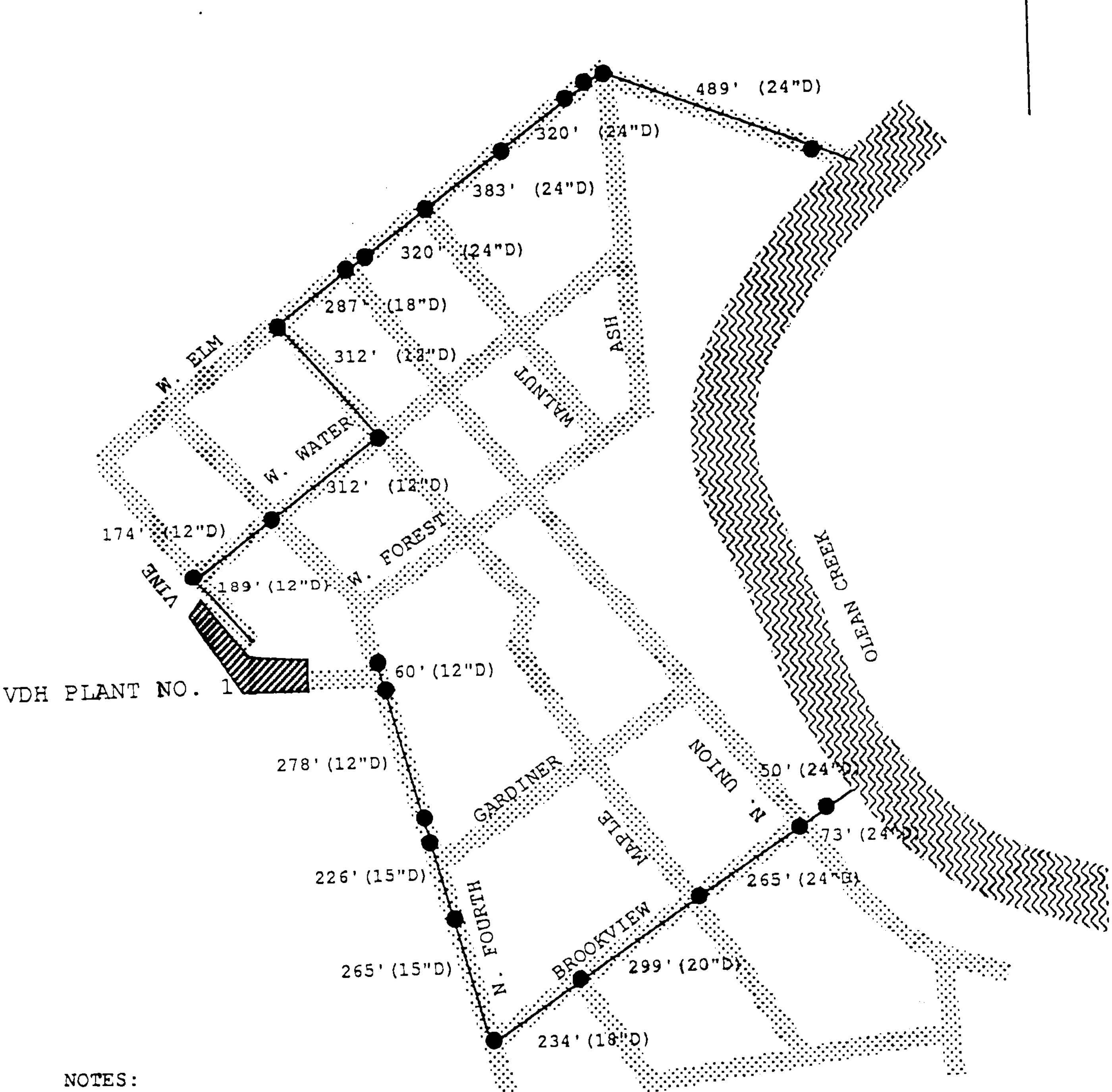
Alternatives 2-7

Alternatives 2-7 have the following four (4) common components, as well as the two listed above: 1) storm sewer cleaning; 2) dredging of creek sediments; 3)demolition/ decontamination of structures/vats; and 4) excavation. These components are described below.

- **Storm Sewer Cleaning** - Storm Sewer cleaning consists of using a high pressure water wash to clean contaminated sediment and debris from the storm sewer system. The sediment/debris will be collected at the manholes and transported in a vacuum truck to a mobil filter press for dewatering, if necessary. The dewatered storm-sewer sediment/debris would then be transported and disposed of along with the sediment dredged from Olean Creek. Video taping of the sewer will be preformed immediately following the cleaning of each reach to verify the cleaning process, prior to contractor demobilization.

  The storm sewer lines that presently appear to require cleaning are shown in Figure 5-1. Note that the storm sewer lines associated with the West Elm Street outfall will require further sampling prior to remediation to identify the extent of contamination within this storm

FIGURE 5-1
STORM SEWER PLAN



NOTES:

1) DRAWING NOT TO SCALE.
2) DRAWING ADAPTED FROM STORM SEWER PLAN PROVIDED BY CITY OF OLEAN ENGINEERING DEPARTMENT.

LEGEND:

———	STORM SEWER LINE POTENTIALLY REQUIRING CLEANING (TOTAL=4,536')
●	MANHOLE POTENTIALLY REQUIRING CLEANING (TOTAL=22 MANHOLES)

TITLE: STORM SEWER PLAN		
PREPARED FOR: NYSDEC		
ERM-Northeast, Environmental Resources Management	SCALE / DATE	FIGURE 5-1

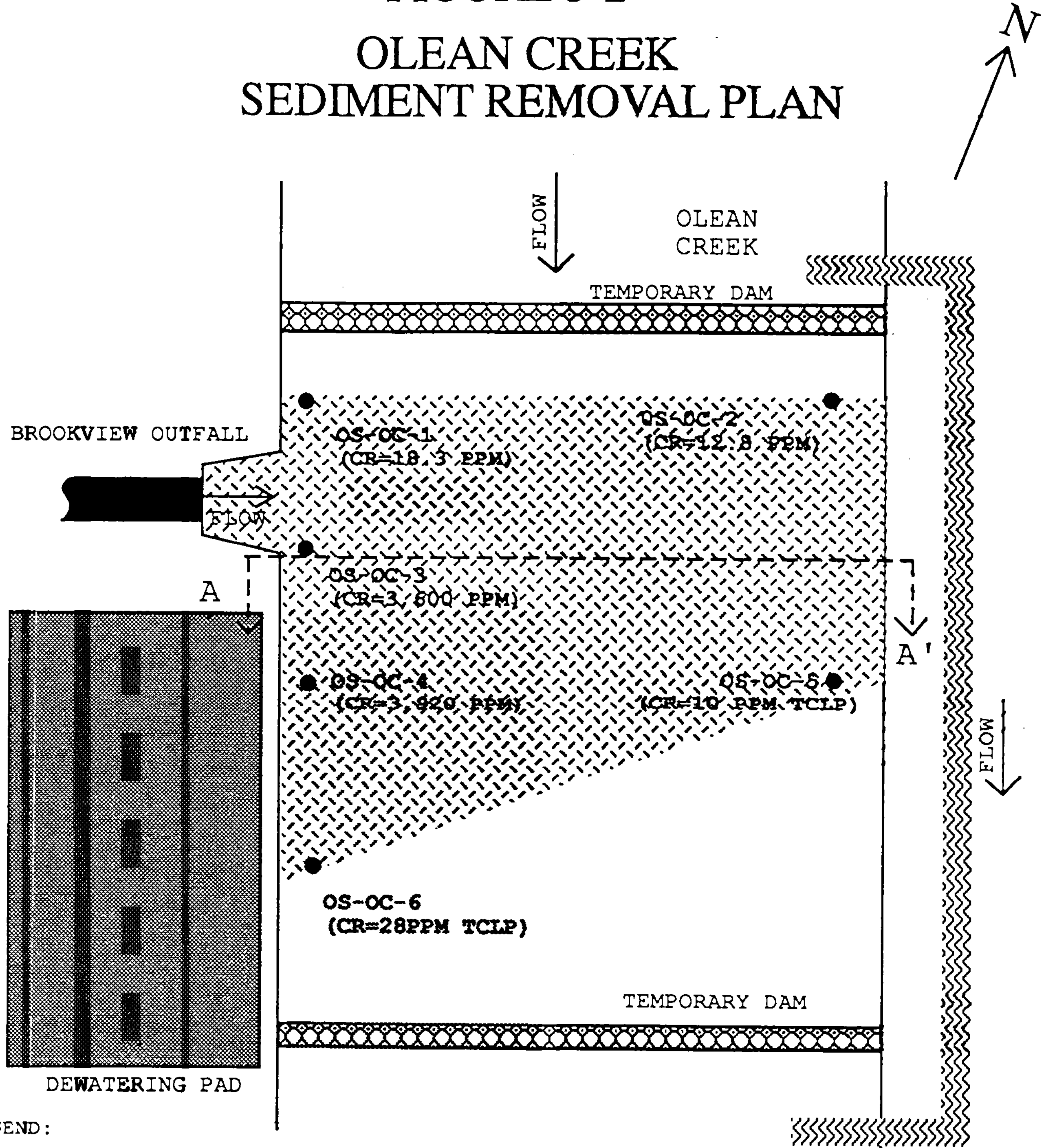
139839

sewer line. Including the storm sewer lines north of the site, the storm sewer cleaning program will potentially involve the cleaning of 4,536 linear feet of line and 22 separate manholes/catchbasins. The estimated volume of sediment that will be removed, based on visual estimates of the depth of sediment in lines and manholes, is approximately 50 cubic yards.

- Dredging - An area of Olean Creek of approximately 10,500 square feet (Figure 5-2) and 0.7 feet deep (Figure 5-3) would be dredged (total volume approximately equal to 272 cubic yards). This area (i.e., sediment with chromium levels greater than 26 ppm) needs to be further delineated prior to remediation since the downstream extent of chromium contamination has not been identified. The dredging would occur during mid to late summer low-flow conditions and would consist of installing a temporary dam on the up- and down- stream sides of the dredging area to limit the transport of potentially contaminated sediment during dredging. Olean Creek would be rerouted during the period of dredging using a diversion channel (see Figure 5-2). The sediment would be removed using a backhoe and dewatered in a mobile filter press. The liquid from the filter press would be treated in conjunction with the selected ground water

FIGURE 5-2

OLEAN CREEK SEDIMENT REMOVAL PLAN



LEGEND:

- ● SEDIMENT SAMPLING LOCATION
- AREA DESIGNATED FOR DREDGING

NOTES:

1) DRAWING NOT TO SCALE.
2) LIMITS OF SEDIMENT DREDGING ARE APPROXIMATE AND WILL NEED FURTHER DELINEATION PRIOR TO REMEDIATION.

TITLE		
OLEAN CREEK SEDIMENT REMOVAL PLAN		
PREPARED FOR NYSDEC		
ERM-Northeast Environmental Resources Management	SCALE DATE	FIGURE 5-2

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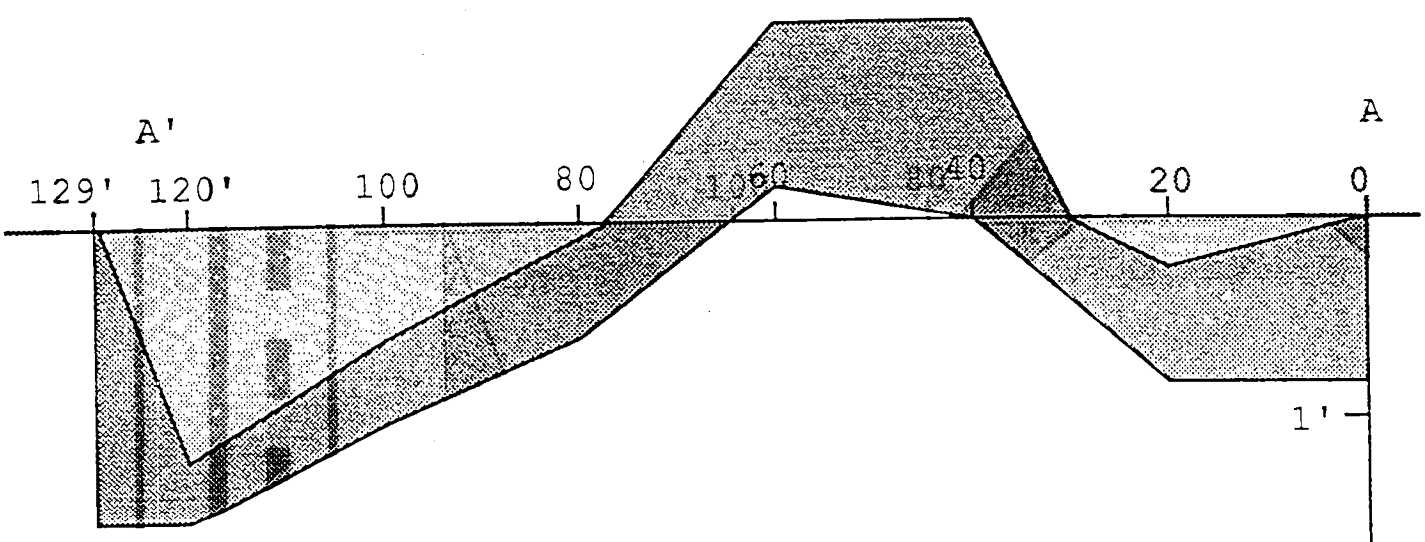
FIGURE 5-3

OLEAN CREEK
CHANNEL CR0SS-SECTION



DISTANCE	WATER DEPTH	SEDIMENT DEPTH
0	0"	10"
20'	3"	10"
40'	0"	12"
60'	0"	10"
80'	1"	7"
100'	7"	12"
120'	14"	18"
129'	0"	18"

LEGEND:

APPROXIMATE SEDIMENT AREA ON 8/30/91

APPROXIMATE WATER AREA ON 8/30/91

NOTES:

1) HORIZONTAL SCALE: 1" = 20'
2) VERTICAL SCALE: 1" = 1'
3) DEPTHS OF SEDIMENT ARE APPROXIMATE AND WERE ESTIMATED BY PROBING AT WIDELY SPACED INTERVALS THE DATA SHOULD BE CONSIDERED ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED.

TITLE		
OLEAN CREEK CHANNEL CROSS-SECTION		
PREPARED FOR NYSDEC		
ERM-Northeast Environmental Resources Management	SCALE DATE	FIGURE 5-3

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treatment alternative, and the remaining solids would be treated in conjunction with the contaminated soil/sediment at the site.

- **Demolition/Decontamination** - Initially, the asbestos containing materials (ACM) within the plant will be removed. Interior and exterior surfaces of the plant building will then be decontaminated using scarification and grit blasting. These methods were selected to limit the generation of liquid wastes. Wastes from the cleaning process will be collected, containerized and treated in conjunction with the selected on-site soil/sediment alternative. If the collected wastes are not compatible with the selected technologies or schedule of implementation, they will be taken to an off-site disposal facility. Once decontaminated, the building structure would be demolished/dismantled by a demolition contractor and the debris would be either sold to a scrap dealer or pulverized/crushed and taken to an off-site C&D landfill.

- **Excavation** - In Alternatives 2-7 excavation or grading is used to varying extents. However, there are associated activities that would take place as part of the excavation process that would be completed regardless of the extent of the excavations. These operations include decontamination, dust control and restoration/ revegetation.

Decontamination would be conducted at the designated decontamination area. This area would include a decontamination pad to be used for decontaminating equipment. The pad would be bermed and sloped to a sump to collect the water used to decontaminate the equipment. This water would then be treated and discharged along with the water from the storm sewer and creek sediment dewatering process.

On-site dust control would take place during construction and excavation operations. This technology would involve wetting down the soil to limit dust emissions. The quantity of water would be limited and would <u>not</u> cause leachate production and contaminant migration vertically into the soil or laterally off-site.

Following excavation, treatment (if required), and backfilling, the disturbed areas will be graded to limit surface flow on the land surface during storm events. The graded areas will then be seeded with perennial grass seed to limit erosion and fugitive dust emissions from the site. This procedure will also improve aesthetic conditions, given that the site is adjacent to residential housing.

Alternatives 3-7

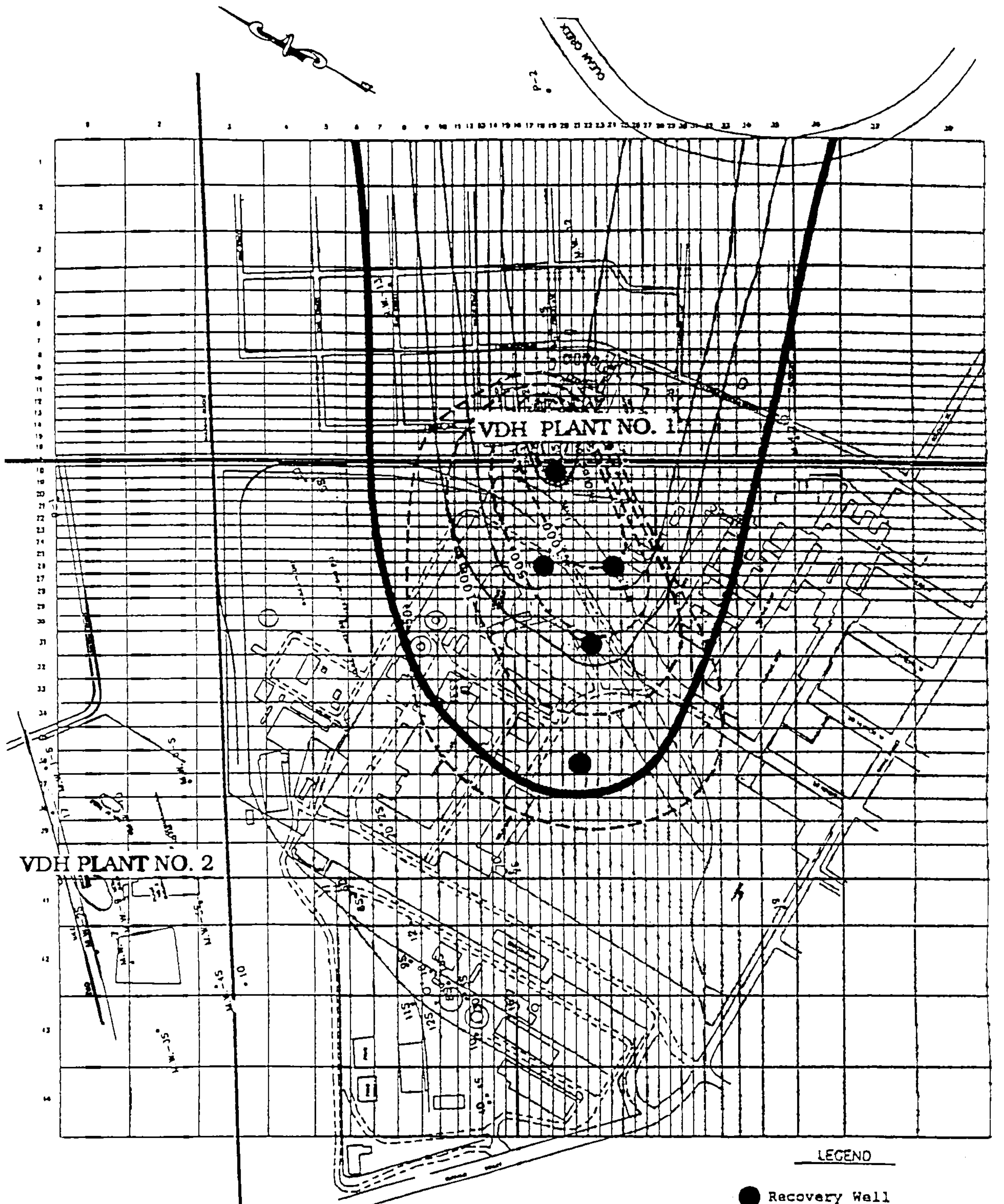
In addition to the six previously mentioned technologies, Alternatives 3-7 have the following three (3) components in common: 1) ground water extraction; 2) ground water treatment; and 3) discharge to either the POTW or to surface water. These components are described below:

- **Ground Water Extraction** - Ground water extraction is completed by strategically installing a series of wells in the study area to capture the contaminant plume (i.e., ground water at a concentration greater than 50 ppb hexavalent chromium). The wells are then continuously pumped, using submersible pumps, until the contaminant plume has been contained and then removed. The monitoring of ground water quality in the on-site monitoring well network as well as the water quality of the extracted ground water is used to assess the progress of the remediation. Remediation is considered complete when ground water levels are below SCGs.

Figure 5-4 shows the location of the proposed extraction wells. Based on the ground water model, this extraction well array will capture the chromium contaminated ground water identified by the deep and shallow monitoring well networks. The combined 5-well pumping rate will be approximately 1,280 gallons per minute (gpm). The total annual estimated volume of ground water that will be extracted is 673 million gallons which is approximately 3 plume volumes based on an estimate of the lateral and vertical extent of the chromium contaminated plume. The period of pumping to meet NYSDEC water quality standards is unknown, and would depend upon source area remediation; however, the performance of the extraction system will be reviewed yearly using the monitoring well sampling results and evaluated every 5 years. Note that the Phase III RI data indicate that the extent of the chromium ground water plume may extend beyond the limits shown on Figure 5-4. Additional ground water monitoring wells in the deep overburden aquifer and further modeling will be required prior to emplacement of the extraction well network.

FIGURE 5-4

GROUND WATER EXTRACTION RECOVERY WELL LOCATIONS



NOTE:

1) THE SCALE AND LOCATION OF SITE FEATURES ARE APPROXIMATE.

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- **Ground water treatment** - Ground water treatment for this site involves two alternatives: 1) carbon adsorption pretreatment followed by discharge to the POTW; or 2) on-site conventional precipitation followed by discharge to surface water. Both options appear appropriate for treatment of the organics and inorganics in the site ground water.

Based on the hexavalent chromium concentrations measured in the ground water samples collected from monitoring wells near or within the plant (e.g., MW-5 and MW-17), it appears that the ground water near and below the plant will require treatment prior to discharge to the POTW. Discussions with the City of Olean POTW have indicated that they will need to upgrade the capacity of their plant to treat the additional 2 million gallons per day of ground water from the extraction wells. This plant has a design capacity of 7 MGD and is currently operating at approximately 4.5 to 5.0 MGD with another 1 MGD guaranteed to surrounding communities. Based on a comparison between City of Olean requirements and the concentrations measured in samples from the monitoring wells sampled during the RI, it appears that pretreatment of the water extracted near the original source (possibly one extraction well near the former vat area) would require pretreatment for hexavalent chromium while the other four extraction wells could discharge directly to the sanitary sewer.

This pretreatment system would involve passing the water from this well through a portable carbon filtration unit until the concentrations of hexavalent chromium in the untreated water fell below the City of Olean limit of 5.5 ppm. Once the ground water reaches the plant it will undergo treatment including mechanical screens, influent pumps and aerated grit chambers, primary clarifiers, aeration tanks, secondary clarifiers, and a chlorine contact tank. The treated wastewater would then be discharged to the Allegheny River. A discharge permit and approval from the City will be necessary. If selected, this alternative will require further study to evaluate POTW upgrading requirements and possible modeling of the wastewater treatment train using the USEPA Fate and Treatability Estimator (FATE) Model.

Under the conventional precipitation alternative, a waste water treatment facility would need to be constructed near the site. Currently, the most feasible location for this facility is Van Der Horst Plant No. 2, due to size restrictions at Plant No. 1. The ground water from Plant No. 1 would be piped to the proposed treatment facility at Plant No. 2. The proposed treatment facility would be designed for the combined flow from Plant Nos. 1 and 2. The plant design is schematically presented on Figure 5-5 and incorporates the findings of the treatability study. The treated water would be discharged to either the storm sewer system (which ultimately discharges to Olean Creek) or to Two Mile Creek (which was previously modified to accommodate a several MGD discharge by Felmont Oil).

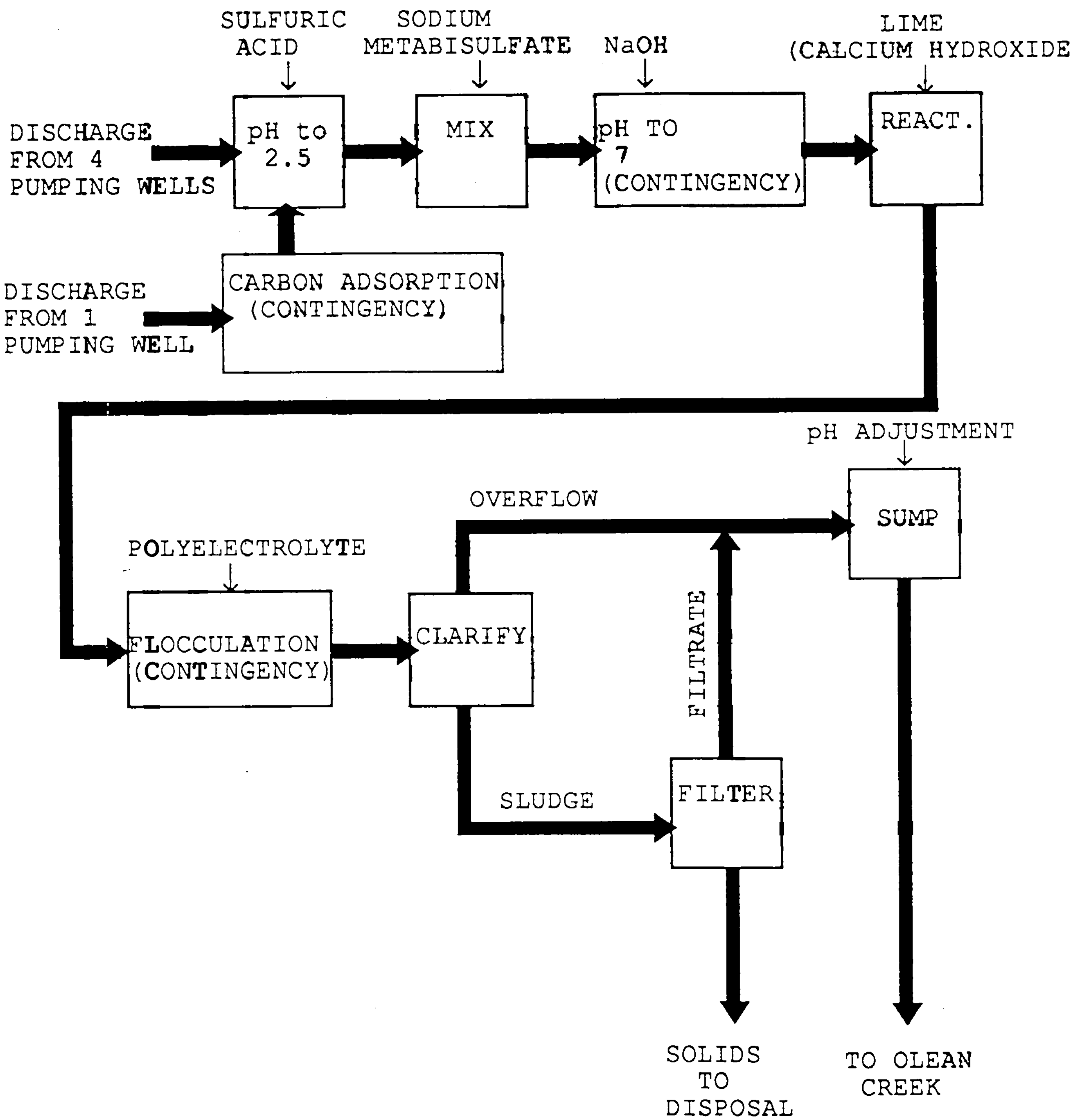
5.1.2 Alternative 1 - No Action/Limited Action

Description

The no-action/limited alternative provides a baseline for comparing other alternatives. Actions under this alternative would include maintaining the present fencing at the site, land use restrictions, supply well installation and usage restrictions, and periodic monitoring of the level of contaminants in monitoring wells and downgradient supply wells, if present.

FIGURE 5-5

ON-SITE GROUND WATER TREATMENT FLOW DIAGRAM



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Assessment

Since no remedial actions would be implemented to correct or contain the contamination with the no-action/limited action alternative, long-term human health and environmental risks for the site would essentially be the same as those identified in the baseline risk assessment. However, the risk associated with future ingestion of ground water would be reduced as a result of the supply well restrictions.

Alternative 1 provides no control of exposure via fugitive dust emissions, only a slight reduction in future risk to human health posed by ground water, and no decrease in impact on benthic life. It also allows for the possible continued migration of the contaminant plume and further degradation of the ground water. Since no action is being taken to reduce or contain the contamination, it would not meet SCGs for a number of analytes including hexavalent chromium, lead and PCE.

This alternative includes no controls for exposure and no long-term management measures. All current and potential future risks would remain under this alternative. This alternative provides no reduction in toxicity, mobility or volume of the contaminated soil or ground water through treatment. There would be no additional risks posed to the community, the workers, or the environment as a result of this alternative being implemented. The only implementation concern is that of the addition of land and supply well use restrictions to the deeds of the effected properties. The present worth cost and capital cost of the individual technologies/process options as well as the comprehensive alternatives are included on Tables 5-2 and 5-3, respectively. The basis and cost estimate forms are included in Appendix D.

5.1.3 Alternative 2 - Containment

Description

The primary components of Alternative 2 are: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/ decontamination of structures/vats; 6) excavation and off-site landfilling of heavily contaminated soil below and adjacent to the plant; 7) off-site landfilling of storm sewer and Olean Creek sediment; and 8) regrading and capping the site with a composite cap including on-site consolidation of surface soil over 50 ppm total chromium outside the property boundary. The composite cap would be constructed in the fenced in area of the site as shown on Figure 5-6. This area is approximately 70,000 square feet, and would initially be covered with a geotextile to provide a protective barrier between the site

TABLE 5-2

Technology Cost Estimate Summary

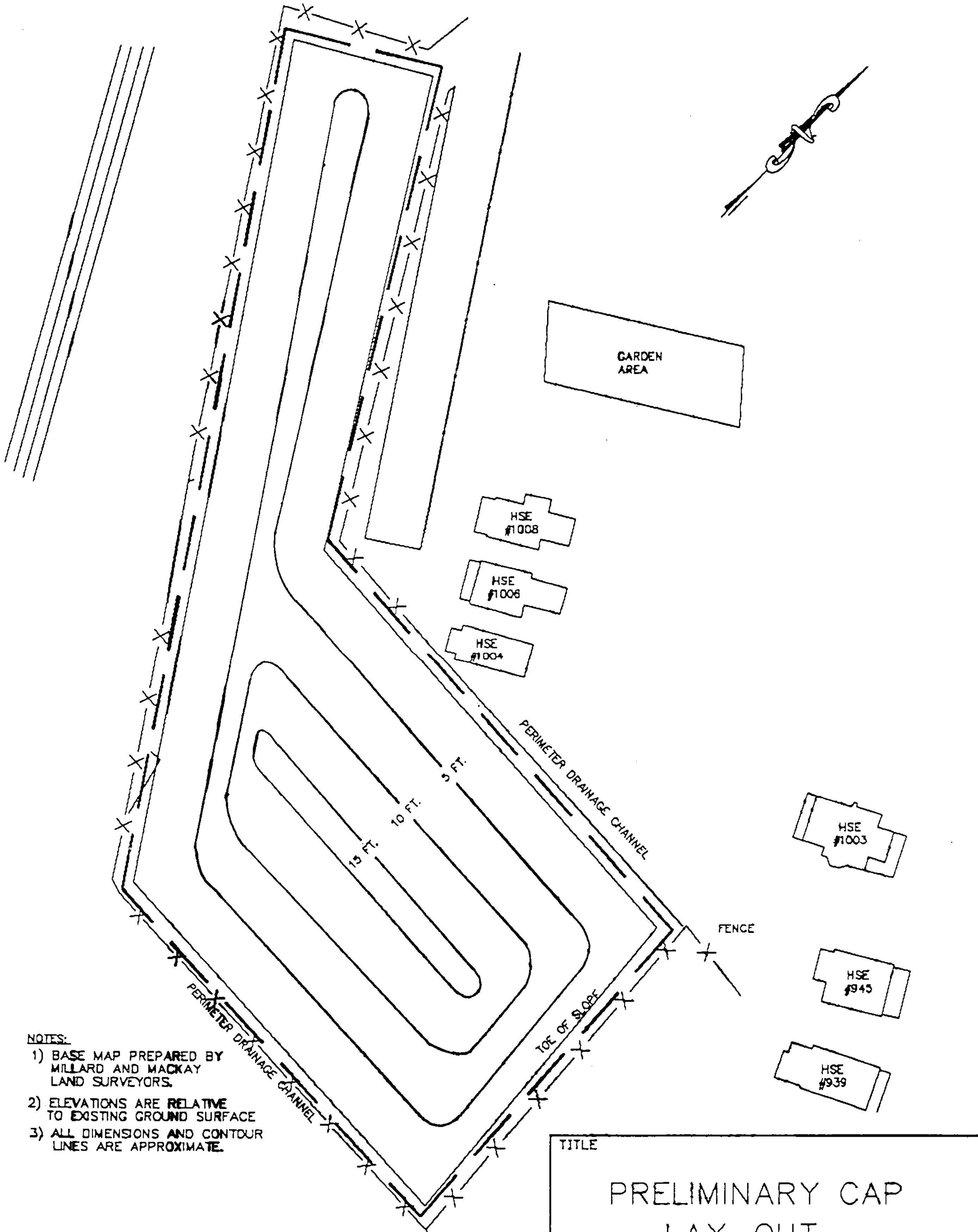
Technology	Direct Costs	Indirect Costs	Capital Costs	Annual O&M	Imp Time	Comp Time	PW Cap. x $1,000	PW O&M x $1,000	Total PW x $1,000
Sediment Removal	$176,239	$82,832	$259,071	$0	1993	2	$235	$0	$235
Storm Sewer Cleaning	$113,400	$50,000	$163,400	$0	1993	2	$148	$0	$148
Surface Soil Removal	$921,500	$368,600	$1,290,100	$0	1993	2	$1,170	$0	$1,170
Sub. Surf. Soil Rem.	$1,858,708	$780,657	$2,639,365	$0	1994	3	$2,280	$0	$2,280
GW Extraction	$155,283	$100,934	$256,217	$130,834	1995	34	$211	$1,655	$1,865
Building Decon.	$960,000	$326,400	$1,286,400	$0	1993	2	$1,167	$0	$1,167
Asbestos Rem.	$95,200	$39,984	$135,184	$0	1993	2	$123	$0	$123
Building Demo.	$662,420	$304,713	$967,133	$0	1993	2	$877	$0	$877
Site Capping	$3,033,645	$1,365,140	$4,398,785	$0	1994	34	$3,800	$0	$3,800
Soil Soid./Stab.	$1,570,086	$1,020,556	$2,590,642	$0	1994	3	$2,238	$0	$2,238
Less Contaminated	$793,750	$515,938	$1,309,688	$0	1994	3	$1,131	$0	$1,131
Highly Contaminated	$776,336	$504,618	$1,280,954	$0	1994	3	$1,107	$0	$1,107
Off-site Landfill(Total)	$6,210,566	$2,794,755	$9,005,321	$0	1993	2	$8,168	$0	$8,168
Less Contaminated	$3,537,500	$1,591,875	$5,129,375	$0	1993	2	$4,652	$0	$4,652
Highly Contaminated	$2,673,066	$1,202,880	$3,875,946	$0	1993	2	$3,516	$0	$3,516
Soil Encap.	$2,237,361	$1,006,812	$3,244,173	$0	1994	3	$2,802	$0	$2,802
Site Rest.	$100,027	$42,011	$142,038	$1,812	1995	34	$117	$23	$140
Act. Carbon to POTW	$345,000	$169,050	$514,050	$1,372,407	1995	9	$423	$4,888	$5,311
G.W. to POTW	$0	$0	$0	$809,480	2000	34	$0	$7,354	$7,354
Conv. Prec. to Surf. Wat.	$245,000	$134,750	$379,750	$3,518,382	1995	34	$312	$44,497	$44,809
Semi-Annual Monitoring	$0	$0	$0	$35,000	1995	34	$0	$443	$443

Note: Imp Time - Year when implementation of technology could be initiated, based on a 1993 project start-up.
Comp Time - Time to complete technology in years.
PW - Present Worth

TABLE 5 - 3
SUMMARY OF ALTERNATIVE COSTS

ALTERNATIVE	CAPITAL COSTS	O&M COSTS	TOTAL COSTS
1	$0	$466,000	$466,000
2	$9,917,000	$466,000	$10,383,000
3	$14,919,000	$14,363,000	$29,282,000
4	$8,989,000	$14,363,000	$23,352,000
5	$11,398,000	$14,363,000	$25,761,000
6	$10,551,000	$14,363,000	$24,914,000
7	$9,553,000	$14,363,000	$23,916,000

Note:
All costs are present worth using a 1991 base year and a maximum 30 year operation period.



NOTES:
1) BASE MAP PREPARED BY MILLARD AND MACKAY LAND SURVEYORS.
2) ELEVATIONS ARE RELATIVE TO EXISTING GROUND SURFACE
3) ALL DIMENSIONS AND CONTOUR LINES ARE APPROXIMATE.

GRAPHIC SCALE
25 0 25 50 100
(IN FEET)

TITLE
PRELIMINARY CAP LAY-OUT

PREPARED FOR
NYSDEC

ERM-Northeast
Environmental Resources Management

SCALE
DATE
FIGURE 5-6

soil and a 60-mil Hypalon geomembrane. The geomembrane would be covered with a 2-foot layer of suitable soil which would be covered with a 6-inch layer of topsoil. The permeability of the completed cap will be approximately 1 x 10^{-12} cm/sec. This cap will be sloped to a drainage system that would collect and transport surface water away from the cap toward the storm sewer and limit run-on. The composite cap will reduce the leaching of chromium to the ground water. The monitoring wells would be used to evaluate the natural attenuation of the chromium, lead and PCE. Also included in this alternative are deed restrictions that will not allow on-site excavation and installation and use of supply wells within the affected area.

Assessment

Alternative 2 is protective of the human health in that exposure to contamination is controlled. Exposure to contaminated soil/sediment and fugitive dust is reduced and further release of contaminants to the ground water and surface water is limited. This alternative, however, allows for the continued migration of the existing contaminated ground water.

Alternative 2 would reduce the risks associated with the contaminated soil/sediment. The capping should reduce fugitive dust emissions and since the sewer lines would be cleaned and the sediment removed from Olean Creek, the contaminant levels in the creek should return to background. Ground water exposure in this alternative would only be limited by restrictions placed on supply well usage and installation.

In order to remain effective over the long-term, careful maintenance of the cap and restricting water well usage is required. Erosion or heaving damage to the cap should be repaired to limit leachate production. Damage to the cap could potentially allow ground water contamination and fugitive dust emissions. Long term monitoring, maintenance, and control would be required under this alternative because contaminated soil would remain on-site and because the ground water may remain contaminated above NYSDEC water quality levels. The institutional controls (i.e., well restrictions) are expected to be effective over the short term but may not be effective over the long term due to the degree of difficulty in enforcing any possible regulation or restriction with new residents or industries not familiar with the local conditions. A review would be conducted every five (5) years to provide adequate protection of human health and the environment in accordance with CERCLA 121(c) as this alternative would leave hazardous substances on-site. Since the sediment is being removed from the creek and storm sewer and being disposed of in a landfill, cleanup of this sediment would be permanent and effective over the long term.

This alternative provides limited reduction in toxicity, mobility or volume of the contaminated soil or ground water through treatment because the highly contaminated soil taken off-site would undergo treatment prior to landfilling. Additionally, the contaminated sediment would be removed from the creek and storm sewer, thereby reducing the volume and the mobility of contaminants in the creek.

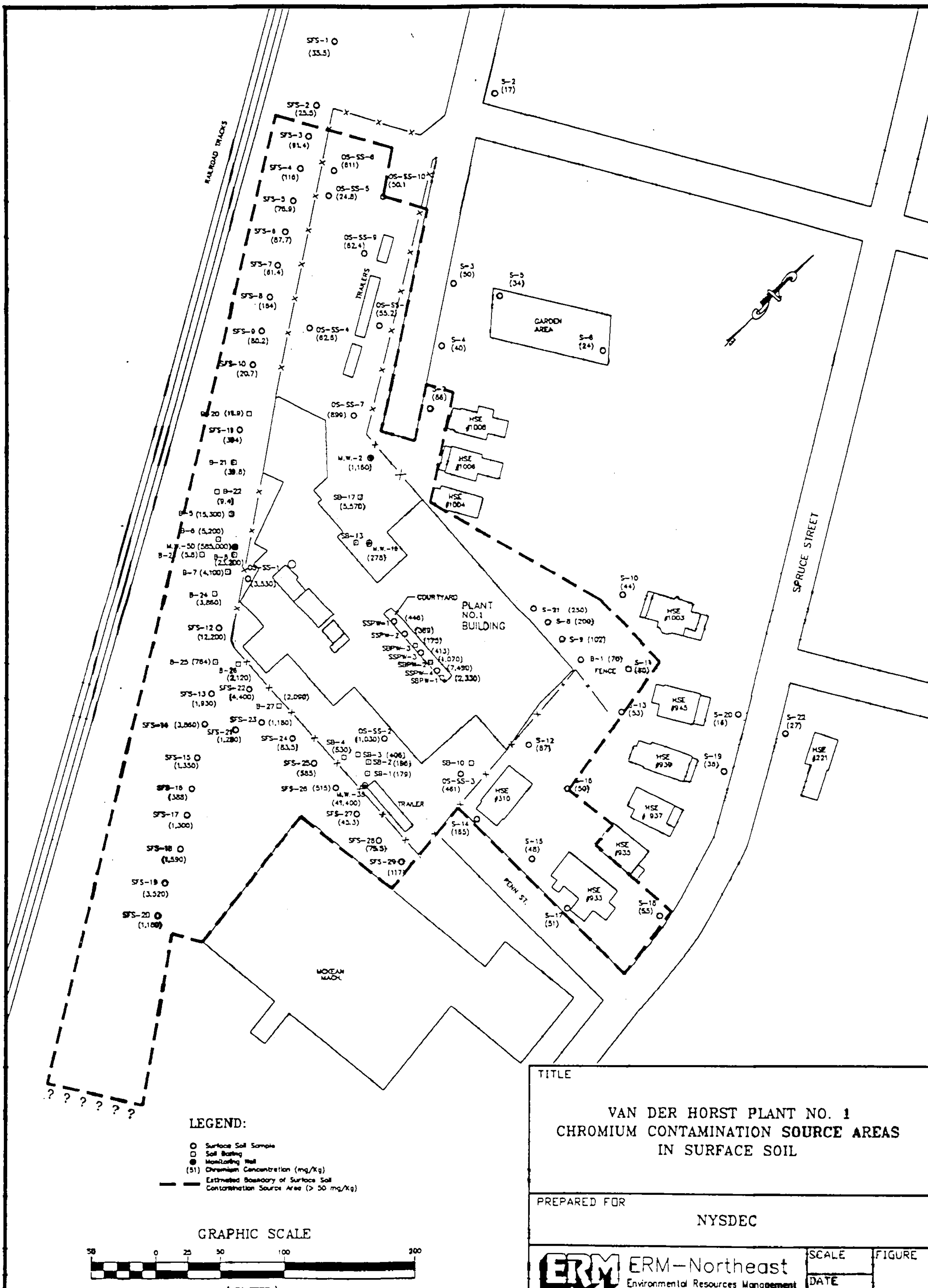
The potential for particulate emissions during construction would be limited through the use of dust control technologies (i.e., watering). The cap limits further fugitive dust emissions and the storm sewer cleaning and dredging limits further impact to benthic life. Once the heavily contaminated soil/sediment is removed, this cap could be constructed within a one-year period. The only implementation concerns are the addition of: 1) land use restrictions; and 2) water supply well restrictions. The other materials and equipment to be used under this alternative are readily available and easy to procure.

The present worth cost of Alternative 2 is presented on Table 5-2. The annual O&M cost are mainly for cap maintenance and monitoring well sampling and analysis.

5.1.4 Alternative 3 - Soil/Sediment Disposal with Ground Water Treatment

Description

The primary components of this alternative include: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/ decontamination of structures/vats; 6) ground water extraction, treatment and discharge to either the POTW or to surface water; and 7) excavation of the on-site soil that exceeds 50 ppm of chromium and disposing of it in a landfill. This soil area includes approximately 21,000 cubic yards of material from the site based on sampling done during the RI. Figures 5-7 and 5-8 show the area of surface soil (0 to 2 feet below ground surface) and subsurface soil (2 to 20 feet below ground surface) above 50 ppm total chromium, respectively. An additional volume of 322 cubic yards from the creek dredging and sewer cleaning would also require disposal.



TITLE

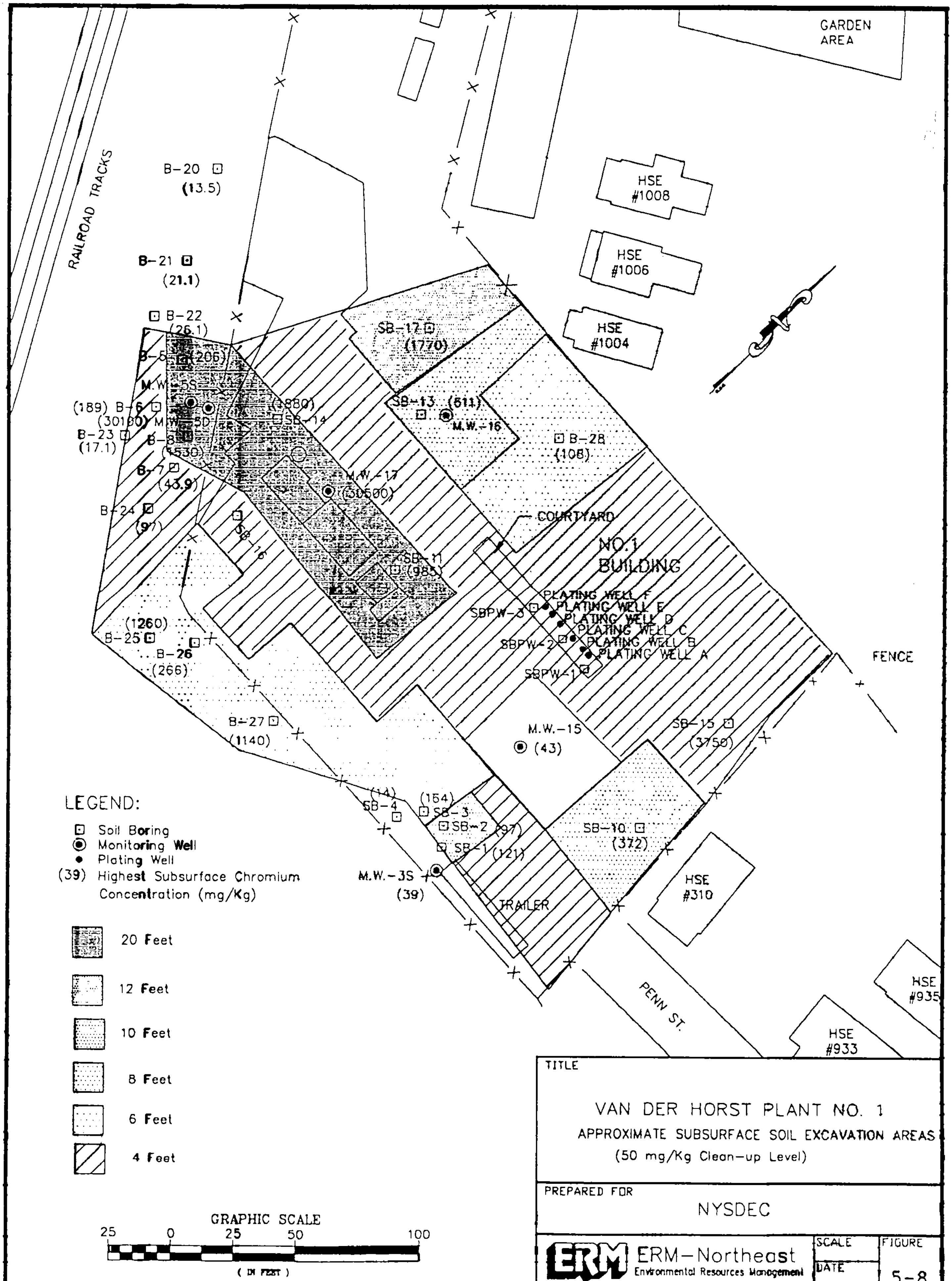
VAN DER HORST PLANT NO. 1
CHROMIUM CONTAMINATION SOURCE AREAS
IN SURFACE SOIL

PREPARED FOR

NYSDEC

ERM–Northeast
Environmental Resources Management

SCALE	FIGURE
DATE	5-7



GARDEN AREA
RAILROAD TRACKS
B-20 (13.5)
B-21 (21.1)
B-22 (26.1)
B-5 (206)
M.W.-5S
(189) B-6
(30130) M.W.-5D
B-23 (17.1)
B-8 (1530)
B-7 (43.9)
B-24 (97)
(1880) SB-14
SB-17 (1770)
SB-13 (611)
M.W.-16
M.W.-17 (30600)
B-28 (108)
COURTYARD
NO. 1 BUILDING
SB-16
SB-11 (985)
PLATING WELL F
PLATING WELL E
PLATING WELL D
PLATING WELL C
PLATING WELL B
PLATING WELL A
SBPW-3
SBPW-2
SBPW-1
(1260) B-25
B-26 (266)
B-27 (1140)
M.W.-15 (43)
SB-15 (3750)
FENCE
HSE #1008
HSE #1006
HSE #1004
(14) SB-4
(164) SB-3
SB-2 (97)
SB-1 (121)
SB-10 (372)
M.W.-3S (39)
TRAILER
HSE #310
PENN ST.
HSE #935
HSE #933
LEGEND:
Soil Boring
Monitoring Well
Plating Well
(39) Highest Subsurface Chromium Concentration (mg/Kg)
20 Feet
12 Feet
10 Feet
8 Feet
6 Feet
4 Feet
GRAPHIC SCALE
25 0 25 50 100
(IN FEET)
TITLE
VAN DER HORST PLANT NO. 1
APPROXIMATE SUBSURFACE SOIL EXCAVATION AREAS
(50 mg/Kg Clean-up Level)
PREPARED FOR
NYSDEC
ERM-Northeast
Environmental Resources Management
SCALE
DATE
FIGURE
5-8

The material would be excavated using bulldozers, backhoes, front-end loaders, and other excavation equipment. The material, after excavation, would be loaded into dump trucks for transportation to a secure landfill where it would undergo pretreatment and landfilling. Following excavation the area would be backfilled with clean fill, regraded to improve drainage, and revegetated. Note that the extent of the highly contaminated soil below the ground water table in the former vat area has not been identified. Should this condition extend several feet below the ground water table, then alternate methods including sheet piling, dewatering and other excavation methods may be required. Post-excavation soil sampling of the excavations' side walls and floor would also be needed to determine the lateral and vertical extents of excavation.

The majority of the excavated soil/sediment would be within TCLP limits, based on TCLP testing done to date. However, to provide a conservative estimate of the costs, we have estimated that all soil/sediment will be disposed of in a secure landfill due to the Superfund status of the site.

Assessment

Protection of human health and the environment in Alternative 3 is done by removing the contaminants and the suspected source(s) of the contamination from the environment. Exposure to contaminated fugitive dust and ground water is reduced. Also, further spread of the contaminants and further environmental degradation are reduced because the source(s) of the contamination are expected to be removed. This alternative would meet SCGs and also would reduce the carcinogenic risk to an acceptable level.

Since soil/sediment excavation, ground water extraction and sewer cleaning are expected to remove contamination from the contaminated media at the site, this alternative would be considered permanent and effective over the long term. The ground water extraction and soil/sediment excavation would reduce the long-term health risk by limiting the contaminants left in the environment. A five (5) year review would be necessary under this alternative to evaluate ground water conditions.

This alternative provides reduction in toxicity, mobility or volume of the contaminated soil/sediment through treatment at the landfill prior to disposal. The ground water would also undergo various treatment processes that would both reduce its toxicity and its mobility. The treatment of the waste water removes the contaminants from the discharge effluent which makes the process irreversible.

The potential for particulate emissions during excavation would be limited through the use of dust control technologies (i.e., watering). The transportation of the soil/sediment between excavation points and the disposal/treatment facilities, and conveyance of the ground water via the sewer system to the treatment facility would cause additional risks to the community, the workers, or the environment as a result of this alternative being implemented. The excavation and removal of soil/sediment would be completed over an approximate 1-year period.

The techniques used in implementing Alternative 3 are established, and the materials (i.e., piping, pumps, fill, and stone) and equipment are readily available. However, identifying a secure landfill to receive the material may be difficult and costly, due to the strain on landfill space in the western New York area.

Capital and O&M costs for this alternative are included on Table 5-3. The major capital costs are those associated with landfilling the soil/sediment (i.e., transportation and disposal costs). O&M costs would include monitoring the site and operating the ground water treatment system.

5.1.5 Alternative 4 - Solidification/Stabilization with Ground Water Treatment

Description

The primary components of Alternative 4 are: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/ decontamination of structures/vats; 6) excavation; 7) ground water extraction, treatment and discharge to either the POTW or surface water; and 8) solidification/stabilization and backfilling of treated soil/sediment.

Once the soil with chromium concentrations greater than 50 ppm is excavated, and the sediment dredged, it will then be solidified/stabilized on-site. The treatability study indicated that a mixture of lime and ferrous sulfate provides the most favorable results with respect to reducing the leaching potential of the soil. The properties of this treated mixture include a 25% volume increase over the original soil/sediment, and the leachability of the material is reduced to a level below the TCLP limit for chromium. Since the TCLP limits for inorganics are based on drinking water standards, it appears that the treated highly chromium contaminated soil as well as the less contaminated soil would not be a source to ground water and could be back-filled on-site. The final topography of the site following soil/sediment treatment and closure would be similar to the cap lay-out presented on Figure 5-6. The height of on-site cap will be a function of the volume increase resulting from the treatment process (i.e., approximately 25%) and a one foot thick topsoil layer to support vegetation.

Note that in-situ solidification/stabilization may be possible for this site; however, this technology did not pass the screening process (see Section 2.0) due to insufficient test data (i.e., only one case study has been completed using this method and the results are inconclusive). This method of mixing may be applicable; however, pilot studies would be needed to measure its effectiveness in stabilizing the site contaminants.

Assessment

Protection of human health and the environment in Alternative 4 is similar to Alternative 3. Exposure to fugitive dust emissions and ground water is reduced in this alternative. Further spread of the contaminants and further environmental degradation are reduced because the source(s) of the contamination are expected to be immobilized. Additionally, this alternative would meet SCGs. This alternative would also appear to reduce the carcinogenic risk to an acceptable level.

This alternative would be considered permanent and effective over the long term. A five (5) year review would be necessary under this alternative to evaluate the progress of the ground water remediation.

This alternative provides on-site reduction in mobility of the contaminated soil/sediment through solidification/stabilization of the soil. The potential for particulate emissions during excavation would be limited through the use of dust control technologies (i.e., watering). The transportation of the soil/sediment between the treatment area (possibly at Plant No. 2 due to space limitations at Plant No.1) and the disposal area would cause a slight potential risk to the community, the workers, or the environment as a result of this alternative being implemented.

The present worth cost of Alternative 4 is estimated on Table 5-3. The annual O&M cost are mainly for monitoring and operation of the treatment facility. The major capital costs are those associated with treating the soil/sediment.

5.1.6 Alternative 5 - Solidification/Stabilization of Less Contaminated Soil with Ground Water Treatment

Description

The primary components of Alternative 5 are: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/ decontamination of structures/vats; 6) excavation; 7) solidification/stabilization and backfilling of treated less contaminated soil (chromium concentration between 50 and 1,000 ppm); and 8) ground water extraction, treatment, and discharge to the POTW or surface water.

Once the soil with chromium concentrations greater than 1,000 ppm is excavated, and the sediment dredged, it will then be taken off-site for treatment and disposal. The remaining soil with chromium concentrations ranging from 50 ppm up to 1,000 ppm will be treated and backfilled on-site. The treatability study indicated that a mixture of lime and ferrous sulfate is effective for treatment of the site soil. The properties of this mixture include a 25% volume increase over the original soil/sediment, and the leachability of the material is reduced to a level below the TCLP limit for chromium. Since the TCLP limits for inorganics are based on drinking water standards, it appears that the treated soil would not be a source to ground water if backfilled on-site. The final topography of the site following soil/sediment treatment and closure would be similar to the cap lay-out presented on Figure 5-6 although the elevation of the mound would be less. The final height of the completed on-site cap will be a function of the volume increase resulting from the treatment process (i.e., approximately 25%) and a one foot thick topsoil layer to support vegetation.

Assessment

Protection of human health and the environment in Alternative 5 is similar to Alternative 4. However, Alternative 5 provides greater protection against potential future leaching of chromium to ground water because it removes the highly contaminated soil. Exposure to fugitive dust emissions and ground water is reduced in this alternative. Further spread of the contaminants and further environmental degradation are reduced because the source(s) of the contamination are expected to be either removed or immobilized. Additionally, this alternative would meet SCGs. This alternative appears to reduce the carcinogenic risk to an acceptable level.

This alternative would be considered permanent and effective over the long term. A five (5) year review would be necessary under this alternative to evaluate the progress of the ground water remediation.

This alternative provides on-site reduction in mobility of the contaminated soil/sediment through solidification/ stabilization of the soil. The potential for particulate emissions during excavation would be limited through the use of dust control technologies (i.e., watering). The transportation of the soil/sediment between the site and the disposal facility would cause a slight potential risk to the community, the workers, or the environment as a result of this alternative being implemented.

The present worth cost of Alternative 5 is estimated on Table 5-3. The annual O&M cost are mainly for monitoring and operation of the treatment facility. The major capital costs are those associated with off-site landfilling and treating the soil/sediment.

5.1.7 Alternative 6 - Containment with Ground Water Treatment

Description

Alternative 6 is the same as Alternative 2 with the addition of ground water treatment. Its primary components are: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/decontamination of structures/vats; 6) excavation and off-site landfilling of heavily contaminated soil below and adjacent to the plant; 7) off-site landfilling of storm sewer and Olean Creek sediment; 8) regrading and capping the site with a composite cap including on-site consolidation of surface soil over 50 ppm total chromium outside the property boundary; and 9) ground water extraction, treatment and discharge to either the POTW or surface water.

The highly contaminated soil would be excavated and taken to an off-site secure landfill and the remaining less contaminated soil would be consolidated below an on-site composite capping system. The composite cap would reduce the leaching of chromium to the ground water and the existing ground water plume would be extracted and treated. The monitoring wells would be used to evaluate the natural attenuation of the chromium, lead and PCE. Also included in this alternative are deed restrictions that will not allow any soil excavation on the site and will also not allow installation and use of supply wells within the affected area.

Assessment

Alternative 6 is protective of the human health in that exposure to contamination is controlled. Exposure to contaminated soil/sediment and fugitive dust is reduced and further release of contaminants to the ground water and surface water is limited.

Alternative 6 would reduce the risks associated with the contaminated soil/sediment. The capping would reduce fugitive dust emissions and since the sewer lines would be cleaned and the sediment removed from Olean Creek, the contaminant levels in the creek should return to background.

In order to remain effective over the long-term, careful maintenance of the cap is required. Erosion or heaving damage should be repaired to limit leachate production. Damage to the cap could potentially allow ground water contamination and fugitive dust emissions. Long term monitoring, maintenance, and control would be required under this alternative because 2contaminated soil would remain on-site. A review would be conducted every five (5) years to provide adequate protection of human health and the environment in accordance with CERCLA

121(c) as this alternative would leave hazardous substances on-site. Since the sediment is being removed from the creek and storm sewer and being disposed of in a landfill, cleanup of the sediment would be permanent and effective over the long term.

This alternative provides limited reduction in toxicity, mobility or volume of the contaminated soil or ground water through treatment because the heavily contaminated soil taken off-site would undergo treatment prior to landfilling and because the ground water would be treated. Additionally, the contaminated sediment would be removed from the creek and storm sewer, thereby reducing the volume and the mobility of contaminants in the creek.

The potential for particulate emissions during construction would be limited through the use of dust control technologies (i.e., watering). The cap limits further fugitive dust emissions and the dredging limits further impact to benthic life. Once the highly contaminated soil/sediment is removed, this cap could be constructed within a one-year period. The other materials and equipment to be used under this alternative are readily available and easy to procure.

The present worth cost of Alternative 6 is presented on Table 5-3. The annual O&M cost are mainly for cap maintenance, operation of the treatment system and monitoring well sampling and analysis.

5.1.8 Alternative 7 - Encapsulation with Ground Water Treatment

Description

Alternative 7 is the same as Alternative 4 except the soil/sediment undergoes encapsulation instead of solidification/stabilization. The primary components of Alternative 7 are: 1) supply well restrictions; 2) ground water monitoring; 3) storm sewer cleaning; 4) dredging of creek sediments; 5) demolition/ decontamination of structures/vats; 6) excavation; 7) ground water extraction, treatment and discharge to either the POTW or surface water; and 8) encapsulation of treated soil/sediment.

Once the soil with chromium concentrations greater than 50 ppm is excavated, and the sediment dredged, it will then be encapsulated on-site. No treatability testing was performed relative to this technology; however, based on the available literature, the process appears effective for the site contaminants. The main limitations of this alternative are the fact that it includes a relatively new technology that is relatively more expensive and more difficult to implement than solidification/stabilization. However, it appears to provide a greater reduction in the leachate potential of the soil when compared to solidification/stabilization. Note that no testing has been conducted to verify this comparison. The final topography of the site following soil/sediment treatment and closure would be similar to the cap lay-out presented on Figure 5-6. The height of on-site cap will be a function of the volume increase resulting from the treatment process and a one foot thick topsoil layer to support vegetation.

Assessment

Protection of human health and the environment in Alternative 7 is similar to Alternative 4. Exposure to fugitive dust emissions and ground water is reduced in this alternative. Further spread of the contaminants and further environmental degradation are reduced because the source(s) of the contamination are expected to be immobilized. Additionally, this alternative would meet SCGs. This alternative appears to reduce the carcinogenic risk to an acceptable level.

This alternative would be considered permanent and effective over the long term. A five (5) year review would be necessary under this alternative to evaluate the progress of the ground water remediation.

This alternative provides on-site reduction in mobility of the contaminated soil/sediment through solidification/stabilization of the soil. The potential for particulate emissions during excavation would be limited through the use of dust control technologies (i.e., watering). The transportation of the soil/sediment between the treatment area and the disposal area would cause a slight potential risk to the community, the workers, or the environment as a result of this alternative being implemented.

The present worth cost of Alternative 7 is estimated on Table 5-3. The annual O&M cost are mainly for monitoring and operation of the treatment facility. The major capital costs are those associated with treating the soil/sediment.

5.2 Comparative Analysis

A comparative analysis of the alternatives discussed in the previous section was completed in general accordance with USEPA 540/6-89/004 and the May 1990 NYSDEC-TAGM for the Selection of Remedial Actions at Inactive Hazardous Waste Sites. The completed evaluation forms for each alternative are included in Appendix C and a summary of the scores for each alternative is included on Table 5-4.

Initially, Section 5.2.1 compares the two potential ground water treatment technologies: 1) carbon adsorption of hexavalent chromium followed by discharge to the POTW; and 2) on-site conventional precipitation. Section 5.2.2 presents the comparison of the seven comprehensive alternatives with inclusion of the ground water treatment technology selected in Section 5.2.1, where applicable.

5.2.1 Ground Water Treatment Evaluation

Initially, the two ground water treatment process options, previously described in Section 5.1.1, were compared using the NYSDEC-TAGM evaluation tables. Based upon our comparative analysis, the recommended option for ground water treatment is activated carbon treatment followed by discharge to the upgraded

TABLE 5-4
SUMMARY OF ALTERNATIVE SCORES

	Compliance w/SCGs	Implementability	Long-Term Effectiveness	Prot. of Human Health and the Env.	Reduction of Toxicity Mobility or Volume	Short-Term Effectiveness	Cost	Total
	(10)	(15)	(15)	(20)	(15)	(10)	(15)	(100)
No Action	0	11	0	2	0	10	15	38
Conv. Precip to Olean Cr.	10	12	13	20	15	9	1	80
Activated Carbon to POTW	10	12	13	20	15	9	13	92
ALTERNATIVE 1	0	11	0	2	0	10	15	38
ALTERNATIVE 2	2.5	12	6	11	15	8	9	63.5
ALTERNATIVE 3	10	13	13	20	15	7	1	79
ALTERNATIVE 4	10	11	13	20	15	7	4	80
ALTERNATIVE 5	10	13	13	20	15	7	3	81
ALTERNATIVE 6	10	11	6	20	15	7	3	72
ALTERNATIVE 7	10	6	12	20	15	7	4	74

POTW. The main difference in scoring between the conventional precipitation option and the activated carbon option was the score for cost. The higher cost to operate the on-site conventional treatment plant resulted in the selection of the POTW option. In the other six categories these two options scored similarly.

The costs of the ground water treatment options were scored on a linear type scale. The no action/limited action option was included to provide a baseline cost. The least expensive option (i.e., no action/limited action) was given a score of 15 and the most expensive option (i.e., on-site conventional treatment) was given a score of 1. The points for the remaining option (i.e., POTW discharge) was then interpolated linearly between the least and most expensive option.

5.2.2 Comprehensive Alternative Evaluation

The ground water treatment option (i.e., activated carbon followed by POTW discharge) was included in Alternatives 3 through 7. All seven alternatives were then scored and compared using the NYSDEC-TAGM evaluation tables. Based upon the NYSDEC-TAGM scoring tables, Alternative 5 had the highest score. However, Alternatives 4 and 3 scored within one and two points of Alternative 5, respectively. The slightly lower scores for Alternatives 3 and 4 can be attributed to: 1) the relatively higher cost in the case of

Alternative 3; and 2) uncertainties regarding the ability of the solidification agents to immobilize the highly chromium contaminated soil in the case of Alternative 4.

The costs of the comprehensive alternatives were scored on a linear type scale. The least expensive option (no action/limited action) was given a score of 15 and the most expensive option (Alternative 3) was given a score of 1. The points for the remaining alternatives were interpolated linearly between the least and most expensive alternatives.

Alternative 3 would have scored higher than the other alternatives if cost was not a factor, due to the ease of implementability and its protection of human health and the environment. Alternative 7 did not score as high as the others due to implementability and long term effectiveness concerns associated with this technology. It was felt that Alternatives 1, and 2 would not meet SCGs and; thus, would not be as effective over the long term and would not be as protective of human health and the environment. As previously mentioned, the completed NYSDEC-TAGM evaluation forms for each alternative are included in Appendix C. A qualitative comparison of the alternatives with respect to each of the evaluation criteria is discussed below.

Compliance with SCGs

Alternatives 3 through 7 are expected to meet their respective SCGs through either removal or treatment technologies or a combination of both. Alternative 1 will not meet SCGs and Alternative 2 will only meet location specific SCGs since it addresses the storm sewer and Olean Creek.

Implementability

Alternatives 1 through 6 scored similarly with respect to implementability. Minor differences in the scores between these alternatives were mainly due to the uncertainties regarding the depth of the excavation under the building, how well the solidification/stabilization technology will work on the highly contaminated soil and the effectiveness of the capping technology. Due to the lack of available information on the encapsulation technology and implementation concerns, Alternative 7 scored the lowest.

Long-term Effectiveness and Permanence

Alternatives 3, 4 and 5 provide the highest degrees of long term effectiveness at the site, compared to the other alternatives, because they use technologies which solidify or stabilize the contaminants, which reduces the hazards. While some wastes would be left on site after the implementation of Alternatives 4 and 5, the wastes would have a reduced mobility due to the treatment technology.

Alternative 7 scored almost as high as Alternatives 3, 4 and 5; however, because of the limited past use of this technology, its long term effectiveness is uncertain. This technology uses both a treatment and a isolation technology to not only reduce the mobility of the waste but to also limit the contact of water with the treated waste.

Alternatives 1, 2 and 6 were felt to be less effective than the other alternatives over the long term mainly due to the untreated waste that would remain at the site. Under Alternative 1 (no action) the contaminated materials would be left in place and a more extensive ground water monitoring program would be required compared to the other alternatives. Under Alternatives 2 and 6 there would be some untreated soil left in place and a cap would be added to reduce infiltration; however, more extensive ground water monitoring would be required to evaluate the impact of the remaining potential sources.

Protection of Human Health and the Environment

All of the alternatives except Alternatives 1 and 2 appear to provide adequate protection of human health and the environment. Risk through direct contact and ground water ingestion are reduced to acceptable levels through Alternatives 3 through 7. These alternatives prevent further migration of the contaminated ground water by extracting and treating the plume to SCG levels.

Alternative 2 provides some measure of protection by removal and off-site disposal of the highly contaminated soil and then capping the site and allowing the ground water to attenuate naturally.

Reduction of Toxicity, Mobility, or Volume Through Treatment

All of the alternatives with the exception of Alternative 1 score high in this category due to the fact that they use a permanent method to treat at least some of the soil and ground water at the site. Alternatives 3, 4, 5 and 7 use a solidification/stabilization technology or a physical treatment technology to reduce the mobility of the contaminants in the soil as well as in the residue from ground water treatment. Results from the treatability study show that the residues from the solidification process as well as the ground water treatment could be classified as non-hazardous wastes (i.e., they pass TCLP). Thus, no hazardous wastes are left at the site in these alternatives.

Under Alternatives 2 and 6 the highly chromium contaminated soil is removed and taken to a secure landfill for treatment and disposal. The remaining soil, although it contains chromium at greater than 50 ppm, has shown through testing to be non-hazardous (i.e., it passes TCLP); thus, these two alternatives score high since no hazardous wastes are left on-site.

Short-Term Effectiveness

Alternative 1 scored highest in terms of short-term effectiveness. This result was due mainly to the short period of time to implement the no action/limited action remedy and the absence of soil disturbance, thereby limiting the risk to the local community and environment.

Alternative 2 scored the next highest in this category. The difference between Alternative 1 and Alternative 2 is that soil is moved in Alternative 2 and the resulting potential dust emissions could impact the local community and the environment. However, dust emissions could be controlled with techniques such as watering.

Alternatives 3 through 7 all scored similarly. The difference between their scores and the score for Alternative 2 is the time to implement the remedy. In the case of Alternative 2, the implementation time is less than 2 years; however, in the remaining alternatives the time to implement the remedy is greater than 2 years due to ground water extraction and treatment.

Cost

Alternative 3 was the most expensive alternative due to the costs associated with off-site disposal and transportation. Alternatives 4 through 7 scored similarly in this section since their costs were within 2.4 million dollars of each other (i.e., within approximately 10% of each other). Alternative 2 was less expensive than Alternatives 4 through 7 because Alternative 2 does not include a ground water extraction and treatment system.

5.3 Cost-Effectiveness Evaluation

In accordance with the Work Plan for this RI/FS, a cost-effectiveness analysis was completed to identify a cost-effective and environmentally sound remedial alternative. This analysis was completed as a further check on the results of the NYSDEC-TAGM evaluation forms. A Cost-Effectiveness (CE) Rating was computed for each alternative. The CE Rating was calculated as the product of the Cost Rating and Effectiveness Rating, as described below.

The cost rating for an alternative reflects both the capital investments and O&M costs. The alternative with the highest capital cost was given a score of 1; the alternative with the lowest capital cost was given a score of 5. Other alternatives were scaled to lie between these extremes. A similar method was used with respect to O&M costs, with the most costly alternative given an O&M score of 1 and the least costly given an O&M score of 5. The Cost Rating is the sum of the two (2) scores.

The effectiveness measure of the alternative required the evaluation of the following criteria: 1) level of achievable remediation; 2) time to achieve remediation; 3) feasibility; 4) implementability; 5) ability to minimize on-site impacts during action; 6) ability to minimize off-site impacts because of action; 7) remoteness of activities; 8) useability of surface water and ground water; 9) compatibility with remedial actions selected for remainder of study area; and 10) compatibility with overall site restoration plan. Each of the alternatives was rated 1 through 5 with respect to each of these criteria. A score of one (1) represented low effectiveness while a score of five (5) represented high effectiveness. The Effectiveness Rating for an alternative was the sum of the individual scores. The scores for each of the alternatives for the above mentioned criteria can be found in Table 5-5.

Alternative 4 was found to be the most cost-effective alternative (excluding Alternative 1) based on this method of analysis. Additionally, Alternatives 2, 5 and 7 had relatively high CE ratings. This result compares favorably with the results of the NYSDEC-TAGM evaluation forms. However, Alternative 3, which scored well using the NYSDEC-TAGM forms had a relatively low CE Rating. Thus, based on both evaluation methods, the selected remedial alternative is Alternative 4; however, there are four contingencies associated with this alternative.

The first contingency is the addition of an on-site conventional precipitation treatment plant to treat the contaminated ground water. This plant would need to be constructed at Van Der Horst Plant No. 2, due to space limitations at Plant No.1. The treated ground water would probably discharge to Two-mile Creek. Note that this option was not selected due to the higher cost of operating such a facility (i.e., $3,500,000 per year) when compared to discharge to the POTW ($2,200,000 per year). This contingency would be implemented if POTW discharge was considered unacceptable by the agencies involved. However, to date discussions with the POTW have indicated that the POTW is interested in receiving the ground water from Plant No. 1 provided

TABLE 5-5
COST-EFFECTIVENESS SUMMARY

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
COST RATING							
1) Capital Cost	5	3	1	4	3	3	4
2) O & M Cost	5	5	4	4	4	4	4
TOTAL	10	8	5	8	7	7	8
EFFECTIVENESS RATING							
1) Level of Achievable remediation	1	2	5	5	5	4	5
2) Time to Achive Remediation	1	2	5	4	4	3	4
3) Feasibility	5	4	2	2	2	3	1
4) Implementability	5	4	2	2	2	3	1
5) Ability to Minimize On-Site Impacts	1	2	5	3	4	2	3
6) Ability to Minimize Off-Site Impacts	1	2	2	3	2	3	3
7) Remoteness of Activities	5	3	1	4	2	3	3
8) Useability of Surface and Ground Water	1	2	5	4	4	3	4
9) Compatibility with Other Remedial Actions	5	4	4	4	4	4	3
10) Compatibility with Overall Site Plan	5	4	4	4	4	4	3
TOTAL	30	29	35	35	33	32	30
OVERALL CE RATING (Total CR x Total ER)	300	232	175	280	231	224	240

Most Favorable = 5
Least Favorable = 1

appropriate upgrades to its system are made to handle the increased volume.

The second contingency involves off-site landfilling of the highly chromium contaminated soil. This contingency would be implemented if further pilot testing indicates that the treated soil is a source to ground water. Based on the results of the Treatability Study, the treated highly chromium contaminated soil would not be considered a source to ground water.

The third contingency involves backfilling the treated soil from Plant No. 1 at Van Der Horst Plant No. 2. This contingency would be implemented based on the compatibility of this option with the selected alternative for Plant No. 2 and the potential aesthetic problems with an increase in elevation at Plant No.1 due to backfilling.

The fourth contingency involves treatment of the highly contaminated soil below the water table. The results of the Pre-Remediation Investigations should provide sufficient data for evaluating specific technologies that are applicable for this area. Some possibilities include in-situ stabilization and dewatering followed by excavation.

As indicated above, the selected remedial alternative for Van Der Horst Plant No. 2 will influence the final details of the remedial design for Plant No. 1. The compatibility of the treatment methods selected for each site and the potential consolidation of treated soil at Plant No. 2 may prove to be cost-effective. However, this compatibility will need to be evaluated during the FS for Plant No. 2.

6.0 CONCEPTUAL DESIGN OF SELECTED REMEDIAL ALTERNATIVE

6.1 Introduction

This section provides a discussion of the selected remedial alternative identified through the Detailed Analysis of Alternatives (Section 5.0). Although some details regarding the selected alternative are provided, further sampling and studies (Pre-Remediation Investigation) will be necessary prior to the engineering design and preparation of construction drawings. Additionally, the selected alternative will undergo further modifications and refinement as more data are collected.

Section 6.2 describes the various tasks included in the selected alternative. These tasks are presented in the approximate chronological order of which they will be implemented.

6.2 Description of Alternative

Task 1: Pre-Remediation Investigation

The initial phase of the implementation of the selected alternative will be a Pre-Remediation Investigation. This investigation will further delineate the lateral and vertical extent of the chromium contaminated ground water and soil.

Specifically, the southwestern extent of the chromium contaminated ground water plume within the deeper portion of the unconsolidated aquifer has not been identified. Additionally, the extent of the chromium contaminated soil/sediment has not been delineated: 1) beneath the former vat area; 2) in the plating well area; 3) in surface soil south of the site; 4) in Olean Creek near the Brookview Outfall; and 5) within the storm sewer lines north of the site. This information will ultimately be needed to complete the design of the remedial alternative. A detailed discussion of the proposed Pre-Remediation Investigation is included in Section 7.2.2 of the RI Report.

Task 2: Pilot Studies

Following completion of Task 2, on-site Pilot Studies will be conducted to refine the treatment processes, specifically, solidification/stabilization of chromium contaminated soil and carbon adsorption for ground water. During this phase of the program, an assessment of the reliability of the solidification/stabilization of the most highly contaminated soil will be conducted. If it is found that the highly contaminated soil can be solidified/stabilized to the degree that it is no longer considered a source of chromium to ground water (via TCLP analysis), then the selected alternative will include treatment and on-site backfilling of all soil with total chromium concentrations over 50 ppm. In-situ Stabilization may also be evaluated through pilot studies (especially of saturated soil, where digging may prove difficult) to assess whether this method provides the thorough mixing required for immobilization of the chromium contaminated soil. Additionally, the capacity and efficiency of the POTW will be assessed and the afore-mentioned FATE model will be used to evaluate the fate of the on-site contaminants if discharged to the POTW. If this discharge proves to be unacceptable, than the selected alternative will be refined to include an on-site (i.e., at Plant No. 2) conventional precipitation treatment system as schematically shown on Figure 5-5.

Task 3: Remedial Design

The information collected during Tasks 1 and 2 will be used in the preparation of the remedial design plans. These plans will include, the project management structure, detailed construction drawings and schedules that will guide the remedial process. Additionally, bids will be received from qualified contractors for the various phases of the project to refine budget estimates and identify the remedial contractors that will perform the work. The sewer lines between the site and the POTW will be evaluated to assess their integrity and capacity, and this information will be taken into consideration during the design phase.

Task 4: Site Preparation

Site preparation will be required prior to initiation of the remediation. Initially, a field trailer will be set-up on-site to provide a communication center where personnel and contractors can maintain contact with their home office, where copies of daily documents can be made and filed and where workers can shower/change prior to leaving the project site. Once the plant building has been removed, the contaminated surface soil in the northern end of the property will be excavated and staged leaving a "clean" area of the site for construction of temporary structures. These structures will include a decontamination pad, equipment storage shelter, and temporary structures needed for the on-site soil solidification/stabilization process.

Site preparation activities will also include obtaining the necessary permits to implement the remedial alternative. For example, a wetlands permit will be needed for dredging Olean Creek in selected areas.

Task 5: Storm Sewer Cleaning

Storm-sewer cleaning will be conducted in the lines and manholes where chromium contaminated sediments have been identified. Cleaning will proceed from the upstream manhole in each line to the next downstream manhole. During the cleaning of a reach, the upstream and downstream trunk lines will be plugged and the upstream water will be pumped around the reach being cleaned into a manhole downstream of the isolated reach. The pumping of water around the reach being cleaned may not be necessary if flows are relatively low (i.e., the upstream water would be allowed to back-up during cleaning).

A wet vacuum truck will be positioned at the downstream manhole to collect the potable wash water generated by the waterblaster. Remaining water and loosened sediments within the manhole will then be vacuumed by a wet/dry vacuum truck (i.e. Guzzler™). The water and the sediments will be stored in a temporary tank for a period of approximately 12 hours to allow the sediments to settle. The water in the temporary tank will then be decanted through a pre-filter to reduce suspended sediments, followed by a portable carbon canister and then into the on-site sanitary sewer.

Video taping of the cleaned storm sewer lines will be conducted to verify the cleaning process and the integrity of the lines. Video taping will follow storm sewer cleaning in each line. The video tape will be reviewed and additional cleaning will be implemented, if necessary, based on the video tape results.

Following decanting of the wash water, the contractor will transfer the sediments in the Guzzler™ vacuum truck to Department of Transportation (DOT) approved 55 gallon drums or other suitable container systems. These drums/containers will be labeled and staged at the plant. The staging areas will be contained and secured in accordance with hazardous materials storage requirements, even though it may be determined that the sediments do not classify as hazardous.

A portable filter press will be used to dewater the sediments, if necessary (based on water content considerations). Initially, the remedial contractor will transfer the sediments from the drums/containers to the filter press. During dewatering, the effluent will be discharged through a pre-filter to reduce suspended sediments, followed by a portable carbon canister and then into the on-site sanitary sewer. The dewatered sediments will then be transferred to DOT approved 55 gallon drums (in a semi-dry form) for subsequent testing and disposal.

Task 6: Sediment Dredging

Sediment dredging will require a temporary rerouting of Olean Creek. Initially a diversion channel will be excavated or piped along the east side of Olean Creek. A temporary dam will then be installed on the up- and down-stream sides of the area requiring dredging and the creek will be rerouted through the diversion channel. Samples of the sediment will then be collected to delineate the contaminated areas utilizing a 24-hour turnaround time for the analysis. The contaminated soil will then be excavated, staged (for initial dewatering) and transported to the plant for mechanical dewatering, if necessary (i.e., if only sands-and-gravels are encountered, then the mechanical dewatering will probably not be necessary). Dewatering and containerization procedures described above for the storm sewer sediment will be used.

The excavated areas will be backfilled with clean soil and the temporary dams will be removed. The diversion channel will then be backfilled and reseeded. It is anticipated that this task can be completed in a two-week time period, not including the time to obtain the necessary permits.

Task 7: Excavation and Treatment of Soils

Excavation of on-site soil will initially concentrate on the areas of high chromium contamination detected near the former vat areas. As previously discussed, the vertical extent of the high chromium contamination within the soil beneath the vat area is unknown. Thus, special techniques to address this soil, if below the ground water table, may be necessary (e.g., sheet piling, dewatering, in-situ stabilization, etc.).

It is anticipated that these soils will undergo on-site solidification/stabilization, contingent upon the results of pilot testing. However, two other possibilities exist: 1) off-site treatment and landfilling in a secure landfill ; or 2) recycling at an off-site reclamation facility (e.g., INMETCO, used by USEPA to recycle the spent chromic acid found in the vats). The less chromium contaminated soil (50 ppm to 1,000 ppm), which based on the Treatability Study produced no detected chromium leachate in its treated state, will be excavated and mixed with the solidification agent, and then backfilled on-site.

The soil will be excavated using backhoes and other earth moving equipment. The areas of excavation will be watered to limit dust generation during remediation. The limits of excavation will be based on sampling and testing of the base and sidewalls until concentrations of less than 50 ppm total chromium are encountered. The excavated soil will be transported to the on-site solidification area (possibly at Plant No. 2) where it will be placed in large containment vessels (e.g., roll-off boxes, vats, etc.) and mixed with the appropriate proportions of solidification agents and water.

Task 8: Consolidation and Cover

The contaminated soil that is excavated from off-site areas will be treated and consolidated on-site. The excavated areas from off-site will be backfilled with clean fill. The increase in volume resulting from the solidification process and on-site consolidation of off-site soil will result in an increase in the elevation of the site as shown on Figure 5-6. The on-site soil will be mounded to promote drainage and a 1-foot thick clean topsoil cover will be constructed to promote on-site vegetation. A perimeter drainage channel will be constructed to control sheet flow from off of the site. The site will be seeded with perennial grass seed, trees and shrubs will be planted for aesthetic value.

Task 9: Extraction

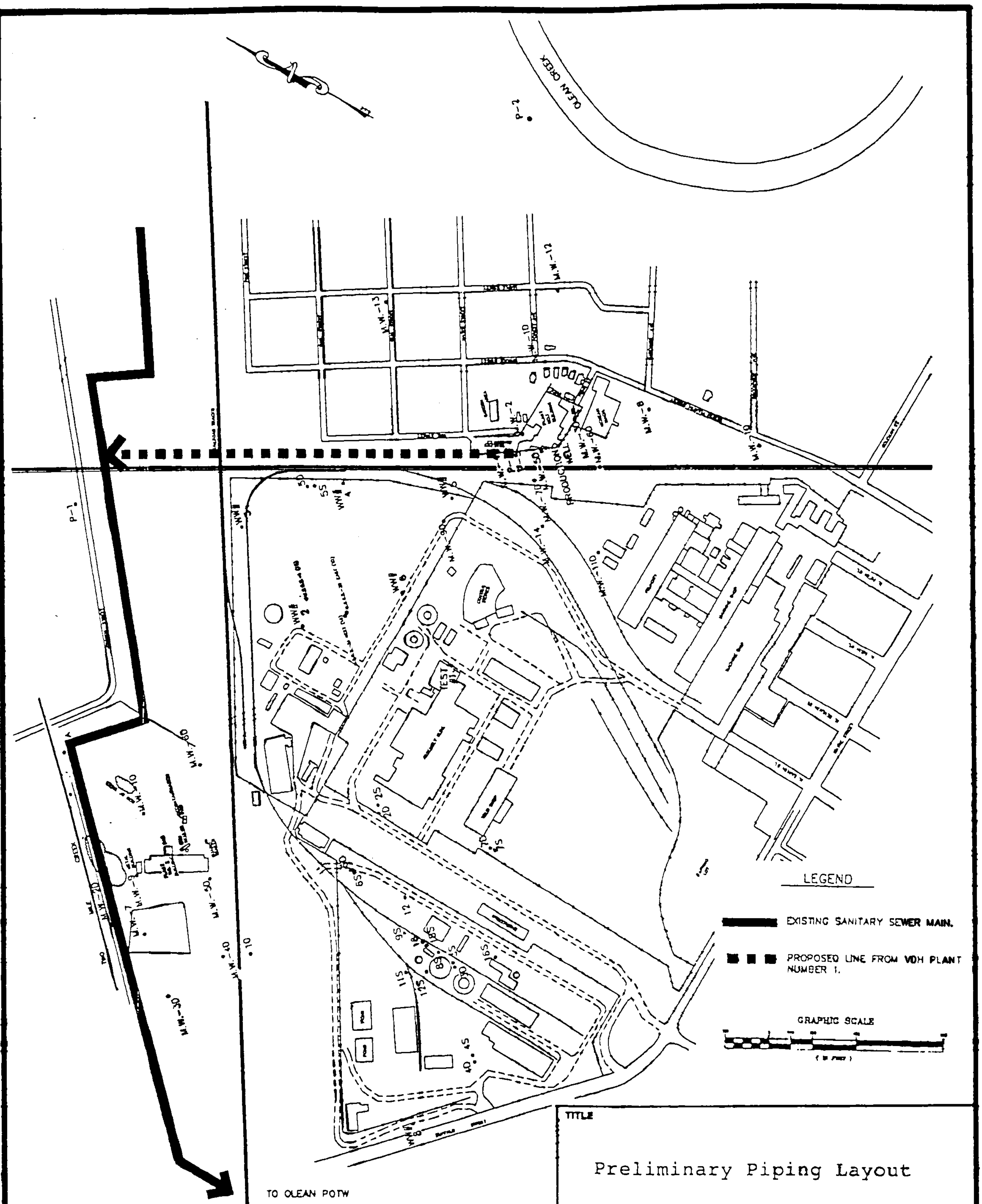
The ground water extraction system will be based on the Pre-Remediation Investigation and further ground water modeling. However, it is currently anticipated that there will be one on-site pumping well installed near the former vat area. This well will extract the ground water with higher concentrations of hexavalent chromium which will be pumped through a temporary carbon adsorption system. The activated-carbon will reduce the hexavalent chromium levels below local POTW limits. The carbon will be replaced as necessary based on the concentration of the extracted ground water and the breakthrough time calculated during the pilot studies. It is currently anticipated that within a 5-year period the hexavalent chromium concentrations in the ground water from this well will be below POTW limits so that the carbon pretreatment can be discontinued.

The remaining four pumping wells will be positioned to capture the ground water with concentrations exceeding 50 ppb hexavalent chromium. This water will be discharged directly to the sanitary sewer. The extraction system will include a submersible pump within each extraction well and appropriate piping and contingency systems.

Task 10: Ground Water Treatment

Ground water from the extraction wells will be routed to the nearest trunk line of the Olean sanitary sewer system. This trunk line is a 22-inch diameter main located north of the site along Franklin Street. The extracted ground water will be pumped from the site to the sanitary sewer in an underground conduit that will be installed along the east side of the Conrail tracks (see Figure 6-1). From Franklin Street, the sanitary sewer line runs in a southerly direction through the west portion of Olean and discharges at the Olean POTW on the Allegheny River.

The Olean POTW utilizes an activated-sludge system which is presented schematically on Figure 6-2. Based on preliminary mass-balance calculations, the POTW will require some upgrades to treat the additional 1.8 million gallons per day of ground water that would be added to the incoming flow. As previously mentioned, the current system is probably capable of treating this additional flow; however, due to previous commitments to the outlying



NOTE:
THE SCALE AND LOCATION OF ALL MAP FEATURES WEST OF THE PLANT NO. 1 SITE AND SOUTH OF THE PLANT NO.2 SITE ARE APPROXIMATE. PLANT NO. 1 MONITORING WELL LOCATIONS WITHIN THIS AREA ARE CORRECT.

TITLE

Preliminary Piping Layout

PREPARED FOR

NYSDEC

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Environmental Resources Management

SCALE

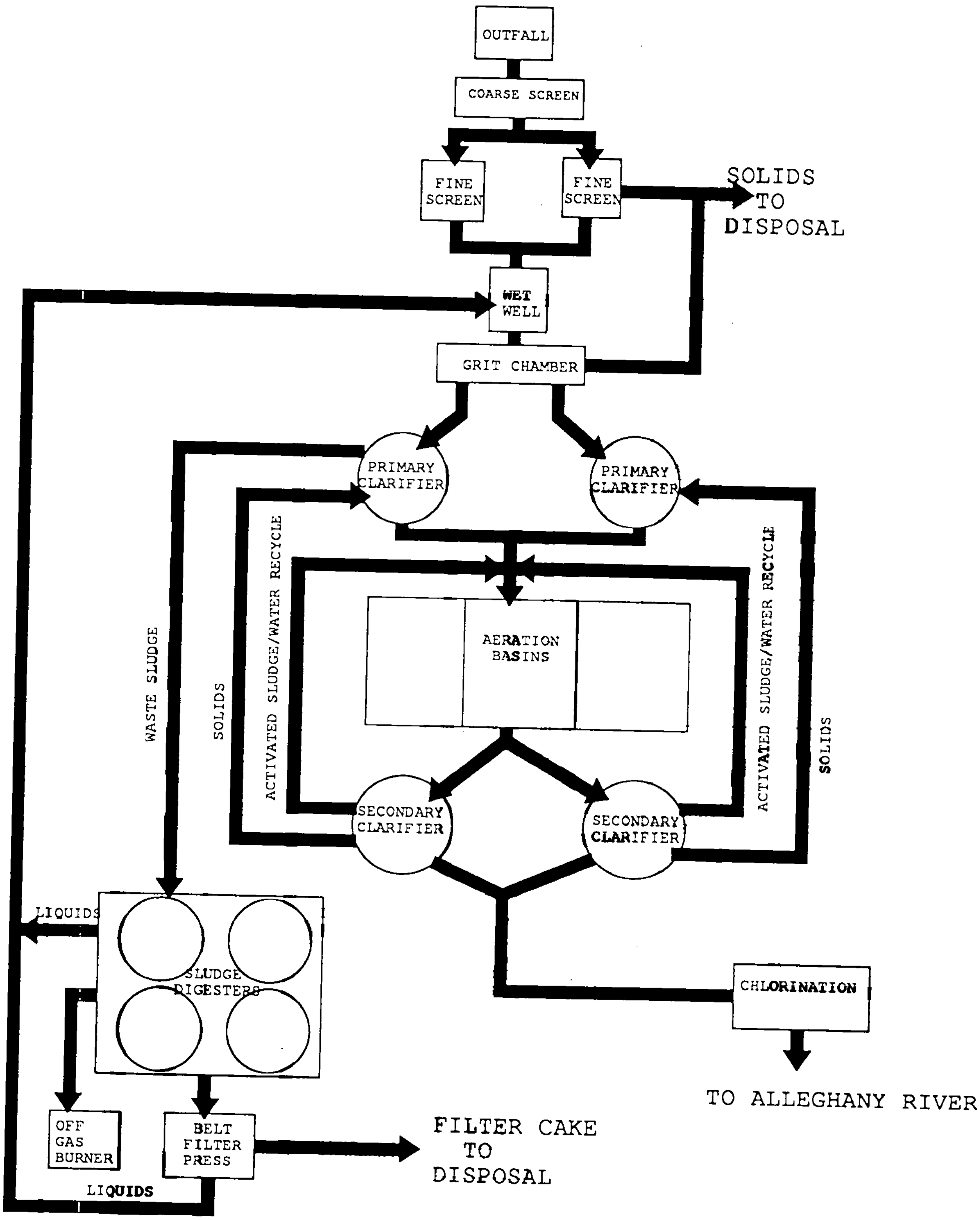
DATE

FIGURE

6-1

139839

FIGURE 6-2
OLEAN POTW WASTEWATER TREATMENT FLOW DIAGRAM



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communities, the future wastewater flows could exceed the design flow. The upgrades to the system would include increasing the size/number of the secondary clarifiers and aeration tanks. The specific upgrades will require a thorough evaluation of the POTW which will be completed during the Pre-Remediation Investigation.

Based on data from the August 1990 "CERCLA Site Discharges To POTWs Treatability Manual", a typical activated sludge system with chlorination has a chromium removal efficiency of approximately 75 percent. Using this removal efficiency, preliminary mass-balance calculations (which include the proposed ground water flow from Van Der Horst Plant No. 1) indicate that the waste sludge generated by the Olean POTW would be below TCLP limits for chromium. Additionally, the treated wastewater effluent would have a chromium concentration below the SPDES permit limits for the POTW. The Pre-Remediation Investigation will be used to verify these initial estimates through a site-specific assessment of the POTW system.

Task 11: Monitoring

Water quality monitoring for the contaminants of concern will be initiated following implementation of the ground water extraction system. Initially, this monitoring may be conducted on a quarterly basis in selected monitoring wells (for selected metals and halogenated VOCs) until a seasonal data base has been developed. This monitoring will then be scaled-back to bi-annually (spring and fall) until remediation is complete. Water levels will be collected (from all monitoring wells) concurrent with ground water sampling. Monitoring and repair, if necessary, will include periodic observations of the cover and full-time on-site maintenance and monitoring of the ground water extraction system.

6.3 Sensitivity Analysis

A Sensitivity Analysis was conducted for the selected remedial alternative to identify worst-case scenarios and to evaluate the need for contingency or reserve funds. The following factors were considered during the Sensitivity Analysis because these factors were considered to have the greatest influence on the total costs of the selected alternative:

1) The Duration of the Clean-Up;
2) The O&M Costs;
3) The Volume of Contaminated Soil and Ground Water; and
4) The Discount Rate.

A summary of the results of the Sensitivity Analysis is presented below. Note that the original estimated total present worth cost for the selected alternative is $23,352,000.

Factor	% Change	Total Cost($)	% Cost Change
Duration	+ 5	23,679,000	+ 1
O&M	+ 5	24,069,000	+ 3
Volume	+ 5	23,801,000	+ 2
Disc. Rate	- 40	28,770,000	+ 20
Disc. Rate	+ 100	15,691,000	- 30
Disc. Rate	- 5	23,924,000	+ 2

The duration of the clean-up was increased from 30 years to 32 years (i.e., increased approximately 5 percent). This time increase resulted in a 1 percent increase in total present worth remediation costs.

The O&M costs for ground water treatment and monitoring were increased 5 percent. This cost increase resulted in an approximate 3 percent increase in the total present worth remediation costs.

The volume of contaminated soil and ground water was increased 5 percent. This volume increase resulted in an approximate 2 percent increase in the total present worth remediation costs.

An increase in the discount rate from 5 to 10 percent resulted in a decrease in the total present worth costs of approximately 30 percent. A decrease in the discount rate from 5 to 3 percent resulted in an increase in the total present worth costs of approximately 20 percent. A decrease in the discount rate from 5 to 4.75 percent (i.e., a relative 5 percent decrease) resulted in an increase in the total present worth costs of approximately 2 percent.

Based on the Sensitivity Analysis presented above, all factors that were evaluated have a similar impact on the estimated total remediation costs. A variation in any of the four factors produced a corresponding smaller variation in the total costs. Of those factors evaluated, the ones most likely to vary during remediation are the volume of contaminated soil and ground water and the duration of the clean-up.

7.0 LIMITATIONS AND USE OF REPORT

This report was prepared in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and we observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. The analyses and conclusions submitted in this report are based in part upon data and information provided by others, and are contingent upon their validity.

This report was prepared exclusively for the NYSDEC for specific application to the Van Der Horst Plant No. 1 site in accordance with generally accepted engineering practice. No other warranty, expressed or implied, is made.

8.0 REFERENCES

The following references were used to develop this FS report for the NYSDEC:

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FEASIBILITY STUDY

PHASES I, II and III
PLANT NO. 1
VAN DER HORST CORPORATION SITE
SITE NO. 9-05-008
OLEAN, CATTARAUGUS COUNTY

VOLUME II OF II

JANUARY 1992

SUBMITTED TO:

DIVISION OF HAZARDOUS WASTE REMEDIATION
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233

SUBMITTED BY:

ERM-NORTHEAST, INC.
5500 MAIN STREET
WILLIAMSVILLE, NEW YORK 14221

ERM-Northeast

APPENDIX A
Screening Evaluation Forms

Ground Water Treatment
No Action

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___0 No _X_4
	o Can the Short-term risk be easily controlled?	Yes ___1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No ___2
Subtotal (maximum = 4)		4
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _X_0 No ___4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___3 No _X_0
Subtotal (maximum = 4)		0
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr _X_1 ≥2yr ___0
	o Required duration of the mitigative effort to control short-term risk.	<2yr ___1 >2yr _X_0
Subtotal (maximum = 2)		1
4. On-site or off-site treatment or land disposal	o On-site treatment*	___3
	o Off-site treatment*	___1
	o On-site or off-site land disposal	_X_0
Subtotal (maximum = 3)		0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes ___3 No _X_0
Subtotal (maximum = 3)		0

Ground Water Treatment
No Action

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr ___3 20-25yr ___2 15-20yr ___1 <15yr _X_0
Subtotal (Maximum = 3)		0
7. 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% _X_0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes _X_0 No ___2
	iii) Is the treated residual toxic?	Yes _X_0 No ___1
	iv) Is the treated residual mobile?	Yes _X_0 No ___1
Subtotal (maximum = 5)		0
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr ___1 >5yr _X_0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X_0 No ___1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___1 Somewhat to not confident _X_0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___2 Moderate ___1 Extensive _X_0
Subtotal (maximum = 4)		0
TOTAL (maximum = 25)		5

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Treatment
No Action

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	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.	X 3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	___2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	X 2
	ii) Required coordination is normal.	___1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		2
3. Availability of Services and materials.	i) Are technologies under consideration generally commercially available for the site-specific application.	Yes X 1 No ___ 0
a. Availability of prospective technologies.	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		14

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Extraction, Treatment, Discharge to **Surface Water**

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___0 No _X_4
	o Can the Short-term risk be easily controlled?	Yes ___1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No ___2
Subtotal (maximum = 4)		
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes ___0 No ___4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___3 No _X_0
Subtotal (maximum = 4)		4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr___1 ≥2yr_X_0
	o Required duration of the mitigative effort to control short-term risk.	<2yr_X_1 >2yr___0
Subtotal (maximum = 2)		1
4. **On-site or off-site treatment or land disposal**	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	_X_ 3 ___1 ___0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_3 No ___0
Subtotal (maximum = 3)		3

Ground Water Extraction, Treatment, Discharge to **Surface Water**

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o **Expected lifetime** or duration of **effectiveness** of the remedy.	25-30yr ___ 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		0
7. 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% _X_ 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ___ 0 No _X_ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr ___ 1 >5yr _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X_ 0 No ___ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident _X_ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___ 2 Moderate _X_ 1 Extensive ___ 0
Subtotal (maximum = 4)		2
TOTAL (maximum = 25)		21

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Extraction
Treatment, Discharge to
Surface Water

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	___2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		6
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	___1
	iii) Extensive Coordination is required.	X 0
Subtotal (maximum = 2)		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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
SUBTOTAL (MAXIMUM = 3)		3
TOTAL (MAXIMUM = 15)		11

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Extraction
Pretreatment, Discharge to
POTW

SHORT-TERM/LONG-TERM EFFECTIVENESS
Pretreatment, Discharge to
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___0 No _X_4
	o Can the Short-term risk be easily controlled?	Yes ___1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No ___2
Subtotal (maximum = 4)		4
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes ___0 No _X_4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___3 No ___0
Subtotal (maximum = 4)		4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	<2yr___1 ≥2yr_X_0
	o Required duration of the mitigative effort to control short-term risk.	<2yr_X_1 >2yr___0
Subtotal (maximum = 2)		1
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	___ 3 _X_ 1 ___ 0
Subtotal (maximum = 3)		1
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_3 No ___0
Subtotal (maximum = 3)		3

Ground Water Extraction,
Pretreatment, Discharge
to POTW

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X___ 2 25-50%___ 1 >50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ____ 0 No _X__ 2
	iii) Is the treated residual toxic?	Yes ____ 0 No ____ 1
	iv) Is the treated residual mobile?	Yes ____ 0 No ____ 1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr___ 1 >5yr_X__ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X__ 0 No ____ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident _X_1 Somewhat to not confident ____0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum___2 Moderate_X1 Extensive_0
Subtotal (maximum = 4)		2
TOTAL (maximum = 25)		19

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Extraction, Pretreatments, Discharge to POTW

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	___2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___1
Subtotal (maximum = 10)		8
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		11

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Ground Water Extraction, Treatment, Reinjection

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes __ 0 No _X_ 4
	o Can the Short-term risk be easily controlled?	Yes ___1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No ___2
Subtotal (maximum = 4)		4
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes ___0 No _X_4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___3 No ___0
Subtotal (maximum = 4)		4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr___1 ≥2yr_X_0
	o Required duration of the mitigative effort to control short-term risk.	<2yr_X_1 >2yr___0
Subtotal (maximum = 2)		1
4. On-site or off-site treatment or land disposal	o On-site treatment*	_X_ 3
	o Off-site treatment*	___ 1
	o On-site or off-site land disposal	___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_3 No ___0
Subtotal (maximum = 3)		3

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X 2 25-50%___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes X 0 No ____ 2
	iii) Is the treated residual toxic?	Yes ____ 0 No X 1
	iv) Is the treated residual mobile?	Yes X 0 No ____ 1
Subtotal (maximum = 5)		3
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr____ 1 >5yr X 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes X 0 No ____ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident X 1 Somewhat to not confident ___0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum __ 2 Moderate __1 Extensive X0
Subtotal (maximum = 4)		1
TOTAL (maximum = 25)		19

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	___2
	iii) Very difficult to construct and/or significant uncertainties in construction.	X 1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.	___3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	___2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___1
Subtotal (maximum = 10)		6
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	___1
	iii) Extensive Coordination is required.	X 0
Subtotal (maximum = 2)		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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
B. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		9

IF THE TOTAL IS LESS THAN 8, PROJECT MAY REJECT THE REMEDIAL ALTERNATIVE FOR FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___0 No _X_4
	o Can the Short-term risk be easily controlled?	Yes ___1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No ___2
Subtotal (maximum = 4)		4
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _X_0 No ___4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___3 No _X_0
Subtotal (maximum = 4)		0
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr _X_1 ≥2yr ___0
	o Required duration of the mitigative effort to control short-term risk.	<2yr ___1 >2yr _X_0
Subtotal (maximum = 2)		1
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	___3 ___1 _X_0
Subtotal (maximum = 3)		0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes ___3 No _X_0
Subtotal (maximum = 3)		0

Soil/Sediment Remediation
No Action/Limited Action

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr ___ 3 20-25yr ___ 2 15-20yr ___ 1 <15yr _X_ 0
Subtotal (Maximum = 3)		0
7. 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% _X_ 0
	ii) Is there treated residual left at the site? **(If answer is no, go to Factor 8.)**	Yes _X_ 0 No ___ 2
	iii) Is the treated residual toxic?	Yes _X_ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes _X_ 0 No ___ 1
Subtotal (maximum = 5)		0
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr ___ 1 >5yr _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X_ 0 No ___ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident _X_ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___ 2 Moderate ___ 1 Extensive _X_ 0
Subtotal (maximum = 4)		0
TOTAL (maximum = 25)		5

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Soil/Sediment Remediation
No Action/Limited Action

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screenign	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	ii) Somewhat difficult to construct. No uncertainities in construction.	__2
	iii) Very difficult to construct and/or significant uncertainities in construction.	__1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.	X 3
	ii) Somewhat reliable in meeting the specifiec process efficiencies or performance goals.	__2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	__1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	__2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	X 2
	ii) Required coordination is normal.	__1
	iii) Extensive Coordination is required.	__0
Subtotal (maximum = 2)		2
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 X 1 No __0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No __0

Capping of
Soils/Removal of
Sediments

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o **Are there significant** short-term **risks to the** community that must be addressed? **(If answer is no, go to Factor 2.)**	Yes X 0 No __ 4
	o Can the Short-term risk be easily controlled?	Yes X 1 No __ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes __ 0 No X 2
Subtotal (**maximum** = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No __ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No __ 0
Subtotal (**maximum** = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	<2yr X 1 ≥2yr __ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X 1 >2yr __ 0
Subtotal (**maximum** = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	__ 3 __ 1 X 0
Subtotal (**maximum** = 3)		0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o **Will the remedy be classified as permanent in** accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 7.)**	Yes __ 3 No X 0
Subtotal (**maximum** = 3)		0

Capping of
Soils/Removal of
Sediments

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr _X_ 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		3
7. 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% _X_ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes _X_ 0 No ___ 2
	iii) Is the treated residual toxic?	Yes _X_ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes _X_ 0 No ___ 1
Subtotal (maximum = 5)		0
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr ___ 1 >5yr _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X_ 0 No ___ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident _X_ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___ 2 Moderate ___ 1 Extensive _X_ 0
Subtotal (maximum = 4)		1
TOTAL (maximum = 25)		12

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Capping of
Soils/Removal of
Sediments

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor		Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility			
a. Ability to construct technology.	i)	Not difficult to construct.	___3
	ii)	Somewhat difficult to construct. No uncertainties in construction.	X 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.	X 3
	ii)	Somewhat reliable in meeting the specific process efficiencies or performance goals.	___2
c. Schedule of delays due to technical problems.	i)	Unlikely	X 2
	ii)	Somewhat likely	___1
d. Need of undertaking additional remedial action, if necessary.	i)	No future remedial actions may be anticipated.	___2
	ii)	Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)			8
2. Administrative Feasibility			
a. Coordination with other agencies.	i)	Minimal coordination is required	___2
	ii)	Required coordination is normal.	___1
	iii)	Extensive Coordination is required.	X 0
Subtotal (maximum = 2)			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 X 1 No ___0
	ii)	Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
b. Availability of necessary equipment and specialists.	i)	Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)			3
TOTAL (MAXIMUM = 15)			11

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Excavation and Off-Site
Landfill Disposal

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 4
	o Can the Short-term risk be easily controlled?	Yes X 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	___ 3 ___ 1 X 0
Subtotal (maximum = 3)		0
*treatment is defined as destruction or separation/treatment or solidification/chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes ___ 3 No X 0
Subtotal (maximum = 3)		0

Excavation and Off-Site
Landfill Disposal

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr X 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		3
7. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None X 3 <25% ___ 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ___ 0 No X 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		5
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr ___ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes ___ 0 No X 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum X 2 Moderate ___ 1 Extensive ___ 0
Subtotal (maximum = 4)		4
TOTAL (maximum = 25)		20

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Excavation and Off-Site
Landfill Disposal

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screenign	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	ii) Somewhat difficult to construct. No uncertainities in construction.	___2
	iii) Very difficult to construct and/or significant uncertainities in construction.	___1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.	X 3
	ii) Somewhat reliable in meeting the specifiec process efficiencies or performance goals.	___2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___1
Subtotal (maximum = 10)		10
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0

Excavation and Off-Site
Landfill Disposal

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		14

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

On-Site
Soil Washing

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 4
	o Can the Short-term risk be easily controlled?	Yes X 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X 1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X 1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	X 3 ___ 1 ___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes X 3 No ___ 0
Subtotal (maximum = 3)		3

On Site
Soil Washing

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X__2 25-50%___1 ≥50% ___0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ____0 No __X__2
	iii) Is the treated residual toxic?	Yes ____0 No ____1
	iv) Is the treated residual mobile?	Yes ____0 No ____1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr_X__1 >5yr____0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes _X__0 No ____1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident X 1 Somewhat to not confident __0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum __2 Moderate _X1 Extensive__0
Subtotal (maximum = 4)		3
TOTAL (maximum = 25)		21

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

On-Site
Soil Washing

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening		Score
1. Technical Feasibility			
a. Ability to construct technology.	i) Not difficult to construct.		___3
	ii) Somewhat difficult to construct. No uncertainties in construction.		X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.		X 2
c. Schedule of delays due to technical problems.	i) Unlikely		___2
	ii) Somewhat likely		X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		___2
	ii) Some future remedial actions may be necessary.		X 1
Subtotal (maximum = 10)			6
2. Administrative Feasibility			
a. Coordination with other agencies.	i) Minimal coordination is required		___2
	ii) Required coordination is normal.		X 1
	iii) Extensive Coordination is required.		___0
Subtotal (maximum = 2)			1
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 ___ No X	1 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X No ___	1 0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X No ___	1 0
Subtotal (maximum = 3)			2
TOTAL (MAXIMUM = 15)			9

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 4
	o Can the Short-term risk be easily controlled?	Yes X 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X 1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X 1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	X 3 ___ 1 ___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes X 3 No ___ 0
Subtotal (maximum = 3)		3

On-Site Solidification/
Stabilization

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr ___ 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		0
7. 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% X 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes X 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No X 1
	iv) Is the treated residual mobile?	Yes ___ 0 No X 1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr ___ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes X 0 No ___ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident X 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___ 2 Moderate X 1 Extensive ___ 0
Subtotal (maximum = 4)		3
TOTAL (maximum = 25)		21

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

On-Site Solidification/
Stabilization

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		7
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		11

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Off-Site Disposal of Heavily Chromium Contaminated Soil & On-Site **Washing of Less Contaminated Soil.**

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o **Are there significant short-term risks to the community that must be addressed? (If answer is** no, go to Factor 2.)	Yes X 0 No __ 4
	o Can the Short-term risk be easily controlled?	Yes X 1 No __ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes __ 0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No __ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No __ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X 1 ≥2yr __ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X 1 >2yr __ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	__ 3 __ 1 X 0
Subtotal (maximum = 3)		0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes __ 3 No X 0
Subtotal (maximum = 3)		0

Off-Site Disposal of Heavily Chromium Contaminated Soil & On-Site Washing of Less Contaminated Soil

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr X 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		3
7. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None X 3 <25% ___ 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ___ 0 No X 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		5
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr ___ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes ___ 0 No X 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum X 2 Moderate ___ 1 Extensive ___ 0
Subtotal (maximum = 4)		4
TOTAL (maximum = 25)		20

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Off-Site Disposal of Heavily Chromium Contaminated **Soil & On-Site** Washings **of Less Contaminated** Soil

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	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.	X 3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	__2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	__1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	__1
Subtotal (maximum = 10)		10
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	__2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	__0
Subtotal (maximum = 2)		1
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 X 1 No __0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No __0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No __0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		14

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Off-Site Disposal of Less Contaminated Soil and On-Site Washing of Heavily Chromium Contaminated Soil

SHORT-TERM/LONG-TERM EFFECTIVENESS

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the Short-term risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr _X_ 1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr _X_ 1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	_X_ 3 ___ 1 ___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_ 3 No ___ 0
Subtotal (maximum = 3)		3

Off-Site Disposal of Less Contaminated Soil and On-Site Washing of Heavily Chromium Contaminated Soil

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X 2 25-50%___1 ≥50% ___0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ____0 No X 2
	iii) Is the treated residual toxic?	Yes ____0 No ____1
	iv) Is the treated residual mobile?	Yes ____0 No ____1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr____0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes X 0 No ____1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident X 1 Somewhat to not confident __0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum __2 Moderate X1 Extensive__0
Subtotal (maximum = 4)		3
TOTAL (maximum = 25)		21

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Off-Site Disposal of Less Contaminated Soil and On-Site **Washing of** Heavily Chromium Contaminated Soil

IMPLEMENTABILITY

(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. <u>Technical Feasibility</u>		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	___2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		6
2. <u>Administrative Feasibility</u>		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
3. <u>Availability of Services and Materials</u>		
a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes ___ 1 No X 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___ 0
Subtotal (maximum = 3)		2
TOTAL (MAXIMUM = 15)		9

IF THE TOTAL IS LESS THAN I, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil

SHORT-TERM/LONG-TERM EFFECTIVENESS

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the Short-term risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr _X_ 1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr _X_ 1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* o Off-site treatment* o On-site or off-site land disposal	_X_ 3 ___ 1 ___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_ 3 No ___ 0
Subtotal (maximum = 3)		3

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X 2 25-50%___1 >50% ___0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ____0 No X 2
	iii) Is the treated residual toxic?	Yes ____0 No ____1
	iv) Is the treated residual mobile?	Yes ____0 No ____1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr____ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes X 0 No ____ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident X 1 Somewhat to not confident __0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum __2 Moderate X1 Extensive__0
Subtotal (maximum = 4)		3
TOTAL (maximum = 25)		21

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Analysis Factor	IMPLEMENTABILITY (Maximum Score = 15) Basis for Evaluation During Preliminary Screening		On-Site Soil Washing of Heavily Chromium Contaminated Soil, Off-Site Landfill Disposal of Sediments and Capping of the Remaining On-Site Soil Score
1. Technical Feasibility			
a. Ability to construct technology.	i) Not difficult to construct.		___3
	ii) Somewhat difficult to construct. No uncertainties in construction.		X 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
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.		X 2
c. Schedule of delays due to technical problems.	i) Unlikely		___2
	ii) Somewhat likely		X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		___2
	ii) Some future remedial actions may be necessary.		X 1
Subtotal (maximum = 10)			6
2. Administrative Feasibility			
a. Coordination with other agencies.	i) Minimal coordination is required		___2
	ii) Required coordination is normal.		X 1
	iii) Extensive Coordination is required.		___0
Subtotal (maximum = 2)			1
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 ___ No X	1 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X No ___	1 0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X No ___	1 0
Subtotal (maximum = 3)			2
TOTAL (MAXIMUM = 15)			9

IF THE TOTAL IS LESS THEN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No __4
	o Can the Short-term risk be easily controlled?	Yes X 1 No __0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes __0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No __4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No __0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X1 ≥2yr __0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X1 >2yr __0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment*	__3
	o Off-site treatment*	__1
	o On-site or off-site land disposal	X 0
Subtotal (maximum = 3)		0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes __3 No X 0
Subtotal (maximum = 3)		0

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr X 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		3
7. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None X 3 <25% ___ 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes ___ 0 No X 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		5
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr ___ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes ___ 0 No X 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum X 2 Moderate ___ 1 Extensive ___ 0
Subtotal (maximum = 4)		4
TOTAL (maximum = 25)		20

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Off-Site Disposal of Heavily Chromium Contaminated Soil and Capping of the Remaining Soil/Sediment Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	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.	X 3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	___2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___1
Subtotal (maximum = 10)		10
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No ___0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		14

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No ___4
	o Can the Short-term risk be easily controlled?	Yes X 1 No ___0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___0 No X 2
Subtotal (maximum = 4)		3
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes X 0 No ___4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No ___0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr X 1 ≥2yr ___0
	o Required duration of the mitigative effort to control short-term risk.	<2yr X 1 >2yr ___0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment*	X 3
	o Off-site treatment*	___1
	o On-site or off-site land disposal	___0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes X 3 No ___0
Subtotal (maximum = 3)		3

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr ___ 3 20-25yr ___ 2 15-20yr ___ 1 <15yr ___ 0
Subtotal (Maximum = 3)		0
7. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site.	None X 3 <25% ___ 2 25-50% ___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes X 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No X 1
	iv) Is the treated residual mobile?	Yes ___ 0 No X 1
Subtotal (maximum = 5)		5
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr ___ 1 >5yr X 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes X 0 No ___ 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident X 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___ 2 Moderate X 1 Extensive ___ 0
Subtotal (maximum = 4)		1
TOTAL (maximum = 25)		20

IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	___3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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.	X 3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	___2
c. Schedule of delays due to technical problems.	i) Unlikely	___2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		7
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	___2
	ii) Required coordination is normal.	X 1
	iii) Extensive Coordination is required.	___0
Subtotal (maximum = 2)		1
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 X 1 No ___0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes ___1 No X 0
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes ___1 No X 0
Subtotal (maximum = 3)		1
TOTAL (MAXIMUM = 15)		9

IF THE TOTAL IS LESS THAN 8, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___ 0 No _X_ 4
	o Can the Short-term risk be easily controlled?	Yes ___ 1 No ___ 0
	o Does the mitigative effort to control short-term risk impact the community life-style?	Yes ___ 0 No ___ 2
Subtotal (maximum = 4)		4
2. Environmental Impacts	o Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤2yr _X_ 1 ≥2yr ___ 0
	o Required duration of the mitigative effort to control short-term risk.	<2yr _X_ 1 >2yr ___ 0
Subtotal (maximum = 2)		2
4. On-site or off-site treatment or land disposal	o On-site treatment* - solidification	_X_ 3
	o Off-site treatment*	___ 1
	o On-site or off-site land disposal	___ 0
Subtotal (maximum = 3)		3
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes		
5. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). (If answer is yes, go to Factor 7.)	Yes _X_ 3 No ___ 0
Subtotal (maximum = 3)		3

SHORT-TERM/LONG-TERM EFFECTIVENESS
(Maximum Score = 25)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
6. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr___3 20-25yr___2 15-20yr___1 <15yr ___0
Subtotal (Maximum = 3)		0
7. 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% X 2 25-50%___ 1 ≥50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 8.)	Yes X 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No X 1
	iv) Is the treated residual mobile?	Yes ___ 0 No X 1
Subtotal (maximum = 5)		4
8. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	<5yr X 1 >5yr___ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "IV")	Yes ___ 0 No X 1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___1 Somewhat to not confident ___0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum X 2 Moderate___1 Extensive___0
Subtotal (maximum = 4)		4
		23

TOTAL (maximum = 25)
IF THE TOTAL IS LESS THAN 10, PROJECT MANAGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

IMPLEMENTABILITY
(Maximum Score = 15)

Analysis Factor	Basis for Evaluation During Preliminary Screening	Score
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct.	X 3
	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.	X 3
	ii) Somewhat reliable in meeting the specific process efficiencies or performance goals.	__2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	__1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	__1
Subtotal (maximum = 10)		10
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required	X 2
	ii) Required coordination is normal.	__1
	iii) Extensive Coordination is required.	__0
Subtotal (maximum = 2)		2
3. Availability of Services and Materials	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes X 1 No __0
a. Availability of prospective technologies.	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No __0
b. Available of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes X 1 No __0
Subtotal (maximum = 3)		3
TOTAL (MAXIMUM = 15)		15

IF THE TOTAL IS LESS THAN 8, PROJECT MANGER MAY REJECT THE REMEDIAL ALTERNATIVE FROM FURTHER CONSIDERATION.

ERM-Northeast

APPENDIX B
Treatability Study Report

Van der Horst Treatability Study

Investigation of Soil and Groundwater Remediation Options Performed by:

General Testing Corporation

for

ERM Northeast
11/16/90 - 02/15/91

INDEX

I. Introduction

On 11/16/90, 15 gallons of groundwater from well # MW-5D, and approximately 20 lb each of soil from areas MW-3 and MW-5 were received at General Testing. This material was identified as originating from the Van der Horst site. Bench scale laboratory studies were requested as follows.

#1. Treatment of the groundwater with 3 reducing agents in an effort to evaluate optimum dosages necessary to reduce hexavalent chromium to the trivalent state.

#2. Two step treatment of groundwater, involving optimum dose of reducing agents combined with pH adjustment with sodium hydroxide and lime, to precipitate metals in solution.

#3. Treatment of groundwater with varying amounts of activated carbon to explore potential removal of hexavalent chromium.

#4. Solidification/stabilization of soil with lime, lime/ferrous sulfate, and lime/fly ash.

#5. Removal of metal contaminants from soil using various wash solutions.

All samples were stored at $4^{o}C$ in a walk-in cooler during the study. The groundwater was received in 3-5 gallon carboys and transferred to a 16 gallon polyethylene drum. The soils were received and stored in 5 gallon plastic pails and were not transferred.

II. Raw Sample Analysis

The raw samples were analyzed to determine a baseline against which treatment options would be judged.

A. Water

	(ppm)
Acidity	<1.0
Alkalinity	229
pH	7.5
Grease & Oil	<5.0
Dissolved Solids	42.7
Suspended Solids	24.6
Sulfate	77.8
Total Organic Carbon	<1.0
Arsenic	<0.005
Barium	0.075
Cadmium	<0.005
Chromium, Hexavalent	6.96
Chromium, Total	20.8
Iron	1.62
Lead	<0.050
Mercury	<0.0002
Selenium	<0.005
Silver	0.021

B. Soils

	(ppm)	
	MW-3	MW-5
Alkalinity	2360	315
% Solids	93.0	78.4
Arsenic	8.77	23.2
Barium	149	3280
Cadmium	2.40	<0.50
Chromium, Hexavalent	66.4	943
Chromium, Total	392	11,800
Lead	258	8960
Mercury	0.229	0.363
Selenium	<0.50	<0.50
Silver	1.48	<1.0

Soils (continued)

		MW-3 (ppm)	MW-5 (ppm)
TCLP:	Arsenic	<0.50	<0.50
	Barium	2.63	3.91
	Cadmium	<0.10	<0.10
	Chromium	0.107	0.717
	Lead	0.206	39.2
	Mercury	<0.0020	<0.0020
	Selenium	<0.50	<0.50
	Silver	<0.10	<0.10

III. Hexavalent Chromium Reduction

Three reducing agents were initially proposed. Optimum dosages were based on the chemistry involved and the concentration of hexavalent chromium in the groundwater.

A. Sodium Metabisulfite

$4\ CrO_3 + 3Na_2S_2O_5 + 3H_2SO_4 \rightarrow$
$2\ Cr_2(SO_4)_3 + 3Na_2SO_4 + 3H_2O$

* based on 7 ppm Cr^{+6} it was calculated 38.4 mg $Na_2S_2O_5$ would be required.

B. Ferrous Sulfate

$2CrO_3 + 6FeSO_4 + 6H_2SO_4 \rightarrow$
$3Fe_2(SO_4)_3 + Cr_2\ (SO_4)_3 + 6H_2O$

* Based on 7 ppm Cr^{+6} it was calculated 112 mg $FeSO_4.7H_2O$ would be required.

C. Sulfur Dioxide

$3SO_2 + 3H_2O \rightarrow 3H_2SO_3$

$2CrO_3 + 3H_2SO_3 \rightarrow Cr_2(SO_4)_3 + 3H_2O$

* Based on 7 ppm Cr^{+6} it was calculated 12.9 mg would be required.

D. Study Procedure

1. 1 Liter of groundwater was transferred to a 1.5 L beaker and warmed to room temperature.

2. The sample was then placed under a paddle stirrer and the paddle submerged to approximately 1/2 the total depth.

3. The stirring apparatus was turned on and adjusted to an RPM of 80.

4. The pH was adjusted to 2.5 with concentrated H_2SO_4.

5. Reducing agents were added at 1x, 1.5x, and 1.75x the theoretical amount required.

Note: Since SO_2 is a gas it was decided to judge optimum on color change of the sample.

6. pH, temperature and appearance were noted.

7. Samples were mixed for 15 & 30 minutes, at which point stirring was discontinued.

8. Sample was poured off for laboratory analysis.

E. Results

Reduction with $Na_2S_2O_5$ and $FeSO_4.7H_2O$ was performed first. Laboratory reports # R90/5479 and R90/5480 presented on pages # 8&9, show little if any reduction had occurred.

It was determined that other chemical reactions were taking place in preference to Cr^{+6} reduction, and that excess reducing agent was required. This was best judged by visual color change noted as samples were treated. An additional effort was initiated in which the reducing agent was added until color change. Ten times this amount was added to a second aliquot. The resulting data as presented in report #R90/5543 (page #10)shows complete reduction of Cr^{+6} had been achieved.

In each trial the solution color changed from a fairly bright clear yellow, to either completely clear or clear blue. No precipitate was formed and no significant temperature change was noted. The pH varied as follows:

Reducing Agent	Amount Added	Initial pH	Final pH
$Na_2S_2O_5$	0.2 g	2.5	2.7
$Na_2S_2O_5$	2.0 g	2.5	3.0
$FeSO_4.7H_2O$	1.2 g	2.5	3.2
$FeSO_4.7H_2O$	1.2 g	2.5	3.2
SO_2	54 ml	2.6	2.3
SO_2	58 ml	2.6	2.1

Hexavalent Chromium Reduction

Reducing Agent	Metabisulfite		Ferrous Sulfate		Sulfur Dioxide	
Amount Added	0.2g	2.0g	1.2g	12g	54 ml	58 ml
Sample Size	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml

(all results in ppm)

Chromium Hex	<0.010	<0.010	<0.010	<0.010	0.045	0.053
Chromium Tot	19.4	18.4	19.2	16.6	16.8	17.6
Acidity	2230	127	888	1860	909	1620
Sus. Solids	4.6	7.4	4.6	19	10	11

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05479 Date: JAN. 11 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:

Ferrous Sulfate Reduction
Van Der Horst

Received : 12/19/90

P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004	-005	-006		
Location:	15 Min 0.1g	15 Min 0.15g	15 Min 0.175g	30 Min 0.1g	30 Min 0.015g	30 Min 0.175g		
Date Collected:	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90		
Time Collected:	--	--	--	--	--	--		
Solids, Suspended	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U		
Chromium, Hex	7.76	7.66	6.56	9.47	5.35	7.16		
Chromium, Total	18.9	19.2	18.5	19.0	19.0	18.0		

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05480 Date: JAN. 11 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:

NA2S205 Reduction
Van Der Horst

Received : 12/19/90

P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004	-005	-006		
Location:	15 Min	15 Min	15 Min	30 Min	30 Min	30 Min		
	0.04g	0.06g	0.07g	0.04g	0.06g	0.07g		
Date Collected:	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90		
Time Collected:	--	--	--	--	--	--		
Solids, Suspended	1.0 U	1.0 U	1.0 U	1.0 U	1.60	1.0 U		
Chromium, Hex	6.15	11.7	11.0	12.3	10.9	10.7		
Chromium, Total	18.5	19.2	18.5	19.0	19.6	19.6		

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05543 Date: JAN. 14 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, NY 14221

Sample(s) Reference:

Van der Horst-Reduction Studies

Collected : 12/26/90

P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004				
Location:	NA2S2O5 0.2g	NA2S2O5 2.0g	FESO4-7H2O;1.2g	FESO4-7H2O;12g				
Date Collected:	12/26/90	12/26/90	12/26/90	12/26/90				
Time Collected:	--	--	--	--				
Acidity, Total	2230	127	888	8060				
Solids, Suspended	4.58	7.39	4.62	18.6				
Chromium, Hex	0.010 U	0.010 U	0.010 U	0.010 U				
Chromium, Total	19.4	18.4	19.2	16.6				

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

IV. Reduction/Hydroxide Precipitation

Following hexavalent chromium reduction with the agents presented in section III, the samples were treated separately with NaOH and Lime to precipitate metals. Additional tests were performed with sodium sulfide as a reducing agent, and precipitation without reducing agent. In each case the pH was adjusted to 10 with the resulting precipitates collected for analysis. Only those contaminants found in the raw water were studied, with the exception of TCLP extracts obtained from precipitates collected. When possible precipitates were analyzed for all 8 RCRA metals.

A. Procedure

1. Reduction was carried out as described in section III, with optimum dosages as previously determined.
2. Aliquots were mixed at 80 RPM.
3. NaOH 50% solution was added to a 1700-2000 ml aliquot of sample from step #1 to achieve a final pH of approximately 10.
4. Hydrated Lime was added to a second aliquot as in step #3.
5. Color and formation of precipitate were noted in each aliquot.
6. Precipitates were allowed to settle for 24 hours.
7. Supernatants were decanted and analyzed for:

    Suspended Solids
    Hexavalent Chromium
    Barium
    Total Chromium
    Silver
    Iron

8. Precipitates were collected into an 8 cm diameter Buchner funnel containing a Whatman ashless glass fiber filter. Vacuum was applied until all free liquid was removed.

B. Results

Estimates of the groundwater volumes required, and the resulting quantity of precipitate, were greatly under estimated. Although this may turn out to be favorable in the field, it prevented assessment of all parameters on many samples. In general the lime addition produced over 5x the amount of precipitate formed upon addition of NaOH. This is probably due in part to insoluble matter present in the lime.

NaOH treatments resulted in relatively poor chromium removal. The one exception, (ferrous sulfate reduction), yielded a precipitate which did not pass toxicity criteria for chrome. Lime addition appears to perform well, but further work with larger initial volumes is required to choose the best reduction option. Results are presented on pages #13-22.

Reduction/Hydroxide Precipitation

Reducing Agent: Sodium Metabisulfite (0.68g)

Treatment Agent: NaOH (1.5 ml - 50%)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		1700 ml	0.52g	
pH	7.5	10.1	NM	NM
Suspended Solids	24.6	90.6	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	IV	NM
Arsenic	<0.005	NM	IV	NM
Barium	0.075	<0.10	80	IV
Cadmium	<0.005	NM	IV	IV
Chromium	20.8	7.6	IV	IV
Lead	<0.050	NM	IV	IV
Mercury	<0.0002	NM	IV	IV
Selenium	<0.005	NM	IV	IV
Silver	0.021	<0.010	<1.0	IV
Iron	1.62	<0.050	NM	NM
Color	NM	Blue		
Turbidity	NM	Low		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Sodium Metabisulfite (0.68g)

Treatment Agent: Lime (6.9 g)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		1700 ml	12.9 g	
pH	7.5	10.1	NM	NM
Suspended Solids	24.6	89.0	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	<1.0	NM
Arsenic	<0.005	NM	5.1	<0.5
Barium	0.075	<0.10	39	2.8
Cadmium	<0.005	NM	2.4	<0.1
Chromium	20.8	0.051	2400	<0.1
Lead	<0.050	NM	5.0	<0.1
Mercury	<0.0002	NM	<0.10	<0.002
Selenium	<0.005	NM	<0.50	<0.5
Silver	0.021	<0.010	3.5	0.22
Iron	1.62	<0.050	NM	NM
Color	NM	Green/ Brown		
Turbidity	NM	High		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Ferrous Sulfate (4.8g)

Treatment Agent: NaOH (2.6 ml - 50%)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	13.4 g	
pH	7.5	10	NM	NM
Suspended Solids	24.6	3.0	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	<1.0	NM
Arsenic	<0.005	NM	<5.0	<0.5
Barium	0.075	<0.10	<10	2.1
Cadmium	<0.005	NM	1.1	<0.1
Chromium	20.8	0.029	2510	8.8*
Lead	<0.050	NM	4.94	<0.1
Mercury	<0.0002	NM	<0.10	<0.002
Selenium	<0.005	NM	<0.50	<0.5
Silver	0.021	<0.010	<1.0	<0.1
Iron	1.62	1.39	NM	NM
Color	NM	Blue/Brw		
Turbidity	NM	High		

NM = Not Measured
IV = Insufficient Volume
* Exceeds Toxicity limits

Reduction/Hydroxide Precipitation

Reducing Agent: Ferrous Sulfate (4.8g)

Treatment Agent: Lime (7.9g)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	23.8 g	
pH	7.5	10	NM	NM
Suspended Solids	24.6	27.4	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	<1.0	NM
Arsenic	0.075	NM	<5.0	<0.5
Barium	0.005	0.20	20.7	0.86
Cadmium	0.0005	NM	1.4	<0.1
Chromium	20.8	0.052	1290	0.49
Lead	<0.050	NM	<5.0	<0.1
Mercury	<0.0002	NM	<0.10	<0.002
Selenium	<0.005	NM	<0.50	<0.5
Silver	0.021	<0.010	<1.0	<0.1
Iron	1.62	1.33	NM	NM
Color	NM	Gren/Orang		
Turbidity	NM	High		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Sodium Sulfide (4.0 g)

Treatment Agent: NaOH (1.9 ml - 50%)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		1700 ml	0.07g	
pH	7.5	10.2	NM	NM
Suspended Solids	24.6	55.5	NM	NM
% Solids	NM	NM	IV	IV
Hexavalent chrome	6.96	<0.010	IV	NM
Arsenic	<0.005	NM	<0.5	IV
Barium	0.075	<0.10	72	IV
Cadmium	<0.005	NM	<0.5	IV
Chromium	20.8	12.4	98	IV
Lead	<0.050	NM	<5.0	IV
Mercury	<0.0002	NM	<0.1	IV
Selenium	<0.005	NM	<0.5	IV
Silver	0.021	0.012	NM	IV
Iron	1.62	0.15	NM	NM
Color	NM	Green/ Blue		
Turbidity	NM	Low		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Sodium Sulfide (4.0 g)

Treatment Agent: Lime (4.6g)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		1700 ml	5.71g	
pH	7.5	10.4	NM	NM
Suspended Solids	24.6	2.5	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	IV	NM
Arsenic	<0.005	NM	<8.0	IV
Barium	0.075	0.16	523	IV
Cadmium	<0.005	NM	IV	IV
Chromium	20.8	0.043	341	IV
Lead	<0.050	NM	<71	IV
Mercury	<0.0002	NM	IV	IV
Selenium	<0.005	NM	<10	IV
Silver	0.021	0.020	NM	IV
Iron	1.62	<0.05	NM	NM
Color	NM	Gray		
Turbidity	NM	High		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Sulfur Dioxide (Excess Used)

Treatment Agent: NaOH (7.3 ml - 50%)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	0.02g	
pH	7.5	10	NM	NM
Suspended Solids	24.6	59.8	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	<0.010	IV	NM
Arsenic	<0.005	NM	IV	IV
Barium	0.075	<0.10	IV	IV
Cadmium	<0.005	NM	IV	IV
Chromium	20.8	6.5	IV	IV
Lead	<0.050	NM	IV	IV
Mercury	<0.0002	NM	IV	IV
Selenium	<0.005	NM	IV	IV
Silver	0.021	0.017	NM	IV
Iron	1.62	0.11	NM	NM
Color	NM	Gray		
Turbidity	NM	Medium		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: Sulfur Dioxide (Excess Used)

Treatment Agent: Lime (16.0g)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	34.4g	
pH	7.5	10.3	NM	NM
Suspended Solids	24.6	131	NM	NM
% Solids	NM	NM	40.4	NM
Hexavalent chrome	6.96	<0.010	LE	NM
Arsenic	<0.005	NM	<0.5	<0.5
Barium	0.075	<0.10	50	0.89
Cadmium	<0.005	NM	<0.5	<0.1
Chromium	20.8	0.022	938	1.1
Lead	<0.050	NM	<5.0	<0.1
Mercury	<0.0002	NM	<0.1	<0.002
Selenium	<0.005	NM	<0.5	<0.5
Silver	0.021	0.023	NM	NM
Iron	1.62	0.06	NM	NM
Color	NM	Biege		
Turbidity	NM	High		

LE = Laboratory Error
NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: None

Treatment Agent: NaOH (0.3 ml - 50%)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	0.47g	
pH	7.5	10	NM	NM
Suspended Solids	24.6	4.3	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	2.82	IV	NM
Arsenic	<0.005	NM	15	IV
Barium	0.075	<0.10	203	IV
Cadmium	<0.005	NM	<0.5	IV
Chromium	20.8	15.4	3.2	IV
Lead	<0.050	NM	<10	IV
Mercury	<0.0002	NM	IV	IV
Selenium	<0.005	NM	<1.0	IV
Silver	0.021	<0.010	NM	IV
Iron	1.62	<0.05	NM	NM
Color	NM	Clear		
Turbidity	NM	Low		

NM = Not Measured
IV = Insufficient Volume

Reduction/Hydroxide Precipitation

Reducing Agent: None

Treatment Agent: Lime (1.7g)

(All results ppm unless otherwise noted)

	Raw Water	Treated Water	Raw Sludge	TCLP Extract
Volume		2000 ml	2.55g	
pH	7.5	9.9	NM	NM
Suspended Solids	24.6	6.3	NM	NM
% Solids	NM	NM	IV	NM
Hexavalent chrome	6.96	9.80	IV	NM
Arsenic	<0.005	NM	<0.5	IV
Barium	0.075	<0.10	<10	IV
Cadmium	<0.005	NM	<0.5	IV
Chromium	20.8	17.3	1.7	IV
Lead	<0.050	NM	<5.0	IV
Mercury	<0.0002	NM	IV	IV
Selenium	<0.005	NM	<0.5	IV
Silver	0.021	<0.010	NM	NM
Iron	1.62	<0.05	NM	NM
Color	NM	Clear		
Turbidity	NM	Low		

NM = Not Measured
IV = Insufficient Volume

V. Activated Carbon Treatment

Treatment of groundwater with activated carbon was investigated with regard to hexavalent chromium removal. Four variations were studied. These included;

a. Carbon/water ratios
b. Glass fiber vs. membrane filter
c. Contact time
d. Precipitation followed by carbon treatment.

A. Carbon/Water Ratios

Eight 200 ml aliquots of groundwater were mixed with 0-20g/100 ml of Calgon WPX pulverized carbon. Mixing was performed in 250 ml Erhlenmeyer flasks with 1" stir bars. Total mixing time was 2 hours after which the carbon was allowed to settle. Samples were then filtered under vacuum through a Whatman 934-AH glass fiber filter. Color in the treated samples varied from a bright yellow at the low dosages, to a light blue/grey at high dosages.

The results indicate treatment down to a level of approximately 1 ppm was possible, with 87% of the Cr^{+6} removed at the 2g/100 ml dosage. Total chromium analysis confirmed our results, which are presented on pages # 25-27.

It was theorized that some level of carbon bleed through may have occurred which would explain the leveling off at 1-2 ppm Cr^{+6}. A second study involving filtration of treated samples with 0.45 um membrane filters was proposed.

B. Carbon Treatment/Membrane Filtration

A duplicate study was performed using Gelman 0.45 um filters following treatment. All other study procedures remained constant.

Initial Cr^{+6} data indicated much less treatment had been achieved. This result was perplexing, if anything treatment should have been no worse. Analysis for total chrome in fact contradicted these data presented on pages # 28-30, and indicates similar treatment had been achieved. Our conclusion is there is no significant advantage between filters, and the Cr^{+6} data was deficient.

C. Contact Time

Although not proposed in the initial study outline, it was determined that contact time should be assessed. The 2g/100 ml dosage was chosen. Contact time was varied between 0 and 120 min. Results are presented on pages # 31-33.

The Gelman 0.45 um filter was chosen for use. All other study parameters remained constant.

The results indicated treatment progressed up to approximately 75 minutes. Again, the limit of treatment was in the 1-2 ppm range.

D. Precipitation/Carbon Treatment

The effect of pH precipitation followed by carbon treatment was studied. An aliquot of groundwater was treated with sodium hydroxide (NaOH) to a pH of 10. The sample was mixed for 15 minutes and filtered through a 0.45 um membrane filter. The pH was then adjusted to 7.0 with nitric acid (HNO_3).

The results of this treatment are presented on pages # 34-35. Precipitation of metals at pH 10 appears to have little effect on hexavalent chromium. The carbon treatment did reduce Cr^{+6} levels by 57% at the 20 g/100 ml ratio.

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05470 Date: JAN. 10 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:
Van Der Horst Groundwater
Carbon Isotherm

Collected : 12/18/90 P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	0.0g /100ML	0.25g /100ML	0.50g /100ML	1.0g /100ML	2.0g /100ML	5.0g /100ML	10g /100ML	20g /100ML
Date Collected:	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90	12/18/90
Time Collected:	--	--	--	--	--	--	--	--
Turbidity, ntu	3.5	1.5	1.5	1.6	2.5	3.1	3.1	2.9
Chromium, Hex	29.9	9.77	6.56	5.05	1.26	1.31	1.10	1.04
Chromium, Total	18.7	13.1	9.03	5.03	2.42	1.90	1.28	1.04

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05470   Date: JAN. 10 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:
Van Der Horst Groundwater
Carbon Isotherm

Collected : 12/18/90   P.O. #:

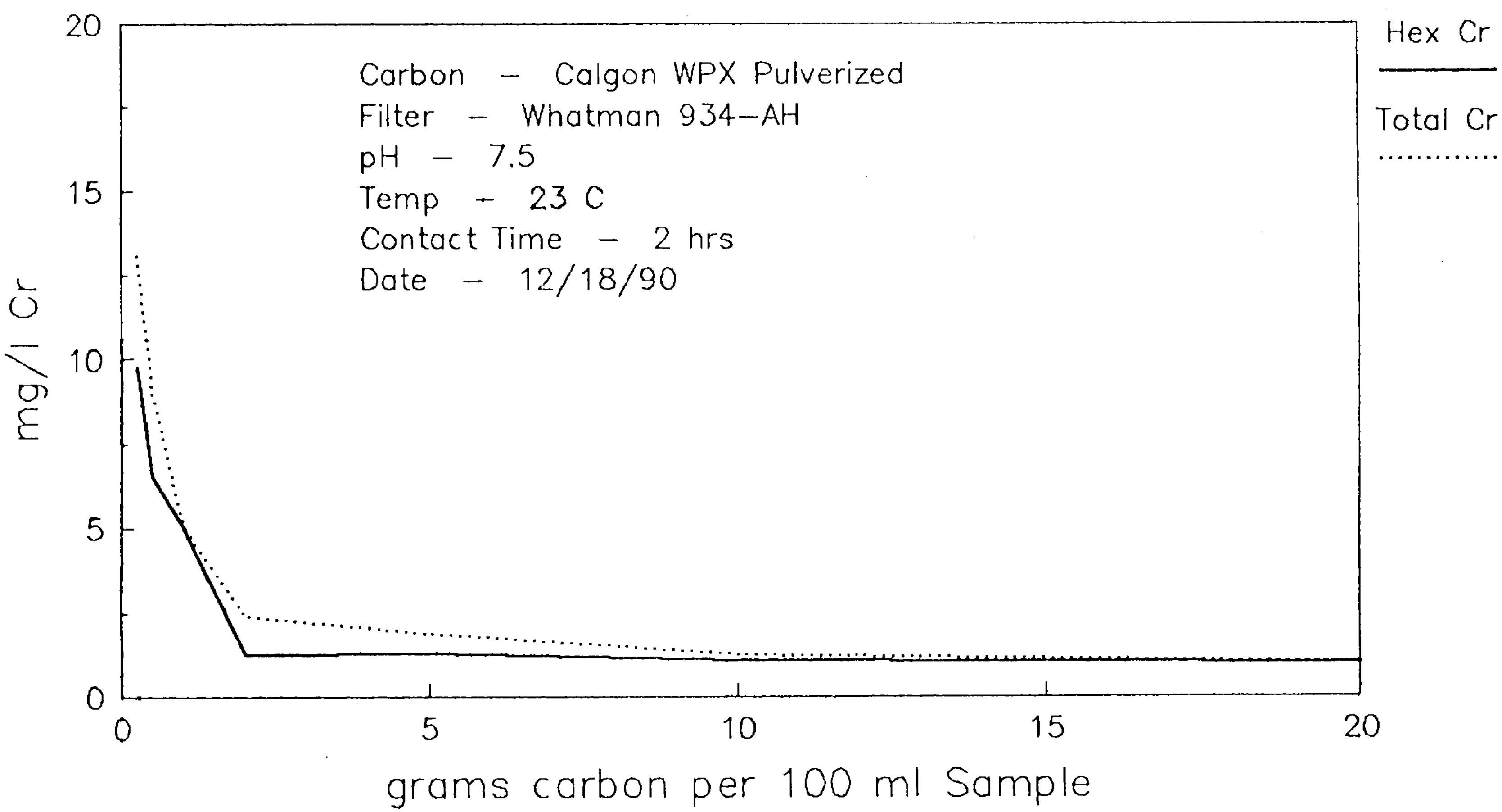
ANALYTICAL UNITS - mg/l

Sample:	-009						
Location:	Raw Water						
Date Collected:	12/18/90						
Time Collected:	--						
Turbidity, ntu							
Chromium, Hex	6.96						
Chromium, Total	19.1						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

CARBON ISOTHERM #1



0027

General Testing Corporation

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LABORATORY REPORT

Job No: R90/05544 Date: JAN. 14 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, NY 14221

Sample(s) Reference:

Van der Horst-
Carbon Isotherm #2

Collected : 12/26/90

P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	Raw	0.0g/ 100ml	0.25g/ 100ml	0.5g/ 100ml	1.0g/ 100ml	2.0g/ 100ml	5.0g/ 100ml	10g/ 100ml
Date Collected:	12/26/90	12/26/90	12/26/90	12/26/90	12/26/90	12/26/90	12/26/90	12/26/90
Time Collected:	--	--	--	--	--	--	--	--
Turbidity, ntu	0.15	0.25	1.5	1.5	1.0	1.5	0.15	0.11
Chromium, Hex	10.1	11.5	9.72	7.03	6.91	4.74	5.37	4.99
Chromium, Total	18.2	17.6	14.3	11.4	7.32	3.87	2.49	2.00

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R90/05544 Date: JAN. 14 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, NY 14221

Sample(s) Reference:

Van der Horst-
Carbon Isotherm #2

Collected : 12/26/90 P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-009							
Location:	20g/ 100ml							
Date Collected:	12/26/90							
Time Collected:	--							
Turbidity, ntu	0.15							
Chromium, Hex	6.52							
Chromium, Total	1.66							

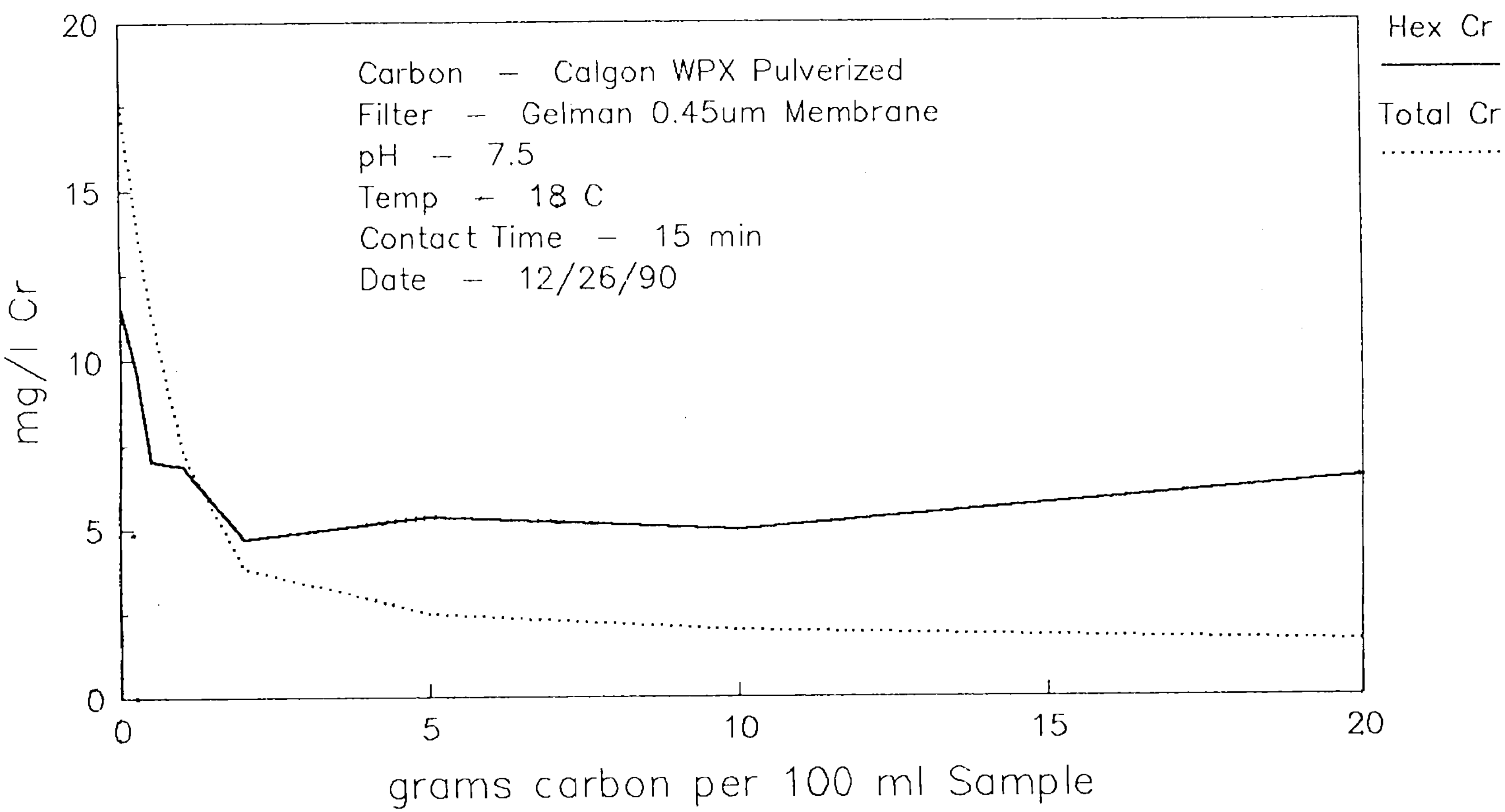
Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

CARBON ISOTHERM #2



0030

General Testing Corporation

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LABORATORY REPORT

Job No: R91/00219 Date: JAN. 25 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:
Van Der Horst
Carbon Isotherm #3

Collected : 01/16/91 P.O. #:

ANALYTICAL UNITS - mg/l

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	30Min MF	45Min MF	45Min GFF	75Min MF	75Min GFF	120Min MF	QC Raw	Raw No Mix GFF
Date Collected:	01/16/91	01/16/91	01/16/91	01/16/91	01/16/91	01/16/91	01/16/91	01/16/91
Time Collected:	--	--	--	--	--	--	--	--
Chromium, Hex	2.73	2.77	2.66	1.82	2.07	1.72	5.61	5.12

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/00219 Date: JAN. 25 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference:

Van Der Horst
Carbon Isotherm #3

Collected : 01/16/91 P.O. #:

ANALYTICAL UNITS - mg/l

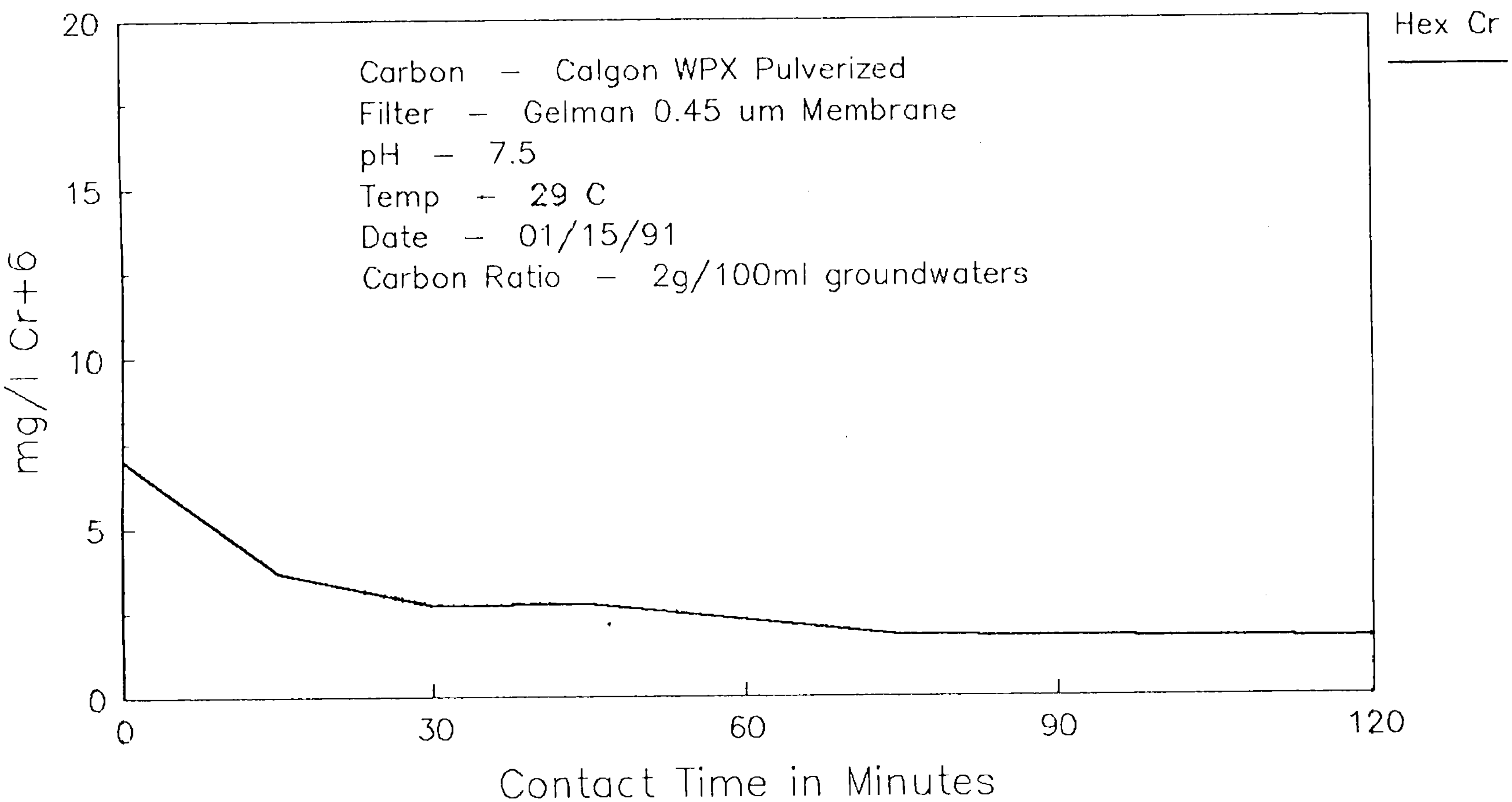
Sample:	-009	-010	-011	-012				
Location:	Raw No Mix MF	120Min NO Carb MB	QC 15Min GFF	QC 15Min MF				
Date Collected:	01/16/91	01/16/91	01/16/91	01/16/91				
Time Collected:	--	--	--	--				
Chromium, Hex	7.00	4.44	3.70	3.70				

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K Perry

Laboratory Director

CARBON ISOTHERM #3



General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/00772 **Date:** 2/22/91

Client:

Mr. Dennis Krause
ERM Northeast
5500 Main Street
Willimsville, NY 14221

Sample(s) Reference:

Van Der Horst Groundwater
Carbon Isotherm #4

Collected : 2/20/91

P.O. #:

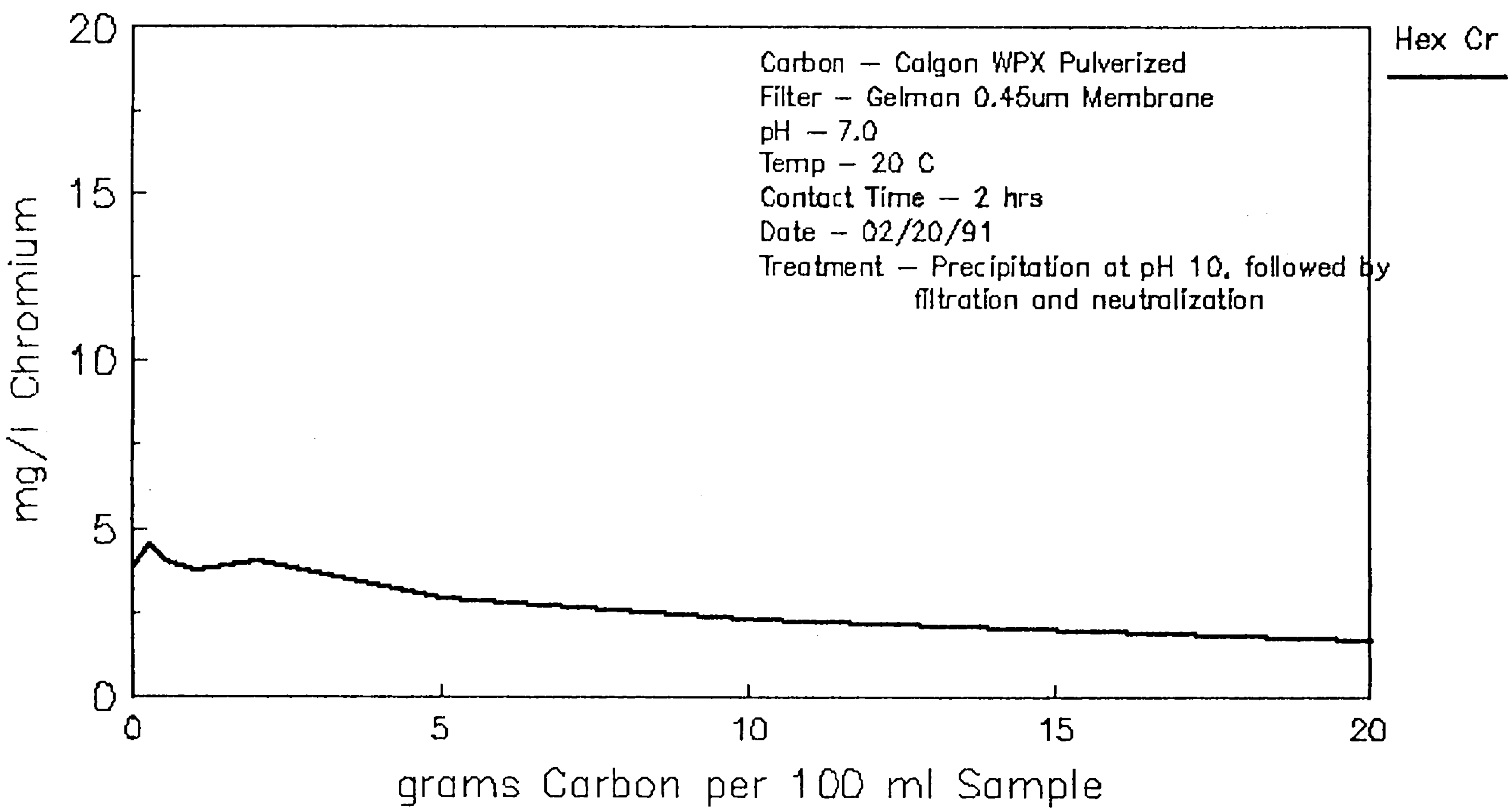
ANALYTICAL UNITS - g/L

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	0.0 g /100 ml	0.25 g /100 ml	0.5 g /100 ml	1.0 g /100 ml	2.0 g /100 ml	5.0 g /100 ml	10 g /100 ml	20 g /100 ml
Date Collected:	2/20/91	2/20/91	2/20/91	2/20/91	2/20/91	2/20/91	2/20/91	2/20/91
Time Collected:								
Chromium, Hex	4.0	4.6	4.1	3.8	4.1	3.0	2.3	1.7

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Laboratory Director

CARBON ISOTHERM #4



VI. Soil Solidification/Stabilization

Solidification of soils for the purpose of stabilizing metal contaminants was investigated. Lime, lime/ferrous sulfate, and lime/fly ash were studied. A review of common literature regarding composition of mortar, concrete and cements indicated that in general a 3:1 ratio of soil to binding agent appeared favorable. Other ratios of 4:1 and 2:1 were studied. 100 ml of water was added to each mixture.

A. Procedure

1. 1 Kg of each soil type (MW-5 and MW-3) was removed and placed in a large stainless steel bowl. The samples were thoroughly mixed.

2. 200,300 and 400g of each soil was transferred to a 1/2 gallon plastic container which had been cut in half.

3. 100 ml DI water was added to approximately 100 hydrated lime and mixed.

4. The lime/water slurry was then added to each of the 6 soil aliquots and mixed.

5. Mixtures were covered with paper towels and allowed to cure for 48 hrs.

6. Above steps were repeated using lime/ferrous sulfate (1:1) and lime/fly ash (3:1) mixtures.

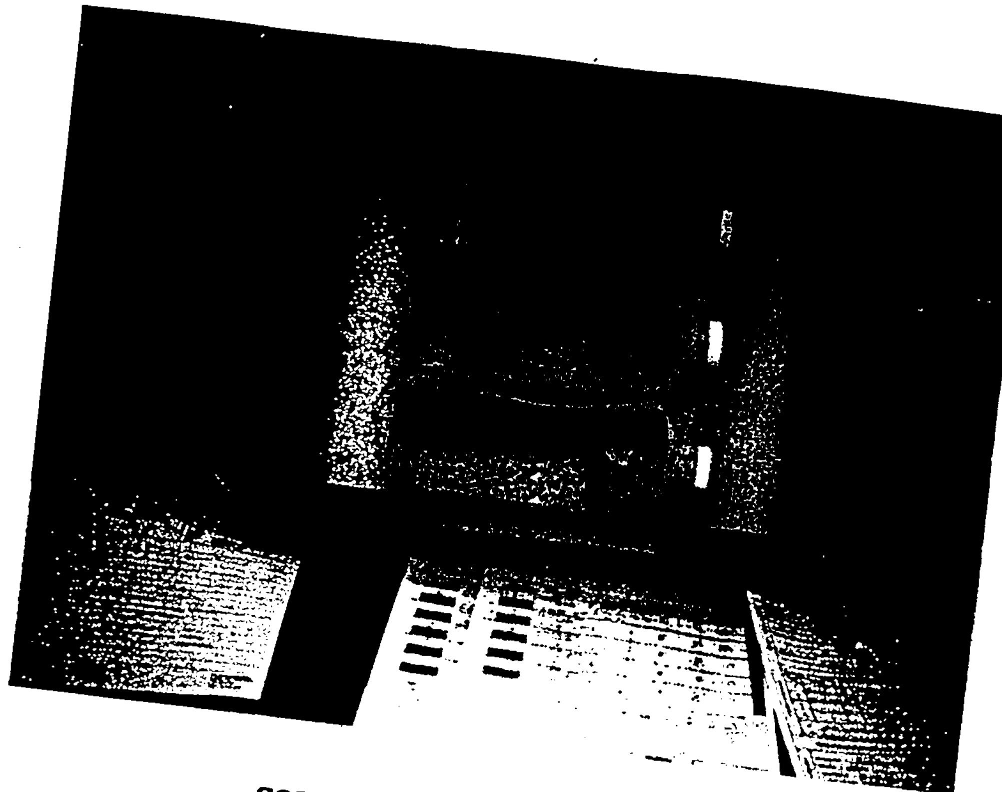
7. Each mixture was submitted for total metals and TCLP metals analysis.B

Results

The results of each treatment are presented on pages # 41-46.

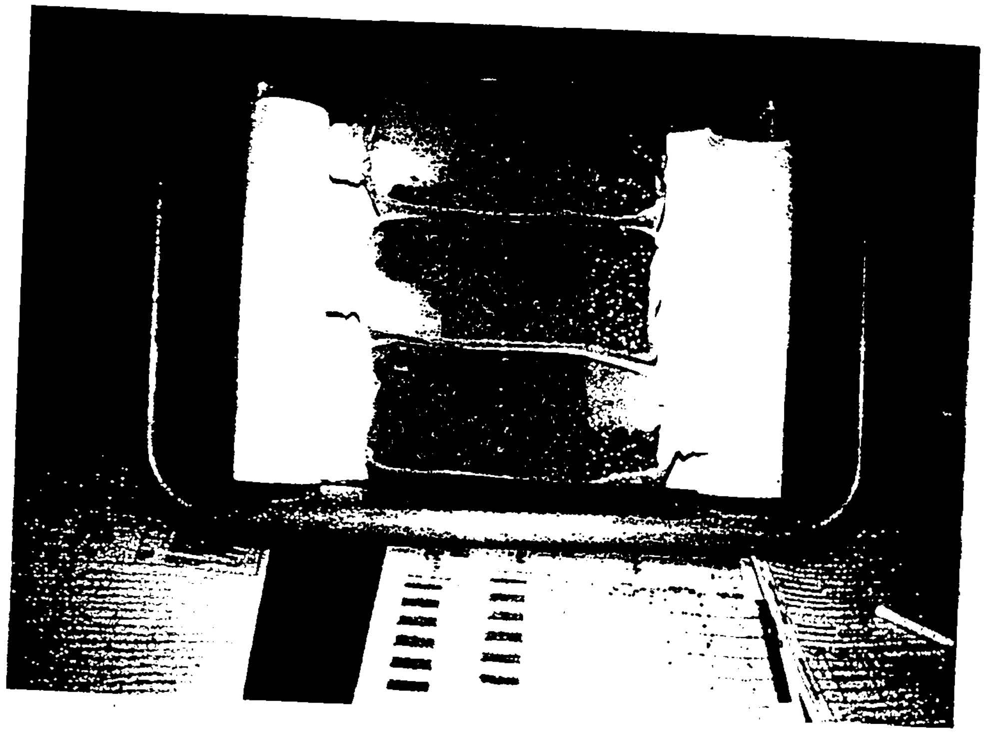
Photographs of the mixtures after curing (pages # 37-38)are provided on the following pages. In general, each mixture dried well and produced a crumbly solid.

The lime/ferrous sulfate mixtures appeared to yield the best stabilization for both soils, particularly with respect to chromium and lead immobilization. Little difference is seen between the 3 ratios used, and further investigation is required to determine the minimum amount of Lime/$FeSO_4$ required.

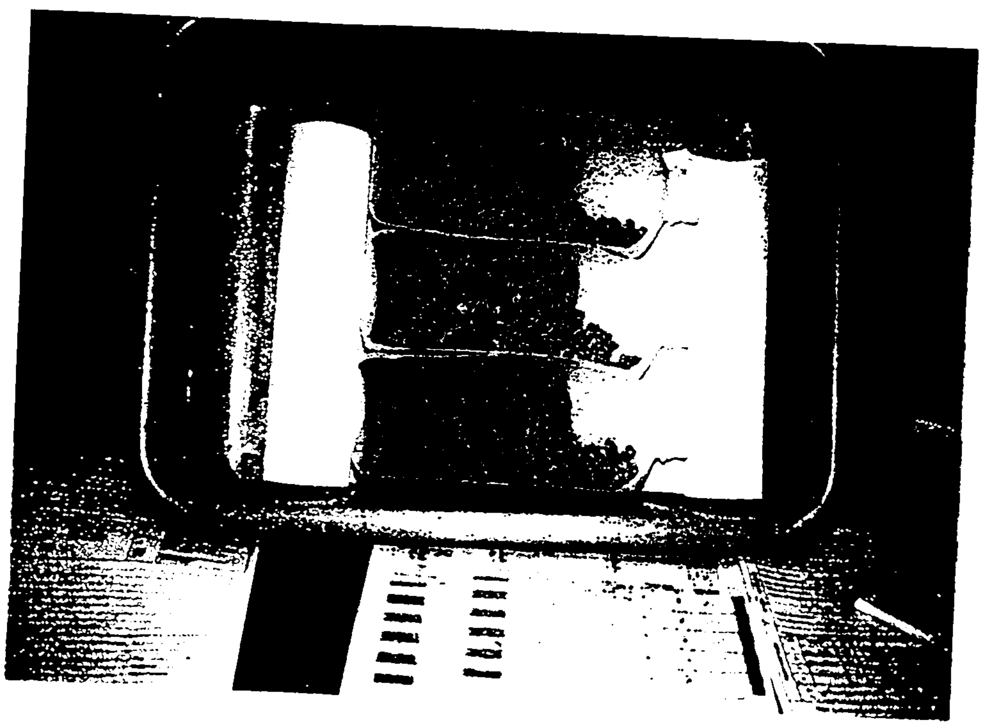


SOIL #1 PLUS LIME

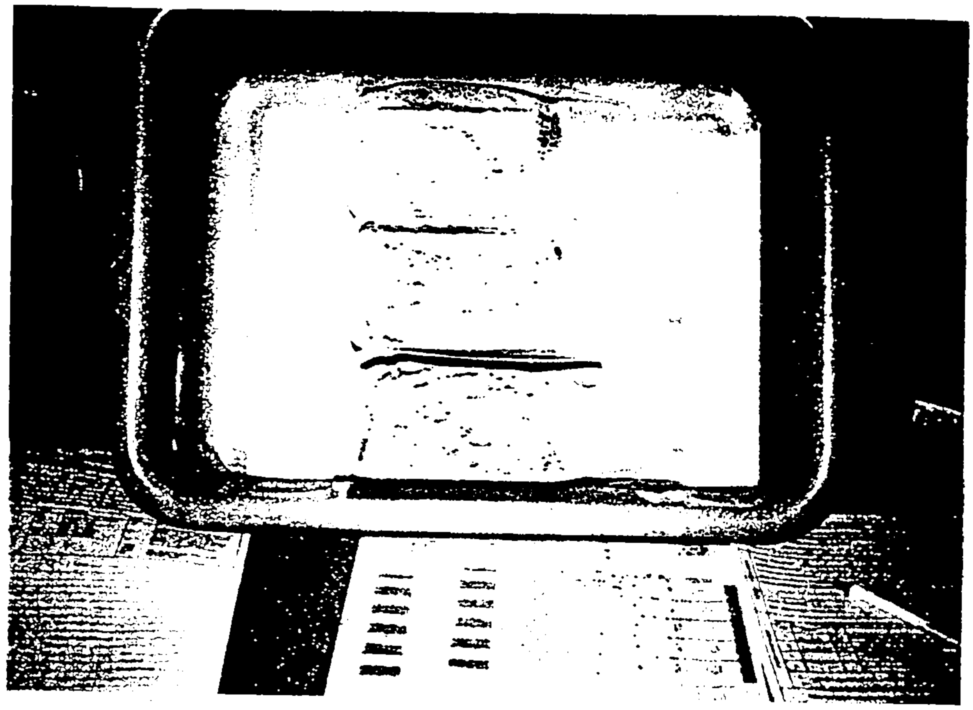
SOIL #2 PLUS LIME



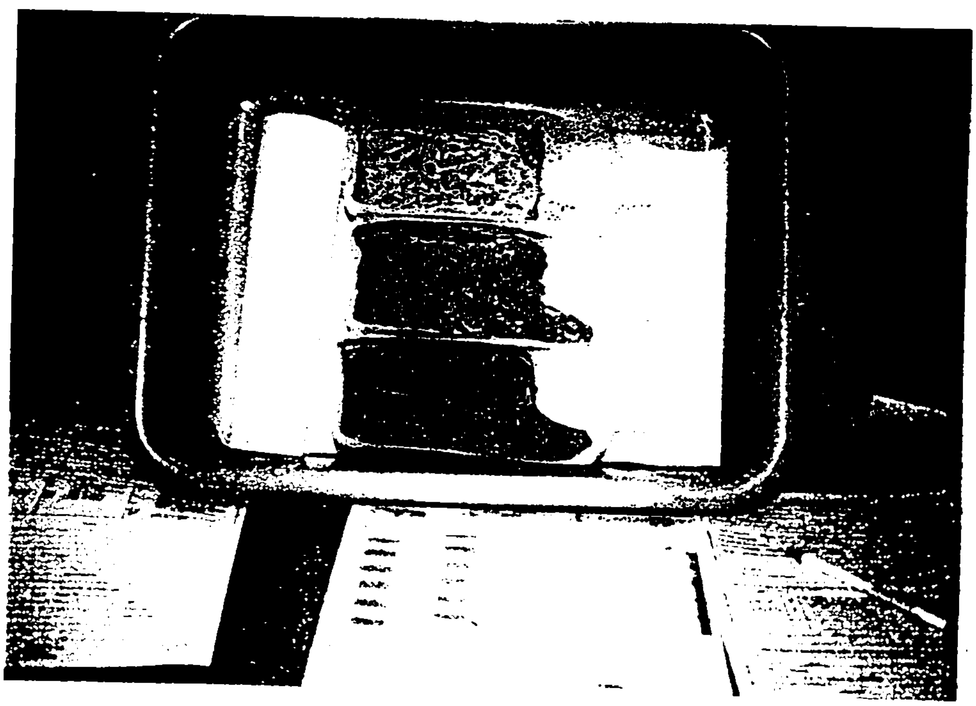
SOIL #1 PLUS $FeSO_4$/LIME



SOIL #2 PLUS $FeSO_4$/LIME



SOIL #1 PLUS FLY ASH/LIME



SOIL #2 PLUS FLY ASH/LIME

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/00356   Date: FEB. 12 1991

Client:
Mr. Dennis Krause
ERM Northeast
5500 Main Street
Williamsville, New York 14221

Sample(s) Reference

Van der horst-Lime & Fly Ash

Collected : 01/25/91   P.O. #:

ANALYTICAL RESULTS - ug/g Wet Wt.

Sample:	-001	-002						
Location:	Lime	Fly Ash						
Date Collected:	01/25/91	01/25/91						
Time Collected:	--	--						
Arsenic	0.54	78						
Barium	14	145						
Cadmium, Total	0.50 U	1.36						
Chromium, Total	1.46	51.2						
Iron, Total	4120	33,600						
Lead, Total	5.0 U	46.3						
Mercury, Total	0.10 U	0.10 U						
Selenium, Total	0.50 U	0.50 U						
Silver, Total	6.32	1.0 U						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

Soil Solidification/Stabilization
(Arsenic)
All results in ppm

Lime

Additive	Soil	Raw	Mix	TCLP
111 g	200 g	8.8	11.8	<0.50
111 g	300 g	8.8	6.2	<0.50
111 g	400 g	8.8	<5.0	<0.50
111 g	200 g	23	15	<0.50
111 g	300 g	23	18	<0.50
111 g	400 g	23	17	<0.50

Lime/Ferrous Sulfate

Additive	Soil	Raw	Mix	TCLP
100 g	200 g	8.8	<5.0	<0.50
100 g	300 g	8.8	<5.0	<0.50
100 g	400 g	8.8	<5.0	<0.50
100 g	200 g	23	7.5	<0.50
100 g	300 g	23	8.5	<0.50
100 g	400 g	23	10	<0.50

Lime/Fly Ash

Additive	Soil	Raw	Mix	TCLP
120 g	200 g	8.8	6.9	<0.50
120 g	300 g	8.8	11	<0.50
120 g	400 g	8.8	11	<0.50
120 g	200 g	23	24	<0.50
120 g	300 g	23	18	<0.50
120 g	400 g	23	20	<0.50

Soil Solidification/Stabilization
(Barium)
All results in ppm

Lime

Additive	Soil	Raw	Mix	TCLP
111 g	200 g	149	91	1.7
111 g	300 g	149	375	2.2
111 g	400 g	149	153	2.7
111 g	200 g	3280	1070	1.8
111 g	300 g	3280	1320	1.6
111 g	400 g	3280	816	1.4

Lime/Ferrous Sulfate

Additive	Soil	Raw	Mix	TCLP
100 g	200 g	149	106	0.22
100 g	300 g	149	136	0.31
100 g	400 g	149	139	0.34
100 g	200 g	3280	150	0.80
100 g	300 g	3280	<10	0.83
100 g	400 g	3280	288	1.0

Lime/Fly Ash

Additive	Soil	Raw	Mix	TCLP
120 g	200 g	149	124	2.0
120 g	300 g	149	126	1.6
120 g	400 g	149	129	2.6
120 g	200 g	3280	1860	1.3
120 g	300 g	3280	1610	0.99
120 g	400 g	3280	1730	0.99

Soil Solidification/Stabilization
(Chromium)
All results in ppm

Lime

Additive	Soil	Raw	Mix	TCLP
111 g	200 g	392	97	<0.10
111 g	300 g	392	2150	0.11
111 g	400 g	392	273	0.16
111 g	200 g	11,800	5560	23
111 g	300 g	11,800	6960	22
111 g	400 g	11,800	7610	31

Lime/Ferrous Sulfate

Additive	Soil	Raw	Mix	TCLP
100 g	200 g	392	154	<0.10
100 g	300 g	392	278	<0.10
100 g	400 g	392	271	<0.10
100 g	200 g	11,800	6080	1.8
100 g	300 g	11,800	7200	2.1
100 g	400 g	11,800	6140	1.6

Lime/Fly Ash

Additive	Soil	Raw	Mix	TCLP
120 g	200 g	392	1040	0.22
120 g	300 g	392	192	0.15
120 g	400 g	392	205	<0.10
120 g	200 g	11,800	5220	14
120 g	300 g	11,800	6550	17
120 g	400 g	11,800	6430	18

Soil Solidification/Stabilization
(Hexavalent Cr,
Water Soluble)
All results in ppm

Lime				
Additive	Soil	Raw	Mix	TCLP
111 g	200 g	66	5.3	-
111 g	300 g	66	6.2	-
111 g	400 g	66	8.7	-
111 g	200 g	943	360	-
111 g	300 g	943	360	-
111 g	400 g	943	740	-

Lime/Ferrous Sulfate				
Additive	Soil	Raw	Mix	TCLP
100 g	200 g	66	<1.0	-
100 g	300 g	66	5.0	-
100 g	400 g	66	<1.0	-
100 g	200 g	943	14	-
100 g	300 g	943	21	-
100 g	400 g	943	10	-

Lime/Fly Ash				
Additive	Soil	Raw	Mix	TCLP
120 g	200 g	66	10	-
120 g	300 g	66	3.7	-
120 g	400 g	66	7.9	-
120 g	200 g	943	170	-
120 g	300 g	943	320	-
120 g	400 g	943	450	-

Soil Solidification/Stabilization
(Lead)
All results in ppm

Lime

Additive	Soil	Raw	Mix	TCLP
111 g	200 g	258	55	0.12
111 g	300 g	258	29	<0.10
111 g	400 g	258	119	<0.10
111 g	200 g	8960	5410	30
111 g	300 g	8960	5400	23
111 g	400 g	8960	6530	5.6

Lime/Ferrous Sulfate

Additive	Soil	Raw	Mix	TCLP
100 g	200 g	258	81	<0.10
100 g	300 g	258	115	<0.10
100 g	400 g	258	123	<0.10
100 g	200 g	8960	4880	<0.10
100 g	300 g	8960	5510	<0.10
100 g	400 g	8960	5570	<0.10

Lime/Fly Ash

Additive	Soil	Raw	Mix	TCLP
120 g	200 g	258	57	0.19
120 g	300 g	258	98	<0.10
120 g	400 g	258	80	<0.10
120 g	200 g	8960	4810	13
120 g	300 g	8960	4600	<0.10
120 g	400 g	8960	4210	<0.10

Soil Solidification/Stabilization
(Mercury)
All results in ppm

Lime				
Additive	Soil	Raw	Mix	TCLP
111 g	200 g	0.23	<0.10	<0.002
111 g	300 g	0.23	<0.10	<0.002
111 g	400 g	0.23	<0.10	<0.002
111 g	200 g	0.36	<0.10	<0.002
111 g	300 g	0.36	<0.10	<0.002
111 g	400 g	0.36	<0.10	<0.002

Lime/Ferrous Sulfate				
Additive	Soil	Raw	Mix	TCLP
100 g	200 g	0.23	<0.10	0.008
100 g	300 g	0.23	<0.10	<0.002
100 g	400 g	0.23	<0.10	<0.002
100 g	200 g	0.36	<0.10	<0.002
100 g	300 g	0.36	<0.10	<0.002
100 g	400 g	0.36	<0.10	<0.002

Lime/Fly Ash				
Additive	Soil	Raw	Mix	TCLP
120 g	200 g	0.23	<0.10	<0.002
120 g	300 g	0.23	<0.10	<0.002
120 g	400 g	0.23	<0.10	<0.002
120 g	200 g	0.36	<0.10	<0.002
120 g	300 g	0.36	<0.10	<0.002
120 g	400 g	0.36	<0.10	<0.002

VII. Soil Washing

Removal of metals contaminants using various wash solutions was investigated. The wash solutions chosen were;

a. Deionized Water
b. TCLP Extraction Fluid
c. 5% EDTA Solution
d. 5% HNO_3 Solution
e. 2:1 EDTA/HNO_3 Solutions

A. Procedure

1. 1.2 Kg of the high contaminant soil was weighed out into a large stainless steel bowl and mixed.

2. 200 g of mixed soil was placed into each of 5-1000 ml beakers.

3. 400 ml of each wash solution was added to 1 of 5 aliquots.

4. Slurries were mixed thoroughly using a small stainless steel spatula.

5. Temperature and pH were measured in each slurry.

6. Each Slurry was mixed at 15 minute intervals for a period of 2 hours.

7. At the end of 2 hours each aliquot was transferred to a 4" diameter ceramic Buchner funnel and dewatered under vacuum through a glass fiber filter.

8. Filtrates were then re-filtered through a 0.45 um membrane filter.

9. Filtrates and washed soils were processed for analysis.

Soil Washing Study

Arsenic

	Raw	Washed Soil	Total Removal	Wash Water
	mg/200g	mg/200g	mg	mg/400ml
Deionized Water	4.64	3.58	1.06	<0.02
TCLP Extraction Fluid	4.64	3.30	1.34	<0.02
5% EDTA Solution	4.64	2.72	1.92	<0.02
5% HNO_3 Solution	4.64	2.92	1.72	0.033
2:1 EDTA/HNO_3 Solutions	4.64	2.78	1.86	<0.02

Soil Washing Study

Barium

	Raw	Washed Soil	Total Removal	Wash Water
	mg/200 g	mg/200 g	mg	mg/400 ml
Deionized Water	656	23	633	<0.1
TCLP Extraction Fluid	656	32	624	0.6
5% EDTA Solution	656	25	631	1.7
5% HNO_3 Solution	656	380	276	51
2:1 EDTA/HNO_3 Solutions	656	185	471	21

Soil Washing Study

Chromium (Total)

	Raw	Washed Soil	Total Removal	Wash Water
	mg/200g	mg/200g	mg	mg/400ml
Deionized Water	2360	1506	854	4.4
TCLP Extraction Fluid	2360	1852	508	4.4
5% EDTA Solution	2360	1676	684	89
5% HNO_3 Solution	2360	192	2168	56
2:1 EDTA/HNO_3 Solutions	2360	1770	590	16

Soil Washing Study

Chromium (Hexavalent)

	Raw	Washed Soil	Total Removal	Wash Water
	mg/200g	mg/200g	mg	mg/400ml
Deionized Water	189	40	149	1.6
TCLP Extraction Fluid	189	38	151	3.3
5% EDTA Solution	189	8.6	180	4.4
5% HNO_3 Solution	189	30	159	0.05
2:1 EDTA/HNO_3 Solutions	189	20	169	3.4

Soil Washing Study

Lead

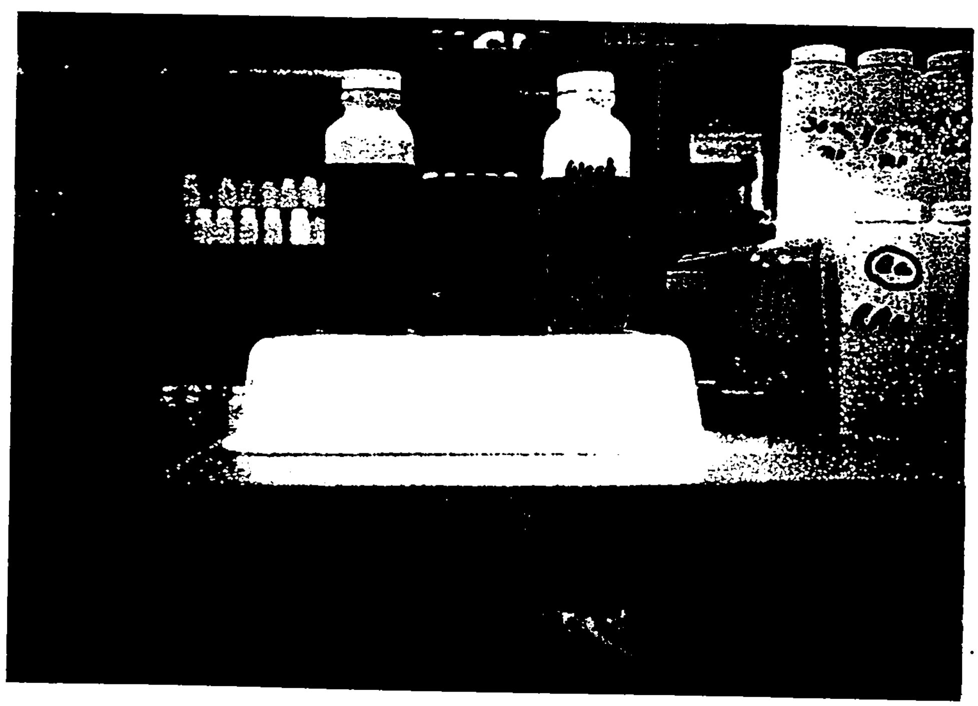
	Raw	Washed Soil	Total Removal	Wash Water
	mg/200g	mg/200g	mg	mg/400ml
Deionized Water	1792	1182	610	0.08
TCLP Extraction Fluid	1792	1370	422	0.02
5% EDTA Solution	1792	676	1116	14.6
5% HNO_3 Solution	1792	886	906	428
2:1 EDTA/HNO_3 Solutions	1792	966	826	38.9

Soil Washing Study

Mercury

	Raw	Washed Soil	Total Removal	Wash Water
	mg/200 g	mg/200 g	mg	mg/400 ml
Deionized Water	0.07	<0.02	0.07	<0.0003
TCLP Extraction Fluid	0.07	<0.02	0.07	<0.0003
5% EDTA Solution	0.07	<0.02	0.07	0.0021
5% HNO_3 Solution	0.07	<0.02	0.07	0.0005
2:1 EDTA/HNO_3 Solutions	0.07	<0.02	0.07	0.0003

pH ADJUSTED GROUNDWATER



EDTA SOIL WASHING

Dual Soil Washing

(5% EDTA Solution)

	ug/g Raw Soil	ug/g Washed Soil	mg/L Wash #1	mg/L Wash #2
Chromium Total	11,800	6170	229	86
Chromium Hexavalent	943	40	10	0.08
Barium	3280	1670	4.7	5.1
Lead	8960	2520	317	472
Mercury	0.363	0.569	0.0017	0.0008
Arsenic	23.2	0.214	<0.05	<0.05
Iron	NM	27,000	12	6.9
pH	NM	NM	5.2	5.2
% Solids	78.4	73.4	NM	NM

NM = Not Measured

VIII. Conclusions

Sodium metabisulfite and ferrous sulfate are both effective reducing agents for the treatment of hexavalent chrome. Sulfur dioxide was more difficult to handle in the lab and did not completely reduce Cr^{+6} at the levels used. Reducing agents must be used in excess of the theoretical optimum.

Of the various reduction/precipitation options, sodium metabisulfite and lime produced the best groundwater treatment when compared with sludge volume and toxicity. Sodium hydroxide did not effectively reduce chromium levels, with the exception of the NaOH/$FeSO_4$ trial. This, however, resulted in a sludge which did not pass toxicity analysis.

Carbon treatment of groundwater to achieve Cr^{+6} removal appears favorable. Trials were performed using two different filter types, over a variety of time intervals, and with different amounts of activated carbon. Glass fiber (1.5 um) and membrane (0.45um) filters were equally effective. The minimum carbon to groundwater dosage is 2g/100 ml. The minimum contact time is 75 minutes.

Precipitation of metals with NaOH at a pH of 10, prior to carbon treatment, did not result in improved Cr^{+6} treatment.

The solidification of soils, for the purpose of stabilizing metals, was best achieved using Lime and ferrous sulfate. The optimum additive to soil ratio was not determined, since each used in this study was equally effective. The resulting mixtures all cured well and yielded a workable composite.

The soil washing study did not yield good results with the solutions employed. No one wash solution was effective in treating all metals involved. Also, rather than recovering the metals in a soluble form in the wash water, it appears they were recovered as particulates during filtration. Further study is suggested.

CALGON

CALGON CARBON CORPORATION P.O. BOX 717 PITTSBURGH, PA 15230-0717 (412) 787-6700

TWX: 671 1837 CCC PGH

FAX ~~412/787-6825~~

January 25, 1991

Mr. Marshall Shannon
General Testing
710 Exchange Street
Rochester, NY 14608

Dear Mr. Shannon,

Attached, per your request, is a copy of a published article by Polaroid Corporation on the use of activated carbon for the removal of hexavalent chromium from water. I hope this will be useful.

Very truly yours,

CALGON CARBON CORPORATION

Alan J. Roy

Alan J. Roy, Manager
Technical Service

AJR:mpk

Attachment

EXHIBIT I

REQUEST FOR TECHNICAL MANUSCRIPT REVIEW

POLAROID CORPORATION

CAMBRIDGE, MASSACHUSETTS 02139

FROM: ROBERT F. PRAINO JR./ JOSEPH DELPICO

DATE: 3/16/81

SUBJECT: PAPER FOR REVIEW

ROUTE TO:
1. S. Degon/R. Ehy DEPT. MGR.
2. M. Malin DIV. MGR.
3. R. Praino/ J. DelPico AUTHOR
4. Charles Zerweck, Jr.

I (we) have prepared the following paper and desire to submit it to the Polaroid Paper Review Procedure. If you approve this paper for publication, sign it and send it to the next person on the list. If not, please return it directly to the author. Thank you.

TITLE: "Hexavalent Chromium Removal from Aqueous Discharges" A Case Study

AUTHOR(S): Robert F. Praino Jr./Joseph Del Pico

DEPARTMENT NUMBER: H23 SUPERVISOR: S. G. Degon

PUBLICATION OR MEETING: Society of Photographic Scientists and Engineers - Annual Conference

MEETING DATE: May 10-14, 1981 PLACE: New York City

COMMENTS (including any deadlines):

I recommend that the paper described above be submitted to the Polaroid Paper Review Procedure. I do not believe it will be harmful to the Company to disclose this information.

SIGNED: [signature] [signature], Department Manager. Date: 3/18/81

[signature], Division Manager. Date: 3/18/81

A CASE STUDY

INTRODUCTION

Several years ago, in preparation for anticipated environmental regulations, Polaroid Corporation conducted a survey of its existing manufacturing operations in an attempt to identify environmental emissions in the areas of aqueous discharge, airborn release, and surface water runoff. Subsequent to this preliminary survey, state-of-the-art technologies were investigated, and the applicability of these various technologies to these emissions was evaluated.

At the present time the major potential trouble spots within the range of manufacturing sites have been identified and these items are being dealt with where possible by improved manufacturing techniques to reduce the discharge of pollutants or, where "end of pipe" treatment is needed, by processes such as precious metal recovery, solvent recovery, and thermal oxidation. Concurrently, facilities having lower volumes of waste discharge are being studied so as to enable appropriate action to be taken as the major environmental cleanup effort continues. Included in this list of manufacturing sites is the Polavision Film Manufacturing Plant which discharges a number of streams of both varying size and composition. It is the purpose of this paper to center attention on one aspect of the waste discharge from this facility.

BACKGROUND

The Polavision Film Plant manufactures the film for the Polavision instant movie system. At the heart of the system is a cassettee containing super 8mm film and the necessary chemicals for processing the film. The film base consists of an additive color screen of miscroscopic red, green, and blue lines which has been overcoated with various photographic layers. (The details of the structure have been described more extensively by Dr. Edwin H. Land at the Annual Conference of the Society of Photographic Scientists and Engineers on May 5, 1978.)

The manufacture of the microscopic additive color screen consists of sequentially exposing a thin dichromated gelatin layer, washing off the unexposed gelatin, and finally dying the remaining hardened line. This process is repeated three times to generate the full structure of the tri-color screen.

The washing steps of this process are the ones on which attention has been focused as regards pollution control. The washing steps generate a 130 gallon per minute stream having a hexavalent chromium concentration of approximately 6 ppm. Current regulations require that discharge of hexavalent chromium be held to less than 0.1 ppm and total chromium to less than 1.0 ppm. For this reason, a major study was undertaken to define the most effective means of waste treatment prior to discharge to the municipal sanitary sewer system.

PRELIMINARY PROPOSAL

The Film Plant waste discharge system prior to construction of the chromium removal facility is shown schematically in Figure 1. Waste streams generated by the Film Plant were mixed in a sump and pH adjusted prior to final discharge.

A preliminary engineering study was undertaken to develop an appropriate treatment scheme for the plant waste streams as shown in Figure 1. For this study, the assumption was made that all waste streams would be mixed and then treated by standard methods which involved chemical additions to effect reduction of the hexavalent chromium, with subsequent pH adjustment, precipitation, filtration, and sludge handling. Due to the high hydraulic load and relatively low contaminant concentration, the cost for construction of such a treatment facility was estimated to be $1.7 million

Because of the high capital expenditure, as well as the anticipated operating costs, an alternative strategy was sought. One alternative was to treat various portic of the total waste stream separately and utilize more specialized technologies for treatment of the pollutants in the waste stream. By adopting this strategy, it was hoped that both economic and operational advantages could be realized.

Towards this end, Polaroid contracted Lancy Laboratories to investigate the available alternatives for the treatment of the gelatin/hexavalent chromium stream. Concurrently, Polaroid continued its own investigations into this waste treatment problem. Below are described the various technologies considered by both Lancy and Polaroid, the methodology behind the final decision made as regards the selection of carbon adsorption as a treatment method and the performance of the installed treatment system to date.

ALTERNATIVES CONSIDERED BY LANCY LABORATORIES

Lancy Laboratories was retained by Polaroid to develop a treatment method for wastes containing hexavalent chromium. Lancy elected to concentrate on three potentially viable alternatives after reviewing several available methods. These included:

1. Chemical reduction and separation using sodium metabisulfite as the reducing agent.
2. Chemical reduction and separation using ferrous sulfate as the reducing agent.
3. Direct carbon adsorption of the hexavalent chromium

Basic flow schematics for each of these are shown in Figures 2, 3, 4. The first two methods are more closely representative of the "standard" treatment initial considered by Polaroid. The difference between these two is that sodium metabisulfit treatment requires one additional pH adjustment step as compared to the ferrous sulfa treatment. However, the ferrous sulfate treatment results in the generation of a lar quantity of sludge and ferric ion discharge. Both capital and operating costs for either of these processing methods were approximately the same and are summarized lat in Table 1.

The use of carbon adsorption as a means of removing the hexavalent chromium was a novel approach proposed by Lancy. The system envisioned, as shown in Figure 4, utilized the carbon for adsorption of the chromium, believed to occur by reduction of the hexavalent chromium to a trivalent chromium form, with subsequent adsorption of the trivalent form. After exhaustion of the carbon adsorption capacity, the carbon would be regenerated by treatment with sulfuric acid. The regeneration acid then would be pH adjusted to precipitate the chromium, with final removal of the sludge by filtration.

The preliminary process conceptualization of the carbon system was made after extensive laboratory scale experiments were conducted. Both capital and operating costs for the system were estimated to be lower than either of the more standard treatment methods. For this reason, Lancy recommended that a pilot study be conducted to answer any remaining questions regarding scale up and extended operation of the system.

ALTERNATIVES CONSIDERED BY POLAROID

Polaroid investigated two alternative processing methods not considered by Lancy:

1. Anionic Exchange
2. Electrochemical Treatment

The anionic exchange method utilized anionic resins in place of carbon in an adsorption system. These resins offered the use of known technology for the removal of chromium from waste water. However, an economic comparison of resin use with carbon use indicated that the operating costs for the resin system would be significantly higher than those of a carbon system. For this reason, no pilot scale work was conducted with such a system.

The electrochemical treatment system utilized the ANDCO Chromate Removal System manufactured by ANDCO, Inc. The process, shown in Figure 5, involved electrochemical addition of ferrous ions to the waste stream to reduce the hexavalent chromium to a trivalent form. Subsequently, polyelectrolyte would be added to flocculate the ferrous and chromium hydroxide produced. Floc concentration was effected by clarification and centrifugation to produce a sludge for disposal. The capital and operating costs of this system appeared to be attractive when compared to those of the regenerative carbon adsorption system, and the system was a technology that was already in use in industry. For these reasons, it was decided to conduct a pilot study of the ANDCO system in conjunction with the carbon adsorption pilot study.

RESULTS OF PILOT STUDIES

A) Electrochemical Treatment

Pilot operation of the ANDCO system revealed two important technical problems unique to the Polaroid application. Firstly, the conductivity of the municipal water supplying the Film Plant was extremely low, which resulted in poor performance of the electrochemical portion of the process. The proposed solution to this problem was the use of a significantly larger electrochemical unit with more power capacity to overcome the low conductivity. However, this solution was accompanied by an associated higher cost of the larger unit. Secondly, the presenc of gelatin in the stream appeared to interfere with the flocculation step. This problem raised questions about the ultimate quality of the effluent from the treatment system and thus terminated our consideration of this technology's applicabilit

B) Carbon Adsorption System

During the pilot study, two operational perameters were found to have a major effect on successful operation of the carbon system. These are:

1. pH of the feed stream to the carbon bed.
2. Pre-filtration of the feed stream to the carbon bed.

The pH adjustment is necessary to extend the life and increase the capacity of the carbon. If pH adjustment to less than 5.0 is not made, bed breakthrough occurs 5-6 times more quickly than with adjustment. The pre-filtration of the feed is required to prevent hydraulic fouling of the bed. Although the gelatin/chromium waste stream is generated by wash-off of unexposed gelatin, there apparently exists some amount of insoluble gelatin in the stream. This filterable gelatin results in plugging of the bed.

After these two problems were addressed during the pilot study, system operation resulted in a hexavalent chromium concentration in the carbon bed effluent of less than 0.1 mg Cr^{+6}/liter until bed breakthrough occurred at a loading of approximately 50 mg Cr^{+6}/gram of carbon. The operation of the system required minimal operator involvement, other than periodic prefilter changes and monitoring, and has fully supported the results predicted by the bench scale tests for operational aspects of the system.

FINAL SYSTEM CONFIGURATION

In light of the technical success of the pilot study, Polaroid conducted a more indepth economic analysis of the proposed carbon system. This analysis revealed that the regenerative carbon system would be more economical than the other technologies considered. A more significant finding, however, was that utilization of the carbon on a once-through disposal mode, as opposed to a regenerative mode resulted in both lower capital and operating costs. These lower costs were achieved due to the elimination of chemicals and equipment needed to handle the regeneration chemicals, and to the feasibility of installation of the system into an existing structure, as opposed to the construction of a building solely for the waste treatment system.

After concluding that a single usage carbon system should be utilized in this application, the means of implementing this decision had to be defined. The most obvious method would be to carry out design and construction of the system as envisioned. However, the alternative chosen was that of contracting a Carbon Service

Agreement with Calgon Corporation. The primary components of the agreement included the lease of an adsorber system, supply of anticipated carbon requirements, carbon handling and disposal service and maintenance support in the event of mechanical or process problems. This choice had the advantages of reducing the capital requirement and eliminating Polaroid labor involvement in carbon handling and disposal. The system configuration as installed is shown in Figure 6. It can be seen that capital outlay by Polaroid was required to provide pH adjustment and pre-filtration of the feed to the adsorber. However this portion of the system would have been required whether or not the system was leased. The adsorber vessel and piping associated with carbon charging and removal were supplied by Calgon as a package. The cost information related to installation and operation are shown in Table 1 and are discussed below.

SYSTEM PERFORMANCE

Transfer of the technology from the pilot scale to the full scale system proved to be straight forward. The system has been in operation for approximately 10 weeks and no performance problems have been encountered. The concentration of hexavalent chromium in the discharge has remained below our detectability limit of 0.05 ppm during operation, and the loading achieved to date is approximately 3 mg Cr^{+6}/gram carbon. The use of a single adsorber corresponds to appropriate sizing based on the pilot work, and final chromium loadings are expected to reach the 50 mg Cr^{+6}/gram carbon level mentioned above without problem.

It should be noted that greater effective utilization of the carbon would be possible if a two adsorber system in series were employed. In this case initial breakthrough of the first bed would be captured by the second bed during which time the first bed would continue to adsorb chromium above the 50 mg/gr level. Carbon in the first bed would then be replaced with the beds alternated such that the fresh bed became the final bed. The choice is an economic one and depends on chromium discharge rates and the additional cost of the second adsorber bed.

SUMMARY

Table 1 summarizes the systems considered during this engineering study. All costs shown are normalized to end-of-1980 values to insure consistency for comparison. The table can be separated into two general categories: 1) More "standard" treatment methods, 2) "Non-Standard" treatment methods.

Under the category of standard methods (Methods 1,2,3) which involve chemical addition and mixing to reduce the hexavalent chromium it can be seen that Method 1, the preliminary engineering design involving treatment of all Film Plant waste streams in a single treatment facility, resulted in capital costs that were significantly higher than other methods considered, and operating costs which were somewhat higher than other methods. Segregation of the gelatin/hexavalent chromium waste stream, as considered in Methods 2 and 3 reduced capital costs by more than half but still involved operating costs which were comparable to those of Method 1. The primary difference between Method 1 and Methods 2 or 3 was a reduction in the waste stream volume to be treated and not in the amount of sludge generated during treatment.

The most significant reduction in estimated cost was realized by the consideration of more "non-standard" treatment methods. The electrochemical system is included in this category because of the mechanism for the addition of a chromium reducing agent. This addition is carried out by electrochemical addition of ferrous ions in a single compact unit instead of by first pH adjusting and then mixing and reacting of chemicals in several vessels. As was mentioned above, however, due to unusally low water conductivity and the presence of gelatin, which apparently inhibited flocculation and settling of the waste materials, the electrochemical system was not chosen although the costs involved were attractive.

The regenerative carbon system had an associated capital cost somewhat lower than the more "standard" methods and an annual operating cost approximately one half of the "standard" methods. However, a major drawback of the system was the requirement of sludge handling and disposal techniques similar to the "standard" methods. The concept of single usage carbon eliminated this drawback and led to even greater economy than with a regenerative system. This economy resulted from a reduction in capital cost for regenerative chemical and sludge handling equipment.

The last remaining drawback of the carbon adsorption system, that of carbon handling and disposal, was addressed by the carbon service agreement. This option provided several advantages over construction and maintenance of a Polaroid owned carbon adsorber. In general, the contracting of the carbon service agreement provided the following:

1. Minimization of capital outlay.
2. Elimination of carbon black as a potential Film Plant contaminant.
3. Assured carbon supply.
4. Carbon disposal expertise via secure landfill.

These advantages more than offset the higher operating expense associated with the system and resulted in implementation of the single usage carbon treatment technology.

CONCLUSION

The evolution of the treatment method implemented by Polaroid for the gelatin/hexavalent chromium described, involved a significant research and development effort as well as an evaluation of available technology. The final system is an economical and operationally passive one which requires minimum operator involvement, and is believed to represent state-of-the-art in this application. In addition, it is expected to provide dependable performance and eliminate the potential adverse environmental impact from the waste stream treated.

As was noted, the development of the solution to the waste discharge problem described required a substantial investment of time and effort. In retrospect, this investment was well spent, in that a high level of success was achieved and the information gained may be applicable to other environmental pollution problems in various sectors of industry. It is the utilization of such new technology, when incorporated into either new or planned facilities, that will allow maximization of investment resources available and will provide effective pollution abatement for the future.

SUMMARY OF COSTS FOR TREATMENT SYSTEMS CONSIDERED

METHOD NO.	TREATMENT SYSTEM	COSTS* CAPITAL	COSTS* ANNUAL OPERATING	COMMENTS
1	"STANDARD" FOR ALL PLANT EFFLUENT	$1,700,000	$122,000	
2	SODIUM METABISULFITE	720,000	89,000	
3	FERROUS SULFATE	730,000	84,000	
4	ELECTROCHEMICAL	540,000	44,000	EFFLUENT QUALITY UNCERTAI
5	REGENERATIVE CARBON	670,000	54,000	
6	SINGLE USAGE CARBON			
	CONSTRUCTED	250,000	33,000	
	LEASED	140,000	60,000	

*END OF 1980 BASIS

FIGURE 1

FILM PLANT WASTE DISCHARGE SYSTEM PRIOR TO INSTALLATION OF CHROMIUM REMOVAL SYSTEM

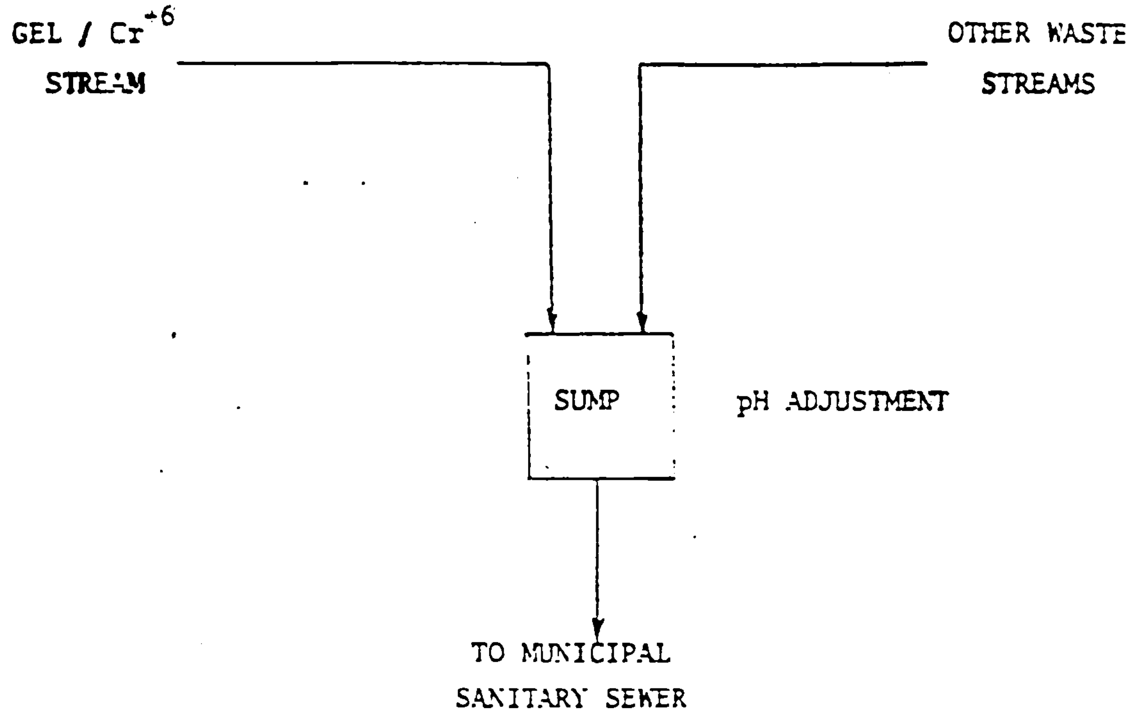


FIGURE 2

CHEMICAL TREATMENT SYSTEM USING SODIUM METABISULFITE REDUCING AGENT

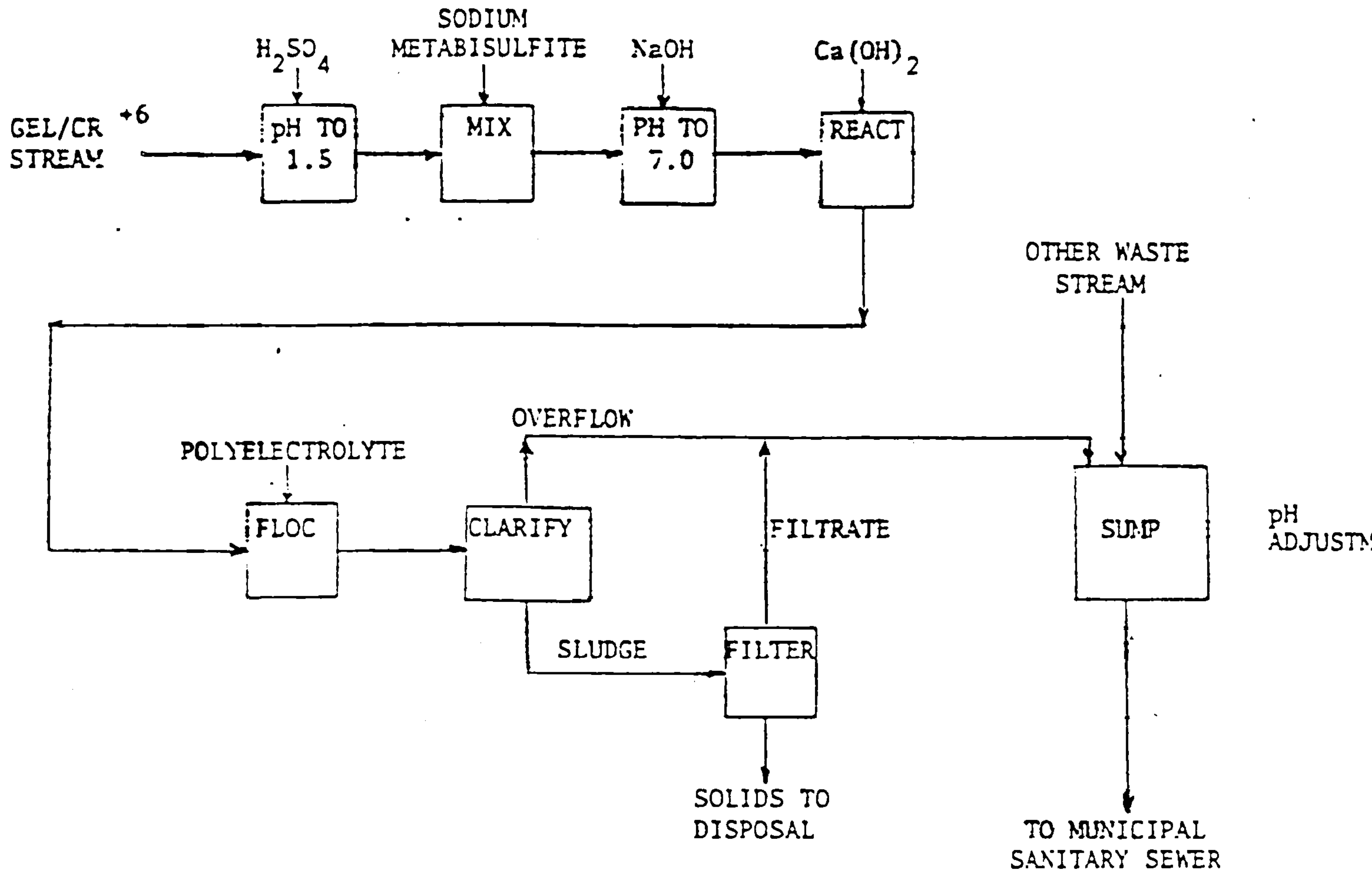


FIGURE 5

CHEMICAL TREATMENT SYSTEM USING
FERROUS SULFATE REDUCING AGENT

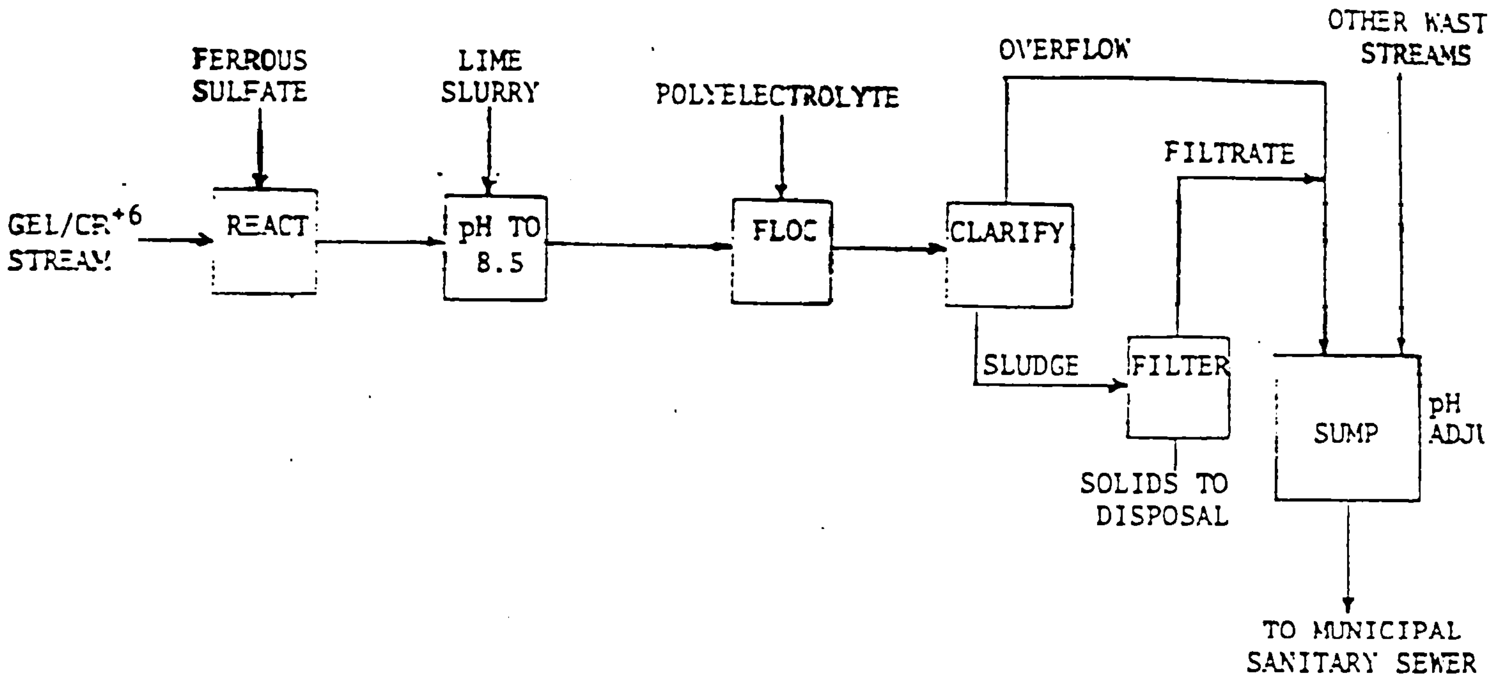


FIGURE 4

REGENERATIVE CARBON ADSORPTION SYSTEM

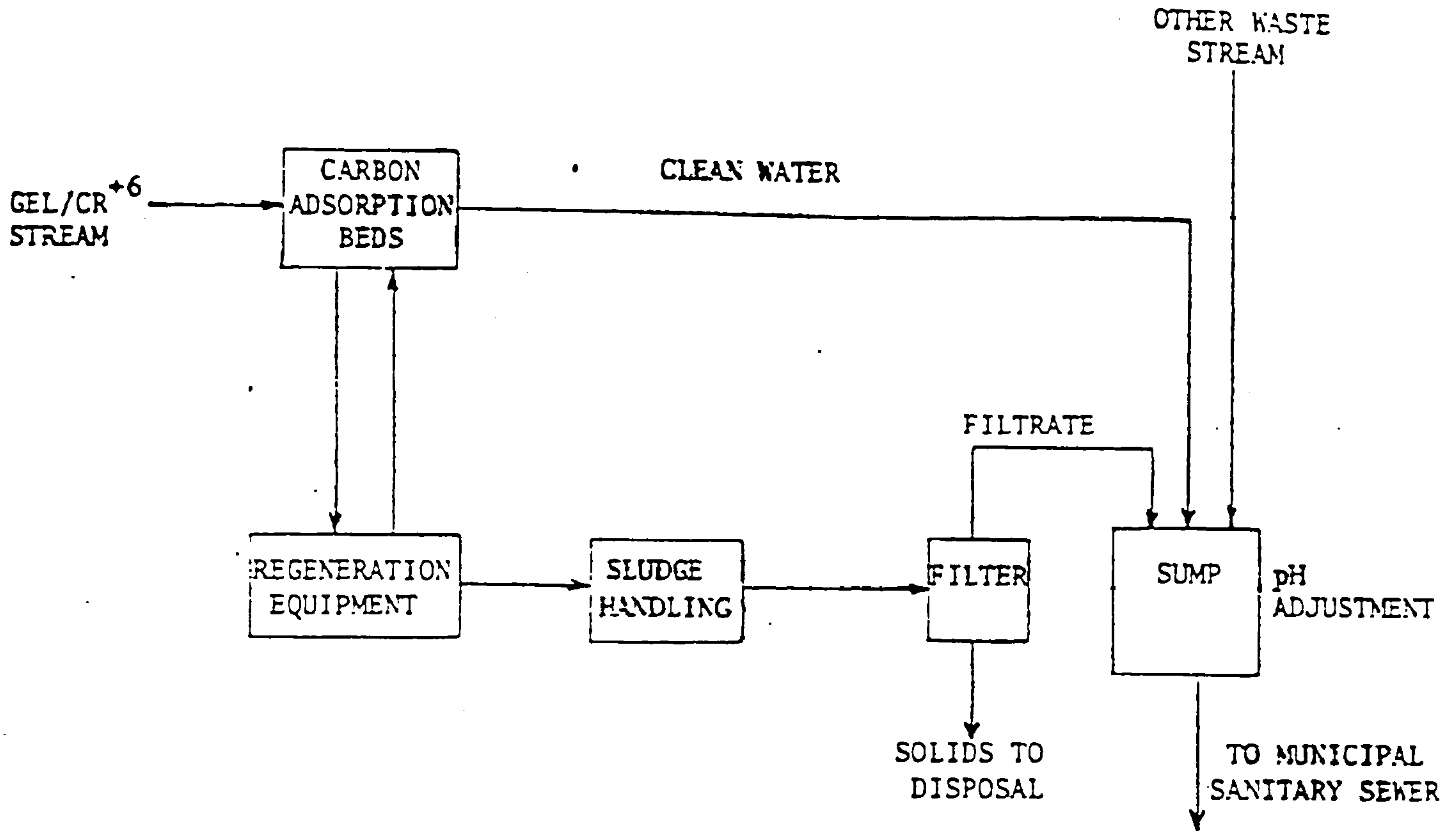


FIGURE 5

ANDCO ELECTROCHEMICAL TREATMENT SYSTEM

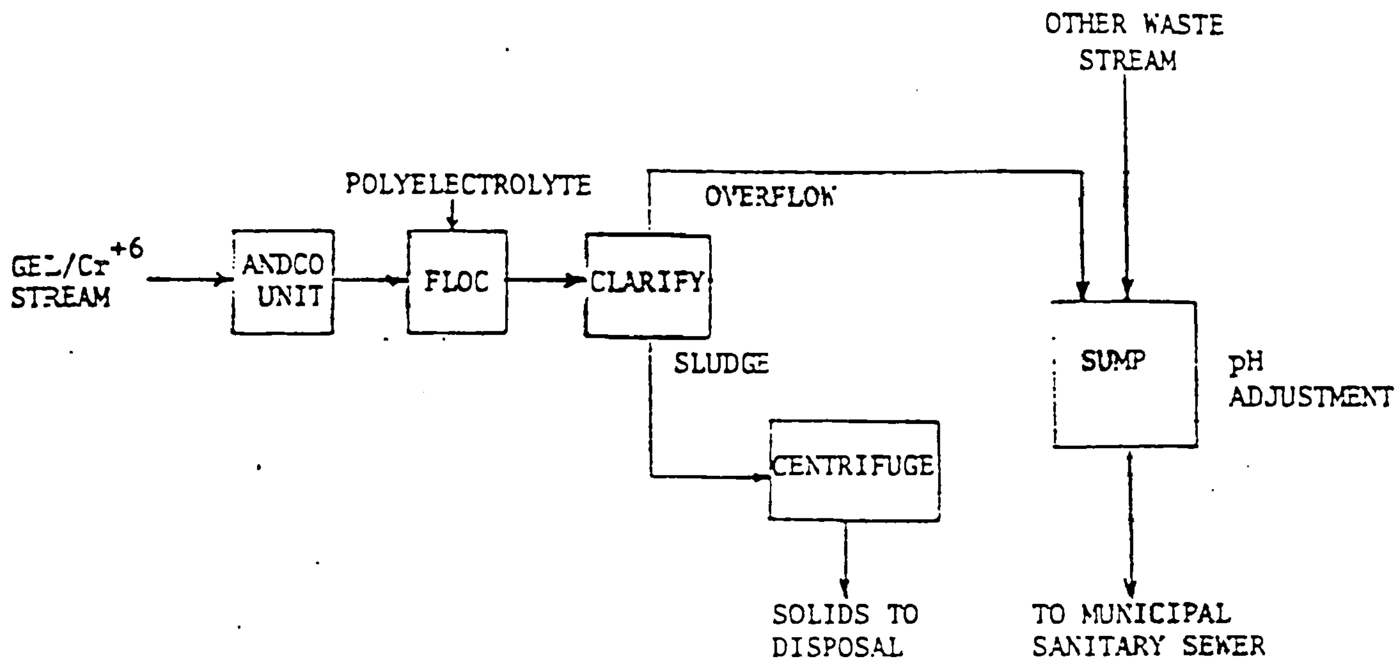
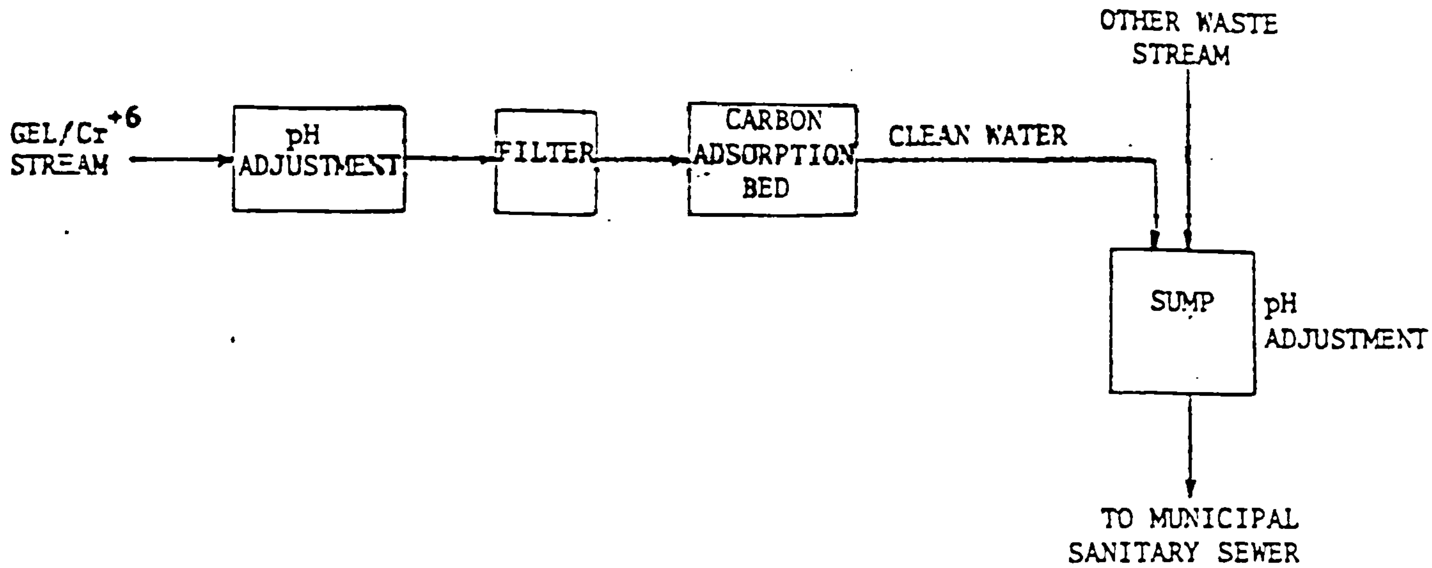


FIGURE 6

SINGLE USAGE CARBON ADSORPTION SYSTEM

AS INSTALLED



APPENDIX C
Detailed Analysis Evaluation Summaries

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes X 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes X 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes X 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes X 2.5 No ___ 0
TOTAL (Maximum = 10)		10

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	X 3
	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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___ 1
Subtotal (maximum = 10)	Minimum Required Score = 7	9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	___ 1
	iii) Extensive coordination is required.	X 0
Subtotal (maximum = 2)		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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		12

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes _X_ 5 No ___ 0
Subtotal (maximum = 5)		5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr.___ 3 15-20yr.___ 2 < 15yr.___ 0
Subtotal (maximum = 4)		0
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes ___ 0 No _X_ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		5
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes ___ 0 No _X_ 2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate _X_ 1 Extensive ___ 0
Subtotal (maximum = 5)		3
TOTAL (Maximum) = 15)		13

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes _X_ 20 No ___ 0
TOTAL (Maximum = 20)		20
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes ___ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes ___ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes ___ 3 No ___ 0
Subtotal (maximum = 10)		0
3. Magnitude of residual public health risks after the remediation.	i) Health risk	$\leq$ 1 in 1,000,000 ___5
	ii) Health risk	$\leq$ 1 in 100,000 ___2
Subtotal (maximum = 5)		0
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	___ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		0
TOTAL (Maximum = 20)		20

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2.)	Yes ___ 0 No X 2
	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
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		12
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	___ 3
	ii) Quantity of Wastes Immobilized	≤ 100% ___ 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		0
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ACTIVATED CARBON TREATMENT AND DISCHARGE TO POTW

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___ 0 No _X_ 4
	o Can the risk be easily controlled?	Yes ___ 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No ___ 2
Subtotal (maximum = 4)		4
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes ___ 0 No _X_ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___ 3 No ___ 0
Subtotal (maximum = 4)		4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ 1 > 2yr. _X_ 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ 1 > 2yr. ___ 0
Subtotal (maximum = 2)		1
TOTAL (Maximum = 10)		9

CONVENTIONAL PRECIPITATION TO OLEAN CREEK

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes X 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes X 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes X 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes X 2.5 No ___ 0
TOTAL (Maximum = 10)		10

CONVENTIONAL PRECIPITATION TO OLEAN CREEK

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	X 3
	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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	__ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	__ 1
Subtotal (maximum = 10)	Minimum Required Score = 7	9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	__ 2
	ii) Required coordination is normal.	__ 1
	iii) Extensive coordination is required.	X 0
Subtotal (maximum = 2)		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 X 1 No __ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No __ 0

CONVENTIONAL PRECIPITATION TO OLEAN CREEK

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		12

CONVENTIONAL PRECIPITATION TO CLEAN CREEK

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes _X_ 5 No ___ 0	
Subtotal (maximum = 5)			5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr.___ 3 15-20yr.___ 2 < 15yr.___ 0	
Subtotal (maximum = 4)			0
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0	
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes ___ 0 No _X_ 2	
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1	
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1	
Subtotal (maximum = 5)			5
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0	
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes ___ 0 No _X_ 2	
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0	
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate _X_ 1 Extensive ___ 0	
Subtotal (maximum = 5)			3
TOTAL (Maximum) = 15)			13

CONVENTIONAL PRECIPITATION TO OLEAN CREEK

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2.)	Yes ___ 0 No X 2
	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
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		12
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	___ 3
	ii) Quantity of Wastes Immobilized	≤ 100% ___ 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		0
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

CONVENTIONAL PRECIPITATION TO OLEAN CREEK

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___ No _X_	0 4
	o Can the risk be easily controlled?	Yes ___ No ___	1 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ No ___	0 2
Subtotal (maximum = 4)			4
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes ___ No _X_	0 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___ No ___	3 0
Subtotal (maximum = 4)			4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ > 2yr. _X_	1 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ > 2yr. ___	1 0
Subtotal (maximum = 2)			1
TOTAL (Maximum = 10)			9

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes _X_ 20 No ___ 0
TOTAL (Maximum = 20)		20
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes ___ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes ___ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes ___ 3 No ___ 0
Subtotal (maximum = 10)		0
3. Magnitude of residual public health risks after the remediation.	i) Health risk	≤ 1 in 1,000,000 ___5
	ii) Health risk	≤ 1 in 100,000 ___2
Subtotal (maximum = 5)		0
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	___ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		0
TOTAL (Maximum = 20)		20

ALTERNATIVE 1

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes ___ 2.5 No _X_ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes ___ 2.5 No _X_ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes ___ 2.5 No _X_ 0
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 _X_ 0
TOTAL (Maximum = 10)		0

ALTERNATIVE 1

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	X 3
	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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	NA 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	__ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	__ 2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		6
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	X 2
	ii) Required coordination is normal.	__ 1
	iii) Extensive coordination is required.	__ 0
Subtotal (maximum = 2)		2
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 X 1 No __ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No __ 0

ALTERNATIVE 1

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		11

ALTERNATIVE 1

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes ___ 5 No _X_ 0
Subtotal (maximum = 5)		0
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr. ___ 4 20-25yr. ___ 3 15-20yr. ___ 2 < 15yr. _X_ 0
Subtotal (maximum = 4)		0
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% _X_ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes _NA_ 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		0
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes _X_ 0 No ___ 2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident _X_ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate ___ 1 Extensive _X_ 0
Subtotal (maximum = 5)		0
TOTAL (Maximum) = 15)		0

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes ___ No _X_	20 0
TOTAL (Maximum = 20)			0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes ___ No _X_	3 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes ___ No _X_	4 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes ___ No _X_	3 0
Subtotal (maximum = 10)			0
3. Magnitude of residual public health risks after the remediation.	i) Health risk	$\leq$ 1 in 1,000,000 ___	5
	ii) Health risk	$\leq$ 1 in 100,000 _X_	2
Subtotal (maximum = 5)			2
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	___	5
	ii) Slightly greater than acceptable	___	3
	iii) Significant risk still exists	_X_	0
Subtotal (maximum = 5)			0
TOTAL (Maximum = 20)			2

ALTERNATIVE 1

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
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% X 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2.)	Yes NA 0 No ___ 2
	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
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		0
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	NA 1
	- Reduced mobility by alternative treatment technologies.	___ 3
	ii) Quantity of Wastes Immobilized	≤ 100% ___ 2 ≥ 60% ___ 1 < 60% X 0
Subtotal (maximum = 5)		0
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	___ 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	X 0
Subtotal (maximum = 3)		0
TOTAL (Maximum = 15)		0

ALTERNATIVE 1

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes ___ No _X_	0 4
	o Can the risk be easily controlled?	Yes ___ No ___	1 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ No ___	0 2
Subtotal (maximum = 4)			4
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes ___ No _X_	0 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes ___ No ___	3 0
Subtotal (maximum = 4)			4
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. _X_ > 2yr. ___	1 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ > 2yr. ___	1 0
Subtotal (maximum = 2)			2
TOTAL (Maximum = 10)			10

ALTERNATIVE 2

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes ___ 2.5 No _X_ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes ___ 2.5 No _X_ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ 2.5 No ___ 0
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 _X_ 0
TOTAL (Maximum = 10)		2.5

ALTERNATIVE 2

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___ 2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		7
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	X 2
	ii) Required coordination is normal.	___ 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		2
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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ALTERNATIVE 2

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		12

ALTERNATIVE 2

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes ___ 5 No _X_ 0	
Subtotal (maximum = 5)			0
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr._X_ 3 15-20yr.___ 2 < 15yr.___ 0	
Subtotal (maximum = 4)			3
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0	
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes _NA_ 0 No ___ 2	
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1	
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1	
Subtotal (maximum = 5)			3
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0	
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes _X_ 0 No ___ 2	
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident _X_ 0	
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate ___ 1 Extensive _X_ 0	
Subtotal (maximum = 5)			0
TOTAL (Maximum) = 15)			6

Alternative 2

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes ___ 20 No _X_ 0
TOTAL (Maximum = 20)		0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes _X_ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes ___ 4 No _X_ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 10)		6
3. Magnitude of residual public health risks after the remediation.	i) Health risk	≤ 1 in 1,000,000 ___ 5
	ii) Health risk	≤ 1 in 100,000 _X_ 2
Subtotal (maximum = 5)		2
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	___ 5
	ii) Slightly greater than acceptable	_X_ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		3
TOTAL (Maximum = 20)		11

ALTERNATIVE 2

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes ___ 0 No X 2
	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
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		12
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	___ 3
	ii) Quantity of Wastes Immobilized	≤ 100% ___ 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		0
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ALTERNATIVE 2

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. _X_ 1 > 2yr. ___ 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ 1 > 2yr. ___ 0
Subtotal (maximum = 2)		2
TOTAL (Maximum = 10)		8

ALTERNATIVE 3

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes _X_ 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes _X_ 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes _X_ 2.5 No ___ 0
TOTAL (Maximum = 10)		10

ALTERNATIVE 3

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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.	X 3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	___ 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___ 1
Subtotal (maximum = 10)		9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	X 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		1
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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ALTERNATIVE 3

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes X 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		13

ALTERNATIVE 3

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes _X_ 5 No ___ 0
Subtotal (maximum = 5)		5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr. ___ 4 20-25yr. ___ 3 15-20yr. ___ 2 < 15yr. ___ 0
Subtotal (maximum = 4)		0
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes ___ 0 No _X_ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		5
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes ___ 0 No _X_ 2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate _X_ 1 Extensive ___ 0
Subtotal (maximum = 5)		3
TOTAL (Maximum) = 15)		13

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes _X_ 20 No ___ 0
TOTAL (Maximum = 20)		20
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes ___ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes ___ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes ___ 3 No ___ 0
Subtotal (maximum = 10)		0
3. Magnitude of residual public health risks after the remediation.	i) Health risk	$\leq$ 1 in 1,000,000 ___5
	ii) Health risk	$\leq$ 1 in 100,000 ___2
Subtotal (maximum = 5)		0
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	___ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		0
TOTAL (Maximum = 20)		20

ALTERNATIVE 3

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 2
	iii) How is the concentrated hazardous waste stream disposed?	On-site land disposal ___ 0 Off-site secure land disposal X 1 On-site or off-site destruction or treatment ___ 2
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		11
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	X 3
	ii) Quantity of Wastes Immobilized	≤ 100% X 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		5
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ALTERNATIVE 3

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight	
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X No ___	0 4
	o Can the risk be easily controlled?	Yes X No ___	1 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ No X	0 2
Subtotal (maximum = 4)			3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes X No ___	0 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X No ___	3 0
Subtotal (maximum = 4)			3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ > 2yr. X	1 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. X > 2yr. ___	1 0
Subtotal (maximum = 2)			1
TOTAL (Maximum = 10)			7

ALTERNATIVE 4

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes _X_ 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes _X_ 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes _X_ 2.5 No ___ 0
TOTAL (Maximum = 10)		10

ALTERNATIVE 4

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___ 2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		7
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	X 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		1
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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ALTERNATIVE 4

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		11

ALTERNATIVE 4

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes _X_	5
		No ___	0
Subtotal (maximum = 5)			5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___	4
		20-25yr.___	3
		15-20yr.___	2
		< 15yr.___	0
Subtotal (maximum = 4)			0
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 _X_	3
		≤ 25% ___	2
		25-50% ___	1
		> 50% ___	0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes _X_	0
		No ___	2
	iii) Is the treated residual toxic?	Yes ___	0
		No _X_	1
	iv) Is the treated residual mobile?	Yes ___	0
		No _X_	1
Subtotal (maximum = 5)			5
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___	1
		> 5yr. _X_	0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes ___	0
		No _X_	2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___	1
		Somewhat to not confident ___	0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___	2
		Moderate _X_	1
		Extensive ___	0
Subtotal (maximum = 5)			3
TOTAL (Maximum) = 15)			13

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes ___ 20 No _X_ 0
TOTAL (Maximum = 20)		0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes _X_ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes _X_ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 10)		10
3. Magnitude of residual public health risks after the remediation.	i) Health risk	≤ 1 in 1,000,000 _X_ 5
	ii) Health risk	≤ 1 in 100,000 ___ 2
Subtotal (maximum = 5)		5
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	_X_ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		5
TOTAL (Maximum = 20)		20

ALTERNATIVE 4

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 2
	iii) How is the concentrated hazardous waste stream disposed?	On-site land disposal ___ 0 Off-site secure land disposal X 1 On-site or off-site destruction or treatment ___ 2
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		11
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	X 3
	ii) Quantity of Wastes Immobilized	≤ 100% X 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		5
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ALTERNATIVE 4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ 1 > 2yr. _X_ 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ 1 > 2yr. ___ 0
Subtotal (maximum = 2)		1
TOTAL (Maximum = 10)		7

ALTERNATIVE 5

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes _X_ 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes _X_ 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes _X_ 2.5 No ___ 0
TOTAL (Maximum = 10)		10

ALTERNATIVE 5

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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.	X 3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	___ 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	X 2
	ii) Some future remedial actions may be necessary.	___ 1
Subtotal (maximum = 10)		9
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	X 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		1
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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ALTERNATIVE 5

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		13

ALTERNATIVE 5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes X 5 No ___ 0
Subtotal (maximum = 5)		5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr.___ 3 15-20yr.___ 2 < 15yr.___ 0
Subtotal (maximum = 4)		0
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 X 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes X 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No X 1
	iv) Is the treated residual mobile?	Yes ___ 0 No X 1
Subtotal (maximum = 5)		5
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. X 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes ___ 0 No X 2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident ___ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate X 1 Extensive ___ 0
Subtotal (maximum = 5)		3
TOTAL (Maximum) = 15)		13

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. **(If answer is yes, go to the end of the Table.)**	Yes ___ 20 No _X_ 0
TOTAL (Maximum = 20)		0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes _X_ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes _X_ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 10)		10
3. Magnitude of residual public health risks after the remediation.	i) Health risk ii) Health risk	$\leq$ 1 in 1,000,000 _X_ 5 $\leq$ 1 in 100,000 ___ 2
Subtotal (maximum = 5)		5
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	_X_ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		5
TOTAL (Maximum = 20)		20

ALTERNATIVE 5

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 2
	iii) How is the concentrated hazardous waste stream disposed?	On-site land disposal ___ 0 Off-site secure land disposal X 1 On-site or off-site destruction or treatment ___ 2
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		11
2. Reduction in mobility of hazardous waste.	i) <u>Method of Reduction</u>	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	X 3
	ii) <u>Quantity of Wastes Immobilized</u>	≤ 100% X 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		5
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ALTERNATIVE 5

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 4
	o Can the risk be easily controlled?	Yes X 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No X 2
Subtotal (maximum = 4)		3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes X 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes X 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ 1 > 2yr. X 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. X 1 > 2yr. ___ 0
Subtotal (maximum = 2)		1
TOTAL (Maximum = 10)		7

ALTERNATIVE 6

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes _X_ No ___	2.5 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes _X_ No ___	2.5 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ No ___	2.5 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes _X_ No ___	2.5 0
TOTAL (Maximum = 10)			10

ALTERNATIVE 6

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	X 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
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	X 2
	ii) Somewhat likely	___ 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___ 2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		7
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	X 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		1
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 X 1 No ___ 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes X 1 No ___ 0

ALTERNATIVE 6

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes _X_ 1 No ___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		11

ALTERNATIVE 6

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes ___ 5 No _X_ 0
Subtotal (maximum = 5)		0
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr._X_ 3 15-20yr.___ 2 < 15yr.___ 0
Subtotal (maximum = 4)		3
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes _NA_ 0 No ___ 2
	iii) Is the treated residual toxic?	Yes ___ 0 No ___ 1
	iv) Is the treated residual mobile?	Yes ___ 0 No ___ 1
Subtotal (maximum = 5)		3
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes _X_ 0 No ___ 2
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident _X_ 0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate ___ 1 Extensive _X_ 0
Subtotal (maximum = 5)		0
TOTAL (Maximum) = 15)		6

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes ___ 20 No _X_ 0
TOTAL (Maximum = 20)		0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes _X_ 3 No ___ 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes _X_ 4 No ___ 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 10)		10
3. Magnitude of residual public health risks after the remediation.	i) Health risk	≤ 1 in 1,000,000 _X_ 5
	ii) Health risk	≤ 1 in 100,000 ___ 2
Subtotal (maximum = 5)		5
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	_X_ 5
	ii) Slightly greater than acceptable	___ 3
	iii) Significant risk still exists	___ 0
Subtotal (maximum = 5)		5
TOTAL (Maximum = 20)		20

ALTERNATIVE 6

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 2
	iii) How is the concentrated hazardous waste stream disposed?	On-site land disposal ___ 0 Off-site secure land disposal X 1 On-site or off-site destruction or treatment ___ 2
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		11
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	X 1
	- Reduced mobility by alternative treatment technologies.	___ 3
	ii) Quantity of Wastes Immobilized	≤ 100% X 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		3
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	___ 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	X 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		1
TOTAL (Maximum = 15)		15

ALTERNATIVE 6

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ 1 > 2yr. _X_ 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ 1 > 2yr. ___ 0
Subtotal (maximum = 2)		1
TOTAL (Maximum = 10)		7

ALTERNATIVE 7

COMPLIANCE WITH SCGs
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Compliance with chemical-specific SCGs.	Meets chemical specific SCGs such as ground water standards.	Yes _X_ 2.5 No ___ 0
2. Compliance with action-specific SCGs.	Meets SCGs such as RCRA minimum technology standards.	Yes _X_ 2.5 No ___ 0
3. Compliance with location-specific SCGs.	Meets location-specific SCGs such as wild and scenic Rivers Act.	Yes _X_ 2.5 No ___ 0
4. Compliance with appropriate criteria, advisories and guidelines.	The alternative meets all relevant and appropriate Federal and State guidelines that are not promulgated.	Yes _X_ 2.5 No ___ 0
TOTAL (Maximum = 10)		10

ALTERNATIVE 7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Technical Feasibility		
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.	___ 3
	ii) Somewhat difficult to construct. No uncertainties in construction.	___ 2
	iii) Very difficult to construct and/or significant uncertainties in construction.	X 1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.	___ 3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.	X 2
c. Schedule of delays due to technical problems.	i) Unlikely	___ 2
	ii) Somewhat likely	X 1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.	___ 2
	ii) Some future remedial actions may be necessary.	X 1
Subtotal (maximum = 10)		5
2. Administrative Feasibility		
a. Coordination with other agencies.	i) Minimal coordination is required.	___ 2
	ii) Required coordination is normal.	X 1
	iii) Extensive coordination is required.	___ 0
Subtotal (maximum = 2)		1
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 X 0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes ___ 1 No X 0

ALTERNATIVE 7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialist may be available without significant delay.	Yes ___ 1 No _X_ 0
Subtotal (maximum = 3)		0
TOTAL (Maximum = 15)		6

ALTERNATIVE 7

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Permanence of the remedial alternative.	o Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c), (If answer is yes, go to Factor 3.)	Yes _X_ 5 No ___ 0	
Subtotal (maximum = 5)			5
2. Lifetime of remedial actions.	o Expected lifetime or duration of effectiveness of the remedy.	25-30yr.___ 4 20-25yr.___ 3 15-20yr.___ 2 < 15yr.___ 0	
Subtotal (maximum = 4)			0
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 _X_ 3 ≤ 25% ___ 2 25-50% ___ 1 > 50% ___ 0	
	ii) Is there treated residual left at the site? (If answer is no, go to Factor 4.)	Yes _X_ 0 No ___ 2	
	iii) Is the treated residual toxic?	Yes ___ 0 No _X_ 1	
	iv) Is the treated residual mobile?	Yes ___ 0 No _X_ 1	
Subtotal (maximum = 5)			6
4. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___ 1 > 5yr. _X_ 0	
	ii) Are environmental controls required as a part of the remedy to handle potential problems? (If answer is no, go to "iv")	Yes _X_ 0 No ___ 2	
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___ 1 Somewhat to not confident _X_ 0	
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives evaluated in the Detailed Analysis).	Minimum ___ 2 Moderate _X_ 1 Extensive ___ 0	
Subtotal (maximum = 5)			1
TOTAL (Maximum) = 15)			12

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes ___ No _X_	20 0
TOTAL (Maximum = 20)			0
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes _X_ No ___	3 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes _X_ No ___	4 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes _X_ No ___	3 0
Subtotal (maximum = 10)			10
3. Magnitude of residual public health risks after the remediation.	i) Health risk ii) Health risk	≤ 1 in 1,000,000 _X_ ≤ 1 in 100,000 ___	5 2
Subtotal (maximum = 5)			5
4. Magnitude of residual environmental risk after the remediation.	i) Less than acceptable	_X_	5
	ii) Slightly greater than acceptable	___	3
	iii) Significant risk still exists	___	0
Subtotal (maximum = 5)			5
TOTAL (Maximum = 20)			20

ALTERNATIVE 7

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

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Volume of hazardous waste reduced (Reduction in volume or toxicity).	i) Quantity of hazardous waste destroyed or treated.	100% X 10 80-99% ___ 8 60-80% ___ 6 40-60% ___ 4 20-40% ___ 2 < 20% ___ 0
	ii) Are there concentrated hazardous waste produced as a result of (i)? (If answer is no, go to Factor 2.)	Yes X 0 No ___ 2
	iii) How is the concentrated hazardous waste stream disposed?	On-site land disposal ___ 0 Off-site secure land disposal X 1 On-site or off-site destruction or treatment ___ 2
Subtotal (maximum = 12) (If subtotal = 12, go to 3)		11
2. Reduction in mobility of hazardous waste.	i) Method of Reduction	
	- Reduced mobility by containment	___ 1
	- Reduced mobility by alternative treatment technologies.	X 3
	ii) Quantity of Wastes Immobilized	≤ 100% X 2 ≥ 60% ___ 1 < 60% ___ 0
Subtotal (maximum = 5)		5
3. Irreversibility of the destruction or treatment of hazardous waste.	Completely irreversible	X 3
	Irreversible for most of the hazardous waste constituents.	___ 2
	Irreversible for only some of the hazardous waste constituents	___ 1
	Reversible for most of the hazardous waste constituents.	___ 0
Subtotal (maximum = 3)		3
TOTAL (Maximum = 15)		15

ALTERNATIVE 7

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis	Weight
1. Protection of community during remedial actions.	o Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes _X_ 0 No ___ 4
	o Can the risk be easily controlled?	Yes _X_ 1 No ___ 0
	o Does the mitigative effort to control risk impact the community life-style?	Yes ___ 0 No _X_ 2
Subtotal (maximum = 4)		3
2. Environmental impacts	o Are there significant short-term risks to the environment that must be addressed? (If the answer is no, go to Factor 3.)	Yes _X_ 0 No ___ 4
	o Are the available mitigative measures reliable to minimize potential impacts?	Yes _X_ 3 No ___ 0
Subtotal (maximum = 4)		3
3. Time to implement the remedy.	o What is the required time to implement the remedy?	≤ 2yr. ___ 1 > 2yr. _X_ 0
	o Required duration of the mitigative effort to control short-term risk.	≤ 2yr. _X_ 1 > 2yr. ___ 0
Subtotal (maximum = 2)		1
TOTAL (Maximum = 10)		7

ERM-Northeast

APPENDIX D
Basis and Cost Estimation Summaries

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Ground Water Extraction System

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction and Equipment Costs

BASIS: Direct capital costs include construction and equipment costs for a five well ground water extraction system. Costs include items such as installation of wells, materials to construct wells, pumps, piping, electrical wiring, instruments and labor for field construction of these items.

CALCULATION/SOURCE: Installation and equipment costs were estimated based on similar costs from the Phase II RI pumping test. Piping, labor and setup costs were calculated using factors from Perry's Chemical Engineers' Handbook, 6th Edition. O&M costs were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated, if necessary to 1991 dollars using ENR Construction Cost Indexes.

CAPITAL COST SUMMARY FOR GROUND WATER EXTRACTION SYSTEM

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction** Costs	144283	Published Cost Factors	1995
a. Equipment			
b. Labor			
c. Materials			
Subtotal	144283		
2. **Equipmet** Costs		Estimated From Phase II Costs	
___ Installed			
_X_ Purchased	11000		1995
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	11000		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs			
Subtotal	0		
TOTAL DIRECT COSTS	155283		
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	23292	15% TDC	
2. **Contingency** Allowance	38821	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	4658	3% TDC	
b. Licence/permit Costs	3106	2% TDC	
c. Start-up & Shake-down	31057	20% TDC	
Subtotal	100934		
TOTAL INDIRECT COSTS	100934		
TOTAL CAPITAL COSTS	256217		1995

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Surface Soil Removal

COST ITEM: Direct Capital Cost   COST COMPONENT: Construction Costs

BASIS: Direct capital costs include excavation of the top two (2) feet of soil with chromium concentrations greater than 50 ppm. Costs include items such as mobilization/demobilization, removing the soil from its current location and stock piling it for treatment on-site, air monitoring for the presence of dust particles and watering to control dust.

CALCULATION/SOURCE: Costs are taken from the "Compendium of Costs of Remedial Technologies at Hazardous Waste Sites", October 1987, page 145, using the average excavation expenditure cost for the USEPA ELI/JRB 1979 surface soil cleanup in Missouri. Costs are updated to 1991 dollars using ENR Construction Cost Indexes.

ERM-Northeast

CAPITAL COST SUMMARY FOR SURFACE SOIL REMOVAL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs a. Equipment b. Labor c. Materials	921,500	Published Costs	1993
Subtotal	921,500		
2. Equipmet Costs ___ Installed ___ Purchased			
3. Land and Site Development a. Equipment b. Labor c. Materials			
Subtotal	0		
4. Buildings and Service a. Equipment b. Labor c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs			
Subtotal	0		
TOTAL DIRECT COSTS	921,500		
INDIRECT CAPITAL COSTS			
1. Engineering and Design	138,225	15% TDC	
2. Contingency Allowance	230,375	25% TDC	
3. Other Indirect Costs a. Legal Fees b. Licence/permit Costs c. Start-up & Shake-down			
Subtotal	368,600		
TOTAL INDIRECT COSTS	368,600		
TOTAL CAPITAL COSTS	1,290,100		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Storm Sewer Cleaning

COST ITEM: Direct Capital Costs

COST COMPONENT: Labor, Eqpt.& Materials

BASIS: Direct costs based on quotations from 4 experienced local storm sewer cleaning contractors to pressure wash lines and vacuum-out sediment and transfer the sediment into 55 gallon drums. Included in the cost are items such as labor, equipment rental, air quality monitoring, safety equipment, video taping of the line and mobilization and demobilization.

CALCULATION/SOURCE: Contractors provided unit cost estimates ($/linear foot) for sewer cleaning based on past experience. These cost estimates ranged from $10/ft. to $32/ft. with an average price of $25/ft. This price includes all associated labor, equipment and material costs including video taping of the lines following cleaning. Total Direct Capital Cost= 4,536 linear ft.x $25/ft.=$113,400.

CAPITAL COST SUMMARY FOR ALTERNATIVE STORM SEWER CLEANING

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs	113400	Quotation	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	113400		
2. Equipmet Costs	NA		
___ Installed			
___ Purchased			
3. Land and Site Development	NA		
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. Buildings and Service	NA		
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs	NA		
Subtotal	0		
6. Disposal Costs	NA		
Subtotal	NA		
TOTAL DIRECT COSTS	113400		1993
INDIRECT CAPITAL COSTS			
1. Engineering and Design	30000		
2. Contingency Allowance	5000		
3. Other Indirect Costs			
a. Legal Fees	5000		
b. Licence/permit Costs	5000		
c. Start-up & Shake-down	5000		
Subtotal	50000		
TOTAL INDIRECT COSTS	50000	ERM Est.	1993
TOTAL CAPITAL COSTS	163400		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Off-site Landfilling

COST ITEM: Direct Capital Costs

COST COMPONENT: Land Development and Disposal Costs

BASIS: Direct capital costs were based on disposal facility unit costs for disposal, transportation and stabilization to meet LDR standards. Costs include items such as procurement, placement and rough grading of clean fill in the excavated areas, treatment of the contaminated soil (if necessary), disposal of the contaminated soil, and transportation of soil/fill to and from the site.

CALCULATION/SOURCE: Cost information for treatment, transportation and disposal came from current vender costs. Cost information for backfilling was from quotes provided to ERM for a similar project recently completed.

CAPITAL COST SUMMARY FOR HIGHLY CONTAMINATED SOIL TO OFF-SITE LANDFIL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction** Costs			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
2. **Equipmet** Costs			
___ Installed			
___ Purchased			
3. **Land** and Site Development	485210	Vender Quotes	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	485210		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs	2187856	Vender Information	1993
Subtotal	2187856		
TOTAL DIRECT COSTS	2673066		
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	400960	15% TDC	
2. Contingency Allowance	668267	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	53461	2% TDC	
b. Licence/permit Costs	80192	3% TDC	
c. Start-up & Shake-down			
Subtotal	1202880		
TOTAL INDIRECT COSTS	1202880		
TOTAL CAPITAL COSTS	3875946		1993

CAPITAL COST SUMMARY FOR LESS CONTAMINATED SOIL TO OFF-SITE LANDFILL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
2. Equipmet Costs			
___ Installed			
___ Purchased			
3. Land and Site Development	687500	Vender Quotes	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	687500		
4. Buildings and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs	2850000	Vender Information	1993
Subtotal	2850000		
TOTAL DIRECT COSTS	3537500		
INDIRECT CAPITAL COSTS			
1. Engineering and Design	530625	15% TDC	
2. Contingency Allowance	884375	25% TDC	
3. Other Indirect Costs			
a. Legal Fees	70750	2% TDC	
b. Licence/permit Costs	106125	3% TDC	
c. Start-up & Shake-down			
Subtotal	1591875		
TOTAL INDIRECT COSTS	1591875		
TOTAL CAPITAL COSTS	5129375		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Building Demolition

COST ITEM: Direct Capital Cost

COST COMPONENT: Construction Costs

BASIS: Direct capital costs include demolition of the VDH Plant #1 building, transportation and disposal costs of the debris. Additional rental costs were included such as air monitoring, safety and heavy demolition equipment. Material is assumed to be disposed of in a C&D landfill. Asbestos removal and building decontamination are covered under separate technology cost items.

CALCULATION/SOURCE: Costs are based on a vender estimate and from costs incurred in similar projects.

CAPITAL COST SUMMARY FOR BUILDING DEMOLITION

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	662420	Vender Estimate	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	662420		
2. **Equipmet Costs**			
___ Installed			
___ Purchased			
3. **Land and Site Development**			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings and Service**			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation Costs**			
Subtotal	0		
6. **Disposal Costs**		Included Above	
Subtotal	0		
TOTAL DIRECT COSTS	662420		1993
INDIRECT CAPITAL COSTS			
1. **Engineering and Design**	99363	15% TDC	
2. **Contingency Allowance**	165605	25% TDC	
3. **Other Indirect Costs**			
a. Legal Fees	6624	1% TDC	
b. Licence/permit Costs	33121	5% TDC	
c. Start-up & Shake-down			
Subtotal	304713		
TOTAL INDIRECT COSTS	304713		
TOTAL CAPITAL COSTS	967133		

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Building Decontamination

COST ITEM: Direct Capital Cost

COST COMPONENT: Construction Costs

BASIS: Direct capital cost includes decontamination of the building and its components to prepare it for demolition/dismantling and disposal. Total cost includes sand blasting surfaces, labor, materials, safety equipment, air monitoring and disposing of waste sand in a secure landfill.

CALCULATION/SOURCE: Decontamination costs were based on a vender quotation.

CAPITAL COST SUMMARY FOR BUILDING DECONTAMINATION

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs	480000	Vender Quote	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	480000		
2. Equipmet Costs			
___ Installed			
___ Purchased			
3. Land and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. Buildings and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs	480000	Estimate	1993
Subtotal	480000		
TOTAL DIRECT COSTS	960000		1993
INDIRECT CAPITAL COSTS			
1. Engineering and Design	67200	7% TDC	
2. Contingency Allowance	240000	25% TDC	
3. Other Indirect Costs			
a. Legal Fees	9600	1% TDC	
b. Licence/permit Costs	9600	1% TDC	
c. Start-up & Shake-down			
Subtotal	326400		
TOTAL INDIRECT COSTS	326400		
TOTAL CAPITAL COSTS	1286400		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Asbestos Removal

COST ITEM: Direct Capital Cost

COST COMPONENT: Construction and Disposal costs

BASIS: Direct capital costs include removal and disposal of asbestos containing material within VDH Plant #1. Asbestos volume is based on preliminary observations and sampling data. Included in the cost are items such as air monitoring, asbestos removal, asbestos disposal, safety equipment and other removal equipment.

CALCULATION/SOURCE: Costs are based on a vender estimate and from waste disposal costs incurred at other similar sites.

CAPITAL COST SUMMARY FOR ASBESTOS REMOVAL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	80000	Vender Estimate	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	80000		
2. **Equipmet Costs**			
___ Installed			
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs	15200	Estimate	1993
Subtotal	15200		
TOTAL DIRECT COSTS	95200		1993
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	14280	15% TDC	
2. **Contingency** Allowance	23800	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	952	1% TDC	
b. Licence/permit Costs	952	1% TDC	
c. Start-up & Shake-down			
Subtotal	39984		
TOTAL INDIRECT COSTS	39984		
TOTAL CAPITAL COSTS	135184		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Site Restoration

COST ITEM: Direct Capital Costs   COST COMPONENT: Land and Site Development

BASIS: Direct capital costs include an additional 154,428 sq. ft. of topsoil, grass and small trees to restore site grade and surrounding area. Included in the cost are items such as procurement, placement and grading of the topsoil, seeding, tree and shrub placement, labor and equipment costs.

CALCULATION/SOURCE: Costs for both direct costs and O&M were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to current dollars using ENR Construction Cost Indexes.

CAPITAL COST SUMMARY FOR SITE RESTORATION

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction** Costs			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
2. **Equipmet** Costs			
____ Installed			
____ Purchased			
3. **Land** and Site Development	100027	Published Costs	1995
a. Equipment			
b. Labor			
c. Materials			
Subtotal	100027		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs			
Subtotal	0		
TOTAL DIRECT COSTS	100027		1995
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	15004	15% TDC	
2. **Contingency** Allowance	25007	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	1000	1% TDC	
b. Licence/permit Costs	1000	1% TDC	
c. Start-up & Shake-down			
Subtotal	42011		
TOTAL INDIRECT COSTS	42011		
TOTAL CAPITAL COSTS	142038		1995

CAPITAL COST SUMMARY FOR SUBSURFACE SOIL REMOVAL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction** Costs	1858708	Published Costs	1994
a. Equipment			
b. Labor			
c. Materials			
Subtotal	1858708		
2. **Equipmet** Costs			
___ Installed			
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs			
Subtotal	0		
TOTAL DIRECT COSTS	1858708		1994
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	278806	15% TDC	
2. Contingency Allowance	464677	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	37174	2% TDC	
b. Licence/permit Costs			
c. Start-up & Shake-down			
Subtotal	780657		
TOTAL INDIRECT COSTS	780657		
TOTAL CAPITAL COSTS	2639365		1994

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Subsurface Soil Removal

COST ITEM: Direct Capital Cost

COST COMPONENT: Construction Costs

BASIS: Direct capital costs include excavation of soil from 2-20 feet with chromium concentrations greater than 50 ppm. Included are costs such as removing the soil from its current location and stock piling it for on-site treatment or loading it for off-site disposal, air monitoring, watering for dust control equipment and labor. Not included are costs for shoring due to presently unknown extent of contamination beneath the plant.

CALCULATION/SOURCE: Costs are taken from the "Compendium of Costs of Remedial Technologies at Hazardous Waste Sites", October 1987, page 146, excavation/ removal costs for soil removal down to 15 feet done by the USEPA ELI/JRB in 1981 in California. Costs are updated to 1991 dollars using ENR Construction Cost Indexes.

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Sediment Removal

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction Costs

BASIS: Direct capital costs include diversion of Olean Creek using a temporary dam and a diversion channel, removal of the contaminated sediments, transportation of the sediments to VDH #1 for staging and restoration of the Creek.

CALCULATION/SOURCE: Costs were taken from the "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to 1991 dollars using ENR Construction Cost Index data.

CAPITAL COST SUMMARY FOR SEDIMENT REMOVAL

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	176239	Attached Calculation	1993
a. Equipment			
b. Labor			
c. Materials			
Subtotal	176239		
2. **Equipmet Costs**			
___ Installed			
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings and Service**			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation Costs**			
Subtotal	0		
6. **Disposal Costs**			
Subtotal	0		
TOTAL DIRECT COSTS	176239		1993
INDIRECT CAPITAL COSTS			
1. **Engineering and Design**	26436	15% TDC	
2. **Contingency Allowance**	44060	25% TDC	
3. **Other Indirect Costs**			
a. **Legal Fees**	3525	2% TDC	
b. **Licence/permit Costs**	8812	5% TDC	
c. **Start-up & Shake-down**			
Subtotal	12337		
TOTAL INDIRECT COSTS	82832		
TOTAL CAPITAL COSTS	259071		1993

BASIS FOR CAPITAL COST FOR ALTERNATIVE: On-site Conventional Treatment with Discharge to Olean Creek

COST ITEM: Direct Capital Costs   COST COMPONENT: Construction Costs

BASIS: Direct Capital costs are for an on-site treatment system which includes items such as equipment purchase/rental, pumps, field construction of plant, instrumentation, piping and secondary containment for the facility. The total costs for O&M include, operator costs, disposal of the sludge and treatment chemical costs.

CALCULATION/SOURCE: Direct costs were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to current dollars using ENR Construction Cost Indexes. Chemical usage numbers and sludge volume were based on the treatability study. Chemical costs were taken from "Technologies for Upgrading Existing or Designing New Drinking Water Treatment Facilities", EPA, March 1990.

CAPITAL COST SUMMARY FOR CONVENTIONAL PRECIP. TO OLEAN CREEK

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs	245000	Published Costs	1995
a. Equipment			
b. Labor			
c. Materials			
Subtotal	245000		
2. Equipmet Costs		Included Above	
___ Installed			
___ Purchased			
3. Land and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. Buildings and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs			
Subtotal	0		
TOTAL DIRECT COSTS	245000		1995
INDIRECT CAPITAL COSTS			
1. Engineering and Design	36750	15% TDC	
2. Contingency Allowance	61250	25% TDC	
3. Other Indirect Costs			
a. Legal Fees	2450	1% TDC	
b. Licence/permit Costs	9800	4% TDC	
c. Start-up & Shake-down	24500	10% TDC	
Subtotal	36750		
TOTAL INDIRECT COSTS	134750		
TOTAL CAPITAL COSTS	379750		1995

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Activated Carbon Treatment of Highly Contaminated Ground Water and Discharge to POTW

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction, Equipment and Buildings Costs

BASIS: Direct Capital costs include leasing a carbon treatment system to treat 250 gpm of contaminated ground water followed by discharge of 1250 gpm of ground water to the POTW. Estimate includes upgrading the local POTW, to increase its capacity for acceptance of site ground water. Also included are items such as construction of a line to tap into the local sanitary sewer main and initial carbon costs.

CALCULATION/SOURCE: Cost data were mainly taken from vendor information and from the "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated, if necessary, using ENR Construction Cost Index data.

CAPITAL COST SUMMARY FOR ACTIVATED CARBON DISC. TO POTW

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	245000	Published Costs	1995
a. Equipment			
b. Labor			
c. Materials			
Subtotal	245000		
2. **Equipmet Costs**			
_x_ Installed (leased)	67000	Vender Quote	1995
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	67000		
4. **Buildings and Service**	33000	Vendor Information	1995
a. Equipment			
b. Labor			
c. Materials			
Subtotal	33000		
5. **Relocation Costs**			
Subtotal	0		
6. **Disposal Costs**			
Subtotal	0		
TOTAL DIRECT COSTS	345000		
INDIRECT CAPITAL COSTS			
1. **Engineering and Design**	34500	10% TDC	
2. **Contingency Allowance**	86250	25% TDC	
3. **Other Indirect Costs**			
a. Legal Fees	3450	1% TDC	
b. Licence/permit Costs	10350	3% TDC	
c. Start-up & Shake-down	34500	10% TDC	
Subtotal	169050		
TOTAL INDIRECT COSTS	169050		
TOTAL CAPITAL COSTS	514050		1995

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Site Capping

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction Costs

BASIS: Direct capital costs include capping of the entire site (approximately 70,000 sq. ft) with a composite cap. The cost estimate also includes solidification to meet the LDR requirements and secure landfill disposal for the highly contaminated soil, Olean Creek sediment and the storm sewer sediment. The cost estimate does not include topsoil which is included in the site restoration technology and cap maintenance which is a separate cost item.

CALCULATION/SOURCE: Direct costs were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to current dollars using ENR Construction Cost Indexes.

CAPITAL COST SUMMARY FOR SITE CAPPING

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs	360579	Published Costs	1994
a. Equipment			
b. Labor			
c. Materials			
Subtotal	360579		
2. Equipmet Costs			
___ Installed			
___ Purchased			
3. Land and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. Buildings and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs	2673066		1993
Subtotal	2673066		
TOTAL DIRECT COSTS	3033645		1994
INDIRECT CAPITAL COSTS			
1. Engineering and Design	455047	15% TDC	
2. Contingency Allowance	758411	25% TDC	
3. Other Indirect Costs			
a. Legal Fees	60673	2% TDC	
b. Licence/permit Costs	91009	3% TDC	
c. Start-up & Shake-down			
Subtotal	151682		
TOTAL INDIRECT COSTS	1365140		
TOTAL CAPITAL COSTS	4398785		1994

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Soil Encapsulation

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction Costs

BASIS: Direct capital costs include microencapsulation of highly and less chromium contaminated soil based upon estimated volumes. Included in the cost are items such as labor, materials, equipment, safety equipment and air monitoring.

CALCULATION/SOURCE: Direct costs were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to current dollars using ENR Construction Cost Indexes.

CAPITAL COST SUMMARY FOR SOIL ENCAPSULATION

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	2237361	Published Costs	1994
a. Equipment			
b. Labor			
c. Materials			
Subtotal	2237361		
2. **Equipmet Costs**			
___ Installed			
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs			
Subtotal	0		
TOTAL DIRECT COSTS	2237361		1994
INDIRECT CAPITAL COSTS			
1. **Engineering** and Design	335604	15% TDC	
2. **Contingency** Allowance	559340	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	44747	2% TDC	
b. Licence/permit Costs	67121	3% TDC	
c. Start-up & Shake-down			
Subtotal	111868		
TOTAL INDIRECT COSTS	1006812		
TOTAL CAPITAL COSTS	3244173		1994

BASIS FOR CAPITAL COST FOR ALTERNATIVE: Solidification/Stabilization of Contaminated Soil

COST ITEM: Direct Capital Costs

COST COMPONENT: Construction Costs

BASIS: Direct Capital Costs include Solidification/Stabilization of highly and less chromium contaminated soil based upon estimated volumes. Included in the costs are items such as labor, equipment rental, construction of on-site facilities for batch mixing, air monitoring and chemical costs.

CALCULATION/SOURCE: Direct costs were taken from "Remedial Action at Waste Disposal Sites: Handbook (Revised)", October 1985. Costs were updated to current dollars using ENR Construction Cost Indexes.

CAPITAL COST SUMMARY FOR SOLIDIFICATION/STABILIZATION OF HIGHLY CONTAMINATED SOIL/SEDIMENT

Cost Compoent	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. **Construction Costs**	776336	Published Costs	1994
a. Equipment			
b. Labor			
c. Materials			
Subtotal	776336		
2. **Equipmet Costs**			
___ Installed			
___ Purchased			
3. **Land** and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. **Buildings** and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. **Relocation** Costs			
Subtotal	0		
6. **Disposal** Costs			
Subtotal	0		
TOTAL DIRECT COSTS	776336		
INDIRECT CAPITAL COSTS			
1. **Engineering and Design**	116450	15% TDC	
2. **Contingency** Allowance	194084	25% TDC	
3. **Other** Indirect Costs			
a. Legal Fees	23290	3% TDC	
b. Licence/permit Costs	15527	2% TDC	
c. Start-up & Shake-down	155267	20% TDC	
Subtotal	504618		
TOTAL INDIRECT COSTS	504618		
TOTAL CAPITAL COSTS	1280954		1994

CAPITAL COST SUMMARY FOR SOLIDIFICATION/STABILIZATION OF LESS CONTAMINATED SOIL/SEDIMENT

Cost Component	Cost Estimate	Basis of Estimate	Year Incurred
DIRECT CAPITAL COSTS			
1. Construction Costs	793750	Published Costs	1994
a. Equipment			
b. Labor			
c. Materials			
Subtotal	793750		
2. Equipmet Costs			
___ Installed			
___ Purchased			
3. Land and Site Development			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
4. Buildings and Service			
a. Equipment			
b. Labor			
c. Materials			
Subtotal	0		
5. Relocation Costs			
Subtotal	0		
6. Disposal Costs			
Subtotal	0		
TOTAL DIRECT COSTS	793750		
INDIRECT CAPITAL COSTS			
1. Engineering and Design	119063	15% TDC	
2. Contingency Allowance	198438	25% TDC	
3. Other Indirect Costs			
a. Legal Fees	23813	3% TDC	
b. Licence/permit Costs	15875	2% TDC	
c. Start-up & Shake-down	158750	20% TDC	
Subtotal	515938		
TOTAL INDIRECT COSTS	515938		
TOTAL CAPITAL COSTS	1309688		1994

O&M COST ESTIMATE

TECHNOLOGY: **Ground Water Extraction**

BASIS: **Published Cost Factors**

CALCULATION:	Power	$9,519 Annually/Pump X 5 Pumps	$47,595
	Operations	$1.90/hr x 8760 hrs x 5 Pumps=	$83,220
		ANNUAL O&M COST	$130,815

O&M COST ESTIMATE

TECHNOLOGY: Site Restoration

BASIS: Published Cost Factors

CALCULATION:		
	Annual Inspection	$604/year
	Mowing/Revegetation	$725/year
	Erosion Control	$242/year
	Repairs	$241/year
	ANNUAL O&M COST	$1,812/year

ERM-Northeast

O&M COST ESTIMATE

TECHNOLOGY: Semi-Annual Monitoring

BASIS: ERM RI Costs

CALCULATION:	Analysis	\$1,319/Sample x 10 Samples=	\$13,190
	Labor	2 persons x 3days/event x 9 hrs/day x \$60/hr=	\$3,240
	Equipment Costs		\$1,000
		Cost/Event	\$17,430
		ANNUAL O&M COST 2x\$17,430=	\$34,860

O&M COST ESTIMATE

TECHNOLOGY: Ground Water to POTW

BASIS: Vender Estimates

CALCULATION:	POTW Charge	1280gal/min x $0.90/748 gal x 525,600 min/yr	$809,480
		TOTAL ANNUAL O&M COST	$809,480

O&M COST ESTIMATE

TECHNOLOGY: Activated Carbon Treatment followed by Discharge to POTW

BASIS: Published Cost Factors and Vender Estimates

CALCULATION:	Carbon and Delivery	$17,000/mo. x 12 mo.	$204,000
	Trans for Disposal	$1,500/mo. X 12 mo.	$18,000
	Lease Cost	$7,800/mo. x 12 mo.	$93,600
	Carbon Disposal	$4,000/mo.x 12 mo.	$48,000
	Power & Maintenance	$9,327/year	$9,327
	Operators	$190,000/year	$190,000
	POTW Charge	$809,480/year	$809,480
		TOTAL ANNUAL O&M COST	$1,372,407

O&M COST ESTIMATE

TECHNOLOGY: Conventional Ground Water Treatment
with Discharge to Surface Water

BASIS: Vender Estimates, Treatability Study and Published Costs

CALCULATION:	Process O&M	$43,139/year	$43,139
	Sludge Disposal	$949,000/year	$949,000
	Chemical Costs	$2,526,243/year	$2,526,243
		TOTAL ANNUAL O&M COST	$3,518,382