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OU2 Surface Soil FS

LEHIGH VALLEY RAILROAD DERAILMENT
Inactive Hazardous Waste Site
OPERABLE UNIT II, SURFACE SOILS

Town of LeRoy, Genesee County, New York
Site No. 08-19-014

FEASIBILITY STUDY

February 1997

Prepared by:
New York State Department of Environmental Conservation
Division of Environmental Remediation

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TOWN OF LEROY, NEW YORK, GENESEE COUNTY
FEBRUARY, 1997

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Executive Summary

The Lehigh Valley Railroad Derailment Site (the "site") is the location of a 30,000 gallon trichloroethene (TCE) spill caused by a train derailment in 1970. Following the accident, in the early 1970's, the Lehigh Valley Railroad conducted limited cleanup efforts. In 1990 sampling of private wells east of the spill site by the New York State Department of Health (NYSDOH) indicated that numerous private wells were contaminated with TCE. Acting on this information the New York State Department of Environmental Conservation (NYSDEC) listed the site on the Registry of Inactive Hazardous Waste Disposal Sites. Using state funds, the NYSDEC started a Remedial Investigation/Feasibility Study (RI/FS) in 1992. In April 1993, the NYSDEC released a report which described the extent of the surface and subsurface soil contamination at the derailment site. Based on this report it was decided to separate the site into two operable units in order to accelerate remediation of the spill area. Operable Unit #2, the focus of this report, addresses the TCE contaminated soils. Operable Unit #1, evaluates the widespread groundwater contamination resulting from the spill. Operable unit #1 is presently in the feasibility study phase.

This Feasibility Study (FS) report is focused on remediation of TCE contaminated surface and subsurface soil at the former spill site. The Preliminary Screening phase of the report (section 4), is designed to select an appropriate list of remedial alternatives for further evaluation in the Detailed Analysis section of the FS (sections 5 - 7). As a basis for the remedial action selection process the NYSDEC is utilizing United States Environmental Protection Agency (USEPA) guidance on "Presumptive Remedies". Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection. The use of presumptive remedy guidance is intended to build on the past experience of the NYSDEC and USEPA to ensure consistency in remedy selection and to streamline the cleanup selection process.

The presumptive remedies in this report are preferred technologies for treatment of soil contaminated with volatile organic compounds (VOCs). The set of remedies selected in the first phase of the FS are presumptively the most appropriate for addressing VOC contaminated soils. In addition, innovative technologies appropriate for the contamination found at the Lehigh Valley Railroad Derailment site (i.e., biological treatment) were also considered.

The seven (7) alternatives were developed in the preliminary screening and evaluated further in the detailed analysis. These included,

1. No Action
2. In-situ (or in place) Vapor Extraction
3. Excavation & Ex-Situ (or above ground) Vapor Extraction
4. Excavation & Low Temperature Thermal Desorption
5. Excavation & On-site Incineration
6. Excavation & Off-site Incineration
7. Excavation & Biological Treatment

Prior to the detailed analysis the NYSDEC conducted a treatability study to evaluate the viability of the presumptive remedies. Using the results of the treatability study, the above alternatives were subject to an evaluation (the detail analysis) from which an informed waste management decision on the appropriate remedial action for the site was made. The detailed analysis was conducted to highlight differences and tradeoffs between the alternatives. To be selected, an alternative most be protective of public health and the environment, be cost effective and to the maximum extent practicable, satisfy the preference for treatment that reduces toxicity, mobility and volume of hazardous waste.

Based on the findings of the treatability study and the evaluation conducted in the FS, the preferred remedial action for the Operable Unit #2 is "Excavation and Ex-Situ Soil Vapor Extraction". This alternative involves excavation of the source area soils to top-of-rock zone. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product if observed. The excavated soils would be treated on-site. The soil would be transferred to on-site vacuum extraction piles. A vacuum would be placed on the piles to extract contaminated vapors. All vapors extracted would be treated prior to discharge. The treated soil would be compared to the remedial action objectives developed for the site, specifically the soil cleanup objectives. It is anticipated that the treated soil would be placed back in the excavation. Gulf Road would be closed and removed to excavate contaminated soil under the road bed. After excavation and bedrock cleaning, Gulf Road would be replaced as per appropriate county road specifications. It is anticipated that Gulf Road would be closed for 6 months.

The preferred remediation, will take two years and a present worth cost of $2.6 million.

This document was prepared by the staff of the Division of Environmental Remediation, Bureau of Western Remedial Action under the New York State Superfund Program.

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Bureau Director:	Edward Belmore, P.E., Environmental Engineer IV

Project Certification Statement

This Feasibility Study is provided and certified by the New York State Department of Environmental Conservation to document the selection of treatment/remediation of contaminated soil presently found at the Lehigh Valley Railroad Derailment Site, Town of LeRoy, New York.

I certify that this document and all attachments were prepared in accordance with appropriate standards, guidance and criteria and to the best of my knowledge and belief, is accurate and complete.

________________________ ______________

David Crosby, P.E. Date
NYSPE License No.072498

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION

LEHIGH VALLEY RAILROAD DERAILMENT SITE
OPERABLE UNIT #2, SURFACE SOIL REMEDIATION
TOWN OF LEROY, COUNTY OF GENESEE, NEW YORK
SITE No. 8-19-014

FEASIBILITY STUDY REPORT

1.0 INTRODUCTION

1.1 General

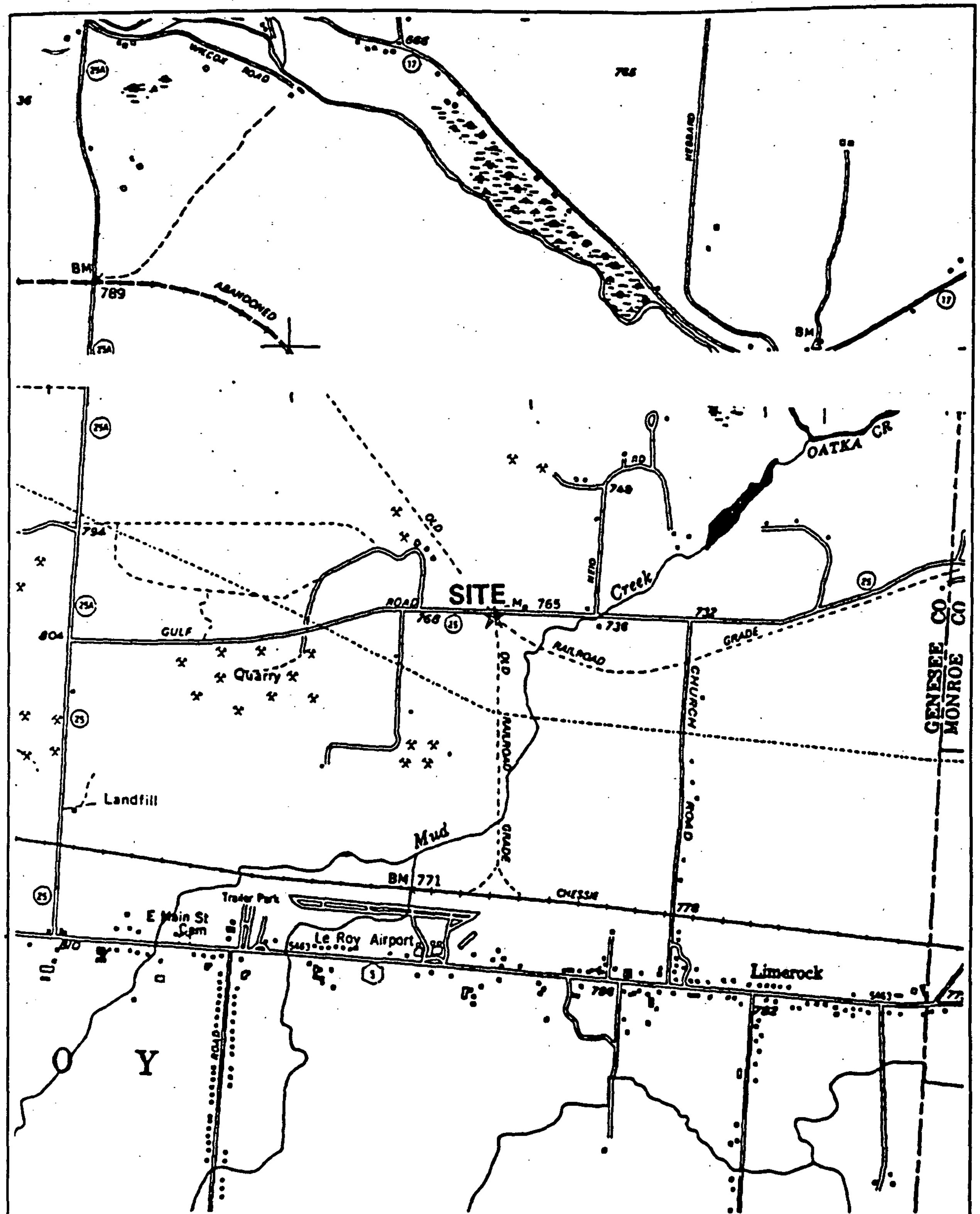
This Feasibility Study (FS) Report has been developed for Operable Unit #2 of the Lehigh Valley Railroad Derailment Site ("the site"), a class 2 inactive hazardous waste disposal site located in the Town of LeRoy, Genesee County, New York. Figure 1 shows the location of the Derailment site. The site has been separated into two operable units. Operable unit #2 (the focus of this report), addresses the contaminated surface and subsurface soils found at the Derailment Site. Operable unit #1 addresses the groundwater concerns and is presently in the Feasibility Study phase. This study was performed by staff of the New York State Department of Environmental Conservation (NYSDEC), Division of Hazardous Waste Remediation, under the New York State Superfund Program.

1.2 Objectives

The objective of the FS is to identify an appropriate remedial action which is not inconsistent with the Comprehensive Environmental, Compensation and Liability Act (CERCLA), Section 121 and the National Contingency Plan (Reference #1). Further, the selected remedy should be protective of the public health/environment and selected in accordance with United States Environmental Protection Agency (USEPA) guidance on conducting Remedial Investigation/ Feasibly Studies (Reference #2). The FS consists of two phases. Phase one, the "Preliminary Screening" of possible remedial actions to develop a list of potential remedial alternatives. Followed by the second phase, the "Detailed Analysis" of the potential remedial alternatives.

1.3 Site Background

On December 6, 1970, a portion of an eastbound 114-car freight train operated by the Lehigh Valley Railroad derailed at the intersection of Gulf Road. Two tank cars containing



Site Location Map

819014 Lehigh Valley Railroad Derailment

NYSDOT Planimetric Quadrangle(s):
CHURCHVILLE, LE ROY

N

0 500 1000 1500 2000
FEET

Scale 1:24,000
March 23, 1996

Figure 1

trichloroethene (TCE), a common industrial solvent, ruptured and spilled their contents onto the ground. It is estimated that roughly 30,000 gallons of TCE was spilled. A third car containing a crystalline form of cyanide was also reported to have partially spilled its contents onto the ground. The amount and the exact location of the cyanide spill are uncertain; however, newspaper articles from the period of the spill and interviews with local emergency response personnel, indicate that most of the cyanide was recovered shortly after the derailment.

In 1971, acting on resident complaints of TCE odors in homes and reported contamination of drinking water supplies, the Lehigh Valley Railroad conducted limited cleanup activities. First, carbon filters were installed on a number of local private wells. Then in the Lehigh Valley Railroad constructed ditches in the area of the TCE spill which were flooded with water in an attempt to flush the TCE out of the ground. No further clean up activities are known to have been conducted at the site, and it was not until further studies were conducted in early 1990 that the full extent of the contamination was discovered.

In 1990, in response to another inactive hazardous waste disposal site, the New York State Department of Health (NYSDOH) sampled private wells east of the spill site and discovered TCE contamination in more than 35 private wells. Acting on this information, the USEPA first provided bottled water and then installed carbon filtration units on water supplies which were found to be contaminated with TCE above the drinking water standard of 5.0 parts per billion (ppb). In the fall of 1991, the NYSDEC listed the site on the Registry of Inactive Hazardous Waste Disposal Sites and determined the need for a Remedial Investigation/Feasibility Study (RI/FS). The NYSDEC contracted the engineering services of Rust Environment and Infrastructure (formally Dunn Geoscience Engineering Co., P.C.) to conduct the RI/FS. The Remedial Investigation (RI), which was initiated in early 1992, was designed to evaluate the nature and extent of the contamination caused by the TCE spill. The investigation was done in two parts. One part evaluated the groundwater contamination and the other, characterized the residual soil contamination at the spill site. The soil investigation phase of the RI was completed in April 1993, with the release of the Spill Site soil Investigation Report (Reference #3). Based on this information, the NYSDEC determined that the contaminated surface and subsurface soils were acting as an ongoing source of groundwater and surface water contamination.

At the same time, the groundwater investigation discovered a complicated karst bedrock groundwater flow system which required in-depth study and analysis. Therefore, based on relative straight forward nature of the soil problem and the apparent complexity of the groundwater issue, the NYSDEC decided to divide the site into two separate operable units.

An Operable Unit represents a discrete portion of a site which, for technical or administrative reasons can be addressed separately to eliminate or mitigate a release, threat of release or exposure pathway resulting from the contamination present at a site. NYSDEC determined that sufficient information was available to go forward with the remedy selection process for the site's contaminated soil while additional information was being gathered to address groundwater concerns.

The groundwater operable unit is evaluating the nature and extent of the groundwater contamination derived from the derailment spill. The RI for this operable unit was recently completed and the project is presently in the FS phase. In Operable Unit #1(Groundwater), the NYSDEC and NYSDOH are developing groundwater contaminant mitigation strategies which will be protective of public health and the environment.

2.0 Site Characterization/Contamination Assessment

In May and June of 1992, Rust performed a soil gas and geophysical survey at the derailment site. The results of the study indicated the presence of residual TCE contamination in surface and subsurface soils. Based on soil gas results greater than 1.5 ppmv concentration, the residual contamination is an irregularly shaped one and one-half acre area centered around the spill location. Figure 2 presents the lateral extent of the spill site soil contamination. Soil samples were collected for laboratory analysis at the location of the two highest soil gas concentration of TCE. The results indicated TCE contamination as high as 550 parts per million (ppm).

Based on this information an additional subsurface exploration was conducted in 1992, which consisted of sixteen (16) test pits was conducted in December 1992. The objectives of the test pits were to evaluate the overburden geology, collect soil samples for analysis, and expose the bedrock surface. Test pits were located both in and out of the contaminated area identified by the soil gas testing to verify the extent of the contamination.

2.1 Site Geology

The geology of the site consists of unconsolidated overburden material consisting primarily of fill, glacial till and weathered bedrock. The fill consists of grey-brown coarse to fine gravel, construction and demolition debris and occasional railroad stone ballast. Coal chips and cinders were occasionally observed. The glacial till consists of a hard, poorly sorted coarse to fine grained silt with a little coarse gravel. The bedrock was reported to be a weathered, light brown to grey limestone. Soil filled bedrock fractures were noted at the top-of-rock zone. The bedrock was encountered at a depth ranging from 1.3 to 9.3 feet below grade. Groundwater was noted in a few of the test pits at the top-of-rock zone; however, this was almost certainly perched water when compared to data from on-site monitoring wells which indicate the groundwater table is deep within the bedrock unit.

2.2 Extent of Volatile Organic Contamination

Figure 2 presents the lateral extent of the site soil contamination based on soil gas results. The soil analytical results correlate well with the soil vapor results. The initial soil sampling which confirmed elevated levels of TCE in subsurface soil at the former spill area. Table 1 presents a summary of the analytical data. The data indicates TCE in soil at levels as high as 230 ppm and 1,2-dichloroethene (DCE) at much lower levels (maximum of 2.1 ppm). TCE contamination was found throughout the 1.5 acre area. The 1,2-DCE is believed to be a natural biodegradation byproduct of TCE.

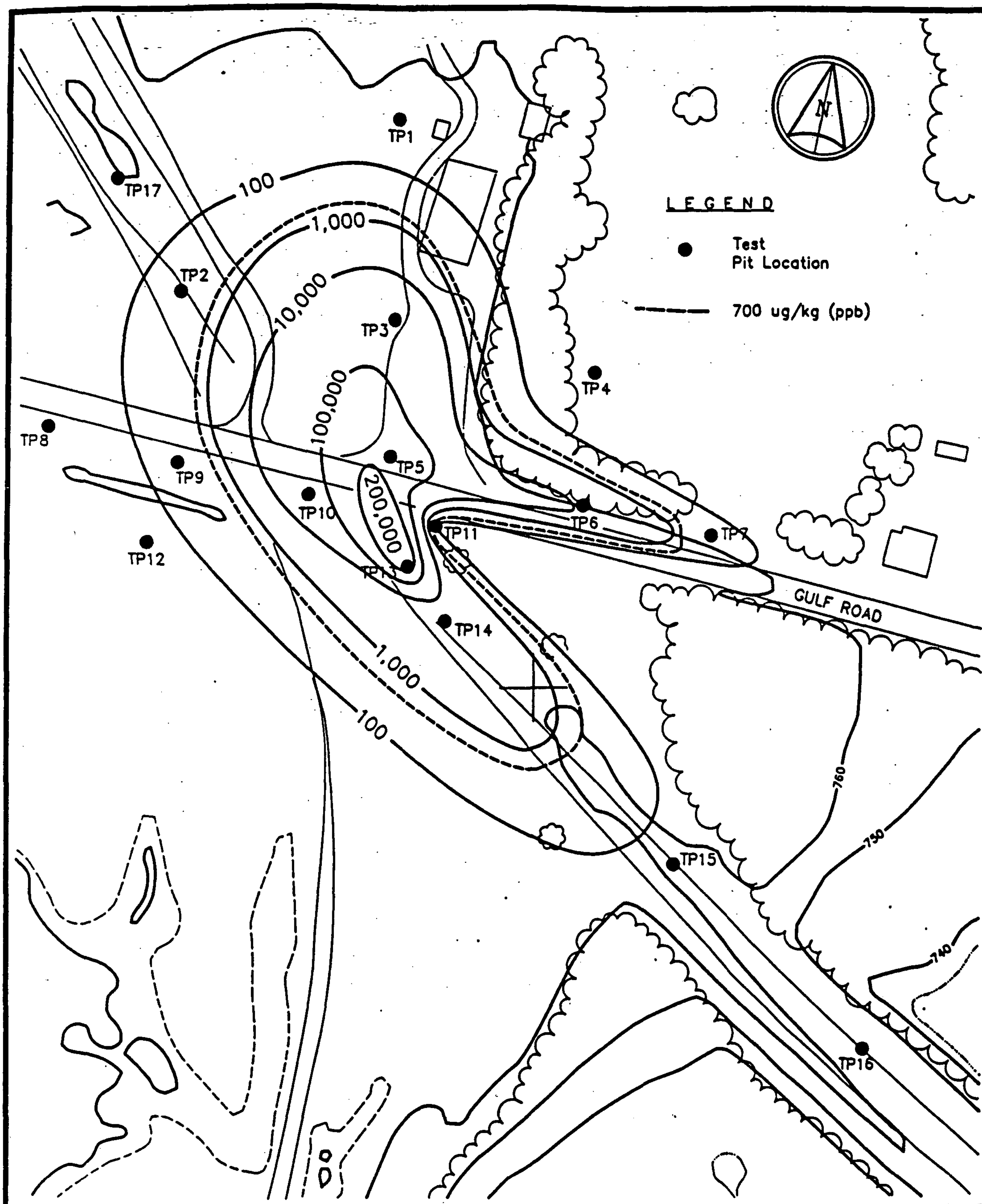
TABLE 1
SUMMARY OF SOIL ANALYTICAL RESULTS
LEHIGH VALLEY DERAILMENT SITE, OPERABLE UNIT #2
SPILL SITE SOIL INVESTIGATION, APRIL 1993

(all results in ppm)

Contaminant	Contaminant Range	Frequency	Contaminant Average
Trichloroethene	1.3 - 230	22 / 22	61.6
1,2-DCE (total)	ND - 2.1	5 / 22	0.5
Mercury	0.1 - 30.4	4 / 4	7.9
Cyanide	ND - 25.3	5 / 12	10.4

[1] Frequency: Number of samples which detected contaminants/ Number of samples
DCE - dichloroethene
ND - not detected

In October 1994, the NYSDEC conducted further sampling of the spill site area (see Reference #4) to resolve data gaps noted in the spill site soil investigation. The sampling locations are indicated on Figure #3 and the summary of the analytical data is present in Table 2. The results of the soil sampling confirmed the presence of TCE and 1,2-DCE in the spill site subsurface soils. The concentrations found in the October 1994, are elevated above the previous results however, the sampling was biased towards areas of historical high TCE concentrations.



DUNN GEOSCIENCE ENGINEERING CO., P.C.
12 Metro Park Road
Albany, NY 12205

TCE CONCENTRATION CONTOURS
(TEST PIT SOILS)

LEHIGH VALLEY RR DERAILMENT SITE

PROJECT NO. 00296-02379	DATE 11/92	DWG. NO. A9181_3	SCALE 1"=100'	FIGURE NO. 2

TABLE 2
SUMMARY OF SOIL ANALYTICAL RESULTS
LEHIGH VALLEY RAILROAD DERAILMENT
NYSDEC SAMPLING, NOVEMBER 1994
Site #8-19-014

(all results in ppm)

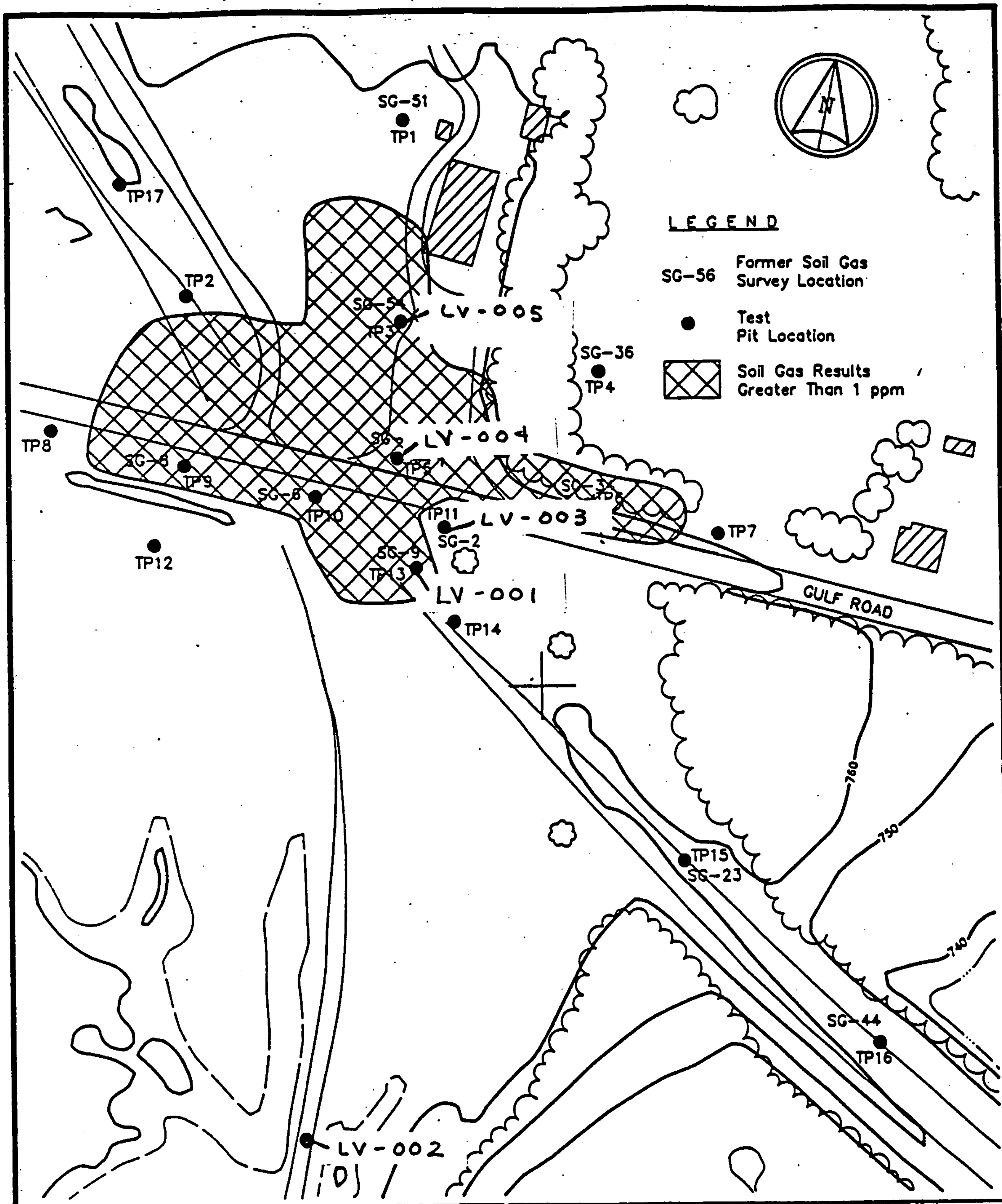
CONTAMINANT	Sampler Number				
	LV-001	LV-002	LV-003	LV-004	LV-005
TCE	280	0.016	320	300	5
1,2-DCE	5.2	ND	ND[1]	ND[2]	ND[3]
MERCURY	0.16	0.06	0.13	0.95	0.06
CYANIDE	64.8	0.5	53.5	1.7	0.45
ORGANIC CARBON %	11.9	43.8	8.7	14.3	3.5

1 - Not detected at a detection limit of 23 ppm
2 - Not detected at a detection limit of 20 ppm
3 - Not detected at a detection limit of 1.5 ppm
TCE - Trichloroethene
DCE - Dichlorethene
For sample locations see Figure 3.

Finally, the site characterization data indicates two important observations which directly affect any proposed remedial plan. First, highly contaminated soil was noted within the fractures of the bedrock at the top-of-rock zone. The site remediation will have address the soil within these fractures to eliminate migration of TCE and 1,2-DCE from the source area. Second, it is apparent that extensive contamination is under Gulf Road. All potential remedies should address the need to remediate soils under the road surface.

2.3 Extent of Mercury Contamination

Analytical results from the 1992 sampling indicate mercury contamination in one test pit (TP-13) which is elevated above the apparent site background. The elevated mercury detection (30.0 ppm)



DUNN GEOSCIENCE ENGINEERING CO., P.C.
12 Metro Park Road
Albany, NY 12205

TEST PIT LOCATIONS
(WITH SOIL GAS POINTS WHERE APPLICABLE)

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WORK ASSIGNMENT NUMBER: 0002520-15.1

LEHIGH VALLEY RR DERAILMENT SITE

PROJECT NO. 00296-02379	DATE 11/92	DWG. NO. A9181	SCALE 1"=100'	FIGURE NO. 3

was noted in only one of four test pits sampled. The average of the other three samples was 0.37 ppm. The source of the mercury contamination is unknown and is not reported to be associated with the derailment. In October 1994, the NYSDEC resampled the location of the elevated mercury result and found 0.13 ppm compared to previously noted 30.0 ppm. The average concentration found in 1994 sampling event was 0.27 ppm. Therefore, the sampling did not replicate the isolated high concentration reported previously. The 1994 results were similar to the previous investigations if the one elevated mercury result is discounted. Therefore, the elevated mercury result is considered an isolated occurrence and that the average concentration of the sampling (discounting the elevated result from the 1992 sampling event) of 0.30 ppm represents site background. Because only one sample result was above the site background concentration, mercury is not considered a concern for the spill site soil.

2.4 Extent of Cyanide Contamination

As discussed previously, it was reported that a solid form of cyanide was spilled during the train derailment. It is also reported that cleanup efforts at the time of the derailment included containment and removal of the spilled solids. As part of the spill site soil investigation in 1992, twelve (12) soil samples were collected and analyzed for total cyanide. There were five (5) detections of cyanide out of the twelve (12) samples. The average concentration of the detections was 9.3 ppm. A maximum of 25.3 ppm was reported in one sample south of Gulf Road (TP-13). In 1994 the NYSDEC collected five samples for cyanide. The average cyanide concentration of 30.1 ppm was above the previous site average of 9.3 ppm. At TP-13, the location of the previous elevated cyanide result, the 1994 sampling found 64.8 ppm. The data indicates that elevated soil cyanide levels are found predominantly south of Gulf Road along the former railroad bed (see Figure 2). The depth to bedrock in this area is extremely shallow (approximately 1.5 ft) and the volume of soil represented by this area is likely to be small. Because of the low frequency of the detections and the expected low volume of cyanide contaminated soils, cyanide is not considered a concern for the spill site soils.

2.5 Organic Carbon Results

The organic carbon results from the 1994 sampling conducted by NYSDEC are substantially higher than would be expected for native soils. The spill site soils average of 9.6% organic carbon is elevated above expected values in native soil of 0.1 - 1.5%. This is significant because soil with high organic carbon content tends to retain TCE more strongly than other soils, making it somewhat more difficult to remove the TCE. Field observations did not indicate soil types normally associated with elevated organic carbon (e.g. black, humus type soils) but instead noted medium brown silty sand and grey-brown fill materials. The field sampling report (Reference #4) noted that the soil samples contained coal bottom ash and cinders residue which are a possible result of historical railroad operations. A sampling location approximately 150 feet north of the railroad bed had a organic carbon content of 3.5% which is still above expected concentrations in native soil.

3.0 REMEDIAL ACTION OBJECTIVES

The goal of the FS is to identify and analyze potential remedial alternatives for the site in a manner which is not inconsistent with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Section 121. The primary objective is the selection of a remedial alternative which is protective of public health and the environment. The remedial technologies are selected based on the nature and the extent of the site contamination and evaluation of the technologies appropriateness. CERCLA requires that preference be given to remediation which significantly reduces the toxicity, mobility and volume of hazardous substance.

Based on the above discussion, the Remedial Action Objectives (RAOs) for this site are as follows:

- Eliminate the potential human and wildlife exposure to soil media containing site related contaminants.
- Minimize the potential for off-site VOC migration by remediating contaminated soil which is acting as a continuing source of groundwater and surface water contamination.
- Contain, treat and/or dispose of contaminated soil in a manner consistent with applicable state and federal regulations and guidance.

Table 3 presents Remedial Action Objectives for site soils as determined by NYSDEC guidance (see Reference #5). For volatile organic contamination such as TCE and 1,2-DCE, the guidance incorporates partitioning theory to establish soil levels which are considered protective of groundwater resources. The partitioning theory calculations includes several assumptions such as the extent of dilution and other attenuation mechanisms as well as determining a soil total organic carbon value that is truly representative of the site. Examining these assumptions results in a cleanup range for TCE from approximately 1.5 ppm to 7.0 ppm. After considering this range and the site under soil organic carbon content of 9.6%, the upper end of the range was selected as the soil remedial action objective.

The goal for mercury is based on observed site background concentrations and the goal for cyanide is based on the protection of groundwater resources and human health. The numerical soil clean up objectives presented in Table #3 will be used to evaluate the remedial technical practicability of the technologies considered.

TABLE 3
REMEDIAL ACTION OBJECTIVES
SOIL CLEANUP OBJECTIVES
FOR SURFACE AND SUBSURFACE SOILS
LEHIGH VALLEY DERAILMENT SITE

(all results in ppm)

CONTAMINANT	SOIL CLEANUP OBJECTIVES
Trichloroethene	7.0
1,2-Dichloroethene	3.0
Mercury	0.3
Cyanide	15.0

Note: Remedial Action Objectives for TCE and 1,2-DCE determined as per Division of Hazardous Waste Remediation Technical and Administrative Guidance Memorandum (DHWR-TAGM) #4046, "Determination of Soil Cleanup Objectives and Cleanup levels", dated January 1994.

- Mercury Remedial Action Goal is based on site background concentration.
- Cyanide Soil Cleanup Objective is based on soil levels proposed for other inactive hazardous waste disposal sites and is derived to protect groundwater and public health.

3.1 Volume of Contaminated Media

Part of the FS process is to determine the amount of contaminated soil above the soil cleanup objectives presented on Table #3. The estimated volume is an important factor in the development of cost estimates of the potential remedies. Based on the remedial action objective for TCE of 7.0 ppm, the estimate of contaminated material at the Lehigh Valley Derailment site is approximately 10,000 cubic yards. The mass of TCE in the contaminated soil matrix is estimated at 3200 pounds. This estimate is derived by taking the source area volume estimate, an average dry bulk density of soil of 120 lb/ft^3 and the average TCE contamination of 100 ppm.

The field observations conducted during the test pit program, indicates highly contaminated soils are present in the bedrock fractures. A soil sample collected from within a bedrock fracture had a TCE concentration of 550 ppm. To adequately address the site source area it appears appropriate to attempt to remediate these hard to reach soils.

4.0 Preliminary Screening; Identification of Potential Remedial Technologies:

The primary objective of the preliminary screening of alternatives is to develop an appropriate range of waste management options that will be analyzed more fully in the detailed analysis of the FS. To develop this list of potential alternatives, we have previously specified the media of concern (surface and subsurface soils), identified the remedial action objectives and goals and identified the volume and area of soil requiring remediation. The purpose of this section is to identify and evaluate technology options which will address site contamination.

4.1 Presumptive Remedies

Following guidance prepared by the USEPA under the Superfund administrative improvements initiative to accelerate site cleanup (see Reference #6), the NYSDEC has determined that the Lehigh Valley Railroad Derailment Soil Remediation (Operable Unit #2) is appropriate for development of "Presumptive Remedies". Presumptive Remedies are preferred technologies for common categories of inactive hazardous waste sites. Presumptive remedy guidance is based on historical patterns of remedy selection and USEPA's scientific and engineering evaluation of performance data of technology implementation.

The presumptive remedy approach is not inconsistent with the requirements of the NCP, and is consistent with the site management principle of streamlining. The presumptive remedy approach simply consolidates what have become common, expected results of site-specific decision making at Superfund sites over the past decade. The various presumptive remedy directives and supporting documentation provides a basis for an administrative record which justifies consideration of a limited number of cleanup options (see Reference #7). These directives and documentation summarize the findings of EPA's research and analysis, and the reasons that were found for considering certain technologies more or less appropriate.

One category of sites appropriate for presumptive remedies is soils contaminated with volatile organic compounds (VOCs). The soil contamination at the Lehigh Valley Railroad Derailment Site consists primarily of TCE and to a lesser extent 1,2-DCE. Both are VOCs. The presumptive remedies for VOCs as outlined in the USEPA guidance are presented on Table 4. Levels of nonvolatile compounds, such as mercury and cyanide, are at relatively lower levels or found at a less frequency then the TCE. The mercury contamination is considered an isolated occurrence and was not replicated in subsequent sampling. Cyanide was found in an area associated with shallow bedrock and is not expected to be in a volume which would effect a remedy based on remediation of VOCs. Therefore, the site characterization does not preclude the use of a presumptive remedy for VOCs

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Table 4
PRESUMPTIVE REMEDIES
LEHIGH VALLEY RAILROAD DERAILMENT SITE
OPERABLE UNIT #2 (SURFACE SOILS)
SITE #8-19-014

PRESUMPTIVE REMEDIES FOR VOCs IN SOIL
- SOIL VAPOR EXTRACTION - INSITU **EXCAVATION WITH:** **-SOIL VAPOR EXTRACTION** **- THERMAL DESORPTION** **- INCINERATION (BOTH ON AND OFF SITE)**

Reference: Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds In Soil, USEPA 540-F-93-048, September 1993.

Finally, the TCE contaminated soils at the site are acting as a continuing source of groundwater and surface water contamination and pose a potential threat to the public through direct exposure to contaminated soil, dust, and vapor. TCE is both toxic and mobile. The wastes containing TCE, if left in place untreated, would continue to present a significant threat to human health and the environment. In accordance with the NCP expectations, wastes constituting "principal threats" posed by a site generally are expected to be treated. Therefore, alternatives to isolate the waste via capping, containment or administrative controls are not considered protective of the environment or human health. In addition, capping or containment would not decrease the contaminant levels found in groundwater and may hinder future remedial measures designed for the contaminated bedrock groundwater system. As such, capping or containment is considered ineffective at protesting the environment or human health and will not be considered further.

The NCP states that the use of innovative technologies should be considered when such technologies offer the potential for comparable or superior performance, implementability, and lower cost. Presumptive remedy guidance does not preclude the consideration of innovative technologies where the criteria of comparable performance and implementability are met. Recent literature indicates bioremediation of chlorinated VOCs may be a viable innovative technology. The NYSDEC, in conjunction with the USEPA and New York State Center for Hazardous Waste Management, is conducting a treatability demonstration of biological treatment of TCE at another inactive hazardous waste disposal site. The goal of the study is to demonstrate the viability of bioremediating TCE and provide biovendors an opportunity to field test biotechnologies. Because of this potentially promising technology and based on site specific conditions, bioremediation will be evaluated in this FS.

4.2 Results of the Preliminary Screening

Based on the USEPA guidance and the site characterization for the Lehigh Valley Derailment Site, the following alternatives are retained for further analysis in the second phase of the Feasibility Study (the Detailed Analysis, section 6).

1. "No Action" - As required by the NCP. Section 4.1 of the NCP requires consideration of this alternative even though it may not be appropriate for this site. It is retained for this reason as a point of reference for other technologies.

2. "In-Situ Soil Vapor Extraction" - This alternative would involve the placement of vapor extraction wells or trenches in the subsurface soils contaminated with TCE. The vapors would be extracted by means of a vacuum. Both vapors and any groundwater recovered would be treated prior to discharge.

3. "Excavation and Ex-Situ Soil Vapor Extraction" - This alternative involves excavation of the source area soils to top-of-rock. The soils would be transferred to on-site vacuum extraction piles. The piles would be constructed within berms, diking and a high density polyethylene (HDPE) liner to prevent the release of contamination to the environment. The piles would be constructed by alternating soil lifts with perforated vacuum extraction

lines. Once constructed to a predetermined height, the soil piles would be covered with HDPE.. A vacuum would be placed on the piles to extract contaminated vapors. All vapors extracted would be treated prior to discharge. The top-of-rock surface and any fractures found would be cleaned of residual contaminated soil or any pure product, if observed. Following treatment to remove contaminants, it is anticipated the remediated soil will be placed back on-site.

4. "Excavation and Low Temperature Thermal Desorption" - In this alternative the contaminated soil would be excavated to the top-of-rock. The soils would be transferred to an on-site low temperature thermal desorption unit. The VOC contaminated soil would be treated by exposing the soil to elevated temperatures (>500° F) and the VOCs would be driven off the soil and treated prior to release to the atmosphere. The top-of-rock surface and any fractures found would be cleaned of residual contaminated soil or any pure product, if observed. Following treatment to remove contaminants, it is anticipated the remediated soil will be placed back on-site.

5. "Excavation and On-Site Incineration" - In this alternative the contaminated soil would be excavated to the top of rock. The soils would be transferred to an on-site incineration unit. The VOC contaminated soil would be incinerated by exposing the soil to elevated temperatures (>1500° F) and the VOCs would be destroyed. If deemed necessary, off-gases would be treated to remove undesirable by-products of combustion such as mineral acids prior, to discharge. The top-of-rock surface and any fractures found would be cleaned of residual contaminated soil or any pure product, if observed. Following treatment to remove contaminants, it is anticipated the remediated soil will be placed back on-site.

6. "Excavation and Off-Site Disposal" - In this alternative the contaminated soil would be excavated to top of rock. The soils would be hauled to a off-site Treatment, Storage and Disposal Facility (TSDF). Because of the levels of TCE found in the source area soils it is assumed that USEPA regulation regarding Land Disposal Restrictions would apply and incineration would be required at the TDSF prior to land disposal. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product if observed.

7. "Excavation and On-Site Bioremediation" - This alternative would involve excavation of contaminated soil and treatment in on-site biovaults. The biovaults would be operated first in an anaerobic and then aerobic mode. This is proposed because the most recent literature

indicates the need for both anoxic and oxygenated conditions to dechlorinate and biodegrade TCE. Nutrients, augmented bioorganisms and water would be added to enhance the bioremediation. The top-of-rock surface and any fractures found would be clean of residual contaminated soil or any pure product if observed. Following treatment to remove contaminants, it is anticipated the remediated soil could be placed back on-site.

4.3 Remediation of Contaminated Soil in Bedrock Fractures:

The Spill Site Soil Investigation Report (Reference #3) noted that the top-of-rock zone at the Lehigh Valley Railroad Derailment Site is extensively fractured and has a highly irregular surface. The fractures at the bedrock surface are filled with soil which has been contaminated by TCE. It is possible that some of the highest soil contamination exists in these fractures because pure product TCE from the spill may have pooled in these fractures. A soil sample collected from within one a these fractures had a TCE concentration of 550 ppm. The soil in these fractures is acting as a continuing source of groundwater and surface water contamination and remediation is required. The purpose of this section is to explore potential cleanup techniques to remediate the contaminated soil in the bedrock fractures. A more detailed evaluation will be conducted in the design phase of the project.

Two mechanisms are proposed; mechanical cleaning and hydraulic washing. Mechanical cleaning involves the physical removal of the soil in a dry condition. This could include the use of a backhoe to rip apart the fractures to facilitate removal of contaminated material followed by vacuum or manual removal of the remaining residual soil. Hydraulic washing could include pressure washing of the fractures and collection of the soil slurry by means of a vacuum truck. It is possible that the pressure wash could be amended with surfactants to improve removals or utilize steam cleaning techniques. The collected slurry would be collected and dewatered. The liquid sludge (dewatered soil) would be treated by the selected soil remediation mechanism and the decanted water treated via carbon.

The actual decision as to the mechanism for removal of soils from the bedrock fractures will be evaluated in the design phase of the project. Any evaluation would have to consider the potential impact on nearby private wells and the carbon treatment system protecting these wells. However, it is plausible that a combination of the above discussed cleanup options would be proposed.

5.0 Treatability Study:

The preliminary screening identified several alternative remedial strategies to be further evaluated in the detailed analysis. Following the public release of the Phase 1 FS report, the preliminary screening was peer-reviewed by parties both within and outside of the NYSDEC. Three outstanding concerns were noted during the peer-review process which required further attention. One, the railroad accident occurred over twenty years ago and volatilization/natural degradation of TCE would have been expected. However, extensive TCE contamination (> 500 ppm) is still found in very shallow soils (< 6") indicating a remarkable persistence of volatile compounds. Second elevated levels of organic carbon in site soils (as high as 14%) could potentially impact TCE removal efficiencies. Finally, mechanical volatilization has been used successfully in New York to remediate TCE contaminated soils and it was suggested that this technology could be utilized for the Lehigh Valley Site.

To address these concerns it was decided that additional information was necessary to properly evaluate the remaining alternatives which passed the screening in the first phase FS and take a hard look at mechanical volatilization and size separation. To collect the necessary information a laboratory bench scale treatability study was designed and implemented.

The laboratory bench scale treatability study was designed to determine the viability of some of the remedial technologies described in Section #4 (including thermal desorption and vacuum extraction) and evaluate mechanical volatilization and size-separation. As suggested by the USEPA guidance (Reference #8) the predetermined performance goal of 50% contaminant reduction in soil was used to evaluate the validity of a technology. If the performance goal was met, the technology was then compared to the soil cleanup objective for the site (see Section #3).

The results of the treatability are presented in the December 1995 report entitled "Laboratory Bench Scale Treatability Study Report, Lehigh Valley Railroad Derailment" (Reference #9). Table 5 presents a summary of the calculated contaminant removal efficiency for the technologies evaluated. In general, vacuum extraction and low temperature thermal desorption were effective at remediating site soils. Both technologies provided removal efficiencies above the predetermined study goal of 50%. Mechanical volatilization did not meet the site contaminant reduction goals. Finally, size-separation or sieving did not reduce the volume of material that would require further treatment.

Table 5
Results of the Laboratory Treatability Study
Lehigh Valley Railroad Derailment
Site #8-19-014

Technology	Removal Efficiency (%)
Low Temperature Thermal Desporation	54.5
Soil Vapor Extraction	54.4
Mechanical Volatilization	31.3

Note: This study goal was a removal efficiency of 50%

Mechanical volatilization did not meet the predetermined study goal of 50% reduction. However, there are some concerns that the treatability study results were skewed because of either sampling error or improper design of the mechanical volatilization experiment. But by utilizing the results of the size-separation experiment the removal efficiency for mechanical volatilization was estimated at 37%. This percentage is below the predetermined study goal of 50% reduction. Possibly the high organic carbon content of site soils makes it difficult for physical mixing to drive off the VOC contamination. Therefore, mechanical volatilization is not considered a viable technology to treat site soils.

The intent of the size separation test was to determine if the VOC contamination was related to soil particle size. Size separation could be used as a remedial technique to reduce the volume of material that would require further treatment. For example, a coarse grained gravel could be screened out and placed back on-site without treatment if the TCE contamination is below the soil cleanup objectives. The results of this test indicated that the coarse fraction had a lower TCE concentration when compared to the initial soil TCE concentration. However, the TCE concentration of the coarse fraction was 15 ppm which is above the soil clean up objective of 7.0 ppm. Therefore, additional treatment of the coarse fraction would be required and the technology would not be considered effective to remediate site soils.

Other important conclusions of the treatability test include the following.

- Sieving of the soil proved difficult due to either excessive soil moisture or some type of binding agent in the soil. Possibly the combination of the high soil moisture and the elevated organic carbon content produced the material handling problems. Soil that was stockpiled, left standing overnight, produced a material that was easier to work and had a lower TCE concentration. It appears that if ex-situ technologies are selected to remedy the site, material preparation prior to treatment (i.e. stockpiling or drying) would be appropriate.

- The study indicated that thermal desorption and vacuum extraction are viable technologies to treat site soils. The two technologies had removal efficiencies over the study goals of 50%. Mechanical volatilization proved ineffective at treating the TCE in site soils but there were some concerns with the testing methodology.

- Grain-size distribution indicated that site soils had little silt and clay sized particles (only 3.7% of the total sample). This is different from geologic field observations (see reference #1 & 3) which implied a silty-sand matrix. Of note was the high organic carbon content (20%) of the fine fraction found during the size separation experiment.

The treatability study provided site-specific data necessary to aid in the selection of an appropriate and cost effective remedy for the site. Sufficient data was collected during the treatability study to indicate whether a given technology could meet the remedial action objectives. The treatability study provide a basis for the detail analysis of remaining alternatives.

6.0 Detailed Analysis: Selection of Preferred Remedy.

The detailed analysis of the alternatives consists of the presentation and evaluation of relevant information needed to allow for an informed waste management decision on the appropriate remedial action for the site. The analysis is conducted to highlight differences and tradeoffs between the alternatives. To be selected, an alternative must be protective of human health, be cost effective, and satisfy the preference for treatment that reduces toxicity, mobility and volume of hazardous waste.

6.1 Description of Remedial Alternatives:

The general alternatives evaluated in the preliminary screening and retained for the detailed analysis have been assembled into specific remedial alternatives. The alternatives are developed to be consistent with the NCP. The following alternatives are proposed for further evaluation:

- Alternative #1: The No-Action alternative; required by the NCP.
- Alternative #2: In-situ Soil Vapor Extraction.
- Alternative #3: Excavation and Ex-situ Soil Vapor Extraction.
- Alternative #4: Excavations and Ex-situ Low Temperature Thermal Desorption.
- Alternative #5: Excavation and On-site Incineration.
- Alternative #6: Excavation and Off-site Disposal.
- Alternative #7: Excavation and Ex-situ Biological Treatment.

A detailed conceptual description of the alternatives is presented in section 4.2.

6.2 Criteria Evaluation of Remedial Alternatives:

In this section, each alternative retained in the first phase FS (preliminary screening) is analyzed with respect to the criteria presented in the NYSDEC, Division of Hazardous Waste Remediation Technical and Administrative Guidance Memorandum #4030 (DHWR-TAGM #4030, Reference #10), the USEPA presumptive remedy guidance (Reference #7) and the USEPA guidance for conducting RI/FS (Reference #1). The evaluation criteria are as follows:

- Compliance with New York Standards, Guidance and Criteria;
- Protection of human health and the environment;
- Short term effectiveness;
- Long term effectiveness;
- Reduction of toxicity, mobility and volume;
- Implement ability; and
- Cost.

Further, each alternative is also evaluated for compliance with the Remedial Action Objectives presented in Section 3.1 and Table 3.

6.3 Comparative Analysis:

In this section the remedial alternatives are compared to each other on a criterion-by-criterion basis to identify the relative advantages and disadvantages of each. Appendix A presents a summary of the criteria evaluation process.

1. "No Action" - As required by Section 4.1 of the NCP. Consideration of this alternative is mandated even though it may not be appropriate for this site. It is retained for this reason as a point of reference for other technologies.

   The "No Action" alternative fails to protect the human health and the environment because the spill site source area soils, if left in place untreated, would continue to act as an ongoing source of groundwater and surface water contamination. Further, the soils are a potential threat to human health via direct contact and inhalation of potentially contaminated vapors and dust, especially if the soils are disturbed in the future. If the no action alternative was selected, there would be no reduction in toxicity, mobility and volume of the hazardous waste constituents and there would be little short-term or long term effectiveness. The "No Action" alternative has been carried into the detailed analysis because it is required by the NCP. It is not considered a plausible remedial action for this site.

2. "In-Situ Soil Vapor Extraction" - This alternative would involve the placement of vapor extraction wells or trenches in the subsurface soils contaminated with TCE. The vapors would be extracted by means of a vacuum. Both vapors and any groundwater recovered would be treated prior to discharge.

   This alternative is considered protective of human health and the environment and does provide a degree of reduction in toxicity, mobility and volume of hazardous wastes. The soil treatability study indicated that vapor extraction technology was effective at reducing TCE soil contamination. However, there are concerns with the ability of the alternative to remediate all of the site soils. The Spill Site Investigation Report (Reference #3) noted highly contaminated soils within bedrock fractures at the top-of-rock zone. It is unlikely that the extraction wells or trenches could be installed in the appropriate locations to capture the contamination within these top-of-rock fractures. Therefore, it is possible that residual contamination would be left at the top-of-rock zone which would continue to act as a source of groundwater and surface water contamination. Therefore, future remedial measures can not be ruled out. In addition, due to the shallow overburden there is the potential for short circuiting of ambient air into the extraction system and impacting the effectiveness of the alternative. Final, the expected duration of the remedy, up to five years, is almost twice as long as alternatives which involve excavation and above ground treatment.

3. "Excavation and Ex-Situ Soil Vapor Extraction" - This alternative involves excavation of the source area soils to the top-of-rock zone. The soils would be transferred to on-site vacuum extraction piles. The piles would be constructed within berms, diking and a HDPE liner to prevent the release of contamination to the environment. The piles would be constructed by alternating soil lifts with perforated vacuum extraction lines. Once constructed to a predetermined height, the soil piles would be covered with HDPE. A vacuum would be placed on the piles to extract contaminated vapors. All vapors extracted would be treated prior to discharge. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product, if observed. Following treatment to remove contaminants, it is anticipated the soil would be placed back on-site.

   This alternative is considered protective of human health and the environment. It provides reduction in toxicity, mobility and volume of hazardous waste. There are some concerns with the ability to meet the remedial action goals because of the elevated organic carbon of site soils. However, the results of the soil treatability study indicate that vapor extraction technology was effective at reducing TCE soil contamination. In addition, the ex-situ soil vapor extraction pile would be constructed to allow for maximum collection of contaminated vapors and engineered controls would mitigate short term environmental effects. Further, by excavating to the bedrock surface, contaminated soils within the fractures at the top-of-rock zone can be removed ensuring long term effectiveness.

4. "Excavation and Low Temperature Thermal Desorption" - In this alternative the contaminated soil would be excavated to the top-of-rock. The soils would be transferred to an on-site low temperature thermal desorption unit. The VOC contaminated soil would be treated by exposing the soil to elevated temperatures ($>500^\circ$ F) and the VOCs would be driven off the soil and would be treated. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product if observed. Following treatment to remove contaminants, it is anticipated the soil will be placed back on-site.

This alternative is considered protective of human health and the environment. It provides reduction in toxicity, mobility and volume of hazardous waste. The low temperature thermal desorption technology has proven reliable and effective at similar sites in meeting remedial action goals for chlorinated VOC contamination. The results of the soil treatability study confirmed the viability of this technology in treating site soils. Engineered controls can mitigate any short term environmental effects. Further, by excavating to the bedrock surface, grossly contaminated soils within the fractures at the top-of-rock zone can be remediated ensuring long term effectiveness.

5. "Excavation and On-site Incineration" - In this alternative the contaminated soil would be excavated to the top-of-rock. The soils would be transferred to an on-site incineration unit. The VOC contaminated soil would be incinerated by exposing the soil to elevated temperatures ($> 1500°$ F) and the VOCs would be destroyed. If deemed necessary, off-gases would be treated to remove undesirable by-products of combustion such as minerals acids, prior to discharge. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product, if observed. Following treatment to remove contaminants, it is anticipated the soil will be placed back on-site.

   The on-site incineration alternative is considered protective of human health and the environment. It provides reduction in toxicity, mobility and volume of hazardous waste. Incineration technology has proven reliable and effective at similar sites in meeting remedial action goals for chlorinated VOC contamination. Further, by excavating to the bedrock surface, grossly contaminated soils within bedrock fractures at the top-of-rock zone can be remediated. However, on-site incineration tends to have a prolonged approval process which can hinder implementability of the technology.

6. "Excavation and Off-Site Disposal" - In this alternative the contaminated soil would be excavated to top-of-rock. The soils would be hauled to a permitted off-site treatment storage and disposal facility (TSDF). Because of elevated TCE levels found in the source area soils and the implications of USEPA regulations regarding land disposal restrictions, it is assumed treatment via incineration would be required at the TSDF. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product, if observed.

   The off-site incineration alternative is considered protective of human health and the environment. It provides reduction in toxicity, mobility and volume of hazardous waste. Off-site disposal would have minimal short term environmental effects as there would be no on-site treatment. Incineration technologies have proven reliable and effective at treating soil contaminated with chlorinated VOCs and excavation/off-site disposal would eliminate the need for on-site disposal of any treated residual soil. Further, by excavating to the bedrock surface, grossly contaminated soils within the fractures at the top-of-rock zone could be remediated. However, there is a preference in the NYSDEC guidance (Reference #10) to conduct on-site versus off-site remediation. There is also additional administrative effort necessary to coordinate the necessary permits and transportation.

7. "Excavation and On-Site Bioremediation" - This alternative would involve excavation of contaminated soil and treatment in on-site biovaults. The biovaults would be operated first in an anaerobic and then aerobic mode. This is proposed because the most recent literature indicates the need for both anoxic and oxygenated conditions to dechlorinate and biodegrade TCE. Nutrients, augmented bioorganisms (organisms engineered to degrade TCE) and water would be added to enhance the bioremediation. The top-of-rock surface and any fractures found would be cleaned of all residual contaminated soil or any pure product if observed. Following treatment to remove contaminants, it is anticipated the soil will be placed back on-site.

Bioremediation is considered an innovative technology with regards to the remediation of chlorinated organic contamination in soil. Recent literature suggests that biological treatment utilizing augmented bioorganisms may be effective at reducing TCE concentrations in contaminated soil. The NYSDEC in concert with the USEPA and the Center for Hazardous Waste Management, State University of New York, University at Buffalo, have funded a treatability demonstration at an inactive hazardous waste site near Brockport New York. The goal of the treatability demonstration is to give bioremediation vendors an opportunity to demonstrate the applicability of their technologies in remediation of chlorinated VOC soil contamination. The study was recently completed but the results are not expected until the Spring of 1997. As such, the evaluation of ex-situ biological treatment for the Lehigh site does not reflect the findings and conclusions of the vendor treatability demonstration.

The ex-situ biological treatment alternative would be protective of human health and the environment. The alternative would also reduce toxicity, mobility and the volume of the hazardous waste at the site. However, traditionally biological treatment is not considered viable to remediate soil contaminated with chlorinated organics and one of the by-products of biodegredation of TCE is vinyl chloride. Vinyl chloride is more toxic than TCE. As such, there are concerns with the reliability of the technology to meet the remedial action objectives and the possibility of further remedial actions can not be ruled out. However, as noted above, recent literature suggest otherwise. But until such claims are demonstrated, the concerns whether the technology can meet the clean up goals remain. Finally, the length of time required to remediate the site via biological treatment is estimated at five (5) years and is twice as long as the other alternatives which involve excavation and treatment.

6.4 Cost of the Remedial Alternatives

The final evaluation criteria is cost. As recommended in the guidance, the cost of the various remedial programs are evaluated on a present worth basis. It is assumed in cost analysis that all the alternatives (except the "No Action" alternative) are capable of equal performance and the most cost effective alternative will have the lower present worth. Table 6 lists the total present worth cost and the estimated time required to implement the seven alternatives. Appendix B contains a conceptual cost estimate for each alternative.

TABLE 6
ESTIMATED TIME TO IMPLEMENT AND PRESENT WORTH COSTS OF REMEDIAL ALTERNATIVES
LEHIGH VALLEY RAILROAD DERAILMENT
OPERABLE UNIT #2 (SURFACE SOILS)

ALTERNATIVE	TIME TO IMPLEMENT	PRESENT WORTH COST
#1 NO ACTION	NA	N/A
# 2 IN-SITU VAPOR EXTRACTION	5 YEARS	$ 2.43
# 3 EX-SITU VAPOR EXTRACTION	2 YEARS	$ 2.38
# 4 EX-SITU THERMAL DESORPTION	1 YEARS	$ 3.27
# 5 ON-SITE INCINERATION	1 YEARS	$ 6.33
# 6 OFF-SITE INCINERATION	1 YEAR	$ 6.95
# 7 EX-SITU BIODEGRADATION	5 YEARS	$ 3.44

Note: Cost are in millions
NA: Not Applicable

The no action alternative has no cost associated with it because it is anticipated that monitoring and other associated activities necessary to protect public health would be handled in the groundwater operable unit.

6.5 Selection of Recommended Alternative:

Alternative one, the "No Action" alternative would leave the site in its present condition. The TCE in the soil would continue to act as a source of groundwater and surface water contamination and may complicate any attempts to remediate the bedrock groundwater. The "No Action" alternative is not considered protective of human health and is not a viable remedial action.

Alternative two, "In-situ Soil Vapor Extraction" would provide for reduction in toxicity, mobility and volume of hazardous waste through treatment. However, the technology may not remediate potentially highly contaminated soils in the top-of-rock fractures as it is doubtful that the extraction wells or trenches could be placed in the appropriate locations. The TCE contamination remaining in the top-of-rock fractures would act as a continuing source of groundwater and surface water contamination and may complicate any future remediation of the groundwater. Further, the ability of in-situ soil vapor extraction to remediate contamination under Gulf Road is unclear. Therefore, future remedial measures can not be ruled out.

That leaves alternatives number 3,4,5,6 & 7 all which involve excavation to expose the bedrock. By remediating the top-of-rock zone all of the remaining alternatives provide a degree of confidence that the contaminated soil would no longer cause further groundwater and surface water contamination.

Alternative seven, "Excavation and Ex-situ Biological treatment" is considered an innovative technology for the treatment of chlorinated organic contaminated soils. Presently, the NYSDEC is conducting a treatability demonstration of biological treatment of chlorinated organic soil contamination at an inactive hazardous waste site near Brockport, New York. The demonstration was recently completed but the results of the study will not be available until the spring of 1997. Without the results of the study the effectiveness of TCE bioremediation in soil is unclear. As such, the bioremediation remedy may not meet remedial action objectives for soil and additional remedial measures can not be ruled out.

Alternative five, "Excavation and On-site Incineration", has concerns of an extensive and prolonged approval process which affects implement ability.

Alternatives #3,4 and 6 provide equal protection of public health and have minimal short term effects which can be addressed by engineering controls. They are all implementable and are considered viable treatment options. Alternative six, "Excavation and Off-site Incineration", does not meet the preference in the guidance (see Reference 10) for a on-site treatment scheme and places a burden on the availability and capacity of permitted TSDFs. It is also the most expensive of the three remaining technologies. Alternative four, "Excavation and On-site Low Temperature Thermal Desorption", and alternative three, "Excavation and Ex-situ Vapor Extraction", provide equal performance when compared with the evaluation criteria. Both of these alternatives are effective at reducing the TCE soil concentrations as noted during the soil treatability study. However, alternative three provides equal performance at a substantially lower cost. The present worth cost of on-site vapor extraction is about $1.0 million less expensive the on-site thermal desorption.

Therefore, based on the evaluation criteria and cost, alternative three, "Excavation and Ex-situ Soil Vapor Extraction" is the recommended treatment option for the Lehigh Valley Railroad Derailment Site, Operable Unit #2.

7.0 Detailed Conceptual Design:

This section presents the detailed conceptual design of the preferred remedial alternative. As stated in Section 6.5, the preferred remedy is Alternative #3, Excavation and Ex-situ Soil Vapor Extraction. Alternative three involves excavation of the source area soils to top-of-rock zone. Excavation of contaminated soils would be completed using excavators, bulldozers, bucket loaders and backhoes. The soil would be excavated in cells to limit the amount of construction water which would require treatment. Sheet piling or slope grading would be utilized to prevent the collapse of excavation walls. Proper health and safety protocols would be utilized to protect site workers and the general public. It is anticipated that Gulf Road would be closed for one construction season (approximately six months). Alternate routes and detours would be posted. The road would be removed to allow for excavation of contaminated soil. After the bedrock surface is clean, Gulf Road would be rebuilt as per appropriate town and county specifications.

Based on the NYSDEC's treatability study and the evaluation presented in this FS, Ex-situ Soil Vapor Extraction is recommended as the soil treatment technology. The soils would be transferred to a on-site vacuum extraction piles. The piles would be constructed within berms, diking and a HDPE liner to prevent the release of contamination to the environment. The piles would be constructed by alternating soil lifts with perforated vacuum extraction lines. Once constructed to a predetermined height, the soil piles would be covered with HDPE. A vacuum would be placed on the piles to extract contaminated vapors. All extracted vapors would be treated prior to discharge to the atmosphere. The discharge vapor would be monitored to ensure protection of the environment and public health. The top-of-rock surface and any fractures found would be cleaned of residual contaminated soil or any pure product if observed. If appropriate, this material would be treated by the on-site system.

The soil vapor extraction piles would be monitored for compliance with the remedial action objectives. Once the soil clean up objectives are achieved, which is estimated at two years time, it is anticipated the soil will be placed back on-site. Minimal mercury and cyanide soil monitoring would be conducted on the treated soil and compared to remedial action objectives. At the present time it is not anticipated the mercury and cyanide will be of a concern. Following the remedial action, site equipment would be decontaminated and decommissioned. The site would be graded, seeded, and Gulf Road would be rebuilt. No long term monitoring is anticipated because the soil would be treated to below the remedial action objectives. Groundwater contamination will be addressed as part of Operable Unit #1.

APPENDIX A

REMEDIAL ALTERATIVE

CRITERIA EVALUATION

APPENDIX A
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
Lehigh Valley Railroad Derailment, Operable Unit # 2

Alternative # 1 ; No Action						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
• Provides no protection of public health or the environment. Contaminated soils would continue to act as a source of groundwater contamination. Potential exposure through direct contact would still exist.	• Does not comply with SCGs.	• Spill Site Soils would continue to act as a source of groundwater contamination and interfere with pending groundwater remedaiton.	• No reduction in toxicity, mobility, or volume.	• Spill Site Soils would continue to act as a source of groundwater contamination and interfere with pending groundwater remediaton. • If selected would take effect immediately.	• Administrative difficulties to implement because public health would have to be protected through extensive monitoring and restriction of land use.	• N/A

1. Note: N/A Not Applicable.
SCG: Standard, Criteria and Guidance

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APPENDIX A
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
Lehigh Valley Railroad Derailment, Operable Unit # 2

Alternative # 2 ; In-situ Soil Vapor Extraction						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
• Provides both short and long-term protection by reducing concentration and exposure to VOCs in soil. • Depending on site-specific conditions, prevents further groundwater contamination. • Maybe unable to remediate highly contaminated soil in bedrock fractures.	• Does not trigger LDRs because it does not involve placement of waste. • Because contamination is removed in place with limited construction and no excavation, few impacts to wetlands, floodplains, or water quality are likely. • Depending on site-specific conditions, may not treat wastes to levels that will prevent exceedance of groundwater cleanup levels. • Emission controls are needed to ensure compliance with air quality standards.	• Is a well-demonstrated technique for removing VOCs from soil. Proved effective during treatability study. • Requires some treatment of residuals (spent carbon or concentrated VOC waste stream generally through regeneration or disposal. • If contamination is left in bedrock fractures future remedial measure can not be ruled out.	• Significantly reduces toxicity, mobility or volume through treatment. • Produces few waste streams. • Some untreated soil contamination will remain in bedrock fractures. • May not effectively treat soil under Gulf Road.	° Does not present substantive risks to on-site workers or community; potential for some dust generation during well installation. ° Potential air emissions are easily controlled through activated carbon adsorption or other technologies. ° Five years to implement. ° Hardware, such as vacuum blower, is readily available from many sources, but SVE system performance is highly dependent upon the lithology of the site and system design.	• Few administrative difficulties. Technology is readily available from many sources. • Used successfully at numerous Superfund sites to address VOC contamination. • Installing and operating extraction wells requires fewer engineering controls than other technologies (i.e., excavation and incineration). • Requires series of soil sampling to determine when clean-up levels are achieved. • Shallow soil depth may cause shot circuiting of air from the surface.	• $2.4

1. Note: Actual cost are in the millions.
SCG: Standard, Criteria and Guidance

APPENDIX A
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
Lehigh Valley Railroad Derailment, Operable Unit #2

Alternative # 3 ; Excavation and Ex-Situ Soil Vapor Extraction						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
• Provides both short-and long-term protection by reducing concentration and exposure to VOCs in soil. • Prevents further ground water contamination by removing highly contaminated soil within bedrock fractures. • Requires measures to protect workers and community during excavation, handling and treatment.	• Does not trigger LDRs because it does not involve placement of waste. • Depending on site-specific conditions, treats wastes to levels that will prevent exceedance of groundwater standards. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil. • Requires some treatment of residuals (spent carbon or concentrated VOC waste stream) generally through regeneration or disposal.	• Significantly reduces toxicity, mobility, or volume through treatment. • Produces few waste streams.	° Does present minimal risks to on-site workers or community. Potential for some vapors and dust generation during excavation. ° Potential air emissions are easily controlled through activated carbon adsorption or other technologies. ° Three years to implement. ° Hardware, such as vacuum blower, is readily available from many sources.	• Few administrative difficulties. Technology is readily available from many sources. • Used successfully at numerous spill sites to address VOC contamination • Installing and operating system will involve fewer engineering controls than other technologies (i.e., bioremediation or incineration). • Requires series of soil sampling to determine when clean-up levels are achieved.	• $2.4

1. Note: Actual cost are in the millions.
SCG: Standard, Criteria and Guidance

Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
• Provides both short and long-term protection by eliminating exposure to VOCs in soil. • Prevents further groundwater contamination by removing highly contaminated soil within the bedrock fractures. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Treats hazardous waste to clean-up levels; thus, there is no LDR problem with residuals. • Generally, treats wastes to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil. Proven viable in treatability study. • Involves some treatment or disposal of residuals (spent carbon or concentrated VOC waste stream) generally through use regeneration or disposal.	• Significantly reduce toxicity, mobility, or volume of contaminants through treatment. • Generally requires test runs to ensure effective treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment. • Relatively short time frame to achieve clean-up levels. • One years to implement.	• Used successfully at other Superfund sites to address solvent contamination. • Requires engineering measures to control air emissions, fugitive dust, run-off, erosion and sedimentation, site access, and transportation. • High degree of certainty of reaching RAOs.	• $3.2

1. Note: Actual cost are in the millions.
SCG: Standard, Criteria and Guidance

APPENDIX A
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
Lehigh Valley Railroad Derailment, Operable Unit # 2

Alternative # 5 ; Excavation and On-site Incineration						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
• Provides both short- and long-term protection by eliminating exposure to VOCs in soil. • Prevents further groundwater contamination and off-site migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Treats hazardous waste well below clean-up levels; thus, there is no LDR problem with residuals. • Generally, treats wastes to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil. • No organic residuals contamination will remain if soil is only contaminated with VOCs.	• Significantly reduce toxicity, mobility, or volume of contaminants through treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment. • Relatively short time frame to achieve clean-up levels. • One years to implement.	• Construction and substantive permit requirements for an onsite incinerator may be somewhat difficult. • Used successfully at other Superfund sites to address solvent contamination. Mobile incinerators are readily available.	• $6.3

1. Note: Actual cost are in the millions.
SCG: Standard, Criteria and Guidance

APPENDIX A
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
Lehigh Valley Railroad Derailment, Operable Unit #2

Alternative # 6 ; Excavation and Off-site Disposal						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
• Provides both short- and long-term protection by eliminating exposure to VOCs in soil. • Prevents further groundwater contamination and off-site migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation, and land disposal regulations • Remove wastes to levels that will prevent exceedence of ground-water clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil. • No organic residuals contamination will exist if soil is only contaminated with VOCs.	• Significantly reduce toxicity, mobility, or volume of contaminants through treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment. • Involves potential short-term risks from handling and transporting waste • Relatively short time frame to achieve clean-up levels. • One years to implement.	• Substantive permit requirements of an off site incinerator may be somewhat difficult. • Used successfully at other Superfund sites to address solvent contamination. • Additional administrative effort is necessary to coordinate the permits and transportation.	• $6.9

1. Note: Actual cost are in the millions.
SCG: Standard, Criteria and Guidance

APPENDIX A

Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil

Lehigh Valley Railroad Derailment, Operable Unit #2

Alternative # 7 ; Excavation and On-Site Bioremediation						
Overall Protection of Human Health and the Environment	Compliance With SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [1]
• Provides both short-and long-term protection by reducing concentration and exposure to VOCs in soil. • Prevents further ground water contamination because highly contaminated soil within the bedrock fractures is removed.	• Does not trigger LDRs because it does not involve placement of waste. • Depending on site-specific conditions, soil may not be treated to levels that will prevent exceedance of groundwater clean-up levels. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is not a well-demonstrated technique for removing VOCs from soil. • Requires some treatment of residuals (spent carbon or concentrated VOC waste stream) generally through regeneration or disposal. • Viability of technology has not been proven. Future remedial measures can not be ruled out.	• Significantly reduces toxicity mobility, or volume through treatment. • May produce a partially remediated soil which would require further actions.	• Does not present substantive risks to on-site workers or community potential for some vapors and dust generation during excavation. • Potential air emissions are easily controlled through activated carbon adsorption or other technologies. • Five years to implement. • Hardware, such as vacuum blower, water recirculation pumps, etc.., is readily available from many sources.	• Administrative difficulties because technology is not readily available from many sources. • Presently being studied by EPA & DEC at inactive waste site in NY. Data not available. • Requires series of soil sampling to determine when clean-up levels are achieved. • Not proven viable for remediation of chlorinated VOCs.	• $3.4

1. Note: Actual cost are in the millions.
   SCG: Standard, Criteria and Guidance

APPENDIX B
Lehigh Valley Railroad Derailment
Summary of Cost Estimates
Operable Unit #2 (Surface Soils)

Alternative	Description	Capital Cost	Annual O & M	Total Present Worth
1	No Action	NA	NA	NA
2	In-Situ Soil Vapor Extraction	$ 1,839,000	$ 112,000	$ 2,426,000
3	Excavation and Ex-situ Soil Vapor Extraction	$ 2,067,000	$ 112,000	$ 2,377,000
4	Excavation and Low Temperature Thermal Desorption	$ 3,053,000	$ 214,000	$ 3,267,000
5	Excavation and On-site Incineration	$ 6,113,000	$ 214,000	$ 6,327,000
6	Excavation and Off-site Disposal	$ 6,855,000	$ 92,000	$ 6,947,000
7	Excavation and On-site Biological Treatment	$ 2,838,000	$ 136,000	$ 3,443,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 2
In-situ Soil Vapor Extraction

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume six months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	200,000	LS	$ 200,000
B. Health and Safety Measures	6	20,000	MO	$ 120,000
C. Construction Management	7	3,000	MO	$ 21,000
D. Vapor Extraction System				
a. Vapor extraction wells	70	3,000	EA	$ 210,000
b. Vapor extraction trenches	5	10,000	EA	$ 50,000
c. Installation of manifold piping	1	30,000	LS	$ 30,000
d. Vacuum Blowers	1	20,000	EA	$ 20,000
e. Vapor phase carbon unit	1	160,000	LS	$ 160,000
f. Treatment structure	1	100,000	LS	$ 100,000
E. System Startup	6	40,000	MO	$ 240,000
Total Direct Capital Costs				$ 1,330,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (20% of Direct Costs)				$ 268,000
C. Contingency (15% of Direct Costs)				$ 201,000
Total Indirect Capital Costs				$ 509,000
Total Capital Costs				$ 1,839,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	5,000	MO	$ 60,000
B. Health and Safety Measures	12	1,000	MO	$ 12,000
C. Maintenance of Treatment System	1	20,000	LS	$ 20,000
D. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 112,000
Present Worth Costs				
A. Total Capital Costs.				$ 1,839,000
B. Total Operation and Maintenance Present Worth (Assume 5 year duration and 4% discount rate)				$ 407,000
Total Present Worth Costs				$ 2,246,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 3
Excavation and Ex-situ Soil Vapor Extraction

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume ten months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	200,000	LS	$ 200,000
B. Health and Safety Measures	8	20,000	MO	$ 160,000
C. Construction Management	10	3,000	MO	$ 30,000
D. Soil Excavation and Preparation	1	300,000	LS	$ 300,000
E. Vapor Extraction System				
a. Construct Piles	1	300,000	LS	$ 300,000
b. Installation and manifold system	1	30,000	LS	$ 30,000
c. Vacuum Blowers	1	20,000	LS	$ 20,000
d. Vapor phase carbon unit	1	80,000	LS	$ 80,000
e. Treatment Structure	1	100,000	LS	$ 100,000
F. System Startup	2	20,000	MO	$ 20,000
G. Clean Bedrock Surface	1	100,000	LS	$ 100,000
F. Gulf Road Replacement				
a. Road demolition and disposal on-site	1	20,000	LS	$ 20,000
b. Road replacement (county road design)	1	142,000	LS	$ 142,000
Total Direct Capital Costs				$ 1,502,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (20% of Direct Costs)				$ 300,000
C. Contingency (15% of Direct Costs)				$ 225,000
Total Indirect Capital Costs				$ 565,000
Total Capital Costs				$ 2,067,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	5,000	MO	$ 60,000
B. Health and Safety Measures	12	1,000	MO	$ 12,000
C. Maintenance of Treatment System	1	20,000	LS	$ 20,000
D. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 112,000
Present Worth Costs				
A. Total Capital Costs.				$ 2,067,000
B. Total Operation and Maintenance Present Worth (Assume 3 year duration and 4% discount rate)				$ 310,000
Total Present Worth Costs				$ 2,377,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 4
Excavation and Low Temperature Thermal Desorption

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume ten months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	300,000	LS	$ 300,000
B. Health and Safety Measures	10	20,000	MO	$ 200,000
C. Construction Management	12	3,000	MO	$ 36,000
D. Soil Excavation and Preparation	1	300,000	LS	$ 300,000
E. Low Temperature Thermal Desorption (10,000 CY * 1.62 ton/cy = 16,200 tons)	16,200	70	TON	$ 1,134,000
F. Clean Bedrock Surface	1	100,000	LS	$ 100,000
G. Gulf Road Replacement				
a. Road demolition and disposal on-site	1	20,000	LS	$ 20,000
b. Road replacement (county road design)	1	142,000	LS	$ 142,000
Total Direct Capital Costs				$ 2,232,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (20% of Direct Costs)				$ 446,000
C. Contingency (15% of Direct Costs)				$ 335,000
Total Indirect Capital Costs				$ 821,000
Total Capital Costs				$ 3,053,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	10,000	MO	$ 120,000
B. Health and Safety Measures	12	7,000	MO	$ 24,000
C. Maintenance of Treatment System	1	50,000	LS	$ 50,000
D. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 214,000
Present Worth Costs				
A. Total Capital Costs.				$ 3,053,000
B. Total Operation and Maintenance Present Worth (Assume 1 year duration)				$ 214,000
Total Present Worth Costs				$ 3,267,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 5
Excavation and On-site Incineration

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume ten months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	300,000	LS	$ 300,000
B. Health and Safety Measures	10	20,000	MO	$ 200,000
C. Construction Management	12	3,000	MO	$ 36,000
D. Soil Excavation and Preparation	1	300,000	LS	$ 300,000
E. On-site Incineration (10,000 CY * 1.62 ton/cy = 16,200 tons)	16,200	200	TON	$ 3,240,000
F. Clean Bedrock Surface	1	100,000	LS	$ 100,000
G. Gulf Road Replacement				
a. Road demolition and disposal on-site	1	20,000	LS	$ 20,000
b. Road replacement (county road design)	1	142,000	LS	$ 142,000
Total Direct Capital Costs				$ 4,338,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (25% of Direct Costs)				$ 1,084,000
C. Contingency (15% of Direct Costs)				$ 651,000
Total Indirect Capital Costs				$ 1,775,000
Total Capital Costs				$ 6,113,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	10,000	MO	$ 120,000
B. Health and Safety Measures	12	2,000	MO	$ 24,000
C. Maintenance of Treatment System	1	50,000	LS	$ 50,000
D. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 214,000
Present Worth Costs				
A. Total Capital Costs.				$ 6,113,000
B. Total Operation and Maintenance Present Worth (Assume 1 year duration)				$ 214,000
Total Present Worth Costs				$ 6,327,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 6
Excavation and Off-Site Disposal

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume ten months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	200,000	LS	$ 200,000
B. Health and Safety Measures	10	20,000	MO	$ 200,000
C. Construction Management	12	3,000	MO	$ 36,000
D. Soil Excavation and Preparation	1	300,000	LS	$ 300,000
E. Off-Site Disposal (assume incineration) (10,000 CY * 1.62 ton/cy = 16,200 tons)	16,200	250	TON	$ 4,050,000
F. Clean Bedrock Surface	1	100,000	LS	$ 100,000
G. Gulf Road Replacement				
a. Road demolition and disposal on-site	1	20,000	LS	$ 20,000
b. Road replacement (county road design)	1	142,000	LS	$ 142,000
Total Direct Capital Costs				$ 5,048,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (20% of Direct Costs)				$ 1,010,000
C. Contingency (15% of Direct Costs)				$ 757,000
Total Indirect Capital Costs				$ 1,807,000
Total Capital Costs				$ 6,855,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	5,000	MO	$ 60,000
B. Health and Safety Measures	12	1,000	MO	$ 12,000
C. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 92,000
Present Worth Costs				
A. Total Capital Costs.				$ 6,855,000
B. Total Operation and Maintenance Present Worth (Assume1 year duration)				$ 92,000
Total Present Worth Costs				$ 6,947,000

Lehigh Valley Railroad Derailment
Cost Estimate
Alternative # 7
Excavation and Ex-situ Biological Treatment

Item	Quantity	Unit Cost	Unit	Cost
Direct Capital Costs (assume ten months to construct)				
A. Mobilization/ Facilities/ Demobilization	1	200,000	LS	$ 200,000
B. Health and Safety Measures	10	20,000	MO	$ 200,000
C. Construction Management	12	3,000	MO	$ 36,000
D. Soil Excavation and Preparation	1	300,000	LS	$ 300,000
E. Biological Treatment System				
a. Construct Biovaults	1	500,000	LS	$ 500,000
b. Installation and manifold system	1	30,000	LS	$ 30,000
c. Air Blowers	1	10,000	LS	$ 20,000
d. Vapor phase carbon unit	1	160,000	LS	$ 160,000
e. Treatment Structure	1	100,000	LS	$ 100,000
f. Nutrient Addition system	1	30,000	LS	$ 30,000
F. System Startup	4	40,000	MO	$ 160,000
G. Clean Bedrock Surface	1	100,000	LS	$ 100,000
F. Gulf Road Replacement				
a. Road demolition and disposal on-site	1	20,000	LS	$ 20,000
b. Road replacement (county road design)	1	142,000	LS	$ 142,000
Total Direct Capital Costs				$ 1,998,000
Indirect Capital Costs				
A. Work plan, QA/QC plan, etc.	1	40,000	LS	$40,000
B. Design and Engineering (20% of Direct Costs)				$ 400,000
C. Contingency (20% of Direct Costs)				$ 400,000
Total Indirect Capital Costs				$ 840,000
Total Capital Costs				$ 2,838,000

Item	Quantity	Unit Cost	Unit	Cost
Annual Operation and Maintenance Costs				
A. Monthly Monitoring Program	12	5,000	MO	$ 60,000
B. Health and Safety Measures	12	3,000	MO	$ 36,000
C. Maintenance of Treatment System	1	20,000	LS	$ 20,000
D. Operation and Maintenance Miscellaneous	1	20,000	LS	$ 20,000
Total Annual Operation and Maintenance Costs				$ 136,000
Present Worth Costs				
A. Total Capital Costs.				$ 2,838,000
B. Total Operation and Maintenance Present Worth (Assume 5 years duration and 4% discount rate)				$ 605,000
Total Present Worth Costs				$ 3,443,000

Appendix C. - References

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4. Lehigh Valley Railroad Derailment - Field Sampling Report, NYSDEC, December 1994.

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6. Presumptive Remedies: Policy and Procedures, USEPA, EPA/540-F-93-047, September 1993.

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9. Laboratory Bench Scale Treatability Study Report, Lehigh Valley Railroad Derailment, NYSDEC, December 1995.

10. Selection of Remedial Actions at Inactive Hazardous Waste Sites, Division Technical and Administrative Guidance Memorandum, NYSDEC, HWR-90-4030.

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