Draft

CZ-5020 D3100

FEASIBILITY STUDY FOR THE CARBORUNDUM FACILITY SANBORN, NEW YORK

October 1990

Prepared for:

BP AMERICA, INC.
200 Public Square 7-4406-B
Cleveland, Ohio 44114-2375

ecology and environment, inc.
BUFFALO CORPORATE CENTER
368 PLEASANTVIEW DRIVE, LANCASTER, NEW YORK 14086, TEL. 716/684-8060
International Specialists in the Environment

recycled paper

TABLE OF CONTENTS

Table of Contents (Cont.)

Table of Contents (Cont.)

LIST OF TABLES

List of Tables (Cont.)

LIST OF ILLUSTRATIONS

1. INTRODUCTION

This volume documents the feasibility study (FS) process conducted for BP America, Inc. (BP) by Ecology and Environment, Inc. (E & E), for BP's Carborundum Company (CC) manufacturing facility at 2050 Cory Road in the Town of Wheatfield, New York. This FS is being performed at the request of the New York State Department of Environmental Conservation (NYSDEC) under the Order on Consent (Site Number 932102) that was implemented on February 21, 1989. This FS is a companion volume to the Remedial Investigation (RI) completed by E & E in June 1990.

This FS was prepared following the guidelines presented in the United States Environmental Protection Agency's (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA-540/G-89-004), Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (EPA-540/G-88-003), and NYSDEC's Technical and Administrative Guidance Manual (TAGM). The framework of this FS has been previously discussed with and approved by NYSDEC. In brief, the FS comprises the following steps: the identification of remedial action objectives, the identification of general response actions, the identification and screening of technologies corresponding to each general response action, the assembly of screened technologies into remedial alternatives, and the evaluation and comparison of the remedial alternatives. Based on this comparison, a preferred alternative is recommended.

2. DEVELOPMENT OF REMEDIAL ALTERNATIVES

This section of the FS describes several alternatives for the remediation of the CC facility developed through a two-part process. First, the areas requiring remediation are defined based on the conclusions of the RI, and, secondly, the remedial action objectives are defined for each medium at the facility. This defining of areas requiring remediation and remedial action objectives forms the basis of the analyses that constitute the FS. General response actions that serve as a guide for selecting applicable remedial technologies are then developed. Selected soil and groundwater remediation technologies are screened to select those most appropriate for the CC facility and then assembled into facility-wide alternatives.

2.1 DEFINITION OF REGION ADDRESSED

Chlorinated organics--principally trichloroethene (TCE), Cis-1,2-dichloroethene (1,2-DCE), vinyl chloride (VC), and, to a lesser degree, 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), and tetrachloroethene (PCE)--are found in both soils and bedrock media at the CC facility. Soil gas surveys and soil sampling have been performed to define the extent of chlorinated organics in soils. Twenty-nine monitoring wells have been installed in bedrock, which is the Oak Orchard Member of the Lockport Dolomite, to define the extent of chlorinated organics in groundwater. In addition, two 8-inch bedrock recovery wells have been pump-tested to determine their hydraulic characteristics and define their area of groundwater capture.

Chlorinated organics located in overburden soils are primarily restricted to the four areas that surround the manufacturing building.

These soils, or "source areas," which contain the chlorinated organics listed earlier, are located in areas southwest and southeast of the manufacturing building, within the central courtyard area of the manufacturing building, and in the area on the north side of the facility parking lot opposite the northeast corner of the manufacturing building. The highest concentration of chlorinated organics--660 ppm of TCE--was detected in a sample from 10 to 12 feet below the surface in the source area on the southwest side of the manufacturing building. The sample was obtained during well installation for the ongoing vapor extraction treatability study being conducted in this area.

Once in place in the overburden, chlorinated organics leach downward until they intercept groundwater. This phenomenon of vertical migration is best documented in the source area on the southwest side of the manufacturing building, where the vapor extraction treatability study is being performed. During installation of vapor recovery wells, this area was extensively sampled at 2-foot intervals in nine borings. High concentrations of TCE and its degradants (primarily 1,2-DCE and VC) were found in samples in the center of the source area from approximately 4 feet below surface to bedrock, or approximately 12 feet below the surface. By comparison, insignificant levels of TCE were found in borings at the edge of the source area until the sample collected at the bedrock/overburden interface, where slightly elevated levels of TCE were detected. This data indicates that chlorinated organics leach downward until they intercept the groundwater.

The primary transport medium of chlorinated organics away from the source areas is the aquifer within the upper 10 feet of the Lockport Dolomite. Movement of groundwater and chlorinated organics is enhanced in this zone because it is several orders of magnitude more transmissive than the silty clays that overlie the bedrock. The directions of groundwater and plume movement are to the south, southeast, and southwest. Generally, levels of chlorinated organics approach EPA-established drinking water standards, which are the maximum contaminant levels (MCLs), off site to the southeast and south. While somewhat variable, the highest levels of chlorinated organics appear in monitoring wells to the southwest of the facility. In the most distant downgradient wells to the southwest (B-29M and B-30M), concentrations of

TCE, Cis-1,2-DCE, and VC have ranged from at or below MCLs to total levels of 100 to 300 ppb. Depending on the compound--TCE, 1,2-DCE, or VC--these maximum concentrations have exceeded MCLs between four and 14 times. It is obvious from this data that the primary direction of plume movement is to the southwest of the CC facility.

This direction of maximum plume movement may be enhanced by a hydraulic gradient that exists to the southwest. The steeper gradient is most evident at the southwest corner of the facility property, where a hydraulic boundary exists. The hydraulic boundary trends from the southeast to the northwest and is primarily expressed as an area of rapidly steepening hydraulic gradient. The boundary is most likely a shallow zone of low hydraulic conductivity. The barrier does permit the transport of contaminants downgradient, however, and consequently must be considered somewhat permeable or discontinuous. Two pumping tests have been conducted upgradient of the barrier. Monitoring wells downgradient of the barrier did not respond in either test. The boundary does appear to lose its identity (the hydraulic gradient becomes less steep) in the fall of the year when groundwater elevations are at their lowest.

The primary pathways of concern that have been evaluated in the risk assessment include inhalation of vapors from soil gas and ingestion of groundwater from domestic supplies. The estimated risks associated with vapor inhalation were several orders of magnitude less than benchmark risks used to determine levels of potential concern. Groundwater, while currently not adversely impacting any area residents, would pose a significant health risk if it were withdrawn at the facility boundary and used over an extended time period for domestic purposes such as drinking, showering, or bathing. Groundwater in the site area is classified as Class GA, whose best use is for human consumption. Remedial action at the site is driven by this classification. Nevertheless, groundwater quality in the site area is quite poor due to its naturally high mineral and metal content. While residential wells do exist, none in the site area supplies water for human consumption. Area residences are connected to a municipal water supply for Niagara County.

2.2 DEFINITION OF REMEDIAL ACTION OBJECTIVES

2.2.1 Cleanup Goals

Remedial action objectives have been developed in the RI to be protective of human health and the environment for all exposure pathways and to comply with applicable standards, criteria, and guidelines (SCGs). As summarized in Section 7 of the RI and noted above, no current threats to human health or the environment are posed by the chlorinated organics at the CC facility. Thus, the requirement for remediation is driven by SCGs. SCGs apply specifically to the groundwater medium. The applicable standard in this case is that all groundwater should meet drinking water standards for the chlorinated organics attributable to the CC facility. These concentrations are presented in Table 2-1. Meeting drinking water SCGs constitutes the remedial action objective for the groundwater medium.

For the soil medium, setting a quantitative remedial action objective is more complicated. As the soil poses no direct health threat, it requires remediation only to the point where it no longer acts as a source for groundwater contamination. As a guideline, a remedial action objective for the soil medium has been set such that the leachate generated by the Toxicity Characteristic Leaching Procedure (TCLP) should contain chlorinated organics at levels no higher than the drinking water standards (MCLs) presented in Table 2-1. This criterion provides a guide for the level of cleanup required; however, it is likely to be conservative because the TCLP procedure calls for much greater contact with a stronger leachant than can be reasonably expected on site at the CC facility. Thus, using the TCLP as a guideline to determine cleanup levels may be overly conservative and not practicable. The TCLP results of soil samples collected and analyzed during well installation for the vapor extraction treatability study indicate that even samples with low concentrations of TCE (less than 500 ppb) still would not meet the TCE MCL of 5 ppb: Sample DE-5 (collected from 4 to 6 feet) contained 410 ppb TCE, and the TCLP extract from this sample contained 380 ppb TCE--more than 75 times the TCE MCL of 5 ppb. However, soils with these contaminant levels would not be expected to impact groundwater. Thus, if certain volumes of soil are not adversely impacting the groundwater (i.e., that the groundwater in the vicinity of those soils is in compliance with SCGs), then those soils would not be required to attain the cleanup guidelines defined by the TCLP analysis.

2.2.2 Action-Specific SCGs

Several action-specific SCGs exist that may apply during remediation if certain remedies are selected. The soil at the facility must be treated as if it were a listed hazardous waste. The chlorinated organics in the soil are spent solvents, classified as F002 wastes by the Resource Conservation and Recovery Act (RCRA). Thus, the soil must be managed as a hazardous waste according to EPA's "contained-in" interpretation (referenced in OSWER Directive 9347.3-05FS). As explained in depth in a June 19, 1989 letter to NYSDEC Commissioner Thomas C. Jorling from the acting assistant administrator of EPA, the "contained-in" policy states that while the soil must be treated as a hazardous waste as long it contains the listed waste in question, if the contaminant is removed from the waste (to de minimus levels), the soil would no longer be considered hazardous waste and would not have to be specifically delisted. The de minimus levels for F002 wastes do not exist on a generic basis. It is likely the de minimus level would be set by NYSDEC at zero or nondetectable. F002 wastes or soils containing F002 contaminants above the de minimus levels are subject to the land disposal restrictions stated in 40 CFR 268. These regulations dictate that should the soil be excavated, it cannot be disposed of unless it meets specific treatment standards. For F002 wastes, the treatment standards state that the extracts from the TCLP test must have levels of TCE, 1,1,1-TCA, and methylene chloride (MC) below 91 µg/L, 410 µg/L, and 960 µg/L, respectively. These limits also apply to any treatment residues from any selected technology, as outlined by the "derived-from" rule (40 CFR 261.3[C][2]). As detailed in the draft CERCLA Compliance with Other Laws Manual Part 1 (EPA 1988), these SCGs apply only if the soil is removed. No-action, containment, or in situ treatment responses are not required to meet these action-specific SCGs.

Likewise, if groundwater is extracted, it has to meet certain standards before it can be discharged. The standards the extracted groundwater must meet are determined by the receiving body. If the groundwater is reinjected to the aquifer, then it must first meet the drinking water standards listed in Table 2-1 that constitute the cleanup goals. If the groundwater is discharged to surface water, it must meet the discharge criteria specified on a system-specific State Pollution Discharge Elimination System (SPDES) permit issued by NYSDEC. As no permit has yet been granted to CC, these standards are not known. However, an estimation of the discharge standards has been provided by NYSDEC for the purposes of the FS. These standards are listed in Table 2-2. Most of these values are the NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) Best Available Technology/Best Professional Judgment (BAT/BPJ) discharge maxima.

A third option for the discharge of groundwater would be to the Niagara County Sewer District (NCSD) No. 1. Discharge to NCSD would be constrained by the limits stated in a permit to discharge to the district. BP has applied for a permit to discharge to NCSD that would provide for an estimated maximum discharge concentration of 1 ppm and a total of 2.5 pounds per day (corresponding to a maximum flow of 300,000 gallons per day). Once this application is approved (approval is anticipated), this would constitute the action-specific SCG for discharge to a publicly owned treatment works (POTW).

Several action-specific SCGs exist regarding air emissions from process equipment (i.e., air strippers or on-site vacuum extraction systems) or excavation activities. The primary regulations are the New York State Code of Air Regulations (6 NYCRR 212) at the state level and the National Emission Standards for Hazardous Air Pollutants (NESHAP) at the federal level (40 CFR 61). These regulations provide the framework for establishing emission standards on a case-by-case basis. Guidance on implementing these regulations is provided in various documents, including the New York State Air Guide-1, the Air Cleanup Criteria (both produced by NYSDEC Division of Air Resources), and the EPA's Air/Superfund National Technical Guidance Study Series (EPA-450 1-89-001 through 004). These documents do not set absolute levels of maximum emissions of various chemicals but, rather, present a procedure for calculating the degree of treatment required. Ambient guideline concentrations (AGCs) would be used to recommend emission levels. TCE and 1,2-DCE are considered moderate-toxicity compounds under these guidelines, while VC is considered a high-toxicity air contaminant. Ultimately, the permitted emission levels would be established by the NYSDEC regional air pollution control engineer using the above-referenced guidelines.

2.3 GENERAL RESPONSE ACTIONS

Based on chemical and hydrogeological information gathered during the RI, general response actions, or classes of responses, were identified for each medium of concern. The response actions that are considered applicable address the presence of chlorinated organics in the overburden as well as in the groundwater present in the bedrock aquifer. The general response actions can be considered as conceptual components of alternatives for each medium of concern. Their identification sets the framework for the identification and selection of remedial alternatives.

2.3.1 General Response Actions for the Groundwater Medium

General response actions for the groundwater medium are limited to no action, extraction, on-site aboveground treatment, and off-site treatment and/or disposal. The effectiveness of extraction in capturing the on-site groundwater plume has been demonstrated through the pumping tests described in Section 4.3.1 of the RI. Aboveground treatment would remove or destroy the chlorinated organics and could be implemented either on site or off site. Containment responses are not considered feasible for the groundwater medium. A substantial amount of the groundwater plume is located in the bedrock aquifer. The water-bearing zones of the aquifer consist of weathered zones and fractures, thereby making it impractical to install containment barriers. In addition, the unknown extent and trend of such fractures prohibits selecting containment barrier locations. This situation also makes in situ groundwater response actions impractical for the groundwater medium. As in situ methods would include the addition of treatment agents to the groundwater, the complex fracture system would make the design of such a system difficult, if not impossible. Furthermore, the on-site soils, which contain the overburden component of the plume on a seasonal basis, are of relatively low permeability, thus making injection of treatment agents into this groundwater difficult and impractical.

2.3.2 General Response Actions for the Soil Medium

The general response actions for the soil medium include excavation, aboveground treatment, off-site disposal, and in situ treatment. Containment responses are not considered feasible for two reasons: first, no direct-contact or vapor-phase threats are posed by the soils and, thus, containment capping would not be needed to mitigate such a threat. Second, although the migration route of concern is from the soil to the groundwater, containment would only minimally reduce the rate of this migration. Groundwater levels on site, where soil contamination is located, fluctuate seasonally from the bedrock level to near the surface. Thus, although containment would reduce the degree of infiltration from surface water and precipitation, just as much infiltration would still occur from the natural level fluctuations and flow of the groundwater.

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

In this section, applicable technologies are identified for each general response action described above. These technologies are screened using the criteria of effectiveness, implementability, and cost to select those most appropriate for the CC facility. The technology screening process is divided into separate sections for the soil and groundwater media. Because of site characteristics, only one technology for each medium's general response action is selected through the screening process. Due to the interaction between the soil and the groundwater at the CC facility, both media are addressed in each developed alternative, rather than through separate operable units. Retaining multiple technologies for each general response action would result in a prohibitively large number of alternatives composed of many different combinations of several soil and groundwater technologies. As evaluating and comparing these many alternatives in subsequent steps would essentially call for additional technology screening, an intensive screening, resulting in the selection of a single technology for each general response action, is conducted in this section.

2.4.1 Groundwater Medium Technologies

2.4.1.1 Groundwater Technology Identification

2.4.1.1.1 Response Action: Groundwater Extraction

Groundwater extraction is typically accomplished through one of two techniques. The first technique involves the use of subsurface drains. This approach entails the installation of perforated pipes below the groundwater table directly in, or downgradient of, the contaminant plume. The pipes drain the groundwater by gravity into a sump. Groundwater collected in the sump is then removed through pumping. This approach is not appropriate for the CC facility, however, as the plume extends into the bedrock aquifer, making the installation of the drains difficult if not impossible.

The second groundwater extraction technique employs the use of extraction wells. The effectiveness of extraction wells in capturing the plume above the hydrogeologic boundary at the CC facility has been demonstrated in pump tests conducted in 1986 and 1989 (see Section 4.3.1 of the RI). These tests indicated that encompassing the entire upgradient plume could be achieved through the use of two extraction wells (P-2 and P-3). Similar pumping tests have not been conducted on the groundwater downgradient of the hydrogeologic boundary. However, this portion of the plume is expected to also be readily captured via extraction wells that would be downgradient of the hydrogeologic boundary.

Groundwater may be pumped from the extraction wells on either a continuous or pulsed basis. Initially, the period of groundwater extraction would be constant; groundwater would be continuously withdrawn from the wells at a fairly constant rate. The optimal rate, which may vary seasonally, would be determined during the start-up of remediation. Production at this rate would continue until the decrease in plume concentrations begins to stabilize. At this point, an extraction program featuring pulse-relax cycles may be implemented. Under this scenario, pumps would be shut off on a periodic basis to encourage chlorinated organics that may have adsorbed to aquifer media to be released into the aquifer and consequently be withdrawn via the extraction wells. This type of extraction technique would be implemented at a later stage of the remedial program when and if the contaminant decline curve stabilizes. The exact duration of pulse-relax pumping would be determined by experiment. However, the period would have to be somewhat conservative to prevent off-site plume migration during the "relax" portions of the cycle.

2.4.1.1.2 Response Action: On-Site Aboveground Treatment

Treatment technologies for groundwater containing chlorinated organics can be divided into the three general areas of biological, physical, and chemical treatment.

Biological Treatment

Biological treatment technologies employ microorganisms to mineralize organic compounds into water, carbon dioxide, and (if chlorinated) hydrogen chloride. Although biological treatment has been used widely to treat nonhalogenated chemicals such as fuels, oils, and polycyclic aromatic hydrocarbons (PAHs), it has, with a few exceptions, been applied to chlorinated organic contamination problems only on a pilot or developmental scale. Although some microbes have been developed to directly mineralize chlorinated organics, most of the research and development has focused on methanotrophic bacteria that require the addition of both oxygen and methane. With such systems, a principal impediment to development is the fact that contaminant removal by stripping (due to the oxygen and methane addition) occurs at levels comparable to rates of biodegradation, indicating that direct air stripping would be more effective in treating extracted groundwater, even if the biological technology were more fully developed.

Physical Treatment

Physical treatment methods include air stripping and carbon adsorption. Air stripping, using packed towers, is widely accepted as an effective method for removing volatile organics from groundwater. Contaminated water is pumped to the top of an air stripping tower, where it is distributed over a bed of packing material. The packing provides a large, wetted surface area for contact between the water and air. Air is introduced (via a blower) below the packing material and is blown up through the tower countercurrently to the water. As the water comes in contact with the air, equilibrium is approached or attained between the aqueous and gas phases. Dissolved organics with high Henry's Law constants (i.e., their equilibrium state favors the gas phase over the aqueous phase) will transfer to the gas phase from the liquid phase. The countercurrent operation of the tower allows the attainment of progressively lower organic levels in the water as it is repeatedly exposed to increasingly fresh air. The organic-laden air is then typically passed through a granulated activated carbon (GAC) filter unit to adsorb contaminants or discharged to the atmosphere without further treatment.

The design of air-stripping towers has been greatly standardized, with off-the-shelf towers readily available from a variety of manufacturers. The installation of air-stripping towers does not pose a construction problem, although some postinstallation adjustments of the extracted groundwater throughout are usually needed to optimize the operation.

Carbon adsorption is a simple and effective means of removing most dissolved organic compounds from water. The principle behind this technology is as follows: as contaminated groundwater comes in contact with the surface of activated carbon, an equilibrium is established between the carbon surface and aqueous phases. As the carbon surfaces are non-polar like the organic compounds of concern at the CC facility, the organic compounds preferentially transfer to the carbon surface phase. If the water comes in contact with the carbon in a stagewise manner or, alternatively, as plug flow across a carbon bed, organic concentrations are reduced to vanishingly small levels as each successive stage or bed segment is exposed to water of decreasing organic levels. This decrease is due to the partial removal of the organics during the previous stage or bed segment. Consequently, an activated carbon column will remove all the adsorbable organic compounds from an aqueous influent as long as the carbon bed has not been saturated with respect to any of those compounds.

For a column operating in plug flow, the influent end of the column will become saturated immediately upon use. Saturation is defined as the maximum amount of the least adsorbable organic compounds that can be loaded onto the carbon, or the amount of loading that would be in equilibrium with the influent concentration. Thus, the loading constituting saturation is directly dependent upon the influent contaminant concentration. As the column is used, the saturated bed volume will grow in direct proportion to the amount of water passed through (assuming the influent concentration remains unchanged). When the saturated zone grows to reach the extent of the column, "breakthrough" is said to occur. Under ideal conditions (no mass-transfer limitations), when breakthrough occurs the quality of the water will rise from organic-free to water that contains the least adsorbable contaminant at its influent concentrations.

Both air stripping and carbon adsorption are applicable to the contamination at the CC facility because they readily remove chlorinated organics. Thus, they will be retained for the technology screening analysis.

Chemical Treatment

A great many of the chemical treatment technologies--such as precipitation, neutralization, and ion exchange--developed for treating aqueous wastes are not applicable to the groundwater at the CC facility because they specifically apply to inorganic contaminants. Chemical treatment for the chlorinated organics present in the groundwater at the CC facility is limited to oxidation treatment. The most effective oxidation technique for the lower chlorinated organic concentrations expected is ultraviolet (UV) catalyzed oxidation. UV oxidation technology is used to chemically oxidize organic compounds present in water. Complex organic molecules are broken down into a series of less complex molecules; the end products are water, carbon dioxide, and hydrogen chloride.

For many years, chemical oxidants (e.g., ozone and hydrogen peroxide) have been widely used for industrial treatment without UV enhancement. Within the past 10 years, UV lamps have been used to catalyze the ozone or hydrogen peroxide reactions. UV light, when combined with ozone and/or hydrogen peroxide, produces a highly oxidative environment significantly more destructive than that created with only hydrogen peroxide or ozone alone or in combination. UV radiation enhances the transformation of ozone and/or hydrogen peroxide to highly reactive hydroxyl radicals (OH^-). Hydroxyl radicals in general are known to react with organics more rapidly than the undissociated chemical oxidants ozone and hydrogen peroxide.

UV oxidation systems are principally available through two commercial vendors: Peroxidation Systems, Inc., and ULTROX International. These vendors were contacted in conjunction with this study, and an overview of each of their systems follows.

Peroxidation Systems, Inc., employs UV light and hydrogen peroxide in a closed reactor to oxidize organic compounds into water, carbon dioxide, and hydrogen chloride. The system is skid-mounted with all required controls built in.

ULTROX Systems, Inc., treatment systems combine UV light plus ozone and/or hydrogen peroxide to oxidize organic pollutants in industrial wastewaters and groundwaters. The ULTROX system is skid-mounted, modular, and usually consists of a UV-oxidation reactor and an oxidation source--either an ozone generator with an air preparation system or a hydrogen peroxide feed system.

Because more data is available to evaluate the application of ULTROX systems in the treatment of groundwater containing chlorinated organics (e.g., EPA reports, professional journals, magazine articles, and client references), the sections describing and evaluating the UV oxidation system use ULTROX as a basis.

A typical ULTROX UV-oxidation treatment system consists of a UV-oxidation reactor, an oxidation source--either an ozone generator with an air preparation system or a hydrogen peroxide feed system--and, if ozone is used, an ozone destruction unit on the gas effluent.

The UV-oxidation reactor (the primary component of the process) is made of stainless steel. The UV lamps are enclosed in quartz sheaths and are vertically mounted within the reactor. A typical reactor may have four to eight stages, depending upon the size of the reactor and the type of water to be treated. The UV lamps are installed either in all stages of the reactor or in designated stages, depending upon the type of treatment specified. When ozone is used as the oxidant, it is introduced at the base of the reactor. The ozone is uniformly dispersed through stainless steel diffusers that extend along the width of the reactor. The number of diffusers needed will depend upon the degree of removal required. If hydrogen peroxide is used, it is introduced into the influent line to the reactor from a hydrogen peroxide feed tank.

Within the reactor, the water flows from stage to stage by gravity flow. When the reactor utilizes ozone, the residual ozone in the off-gas is converted to oxygen by the ozone destruction unit.

2.4.1.1.3 Response Action: Off-site Treatment and/or Disposal

Three options were identified for off-site treatment and/or disposal of extracted groundwater: POTWs, reinjection into the groundwater aquifer, and surface water discharge.

Publicly Owned Treatment Works

NCSD No. 1 presently services the CC facility. BP has contacted NCSD regarding the possibility of discharging extracted groundwater to its treatment plant. Specifically, BP has requested permission to discharge extracted groundwater containing 200 to 1,000 ppb of total chlorinated organics. The groundwater would be treated by the POTW. Pending expected approval of a modification to its SPDES permit, NCSD would allow such a discharge. Thus, discharge to a POTW is a viable option.

Reinjection to Groundwater

Treated groundwater may be reinjected into the aquifer from which it was withdrawn. This approach can be used to help direct the flow of contaminated groundwater toward the extraction wells or recovery trenches.

Surface Water Discharge

Treated groundwater may be discharged to a nearby surface water body. An outfall to the adjacent Cayuga Creek exists at the facility, and BP has applied for renewal of the SPDES permit for the CC facility to allow, if necessary, the discharge of treated groundwater to Cayuga Creek.

2.4.1.2 Groundwater Technology Screening

In this section, the groundwater technologies identified in the previous section are screened on the bases of effectiveness, implementability, and, to the degree appropriate, cost.

2.4.1.2.1 Response Action: Groundwater Extraction

Two technologies, extraction wells and subsurface drains, were identified earlier for the groundwater extraction response action. As previously discussed, extraction wells have proven effective in capturing the entire on-site portion of the plume during pumping tests. Additional wells may be readily installed in that portion of the plume downgradient of the hydrogeologic boundary. Thus, no obstacles exist that would impede implementation.

Subsurface drains, on the other hand, may not be effective because of the complex hydrogeology of the fractured bedrock. Excavation into the bedrock for drain installation would be difficult to implement and extremely expensive. For these reasons, the use of subsurface drains is not feasible, and extraction wells alone will be considered in the remedial alternatives.

2.4.1.2.2 On-site Aboveground Treatment

Three technologies were identified for on-site aboveground treatment of extracted groundwater: air stripping, carbon adsorption, and UV oxidation. Each of these technologies is screened on the bases of effectiveness, implementability, and cost. As these three technologies are apparently equally effective and implementable, greater detail on costs is provided in this screening evaluation than is customarily included in technology-screening evaluations. This cost analysis is to assist in the selection of technologies to be included in the site-wide remedial alternatives.

In order to adequately compare the aboveground treatment technologies, especially with respect to the cost criterion, a treatment basis must first be established. Groundwater at the CC facility contains several types of chlorinated organics, including TCE, 1,2-DCE, 1,1-DCE, VC, MC, 1,1,1-TCA, 1,1-DCA, PCE, and chloroform. Although many of these compounds are present above drinking water standards in numerous monitoring wells at the facility, sampling during a pump test at extraction well P-2 revealed that only TCE and 1,2-DCE were present in significant amounts once steady-state concentrations were achieved. These compounds were found at levels of approximately 150 ppb and 25 ppb, respectively. Other chlorinated organic compounds totaling approximately 25 ppb were also detected, for a total chlorinated organics concentration of 200 ppb. However, these compounds are either below levels of concern or are present at levels sufficiently low that whatever treatment was applied to reduce TCE and 1,2-DCE to discharge standards would necessarily also reduce the less concentrated compounds to below discharge standards. To test the sensitivity of the cost estimates on this predicted influent concentration, a higher influent concentration basis of 500 ppb (total chlorinated organics) is also examined. This alternate influent is assumed to contain 375 ppb TCE, 62.5 ppb 1,2-DCE, and 62.5 ppb of other chlorinated organics. The level of treatment required is taken to be the estimated creek discharge levels presented in Section 2.2.2. Two flow rates, 100 gpm and 200 gpm, were considered, corresponding to extraction of groundwater above the hydrogeologic boundary alone and extraction of groundwater both above and below the hydrogeologic boundary.

AIR STRIPPING

Effectiveness

Air stripping is a well-demonstrated technology used to remove volatile organics from groundwater. This treatment technology would effectively reduce the concentration of chlorinated organics (dominated by TCE and 1,2-DCE) from groundwater extracted at the CC facility to acceptable levels. As air stripping is routinely used to treat groundwater containing volatile chlorinated organics. Its effectiveness is generally contaminant-specific and not influenced by the quality of the water. Air stripping would be expected to readily treat the extracted groundwater to attain or exceed the discharge standards. No downstream "polishing" with liquid phase carbon adsorption is expected to be required. Should groundwater containing higher levels of chlorinated organics be encountered during the remediation, the operational parameters, e.g., the air and groundwater flow rates, could be adjusted so that the effluent would continue to meet the discharge standards.

Air stripping alone, however, would not permanently destroy the chlorinated organics. Air stripping is a mass-transfer process in which the volatile chlorinated organics in the groundwater are transferred to the air flowing through the tower. The air effluent from the tower would then require additional treatment prior to release to the atmosphere. A vapor phase carbon adsorption unit would most likely be used in conjunction with the air stripper to remove the chlorinated organics from the effluent air. The activated carbon in the unit would require periodic replacement and/or regeneration, contributing to the total treatment cost. Depending on the arrangements made for the activated carbon disposal, the chlorinated organics adsorbed to the carbon may be permanently destroyed. A likely disposal option would be off-site regeneration in which the desorbed organic vapors are incinerated, resulting in their permanent destruction.

Pretreatment of the water may be required to prevent potential plugging or fouling associated with high iron and manganese concentrations in the water. This would also increase the cost of treatment. However, for the purposes of this evaluation, it is assumed that such pretreatment would not be required. The need for such pretreatment would be established either through a pilot test or, if no pilot test is conducted, through modification of the treatment facility once it was installed and started.

Implementability

An air-stripping treatment system is relatively simple to construct and operate. Few technical difficulties or unknowns are expected to be encountered during construction and operation since the technology is well established. The necessary materials, equipment, and personnel are readily available through a variety of vendors. Maintenance requirements on the tower should be minimal and would include periodic inspection of the air-stripper column bed for plugging and bacterial growth. Power consumption should not be excessive because of the relatively low air flow rates required.

The only major issue related to the implementation of this treatment option is the need to make arrangements for disposing of the spent activated carbon from the vapor phase carbon adsorption unit. The contaminants in the soil and groundwater at the CC facility are classified as RCRA hazardous wastes (F002); therefore, any groundwater treatment residuals (e.g., the spent carbon) would also be classified a RCRA hazardous waste and subject to the land disposal restrictions associated with the RCRA-listed waste it contains. The spent carbon must, therefore, either meet the established treatment standards or be delisted under RCRA before disposal. Delisting would not be considered due to the small quantity of waste expected to be generated over the lifetime of the treatment process. It is expected that the spent carbon would require incineration or thermal desorption followed by vapor-phase incineration to destroy the adsorbed organics prior to final disposal. Three incineration or regeneration facilities are located less than 400 miles from the CC facility and could accept the spent carbon if it met their acceptance criteria. Although one of these facilities is not operational at this time, it will be within a year.

Cost

Three vendors of air-stripping equipment were contacted to obtain cost estimates for air-stripping process equipment suitable for application at the CC facility. The quotations received were for the base case application of a 100-gpm groundwater flow rate with 200 µg/L total chlorinated organics. The cost estimates were compared to more general data available in more general air-stripping literature for both validation of the quotations and for a basis of expanding the information obtained to cover the additional applications considered (e.g., higher flow rates and higher concentration of influents).

A wide range of cost data was provided by the vendors contacted. The quotations for the capital cost of the air stripping tower, including packing, sump, and blower, ranged from $13,000 to $43,000. The upper ranges of the quotations received for costs of these process units were in line with the cost data available from the above-cited references, and, thus, these data are used in the cost analysis.

Based on correlations of costs as a function of capacity provided by the American Water Works Administration (AWWA, 1983, Occurrence and Removal of Volatile Organic Chemicals from Drinking Water) and cost data as a function of degree of treatment provided by both the AWWA and the EPA (Federal Register, Vol 47, page 9350), process equipment costs for the alternative scenarios were also calculated. Installation labor costs are estimated to be $5,000. Two vendors supplied cost information on vapor-phase carbon adsorption units. Depending on their size, the units cost from $940 to $6,650. The least expensive unit holds 160 pounds of carbon that is estimated to last approximately 45 days. The more expensive unit holds 1,000 pounds of carbon that is estimated to last approximately 285 days. If the small units were selected, two units would be used in parallel. This would increase the time before the carbon in each unit is spent and must be replaced. In addition to these two systems, another vendor, Calgon Carbon Corporation, offers a "Vapor-Pak" service unit that holds 1,800 pounds of carbon. Calgon would take this entire unit back once the carbon is spent, if it meets Calgon's carbon acceptance criteria (Calgon is RCRA-permitted to accept this type of waste). The Vapor-Pak unit costs $4,600. This price includes the first two months of use, after which the cost is $390 per month until the unit is returned. If additional units are required, an initial cost of $4,600 is again required. In addition to the process equipment itself, many ancillary pieces of equipment would require installation to operate the air-stripping system. In addition to a building for housing the equipment (30 feet by 40 feet by 20 feet in size and including a slab foundation and some utilities), a 12,000-gallon influent surge/equalization tank, pumps, piping, sampling equipment, controllers, and instrumentation would be required. Additional costs would be incurred for the design of the system, the provision of general services during construction, the provision of half-time inspection services during construction, the production of an operation and maintenance (O&M) manual, and plant start-up. A summary of the estimated costs for each flow rate and contaminant concentration scenario is presented in Table 2-3.

The O&M costs associated with this system include the power requirements for the pump and blower, maintenance on the tower, labor, and the cost for the disposal and replacement of the spent carbon from the GAC unit. The cost of electricity to operate this system is estimated at approximately $3,000 to $5,000 per year. Maintenance on the tower would include the cost of adding chemicals to prevent fouling or, if necessary, the cost for changing the packing in the tower on a yearly basis. This cost is estimated at between $1,500 and $3,000 per year. Carbon usage costs were based on the use of Calgon's Vapor Pak service described above. Costs for oversight of the system's operation, including weekly collection and analysis of process samples, is estimated at $22,500 per year. The O&M costs for air stripping, for each of the scenarios considered, is presented in Table 2-4.

For each scenario considered, a present-worth cost was calculated incorporating both the capital costs and the O&M costs, with future O&M costs discounted to reflect their present worth and assuming a net interest rate of 5%. The 5% rate was chosen as the difference between an assumed 10% discount rate and an assumed inflation rate of 5% (the discount rate reflects the discounted cost of future purchases, while the inflation rate increases these future costs). For comparison, present-worth costs were calculated for both the expected duration of treatment of 5 years as well as for extended treatment durations of 10 and 30 years. These costs are presented in Table 2-5. These costs do not include the cost of groundwater extraction or disposal of treated groundwater.

UV/OZONE OXIDATION

Effectiveness

The ULTROX UV/Ozonation Systems have been in commercial service for over eight years and have been used for removing volatile organic compounds from drinking water supplies, treating contaminated groundwater, and pretreating industrial wastewaters prior to discharge to POTWs. The ULTROX process employs a controlled combination of ozone and UV light to induce rapid photochemical oxidation of halogenated organic compounds to achieve 85 to 99% destruction efficiency for most organic compounds. (It has been ULTROX's experience that organic compounds with single bonds [e.g., 1,1-DCA and 1,1,1-TCA] are relatively difficult to oxidize, but organic compounds with double bonds such as TCE, 1,2-DCE, and VC [the primary chlorinated organics at the CC facility] are easily oxidized.) Table 2-6 presents a list of selected ULTROX applications and their results.

As part of the EPA's Superfund Innovative Technology Evaluation (SITE) program, a field evaluation of ULTROX's system was performed from February 27 through March 10, 1989 at the Lorentz Barrel and Drum site in San Jose, California. The shallow groundwater at the site was found to be contaminated with TCE (280 to 960 ppb), vinyl chloride (51 to 146 ppb), and 1,2-DCE (42 to 68 ppb). The conclusions from the evaluation are summarized as follows (Lewis et al. 1989):

- The groundwater treated by the ULTROX system met the National Pollutant Discharge Elimination System (NPDES) discharge standards into a nearby waterway at the 95% confidence level;

- No volatile organic compounds (VOCs) were detected in the air emissions from the treatment unit;

- The ozone destruction unit destroyed ozone off-gas from the treatment unit to levels less than 0.1 ppm (Occupational Safety and Health Administration [OSHA] Standards) with destruction efficiencies greater than 99.9 percent;

- The ULTROX system achieved removal efficiencies as high as 90% percent for total VOCs present in the groundwater at the Lorentz Barrel and Drum Site. Removal efficiencies for TCE were greater than 99%, but maximum removal efficiencies for 1,1-DCA and 1,1,1-TCA were about 65% and 85%, respectively;

- A significant removal fraction of 1,1-DCA and 1,1,1-TCA was due to stripping. (Ozone gas is bubbled through the groundwater by the ULTROX system, and, hence, volatile organic compound (VOC) removal can be attributable to stripping in addition to oxidation.) The extent of stripping was low for TCE and VC. (It is easier to oxidize TCE and VC than 1,1-DCA and 1,1,1-TCA because of the double bonds between the carbon atoms in TCE and VC and because stripping is a significant removal pathway for organic compounds that are relatively difficult to oxidize); and

- VOCs present in the off-gas from the treatment unit at levels of approximately 0.1 to 0.5 ppm were removed to below detection limits by the ozone destruction unit.

To determine the effectiveness of ULTROX's technology for specific groundwater and wastewater applications, a bench-scale laboratory study would have to be performed by ULTROX prior to implementation of a full-scale system. Typically, the bench-scale laboratory study is followed up with an on-site pilot-plant study to obtain the engineering data required for scale-up to the full-size commercial system. However, according to ULTROX, a pilot-plant study would probably not be required for treatment of the groundwater at the CC facility for the following reasons:

- ULTROX has applied their UV/oxidation technology to many applications involving TCE and 1,2-DCE;
- TCE and 1,2-DCE are easily oxidized at typically high destruction efficiencies; and
- The estimated discharge standards (10 ppb TCE and 30 ppb 1,2-DCE) are easily obtainable based upon the two previous statements.

The appropriateness of a pilot-plant study for the groundwater at the CC facility would be determined based upon the results of the bench-scale laboratory study.

The UV/ozone process is easy to operate and control. It can be fine-tuned to achieve desired discharge limits. Additionally, a safety factor is built into the design of an ULTROX system so that desired discharge standards could still be met even if a slug of contamination caused the influent concentrations to increase two to threefold.

UV lamps are vertically mounted in the UV/oxidation reactor and are enclosed in quartz sheaths. Increased amounts of ozone scaling on the lamps or quartz sheaths may reduce the effectiveness of the treatment process, but scaling is not anticipated to be a problem for treatment of the groundwater at the CC facility because the iron content is marginal (3 ppm) and because of the low heat flux of the ULTROX system.

Implementability

The ULTROX system is readily available for shipping from ULTROX's Santa Ana, California office. The system is skid-mounted and modular for easy on-site installation, and it is assembled and tested at an ULTROX facility before being shipped to the job site.

The full-scale ULTROX systems are fully automated and are designed to operate in a batch or continuous mode depending upon treatment requirements. Monitoring of the treated groundwater and also of the air emissions from the ULTROX system would be required. The effluent monitoring schedule would be determined through negotiations with the lead regulatory agency (NYSDEC) and would be more intensive during the start-up phase of the system.

Minimal maintenance of the system is necessary. The UV lamps will require replacement after 9,000 hours of use (about once a year). The quartz sheaths in which the UV lamps are enclosed may require cleaning once or twice a year to remove any scaling. Scaling is not anticipated to be a problem for the reasons discussed above. Cleaning of the quartz sheaths is a simple process, however, and can be accomplished in several hours. The ozone generator contains dielectric cells that will require cleaning once every two years. The air compressor calls for normal routine maintenance (e.g., lubrication).

Cost

A bench-scale laboratory treatability study will be required to determine the design parameters for a full-scale ULTROX system applicable for treatment of the groundwater at the CC facility. The laboratory treatability study costs $600 per day, with a five-day minimum, plus analytical costs. It is estimated that the bench-scale laboratory treatability study will last five days. Based upon conversations with ULTROX personnel, a pilot-plant study probably would not be necessary; therefore, the cost for a pilot-plant study has not been included in this cost analysis.

The capital cost for a 100-gpm ULTROX system suitable for treating an average VOC influent concentration of 200 ppb is estimated to range from $90,000 to $125,000. (The ULTROX system selected will depend upon the results of the bench-scale laboratory study). System costs would increase $15,000 to $20,000 for units capable of treating an influent concentration of 500 ppb. If a 200-gpm ULTROX system were required, two 100-gpm systems could be run in parallel or a larger system could be purchased at an approximate savings of 20% compared to the cost of purchasing and operating two ULTROX systems together. This capital cost does not include shipping or installation. Shipping costs from Santa Ana, California are estimated at $2,500. Installation and set up costs are estimated at $10,000. (The vendor would be under a performance guarantee; therefore, the system would be functioning as specified in the performance guarantee before ULTROX left the site.) Additional costs would be incurred for similar ancillary equipment described above for air stripping that would be needed for the installation and operation of the oxidation system (some of these items would be smaller and/or less expensive than those needed for air stripping due to UV/ozonation's more integrated nature and smaller size). Costs for design and consultant services during construction would also be required. The total estimated capital costs for the UV/ozonation system for the several scenarios considered are presented in Table 2-7.

O&M costs for a 100-gpm ULTROX system suitable for treating an average VOC influent concentration of 200 ppb were quoted to be in the range of $0.15 to $0.20 per 1,000 gallons (assuming the cost of electrical energy to be $0.06/KWH). If the UV/ozonation system would be required to treat at a higher total chlorinated organic average influent concentration of 500 ppb, there would be an an approximate 25% increase in O&M costs. Therefore, the estimated O&M costs would range from $0.20 to $0.25 per 1,000 gallons. This cost range includes the electricity needed to operate the system. Costs for oversight of the system's operation, including weekly collection and analysis of samples, is estimated at $22,500 per year. The O&M costs for UV/ozonation for each of the scenarios considered are presented in Table 2-8.

For each scenario considered, a present-worth cost was calculated incorporating both the capital costs and the O&M costs, with future O&M costs discounted to reflect their present worth, assuming a net interest rate of 5%. For comparison, present-worth costs were calculated for both the expected duration of treatment (5 years) and for extended treatment durations of 10 and 30 years. These costs are presented in Table 2-9. It must be noted that these costs do not include the cost of groundwater extraction or disposal of treated groundwater.

CARBON ADSORPTION

Effectiveness

Carbon adsorption is a well-demonstrated technology for removal of organic contaminants like those found in groundwater extracted at the CC facility. As carbon adsorption is routinely used to treat groundwater (or other drinking water sources) containing chlorinated organics, it would be expected to readily remove all the chlorinated organics from the extracted groundwater. A site-specific isotherm study performed with CC groundwater has shown that carbon is effective in removing chlorinated organics in batch mode. As discussed in Section 2.4.1.1.2, continuous carbon treatment completely removes organic compounds from the aqueous solution until the column becomes saturated. Slugs of groundwater containing higher or lower levels of chlorinated organics would not affect effluent quality, although total bed capacity (i.e., time to saturation) would vary.

Carbon adsorption alone, however, would not permanently destroy the chlorinated organics. Carbon adsorption is a mass-transfer process in which organic compounds are transferred to the activated carbon. The activated carbon would have to be replaced periodically and the spent carbon regenerated and/or disposed of. A likely disposal option would be off-site regeneration in which the desorbed organic vapors are destroyed by incineration.

Implementability

A carbon adsorption treatment system would be relatively simple to construct and operate. Because the technology is well established, few technical difficulties or unknowns are expected to be encountered during construction and operation. The necessary materials and equipment are readily available from several vendors. O&M requirements would be minimal and would mainly involve monitoring the effluent for breakthrough.

As with air stripping (with vapor-phase carbon-adsorption), the only major issue related to the implementation of this treatment option is the necessity to arrange for the disposal of spent activated carbon. The chlorinated organics are classified as F002 RCRA wastes; the spent carbon would be similarly classified and subject to the land disposal restrictions associated with the RCRA-listed waste it contains. Most likely, the spent carbon would be incinerated or otherwise treated/regenerated by a RCRA-permitted facility. Three incineration facilities are located less than 400 miles from the CC site; these facilities would accept the spent carbon if it met their acceptance criteria.

Cost

The process-specific costs for carbon adsorption include only the capital cost of the carbon columns (two in series), the O&M cost of spent carbon replacement, and the labor required to monitor the system. The size of the carbon columns, and hence their costs, are determined by the groundwater flow rate and the time that elapses between carbon replacement. Because of the relatively large flow rates considered for the CC facility, appropriately sized columns would be required to produce an acceptable low-pressure drop and provide sufficient resident time to ensure good mass transfer.

Three vendors were contacted for cost estimates on capital and carbon costs. Costs were obtained for two vessels in series, each capable of containing 6,500 pounds of carbon. This capacity allows approximately 17 minutes of contact time (per adsorber) at 100 gpm, or 8.5 minutes of contact time (per adsorber) at 200 gpm. Price quotations ranged from $30,500 to $98,000. The highest- priced unit is the Model 7.5 adsorption system from Calgon Carbon. This model's higher price reflects the fact that the unit is fully assembled (skid-mounted) and contains all the necessary piping and valves. Because of this unit's high degree of integration, it is chosen as the representative carbon adsorption equipment for costing purposes. The size of the vessel costed would be applicable to either flow rate considered. The different vendors contacted provided conflicting estimates on the size of the vessels required. However, as all the vendors recommended a 6,500-pound carbon adsorber for one or both of the flow rates considered, this size was considered appropriate for both flow rates for this preliminary cost estimate.

Other capital costs required for carbon adsorption treatment would include costs for a bench-scale column treatability study to more accurately predict the carbon usage rate, as well as the ancillary equipment described previously for air stripping that would be needed for the installation and operation of the carbon adsorption system (some of these items would be smaller and/or less expensive than for air stripping due to the carbon adsorption unit's more integrated nature and smaller size). Costs for design and consultant services during construction would also be incurred. The total estimated capital costs for the carbon adsorption system are presented in Table 2-10.

Carbon usage rates can be estimated from the site-specific carbon adsorption isotherm produced by E & E in 1989 (E & E 1989). The isotherms for TCE, 1,2-DCE, VC, and MC, constructed from results of tests on groundwater from monitoring well B-17M, are presented in Figure 2-1. For a continuous carbon column system with no mass-transfer limitations, the carbon may be loaded up to the point in equilibrium with the influent contaminant concentration. The carbon usage rate (in grams per liter of influent) is calculated from this figure as follows:

$$\text{carbon usage rate (g/L)} = \frac{\text{influent concentration (mg/L)}}{\text{carbon loading (mg/g)}}$$

The influent contaminant concentrations, the associated carbon loading, and the calculated carbon usage rate for both principal contaminants of concern and for the two concentration scenarios are presented in Table 2-11. It should be noted that VC is not included in this table, despite the fact that this compound often is the limiting compound for carbon adsorption due to its poor adsorbability. However, the expected concentration in the extracted groundwater would be less than 25 ppb, thus below the expected surface-water action-specific SCGs (see Section 2.2.2). These figures show that DCE, while at a lower concentration than TCE, dictates the carbon usage rate because of its poorer adsorbability.

Actual carbon usage rates would be higher than those indicated because of finite mass transfer rates and a certain degree of backmixing, leading to a sloped breakthrough curve. For costing purposes, carbon usage rates are assumed to be three times greater than predicted by the isotherm data. With these assumptions, the 6,500 pounds of carbon in the lead (upgradient) adsorber would have to be replaced every 6.6 months for the low concentration scenario and 3.9 months for the high concentration scenario, assuming a flow rate of 100 gpm. If the flow rate were 200 gpm, the carbon would require replacement twice as often.

The cost of carbon would include not only fresh carbon but the disposal of spent carbon. The cost of such an exchange of carbon, including transportation to and from the carbon regeneration facility, is estimated at $1.50 per pound, based on vendor quotations. Because it is an inherently simpler operation, treatment by carbon adsorption requires less labor than air stripping or UV oxidation. On the average, only 2 labor-hours per week are estimated to be required, principally for pressure-drop monitoring and sampling, and the periodic back-flushing and carbon replacement. A summary of the operating costs for each scenario is presented in Table 2-12.

For each scenario considered, a present-worth cost was calculated incorporating both the capital costs and the O&M costs, with future O&M costs discounted to reflect their present worth, assuming a net interest rate of 5%. Present-worth costs were calculated for both the expected duration of treatment (5 years), as well as extended treatment durations of 10 and 30 years, for comparison. These costs are presented in Table 2-13. These costs do not include the cost of groundwater extraction or disposal of treated groundwater.

2.4.1.2.3 General Response Action: Off-Site Treatment and/or Disposal

DISCHARGE TO POTW

Effectiveness

Unlike the other two technologies under this general response action, discharge to a POTW would accomplish two objectives: treatment of extracted groundwater and discharge to surface water (i.e., to the Niagara River via the POTW's effluent). No specific testing has been conducted on the effectiveness of the NCSD plant's treatment of the CC facility's groundwater. However, according to NCSD, their influent currently contains TCE at comparable concentrations, while its effluent meets the discharge standards for TCE specified in its SPDES permit. The TCE is probably treated by a combination of physical (volatilization and adsorption) and biological processes, resulting in its removal from the water. Thus, the POTW would be considered effective for the treatment of the CC facility's groundwater. Regarding the disposal function of the POTW, the effluent is discharged to the Niagara River, thereby providing effective disposal of the treated groundwater.

Implementability

NCSD must obtain a modification of its SPDES permit to specifically allow the acceptance of the CC facility groundwater. NCSD has applied for this modification and expects to have it approved in the near future.

Cost

The cost of treatment and disposal has been proposed by NCSD to be $1.37 per 1,000 gallons discharged. This corresponds to an annual cost of $71,900 per year for a 100-gpm discharge and $143,800 for a 200 gpm discharge. An additional $5,000 annually is estimated to be required for periodic sampling and analysis of the discharged groundwater. Table 2-14 summarizes these operating costs and presents their present worths for 5, 10, and 30 years of operation.

REINJECTION TO GROUNDWATER

Effectiveness

If the problems associated with implementation discussed below are resolved, reinjection to groundwater would be an effective means to dispose of treated groundwater.

Implementability

With this technology, groundwater would be reinjected into the bedrock aquifer following treatment. There are several obstacles to implementing reinjection. First, a higher treatment level compared to that required of groundwater discharged to surface water (most likely, to drinking water standards) would be required before the groundwater would be injected. Second, due to the complex nature of the fractured bedrock at the site, it may be quite difficult to locate areas suitable for injection. As a worst case, an injection well could partially redirect the groundwater plume inadvertently. Thirdly, the high natural content of metals and dissolved solids in the Lockport Dolomite aquifer would result in the need for periodic maintenance to remove precipitants from injection wells. Injection wells could potentially be abandoned because of this problem.

Injection wells would be beneficial at a site where an increased volume of water or an increased hydraulic gradient would provide for more rapid groundwater remediation. Both of the factors would result from upgradient injection. However, as demonstrated by two pumping tests, a sufficient volume of groundwater exists in the bedrock aquifer, and groundwater velocities are high enough to promote effective groundwater remediation. Thus, reinjection is not regarded as a viable alternative due to the potential mechanical problems and fracture media heterogeneities discussed previously. Moreover, there would be no perceived benefit to assist in groundwater remediation at the site.

Cost

The cost is not specifically estimated for the reinjection option because, at face value, this process is more expensive than discharging to surface water. Greater pressure would be required to pump the liquid to the discharge point, capital cost would be greater as it would require installation of an injection well, and associated treatment costs may be higher due to potentially stricter discharge standards.

DISCHARGE TO SURFACE WATER

Effectiveness

Cayuga Creek is located adjacent to the CC facility. The creek has been used previously as a point for permitted wastewater discharge and thus would be effective for future discharges.

Implementability

A new SPDES permit would be required before treated groundwater is discharged to the creek. Such a permit would likely be issued, and it would specify the levels to which the groundwater should be treated prior to discharge. Overall, there are no significant obstacles to implementation.

Cost

Only minor costs would be associated with the discharge-to-surface-water option, as a SPDES outfall trench already exists. If, for security reasons, this trench is replaced with an enclosed pipe, the pipe would cost approximately $15,000, estimated as 3,000 feet of pipe at $5 per foot.

2.4.1.3 Groundwater Technology Selection

For the general response action of groundwater extraction, it is clear that extraction wells are more effective and more easily implemented than subsurface drains. Thus, alternatives calling for extraction of groundwater would use extraction wells for this purpose.

The general response actions of on-site aboveground treatment and off-site treatment and/or disposal are considered together, to a certain extent. Specifically, the off-site treatment technology of discharge to POTWs is compared and evaluated with the three on-site treatment technologies: air stripping, UV/ozonation, and carbon adsorption. Whereas the other two off-site disposal technologies (discharge to groundwater and discharge to surface water) would require treatment first, raw extracted groundwater would be discharged to a POTW for both treatment and disposal. This is directly comparable to aboveground on-site treatment technologies, which would also receive the raw extracted groundwater.

All three of the on-site treatment technologies, as well as discharge to POTWs, are equally effective. Air stripping and carbon adsorption are widely used technologies. Air stripping's effectiveness in removing volatile chlorinated organics would not be influenced by any properties of the groundwater. Carbon adsorption's effectiveness has been demonstrated through a site-specific isotherm study and is also known to be effective in industry for treatment of chlorinated organics. UV/ozonation has not been tested for its effectiveness on CC facility groundwater, but, based on its performance on similar aqueous streams, it is expected to be effective. The NCSD POTW's influent currently contains TCE and other volatile organics at levels at or above what would be extracted at the CC facility. NCSD adequately treats these components, as demonstrated by meeting the discharge requirements for these compounds.

The implementability of each of the on-site treatment technologies and discharge to a POTW are equivalent. Although selection of an on-site treatment technology would require the installation of such a system, these treatment units are readily available from commercial suppliers.

Cost would thus be the determining factor in selecting a groundwater treatment technology. The cost estimates for the on-site treatment technologies were developed in greater detail than is normally employed in feasibility studies. This was done in order to accurately compare the true overall costs of these technologies with the much more basic and uncomplicated cost of direct discharge to a POTW that would consist solely of the discharge fee and periodic monitoring costs (note that the costs for the extraction of the groundwater are external and thus excluded from this analysis; they would be equivalent for all options).

The present worths of each of the technologies have been calculated in the previous section. These estimates show that the most economical option depends on which flow rate is assumed, what concentration level is treated, and how long the treatment lasts. Table 2-15 presents the option or options that are the most economical for each of the conditions considered. Where costs of competing technologies are estimated to be within 5% of each other for a given scenario, each of these options is listed. Where a certain technology is estimated to be clearly less expensive than the alternatives, it is listed along with the relative cost of the next cheapest option.

Table 2-15 shows that, depending on the conditions assumed, any of the four treatment options may be considered the most cost-effective. Several trends are evident from this table. In the long term (i.e., 30 years of operation), direct discharge to a POTW is not cost effective due to its high annual operating cost (i.e., the discharge fee of $1.37 per thousand gallons). In the short term, however (5 or 10 years), discharge to a POTW is economical for lower flow rates (i.e., 100 gpm). Indeed, for 5-year operation scenarios, discharge to a POTW is overwhelmingly the most cost-effective due to its lack of initial costs. At higher flow rates, however (i.e., 200 gpm), the discharge costs, which are proportional to the flow rate, put the POTW at a disadvantage to on-site treatment technologies. At these higher flow rates, air stripping is more cost effective at the higher concentrations (i.e., 500 ppb) and longer treatment durations. Other technologies are also cost-effective, however: at shorter durations, carbon adsorption is competitive due to its lower capital costs, while UV/ozonation is competitive at longer durations due to its lower O&M costs. At the lower concentrations (i.e., 200 ppm), carbon adsorption is cost-effective in many cases. The lower concentrations translate into lower carbon usage rates and, thus, lower O&M costs. UV/ozonation is also cost-effective at the lower concentrations and higher flow rates.

What these results really indicate is that, except for 5-year operation at the lower flow rate, all four technologies are equivalently priced. Many assumptions have gone into the cost estimates, making their margin of error an estimated 20% to 30%. For the purposes of the feasibility study, the technologies shown in Table 2-16 (based on data from Table 2-15) will be used. However, as any remedial action at the CC facility will employ some groundwater extraction and treatment, it is recommended that CC initiate groundwater treatment with the discharge-to-POTW option. Once groundwater extraction has commenced, a clearer picture of the contaminant concentrations, flow rate, and, possibly, duration of treatment will emerge. At that point, a more accurate cost estimate for the various technologies can be made, and firm bids from technology vendors could be evaluated. The actual groundwater treatment technology ultimately selected does not have a bearing on the effectiveness, implementability, or cost of the remedial alternatives in Section 3.

Table 2-16 shows that carbon adsorption is apparently the preferred technology for all classes of alternatives except for those that include source remediation and extract groundwater only upgradient of the hydrogeologic boundary (i.e., the lower-flow-rate and shorter-duration alternatives). It should be noted that carbon adsorption is recommended for the higher-flow-rate, longer-duration alternatives, despite the fact that Table 2-15 indicates UV/ozonation and air stripping are more cost-effective for these conditions. This is because the higher-flow-rate scenario would not occur for longer than 5 years. Pumping of the upgradient portion of the plume would hydraulically contain the contaminants. Without a continuing source of contaminants, the downgradient plume need only be extracted until it is remediated (in an estimated 5 years). At that time, only on-site extraction would be required. Thus, after 5 years, groundwater would only be pumped at the lower flow rate and thus be appropriate for carbon treatment.

Regarding disposal of on-site treated groundwater, two technologies were considered: reinjection to groundwater and discharge to surface water. Discharge to surface water is selected for incorporation into remedial alternatives because it is as effective as reinjection to groundwater but is far easier and less costly to implement.

2.4.2 Soil Medium Technologies

2.4.2.1 Soil Technology Identification

2.4.2.1.1 Response Action: Excavation

Excavation, removal, and hauling of contaminated soils are generally accomplished with conventional heavy construction equipment (e.g., backhoes, bulldozers, and dump trucks). Excavation of contaminated soils is typically followed by land disposal or treatment.

2.4.2.1.2 Response Action: Disposal

Three types of disposal are considered under this response action: disposal in an off-site RCRA facility, disposal in a constructed on-site RCRA facility, and disposal on-site as a non-RCRA waste. Land disposal of contaminated soils has historically been a popular remedial alternative; this procedure often represented the quickest, simplest approach to remediating a site. More recently, the trend has been toward utilizing treatment technologies to remediate a site. This trend is attributable to the following two factors:

- Section 121 of the Superfund Amendments and Reauthorization Act (SARA) of 1986 requiring that preference be given to remedial action that "...permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances." SARA further states "that off-site transport and disposal...without such treatment should be the least favored alternative remedial action where practical treatment technologies are available."

- In 1984, Congress passed the Hazardous and Solid Waste Amendment of 1984 (HSWA) that mandated stringent new land disposal limitations--the RCRA land disposal restrictions.

The RCRA land-disposal restrictions are applicable to the soils at the CC facility since they contain a RCRA hazardous waste (F002) that is restricted from land disposal. Under the land-disposal restrictions, the soil from the CC facility cannot be land disposed unless the leachate from the TCLP assay meets the treatment standards for F002 wastes. The treatment standards for F002 wastes are provided in Table 2-17 and are listed in 40 CFR 268. The results of TCLP analyses indicate that treatment of the soils would be required prior to land disposal. Soils treated to below-TCLP levels mandated by the land-disposal restrictions would still need to be disposed of as a hazardous waste in a RCRA-permitted facility. There are two RCRA-permitted land disposal options: either construction of an on-site disposal facility or off-site disposal in a commercial facility. Off-site disposal for the soils at the CC facility is viable if the off-site facility also has treatment capabilities. This option would be quite expensive, primarily because of the off-site treatment required prior to disposal.

Because of the RCRA land-disposal restrictions, on-site disposal would require on-site treatment. On-site treatment options applicable for remediation of the soils at the CC facility include volatilization, low-temperature thermal desorption, and incineration. However, all three of these remedial technologies may remove the chlorinated compounds from the soils to the extent that the treated soils would not require disposal in a secure landfill. Specifically, the soils would be treated to levels such that they could be considered to not contain the listed contaminants, either through non-detection of these compounds or through their being present below de minimus levels. According to the EPA's "contained-in" policy (see Section 2.2.2), the treated soil would then not have to be managed as a hazardous waste. Most likely, the treated soils could be backfilled on-site. This backfilling would constitute non-RCRA-regulated on-site disposal. (NYSDEC would determine the de minimus levels at which the soils would no longer be required to be managed as a hazardous waste and could be backfilled on site. These de minimus levels may be set at zero or non-detect.)

2.4.2.1.3 **Response Action: Aboveground Treatment**

Treatment technologies for soil containing chlorinated organics can be divided into three general areas of treatment: biological, physical, and chemical.

BIOLOGICAL TREATMENT

Biological treatment technologies employ microorganisms to mineralize organic compounds into water, carbon dioxide, and (if chlorinated) hydrogen chloride. As discussed in Section 2.4.1.1.2, biological treatment has, with a few exceptions, been applied to chlorinated organic contamination problems only on a pilot or developmental scale. Furthermore, the aerobic techniques under development require thorough aeration, and, for some systems, the addition of methane. This procedure results in the removal of a significant fraction of the chlorinated organics through volatilization, indicating removal through volatilization itself would be more effective than biodegradation, although further treatment or disposal of the resulting vapors may be required.

PHYSICAL TREATMENT

Physical treatment technologies involve physical manipulation of the soil in order to immobilize or remove waste constituents. These technologies include volatilization, soil washing, and solidification.

Volatilization

Volatilization is a process that uses air, heat, and/or mechanical agitation to physically transfer contaminants into the air phase. Recently, various volatilization techniques have been tested and used as innovative technologies to remediate soils containing volatile organic compounds. The two volatilization techniques that appear to be the most applicable for the CC facility are volatilization utilizing a mobile low-temperature thermal desorption unit and volatilization utilizing a vibratory screen method. Each of these two methods is described below.

Low-Temperature Thermal Desorption

Low-temperature thermal desorption is a physical separation process used to transfer volatile compounds from a solid matrix into a gas stream, typically using air, heat, and mechanical agitation. The volatile compounds transferred into the gas stream are then subjected to further treatment (e.g., carbon adsorption or high-temperature incineration). This is a relatively new technology, and many applications are under development. This technology is most effective on the more volatile organic compounds (i.e., those with a Henry's Law constant greater than 3.0×10^{-3} atm-m^3/mole). The organic compound of concern at the CC facility, TCE, has a Henry's Law constant equal to 9.1×10^{-3} atm-m^3/mole, indicating that low-temperature thermal desorption could be a favorable technology for remediation of soil at the CC facility. Removal efficiencies exceeding 99.9% for non-polar halogenated aromatic compounds like TCE have been demonstrated by low-temperature thermal desorption units during bench, pilot, and full-scale studies (CDM 1989). A bench-scale study would be recommended to determine the applicability/feasibility of utilizing low-temperature thermal desorption to remediate the soils at the CC facility.

There are primarily three low-temperature thermal desorption units commercially available. Although these units are not identical, the overall process description can generally be described as follows: contaminated soil is excavated and stockpiled for feeding into a thermal processor or materials dryer. Within the thermal processor or materials dryer, the contaminated soil is heated to 400 to 800°F and mixed/agitated, allowing the moisture and volatiles to escape from the soil. After processing, the heated soil is discharged from the processor/dryer as a powdered or granular material. For most applications, water will be mixed with the exiting soil for cooling purposes and to mitigate dust generation during the handling of the treated soil. The treated soil is stockpiled until laboratory analysis verifies that cleanup goals have been met. The dryer gases, containing VOCs and dust, are vented into a cyclone/baghouse (fabric filter) system to remove the entrained particulate material. The air stream is then directed into a condenser to condense the volatile organic compounds for subsequent treatment using either a vapor phase carbon adsorption unit or an afterburner.

The treated soils may be suitable for use as on-site backfill. Use of the treated soil as backfill would depend upon NYSDEC, which would determine the de minimus levels at which the soil would no longer have to be managed as a hazardous waste. Although NYSDEC has not determined de minimus levels for soils containing F002 wastes (below which the F002 contaminated soils would no longer have to be managed as a hazardous waste), it can be reasonably assumed that low-temperature thermal desorption would achieve the de minimus levels because removal efficiencies of more than 99.9% have been demonstrated for halogenated chlorinated organic compounds. Any residual products from the thermal desorption treatment process (e.g., spent carbon, condensed oil, particulate matter) would be considered as containing a hazardous waste and would have to be managed appropriately.

Vibratory Screen Method

The vibratory screen method is a volatilization technique that disturbs the structure of the soil, facilitating the release of volatile compounds. This volatilization technique employs a vibratory screen mechanism, or mechanical sieve. A mechanical sieve is a conventional piece of portable construction equipment typically used for size fraction grading in the construction and quarry industries.

Using this volatilization technique, contaminated soils are excavated and dumped into the loading hopper of the mechanical sieve. The mechanical sieve processes the soil through a series of blades and grates to break it down. The soil is then transported on a conveyor belt to a series of vibratory screens that further disaggregate and separate the soil into three size fractions. The soil is then stockpiled until samples collected from the treated soil verify that cleanup goals have been met. Some soil may require more than one pass through the mechanical sieve to achieve cleanup goals. A treatability study would be recommended prior to implementing this method of volatilization to determine its effectiveness for remediation of the soils at the CC facility.

As with low-temperature thermal desorption, the soil treated with a mechanical sieve may be used as on-site backfill (i.e., the soil would no longer be considered as containing F002 wastes, assuming it met the de minimus levels established by NYSDEC.)

Soil Washing

Soil washing is a physical transfer process in which contaminants are disassociated from the soil by becoming dissolved or suspended in a liquid medium. Water could be used as the liquid medium to remove/disassociate the lower weight halogenated hydrocarbons (e.g., TCE) that are found in the soil matrix at the CC facility. However, soil washing is not considered an applicable technology for remediation of the soils at the CC facility for the following reasons:

- Typically, soil washing is more effective on sandy soils than on soils high in clay because the contaminant-soil bond is within the clay particles, rather than on the outside of the sand particles, and clays have proportionally more surface area than sand available for contaminant adsorption. The soils at the CC facility are primarily fine-grained silts and clays, making soil washing a remedial technology of questionable effectiveness.

- Some difficulties related to solid/liquid separation subsequent to the washing phase have occurred in soil washing systems. Such difficulties are often due to a high percentage of fine-grained silts or clays in the soil material. Since the soil at the CC facility is made up of primarily fine-grained silts and clays, it could be difficult to remove fine particles from the washing solution, thus hindering the overall effectiveness of soil washing as a remedial technology.

- Although the soil may be treated so that it no longer has to be managed as a RCRA hazardous waste (i.e., it could be backfilled on site), any treatment residues would have to be managed as a RCRA hazardous waste and would be subject to the land disposal restrictions. Treatment and disposal of any residues generated from the soil washing process could add significant costs to this remedial option.

Solidification

Solidification/stabilization is a physical treatment process wherein the contaminants are bound in a solid matrix through the addition of chemicals. Solidification of wastes produces a monolithic block with high structural integrity. The contaminants do not necessarily interact chemically with the chemical reagents, but are mechanically locked within the solidified matrix, thereby limiting the solubility or mobility of the contaminants. Although solidification treatment can be used on organic compounds, it is not considered a viable option for treatment of soils at the CC facility for the following reasons:

- o Solidification/stabilization is not well demonstrated for the remediation of soil containing VOCs. Volatile organics are typically not immobilized (creating the potential for migration as vapors) and may be driven off by heat-of-reaction processes, although certain proprietary processes claim to bind lighter organic compounds, as well.

- o Following treatment, the solidified soil would still have to be managed as a hazardous waste under RCRA and would be subject to the land-disposal restrictions. The treatment standards codified in 40 CFR Part 268 for an F002 waste would have to be met prior to land disposal in a secure landfill. Considering that the soil volume would expand upon solidification treatment, and the potentially large volume of soil requiring treatment at the CC facility, the issue of final disposal is a significant deterrent to utilizing solidification treatment.

THERMAL TREATMENT

Thermal treatment is a method that employs high-temperature oxidation under controlled conditions to degrade substances into products that generally include carbon dioxide, water vapor, sulfur dioxide, nitrogen oxides, hydrogen chloride, and ash. Several types of incinerators are technically feasible and have been used to treat hazardous soil, including multiple-hearth, fluidized-bed, and rotary-kiln incinerators. Rotary kiln incineration is most commonly used for soil, probably because of its relative simplicity and more readily available equipment. Feed systems can be altered to accommodate large-diameter particles, and residence times can be increased to ensure that all contaminants have been treated. Depending on the capacity of the unit, rotary kilns can also process large volumes of wastes.

Thermal destruction is a proven technology that can effectively and rapidly treat all organic compounds. This procedure consistently achieves the best overall results for these contaminants, usually accomplishing well over 99% removal.

The soil at the CC facility containing chlorinated organics could be incinerated utilizing one of three options:

- o On-site incineration by the construction of a site-specific thermal destruction unit;
- o On-site incineration utilizing a mobile incineration system; or
- o Off-site incineration at a RCRA-permitted incineration facility.

Given the estimated volume of soil containing chlorinated organics (32,500 yd^3), construction of a site-specific incinerator would be prohibitively expensive for remediation of the soils at the CC facility. A more realistic on-site incineration option would be to utilize a mobile rotary kiln incineration system; these systems are widely available from many commercial vendors and are widely used for the treatment of hazardous waste.

Even though a number of RCRA-permitted incineration facilities are located less than 500 miles from the CC facility, the off-site incineration option is not considered economically feasible for the soils at the CC facility. Off-site incineration costs from approximately $0.70 to $0.90 per pound of soil, making it a prohibitively expensive remedial option (incineration costs alone would be in excess of $60 million).

To summarize, on-site incineration utilizing a mobile rotary kiln system is the most applicable of the three incineration options available for remediation of the soils at the CC facility. This option will be screened with the other applicable remedial technologies in Section 2.4.2.2, Soil-Technology Screening.

2.4.2.1.4 Response Action--*In Situ* Treatment

A number of treatment methods involve in-place or *in situ* treatment of contaminated soils and wastes. The *in situ* treatment methods potentially applicable to the halogenated organic compounds found in the soils at the CC facility include soil flushing, vacuum extraction, and bioremediation.

Soil Flushing

In situ soil flushing is a process applied to unexcavated soils using a groundwater extraction/reinjection system. An aqueous solution is injected into the area of contamination, and the contaminant elutriate is pumped to the surface for removal, recirculation, or on-site treatment. During elutriation, sorbed contaminants are mobilized into solution because of solubility, formation of an emulsion, or chemical reaction with the flushing solution. An _in situ_ soil-flushing system includes extraction wells installed in the area of soil contamination, injection wells installed upgradient of the contaminated soil area, and a wastewater treatment system.

Vacuum Extraction

In situ vacuum extraction is a technique for the removal of volatile organic compounds (VOCs) from the vadose (or unsaturated) zone of soils. The basic components of the system include production wells, monitoring wells, and high-vacuum pumps. The vacuum pumps are connected via a pipe system to the production wells, which are installed through the contaminated soil zone. The monitoring wells are installed around the production wells to monitor the interstitial air pressure.

The _in situ_ vacuum extraction system operates by applying a vacuum through the production wells. The vacuum system induces air flow through the soil, stripping and volatilizing the VOCs from the soil matrix into the air stream. Along with the gaseous VOCs, contaminated groundwater is generally extracted. (The quantity of extracted VOC-contaminated groundwater will depend on the moisture content of the soil in the vadose zone.) The two-phase flow of contaminated air and water flows into a vapor-liquid separator, where the contaminated groundwater is removed. The groundwater will require subsequent treatment (e.g., carbon adsorption or air stripping). The contaminated air stream is typically treated by utilizing an activated carbon bed.

Since vapor extraction is an _in situ_ treatment (it does not involve the placement of hazardous waste), RCRA land disposal restrictions are not applicable. However, residuals generated from the vapor extraction treatment process must be managed as restricted hazardous waste.

2.4.2.2 Soil Technology Screening

The following remedial technologies were identified in the previous section as the technologies most applicable to remediation of the soils at the CC facility:

- Response Action: Excavation
  - o Excavation
- Response Action: Aboveground Treatment
  - o On-site thermal desorption
  - o On-site vibratory screen volatilization
  - o On-site incineration
- Response Action: _In situ_ Treatment
  - o Vacuum extraction
  - o Soil flushing.

In this section, each of the aforementioned technologies is analyzed/screened based upon the criteria of effectiveness, implementability, and, to the degree appropriate, cost. These criteria will be used to reduce the list of applicable technologies to the single, most-appropriate technology for a general response action.

2.4.2.2.1 Response Action: Excavation

Excavation is a well demonstrated and reliable technology for the removal of contaminated soil.

Implementation is relatively simple, and no special equipment or materials are required. Due to the seasonally high groundwater levels, groundwater seepage into excavation areas could impede excavation operations. However, groundwater extraction or cutoff techniques can be used to facilitate efficient removal of contaminated soils.

Excavation of soils containing VOCs presents the possibility of releasing the volatile contaminants into the atmosphere, in addition to the possibility of generating contaminant-laden dust. During excavation activities, air quality monitoring is required and dust and/or vapor control measures (e.g., foam or water) could be required.

Soil sampling would be required upon completion of excavation to verify that all soil not meeting established cleanup goals has been removed.

A problem with implementability is posed, however, since a significant amount of contaminated soil is located immediately adjacent to buildings that are currently in use. Removal of these buildings would pose an unacceptable burden on CC's operations. However, due to excavation's effectiveness in removing contaminated soil from areas where it could impact groundwater quality, this technology is retained for possible incorporation into remedial alternatives.

2.4.2.2.2 Response Action: Aboveground Treatment

VOLATILIZATION

The two volatilization techniques (low-temperature thermal desorption and vibratory screen method) identified in the previous section are technically similar (i.e., they strip VOCs from soils by excavating, disturbing, aerating, and sometimes heating). The evaluations of these two volatilization technologies based on the criteria of effectiveness, implementability, and cost are described together below.

Effectiveness

Low-Temperature Thermal Desorption. Low-temperature thermal desorption is a relatively new technology. Bench-, pilot-, and several full-scale demonstrations have been performed on soil containing VOCs such as TCE; a 99.9% VOC removal efficiency was typically achieved during these demonstrations. Below is a brief summary of selected applications of the low-temperature thermal desorption technology. All of the thermal desorption systems described here are fully mobile.

- o Under contract with the United States Army Toxic and Hazardous Materials Agency (USATHAMA), Roy F. Weston, Inc. performed a pilot- and full-scale demonstration of its Low-Temperature Thermal Treatment (LT^3) system for remediation of VOC-contaminated soil. Greater than 99.9% VOC removal from the soil was demonstrated. Recovered volatiles were destroyed in an afterburner. Stack emissions were in compliance with all federal and state regulations, including those for VOCs, HCL, CO, and particulates.

- o The low-temperature thermal aeration (LTTA) system developed by Canonie Environmental Services Corporation (Canonie) has been used to remediate soils containing, primarily, chlorinated solvents and nonchlorinated aromatic hydrocarbons at two EPA Superfund sites: the McKin Superfund site in Gray, Maine and the Ottatiand Goss/Great Lakes Container Corporation site in Kingston, New Hampshire.

- o Chemical Waste Management has developed the X*TRAX Low Temperature Treatment process to remove volatile or semi-volatile compounds from a solid matrix. To date, laboratory and pilot-scale systems have demonstrated the effectiveness of the X*TRAX system in separating semi-volatile and volatile compounds from a solid matrix. The first full-scale X*TRAX unit has been functionally tested and will be moved to an EPA Superfund site in mid- to late-1990 for remediation of soils containing primarily PCBs and chlorinated solvents such as TCE and PCE.

To determine the remedial effectiveness of thermal desorption, bench-scale equipment is used to predict the expected capability of a full-scale unit to process a given soil matrix with specific contaminants. Pilot-scale testing would not be necessary since data generated from the bench-scale study is typically sufficient to determine the applicability of using a full-scale, low-temperature thermal desorption unit for soil remediation.

Thermal desorption alone, however, would not permanently destroy the chlorinated organics found in the soil matrix at the CC facility. Thermal desorption is a mass-transfer process in which the VOCs in the soil are transferred into the air stream within the thermal processor/materials dryer. The gases released from the thermal processor/materials dryer would require additional treatment prior to release into the atmosphere. A vapor-phase carbon adsorption system or combustion afterburner could be used to remove the organic compounds from the off-gases. A carbon adsorption system would require periodic replacement and/or regeneration. Depending on the disposal arrangements made for the spent carbon, the organic compounds adsorbed into the carbon may be destroyed. A likely disposal option for the spent carbon would be off-site regeneration in which the organic vapors are destroyed by incineration. If a combustion afterburner were used for treatment of the off-gases from the thermal processor/materials dryer, the organic compounds would be destroyed on site. A permit would be required for the combustion afterburner, and stack emissions would have to be in compliance with all applicable federal and state regulations. Pilot- and full-scale demonstrations of thermal desorption systems utilizing combustion afterburners for treatment of system off-gases were in compliance with federal and state regulations, including those for VOCs, HCL, CO, and particulates.

A typical thermal desorption system design includes a condenser. Condensate from the condenser is composed of water and condensed volatile organics and may contain oil from the heating system. The two-phase condensate is separated in an oil/water separator. The separated oil is stored for future transport and processing off site. The water, with a relatively low concentration of soluble organics, is typically treated using a carbon adsorption system. The treated water is sprayed on the treated soil to cool it and suppress dust generation. The spent carbon from the carbon adsorption system would require periodic replacement and/or regeneration. A likely disposal option for the spent carbon would be off-site regeneration in which the organic vapors are destroyed by incineration.

Vibratory Screen Method. Use of a vibratory screen (mechanical sieve) is a new and innovative technology for remediation of soils containing VOCs. This volatilization method has been employed to remediate VOC-contaminated soils for a RCRA facility closure; this procedure will also be used to remediate TCE-contaminated soils at an EPA Superfund site in Pennsylvania.

The primary contaminant of concern at the CC facility, TCE, is characterized by a high vapor pressure and Henry's Law constant, thereby indicating that volatilization would be a feasible method for removal of TCE from the soils.

The high volatility of the contaminant TCE would cause it to readily partition to the atmosphere when the soil structure is disturbed/disaggregated via processing through a mechanical sieve. Disaggregation of the soil structure could be hindered significantly by excessive moisture within the soil matrix (i.e., very wet material could result in clogging of the vibrating screens). Although provisions would be made to lower the groundwater table at the CC facility to facilitate soil excavation activities, use of a mechanical sieve may also be necessary to provide for additional dewatering/drying of excavated soils to allow efficient stripping of VOCs from the soil matrix.

This method for soil remediation is a mass-transfer process in which the VOCs in the soil are transferred into the atmosphere, thus providing significant reductions in soil contaminant toxicity, mobility, and volume, but also creating significant short-term discharge of potentially high concentrations of VOCs into the atmosphere. Before this technology is implemented, a NYSDEC air permit is required. Releases of VOCs would have to be in compliance with this air permit.

A brief treatability study could be conducted to evaluate the overall effectiveness/feasibility of using a mechanical sieve for soil remediation at the CC facility.

Implementability

Low-Temperature Thermal Desorption. The low-temperature thermal desorption systems currently available are fully mobile and owned and operated by commercial vendors. Permitting of the system would be required, as well as the development of monitoring and analytical procedures and protocols. Permitting could be expensive and time consuming.

Once all the proper permits were secured and site preparation activities (e.g., establishment of utilities) were completed, the thermal desorption units could be mobilized. Typically, the systems are transported on flatbed trailers, and approximately one week is required for set-up.

Treated soil could be disposed of on site, assuming that sampling verified the de minimus soil VOC concentrations established by NYSDEC had been met (i.e., the soil no longer is considered to contain a hazardous waste and, therefore, does not have to be managed accordingly). Any treatment residuals (e.g., spent carbon or condensed oil) would most likely have to be managed as a hazardous waste requiring off-site treatment and/or disposal.

Vibratory Screen Method. This remedial technology requires no special equipment or procedures for implementation. Mechanical sieves are readily available from the construction industry.

An air permit from NYSDEC would be required as well as the development of monitoring and analytical procedures and protocols.

As with treatment using low-temperature thermal desorption, soil treated by a mechanical sieve could be disposed of on site, assuming that sampling verified the de minimus soil VOC concentration established by NYSDEC had been met.

Cost

Low-Temperature Thermal Desorption. The estimated cost for the bench-scale study necessary to determine the feasibility of utilizing low-temperature thermal desorption for soil remediation is $15,000 to $20,000. Technology-specific treatment costs are estimated to be $100 to $150 per ton (based on 20% moisture content).

Vibratory Screen Method. Treatment costs for the vibratory screen method are estimated to be $15 to $25 per ton.

INCINERATION

Effectiveness. Incineration is a well-proven technology for the treatment of chlorinated organic compounds in soil. This high-temperature technology (a technology having the ability to heat soil to greater than 1,000°F) has been used to remediate numerous hazardous waste sites. The high-temperature operation virtually guarantees destruction of organic constituents. Destruction and removal efficiencies of 99.99% for the chlorinated organic compounds found at the CC facility have been well demonstrated by both mobile and fixed incineration systems.

Before the beginning of on-site incineration activities utilizing a mobile system, a trial burn would be required to demonstrate that the system meets applicable federal and state environmental criteria.

On-site thermal systems would require careful monitoring of feed-stream characteristics. Development of reliable materials-handling systems would be required to transport, prepare, and feed the soil to the thermal unit. Materials handling and preparation systems for on-site thermal systems are often complex and may add considerably to the time requirements for thermal treatment; increased downtime could also be a result.

Implementability

Implementation of an on-site mobile incineration system may be difficult due to the permitting that would be required. Approval of all necessary permits pertaining to the construction and operation of an on-site mobile incineration system would be required before any site preparation/construction activities are begun. Permitting of thermal incineration systems has historically been difficult and has proven to be a costly and lengthy procedure. Once all the proper permits are secured, the following activities would have to be implemented in the order specified:

- o Installation of the transportable thermal unit;
- o Startup and shakedown operations; and
- o Trial burns.

As with the task of permitting the system, the basics of system mobilization and trial burns are frequently quite lengthy. Mobilization and construction of the unit could take an estimated 12 to 16 weeks. The start-up and shakedown operations would be conducted until trial burns demonstrate that the thermal incineration system meets all federal and state environmental regulations.

The incinerator ash could be disposed of on site after sampling verified that cleanup goals had been met (i.e., the soil no longer contains a hazardous waste).

After completion of remedial activities, demobilization and decontamination of the system would be required. This task would take an estimated two to six weeks.

An additional factor to be considered would be community relations.

Implementation of a program of on-site incineration could generate community opposition.

Cost

Estimated unit costs for on-site thermal incineration range from \$250/ton to \$350/ton, yielding a total cost for on-site incineration of \$12.2 million to \$17 million. Included in this unit cost estimate are the following items:

- o Site preparation (preparation of a graded, graveled work area; concrete pads; and all-weather access roads);
- o System mobilization/demobilization;
- o Labor; and
- o Utilities.

2.4.2.2.3 Response Action: In Situ Treatment

IN SITU VAPOR EXTRACTION

Effectiveness

In situ vapor extraction is a well-demonstrated technology used to remove VOCs from the vadose or unsaturated zone of soil. This technology has been successfully applied for VOC removal at numerous sites over a wide range of geologic and hydrogeologic conditions. All of the volatile priority pollutants have been successfully extracted with the vacuum extraction process, and applications have ranged from small gas stations to large Superfund sites.

In order for a vacuum extraction system to be successful, the system design would have to take into consideration a number of parameters, including soil permeability, porosity, moisture content, stratigraphy, depth to groundwater, and contaminant chemical properties. The soil should have a sufficient air-filled porosity to allow the vacuum and extraction air to do its job of in situ stripping of the VOCs from the soil matrix. Water deters this stripping action as it reduces the air-filled porosity.

Where contaminated soils are periodically saturated with groundwater, as in the case at the CC facility, remediation may be more effective if a dual extraction approach is implemented. Dual extraction is a term that describes the process of simultaneously extracting groundwater and organic vapors from the vacuum extraction wells. This technique would lower the water table, thereby increasing the effective unsaturated zone of soil in which the vacuum extraction process could vaporize organic contaminants. Simultaneous extraction of groundwater and vapors under vacuum enhances recovery of groundwater contaminants and reduces the time frame for total cleanup.

Air and/or groundwater extracted from a vacuum extraction well would require proper handling and may require treatment prior to discharge since vacuum extraction is a mass transfer process and would not destroy the chlorinated organics found at the CC facility. The contaminated air stream would most likely be treated using vapor-phase activated-carbon units. These units would require periodic replacement and/or regeneration. A likely disposal option for the spent carbon would be off-site regeneration so that the organic compounds adsorbed on the carbon could either be recycled or destroyed. Any contaminated groundwater extracted in conjunction with an <u>in situ</u> vapor extraction system would most likely be treated and/or disposed of utilizing the technology selected during this study for remediation of the groundwater beneath the CC facility.

The first phase of a pilot-scale treatability study has been completed at the CC facility. This study consisted of the installation of nine dual extraction (i.e., both vapors and groundwater were extracted) wells that were connected to a vacuum manifold at approximately 15 inches of water vacuum. A higher vacuum pump (i.e., approximately 30 inches of water) was intermittently attached to individual wells. This study showed that the low vacuum system could recover approximately 2 pounds of total chlorinated organics per day out of all nine wells. The higher vacuum system, on the other hand, fitted to only one well at a time, generated both lower pressures and higher flow rates and was thus able to extract an average of 4 pounds per day <u>per well</u>.

In general, these results demonstrate the effectiveness of this technology. However, certain problems were found that will be examined in the second phase of the treatability study. These problems primarily revolve around generating appropriate air flow patterns through the contaminated zones of the soil. Due to the low permeability of the soils and the high vacuum that would be used, several instances of short-circuited air flow (i.e., air flowing from the surface immediately adjacent to the well) occurred. Ideally, air would enter the soil further from the well, migrate through the contaminated portions of the soils, and then enter the extraction well. To promote this, Phase II of the treatability study will incorporate two techniques: first, the ground would be covered with plastic to prevent short-circuiting near the wells, and, second, to ensure air introduction at the appropriate depths and distances from the wells, soil probes (consisting of 0.5-inch steel pipe with a 1-foot screened section at the tip) would be inserted into the contaminated soils. These measures are expected to overcome the short-circuiting problems encountered during the first phase of the treatability study.

Implementability

An <u>in situ</u> vapor extraction system would be relatively simple to construct and operate. The necessary materials, equipment, and personnel are readily available through a number of vendors. Permitting of the system would be required as well as the development of monitoring and analytical protocols and procedures.

Minimal maintenance of the system would be required. Sampling of the off-gases and wastewater would be required to ensure regulatory compliance. The activated carbon units would require replacement when breakthrough has occurred on the primary units. (The primary vapor phase carbon units would be followed by secondary or backup carbon units to ensure that no contamination reaches the atmosphere.)

Since this technology is an <u>in situ</u> treatment, it does not involve the placement of a waste restricted from land disposal under the RCRA regulations, and, therefore, the RCRA land disposal restrictions would not apply to the soil. However, any residuals generated from the treatment of the soils (e.g., activated carbon and recovered groundwater) would have to be managed as a RCRA hazardous waste, subject to the land disposal restrictions.

Cost

The cost for the initial phase pilot-scale study required to determine the effectiveness of in situ vapor extraction was $150,000. (The pilot study has been designed such that it could be integrated into the full-scale remedial action.) Treatment costs for in situ vapor extraction are estimated to be $75 to $125 per cubic yard for the lower-permeability soils found at the CC facility. Additional costs would be required for the activated carbon regeneration.

SOIL FLUSHING

Effectiveness. The effectiveness of soil flushing is limited by the CC facility's hydrogeology. The overburden beneath the facility is rich in silts and clays and thus has a fairly low permeability. The low permeability makes it difficult to force flushing solutions into the overburden and limits the potential for the flushing solution to come into contact and subsequently solubilize the soil contaminants. Additionally, the fractured bedrock system beneath the CC facility complicates the collection of the spent elutriant. In fact, due to the complex geology of the fractured bedrock, there is some possibility that the contaminants may be mobilized from the soil further into the bedrock aquifer, creating a greater contamination problem.

Implementability

There are no technological impediments to implementing a soil flushing system. The only equipment required is injection and recovery wells. However, a SPDES permit would be required to inject the elutriant into the ground. Due to the potential problems with the effectiveness of this treatment method, including the possibility of further migration of the contaminants, such a permit may not be issued. This would present an institutional impediment to implementing this technology.

Cost

Due to the significant disadvantages of this technology as outlined above, no cost estimates have been generated. This technology can be adequately compared to the <u>in situ</u> treatment technologies on the basis of effectiveness and implementability.

2.4.2.3 Soil Technology Selection

Two general response actions were identified for the soils at the CC facility that include soil treatment: on-site aboveground treatment and <u>in situ</u> treatment. For each of these general response actions, the most applicable remedial technologies were identified.

For the general response action of on-site aboveground treatment, volatilization and incineration were identified as the most applicable treatment technologies. Both technologies would effectively meet the remedial cleanup goals established for the soil at the CC facility, though it appears that implementation of on-site incineration activities presents more difficulties (i.e., extensive permitting, lengthy mobilization and trial burn periods, and community opposition). Therefore, volatilization will be the selected on-site aboveground treatment technology to be considered as a component of potential remedial alternatives. Two volatilization technologies were considered: vibratory screening and thermal desorption. To utilize an on-site aboveground treatment, the treatment technology would have to reduce the contaminant concentration to very low levels, potentially non-detect (as a result of the contaminants being RCRA-listed; see Section 2.2.2). Thermal desorption is a much more intensive volatilization technology than vibratory screening. Vibratory screening does not supply heat to drive off the contaminants and water. Contaminants may remain adsorbed to the fine clay particles in moist soil particle aggregates that may pass through the screens, and, therefore, the technique would likely not be adequately effective. As the intensiveness of treatment is of such importance to the selection of an aboveground treatment, thermal desorption is selected as the preferred technology for this general response action.

For the general response action of in situ treatment, in situ vapor extraction and soil flushing were identified as applicable in situ treatment technologies. Because in situ vapor extraction is projected to be particularly applicable and effective, while soil flushing would likely have limited effectiveness, in situ vapor extraction will be retained as the in situ treatment candidate component for the CC facility.

2.5 DEVELOPMENT OF REMEDIAL ALTERNATIVES

In the previous section, several technologies were selected corresponding to the general response actions identified in Section 2.3. In this section, many of these technologies are assembled into comprehensive remedial alternatives for the CC facility. Technologies from each general response action are used in one or more alternatives.

2.5.1 Alternative 1

Alternative 1 is the no action alternative and will serve as a baseline to which the cost and effectiveness of the other alternatives may be compared. The no action alternative does include, however, groundwater monitoring.

2.5.2 Alternative 2

Alternative 2 comprises extraction of groundwater upgradient of the hydrogeologic boundary (see Section 2.1) and treatment of the extracted groundwater by carbon adsorption and subsequent discharge of the treated water to Cayuga Creek through the existing SPDES outfall. No soil treatment is included. Pumping tests have indicated that pumping the existing extraction wells at the facility adequately collects that portion of the plume upgradient of the hydrogeologic barrier. The plume downgradient of this barrier is in poor communication with the "on-site" plume. In this alternative, the downgradient plume would be allowed to naturally attenuate via biodegradation and dispersion. The capture of the "on-site" plume would prevent additional contamination of the downgradient plume.

2.5.3 Alternative 3

Alternative 3 is identical to Alternative 2 except for the additional action of the extraction and treatment of the downgradient plume. Specifically, this alternative calls for the extraction of groundwater from the plume both upgradient and downgradient of the hydrogeologic boundary, treatment by carbon adsorption, and discharge to Cayuga Creek. No soil treatment is included.

2.5.4 Alternative 4

Alternative 4 comprises the in situ treatment of contaminated soil areas with in situ vapor extraction, as well as the extraction and treatment of groundwater upgradient of the hydrogeologic boundary. Under this alternative, groundwater would be discharged to NCSD for disposal and treatment. As discussed in Section 2.4.1.3, this groundwater treatment option would be more economical than on-site treatment for the conditions provided by this alternative.

2.5.5 Alternative 5

Alternative 5 comprises in situ vapor extraction of source areas, groundwater extraction upgradient and downgradient of the hydrogeologic boundary, and carbon adsorption and discharge to Cayuga Creek.

2.5.6 Alternative 6

Alternative 6 comprises the excavation of contaminated soils, treatment via thermal desorption until they no longer contain the chlorinated organics (and thus do not need to be managed as hazardous wastes), and back-filling (disposal) at the site. The "contained-in" interpretation, as stated in OSWER Directive 9347.3-05FS and explained in depth in a June 19, 1989 letter to NYSDEC Commissioner Jorling from the acting assistant administrator of EPA, states that the soils no longer have to be managed as a hazardous waste when they no longer contain the listed chemicals or their concentrations have been reduced to below a risk-based (de minimus) level. Additionally, the groundwater upgradient of the hydrogeologic barrier would be extracted and treated off site by NCSD.

2.5.7 Alternative 7

Alternative 7 comprises excavation of contaminated soils, treatment via thermal desorption, and back-filling at the site. Groundwater would be extracted both upgradient and downgradient of the hydrogeologic boundary, treated with carbon adsorption, and discharged to Cayuga Creek.

Table 2-1

GROUNDWATER SCGs

Compound	Category	SDWA MCL (a) (μg/L)	NYS WQS&G GA(b)(μg/L)
Carbon Tetrachloride	C	5	5
Chloroform	C	100(c)	100(c)
1,1-Dichloroethane	C	--	--
1,1-Dichloroethene	C	7	--
1,2-Dichloroethene	N	cis: 70(p) trans: 100(p)	--
Methylene Chloride	C	--	--
Tetrachloroethene	C	5(p)	--
1,1,1-Trichloroethane	N	200	--
Trichloroethene	C	5	10
Vinyl Chloride	C	2	5

[AD]CZ5020:D3100/3953/27

C: Carcinogen
N: Noncarcinogen

a: Safe Drinking Water Act Maximum Contaminant Level.
b: New York State Water Quality Standards and Guidance Values for Class GA Groundwater (NYSDEC TOGS Series 1.1.1).
c: As trihalomethanes.
p: Proposed value; will become an SCG if it is adopted as final.

Table 2-2

ESTIMATED CONCENTRATION LIMITS FOR DISCHARGE OF TREATED GROUNDWATER TO CAYUGA CREEK

Compound	Concentration (ppb)
Trichloroethene	10
Vinyl chloride	50
Tetrachloroethene	30
Chloroform	50
1,1-Dichloroethene	10
1,2-Dichloroethene	30
Methylene chloride	50
1,1,1-Trichloroethane	20
1,1-Dichloroethane	30

[AD]CZ5020:D3100/3955/42

Source: Martin Doster, P.E., NYSDEC, personal communication to E & E, December 29, 1989.

Table 2-3

CAPITAL COST ESTIMATE FOR AIR STRIPPING*

Item (installed, except for process equipment)	Scenario (flow rate and total contaminant concentration) 100 gpm 200 ppb	200 gpm 200 ppb	100 gpm 500 ppb	200 gpm 500 ppb
Tower, packing, sump, blower	$ 43,000	$ 63,800	$ 50,800	$ 94,700
Installation of process equipment	3,500	5,000	4,000	6,000
Ductwork/blower, towes, vapor pack connection	3,500	5,000	4,000	6,000
Building with slab, electric, HVAC, lights, heat	94,500	94,500	94,500	94,500
Influent tank, with foundation, dike, insulation	15,000	20,600	15,000	20,600
Pumps (3)	6,000	6,000	6,000	6,000
Piping, valves, fittings	9,600	9,600	9,600	9,600
Composite sampler	10,000	10,000	10,000	10,000
Tank level indicator	4,050	4,050	4,050	4,050
Level controller and recorder	12,000	12,000	12,000	12,000
Pressure monitor	1,000	1,000	1,000	1,000
Air flow sensor	1,000	1,000	1,000	1,000
Totalizing flow meter	5,000	5,000	5,000	5,000
Instrument panel	5,000	5,000	5,000	5,000
Transformer	700	700	700	700
Electrical conduit	3,000	3,000	3,000	3,000
Junction/fuse boxes	1,500	1,500	1,500	1,500
Copper wire	1,100	1,100	1,100	1,100
Distribution panel	950	950	950	950
Power to building	10,000	10,000	10,000	10,000
Design	75,000	75,000	75,000	75,000
General services during construction	30,000	30,000	30,000	30,000
Half-time inspection during construction	40,000	40,000	40,000	40,000
O&M manual	12,500	12,500	12,500	12,500
Start-up	6,000	6,000	6,000	6,000
TOTAL CAPITAL COST	$393,900	$423,300	$402,700	$456,200

02[AD]CZ5020:D3100/3958/12

*The costs presented do not include costs for groundwater extraction or disposal of treated groundwater.

Table 2-4

ANNUAL OPERATION AND MAINTENANCE (O&M)
COST ESTIMATE FOR AIR STRIPPING IN DOLLARS PER YEAR*

Item	Scenario (flowrate and total contaminant concentration)			
	100 gpm 200 ppb	200 gpm 200 ppb	100 gpm 500 ppb	200 gpm 500 ppb
Packing Maintenance	2,000	2,000	2,000	2,000
Electricity	3,500	5,000	5,000	6,000
Carbon	7,400	10,400	11,700	19,100
Carbon Transport	1,000	2,000	2,000	5,000
Oversight Monitoring (Labor and sampling)	22,500	22,500	22,500	22,500
General Maintenance (2% of capital)	7,900	8,500	8,100	9,100
Insurance and Taxes (1% of capital)	3,900	4,200	4,000	4,600
Total	48,200	54,600	55,300	68,800

02[AD]CZ5020:D3100/3957/24

*These costs presented do not include costs for groundwater extraction or disposal of treated groundwater.

Table 2-5

SUMMARY OF COSTS FOR TREATMENT BY AIR STRIPPING*

Scenario	Capital Costs	Annual O&M Costs	Present-Worth Costs: 5-Year Operation	Present-Worth Costs: 10-Year Operation	Present-Worth Costs: 30-Year Operation
100 gpm, 200 ppb	393,900	48,200	612,000	780,700	1,150,600
200 gpm, 200 ppb	423,300	54,600	670,300	861,400	1,280,500
100 gpm, 500 ppb	402,700	55,300	652,900	846,400	1,270,900
200 gpm, 500 ppb	456,200	68,800	767,500	1,008,300	1,536,400

02/[AD]CZ5020:D3100/3956/16

*The costs presented do not include the cost of groundwater extraction or treated groundwater disposal.

Table 2-6

SELECTED ULTROX APPLICATIONS

Customer	Application	Contaminants	Results
Municipal water producers	Contaminated drinking water supply	TCE and PCE	VOCs reduced to below state action levels
Automotive foundry	Contaminated groundwater	TCE, trans-1,2-DCE, methylene chloride	Water treated and discharged to a lake
EPA SITE Program - Lorentz Barrel and Drum site	Contaminated groundwater	TCE, PCBs, 1,2-DCE, and vinyl chloride	Water treated and discharged to nearby waterway (pilot-plant study)
Automotive parts manufacturer	Contaminated groundwater	TCE (5,500 ppb)	Water treated to achieve effluent TCE concentration of 1 ppb
Aerospace company	Contaminated groundwater	TCE, TCA, DCA, PCE, methylene chloride, and vinyl chloride	Water treated and discharged to POTW
Sealed power technologies	Contaminated groundwater	TCE and other chlorinated organics	3-9 ppm treated to 0-10 ppb

[AD]CZ5020:D3100/3954/14

Source: ULTROX, Inc. 1990.

Table 2-7

CAPITAL COST ESTIMATE FOR UV/OZONATION IN DOLLARS*

Item (installed, except for process equipment)	Scenario (flow rate and total containment concentration) 100 gpm 200 ppb	200 gpm 200 ppb	100 gpm 500 ppb	200 gpm 500 ppb
Treatability study	5,000	5,000	5,000	5,000
UV/ozonation system	125,000	145,000	200,000	232,000
Shipping costs	2,500	2,500	5,000	5,000
Installation	10,000	10,000	10,000	10,000
Building with slab, electric, HVAC, lights, heat	82,000	82,000	82,000	82,000
Influent tank with foundation, dike, insulation, reinforcing	15,000	20,600	15,000	20,600
Pumps (3)	6,000	6,000	6,000	6,000
Piping, valves, fittings	4,800	4,800	4,800	4,800
Composite sampler	10,000	10,000	10,000	10,000
Tank level indicator	4,050	4,050	4,050	4,050
Lead controller and recorder	12,000	12,000	12,000	12,000
Totalizing flow meter	5,000	5,000	5,000	5,000
Instrument panel	5,000	5,000	5,000	5,000
Transformer	700	700	700	700
Electrical conduit	3,000	3,000	3,000	3,000
Junction/fuse box	1,500	1,500	1,500	1,500
Copper wire	500	500	500	500
Distribution panel	950	950	950	950
Power to building	10,000	10,000	10,000	10,000
Design	30,000	30,000	30,000	30,000
General services during construction	30,000	30,000	30,000	30,000
Half-time inspection	25,000	25,000	25,000	25,000
O&M manual	5,000	5,000	5,000	5,000
Start-up	5,000	5,000	5,000	5,000
Total Capital Cost	398,000	423,600	475,500	513,100

02[AD]CZ5020:D3100/3962/14

*The costs presented do not include costs for groundwater extracton or disposal of treated groundwater.

Table 2-8

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATE FOR UV/OZONATION IN DOLLARS PER YEAR*

Item	Scenario (flow rate and total containment concentration)			
	100 gpm 200 ppb	200 gpm 200 ppb	100 gpm 500 ppb	200 gpm 500 ppb
Operation costs (includes electricity)	10,000	13,300	21,100	26,300
Oversight/monitoring (labor and sampling)	22,500	22,500	22,500	22,500
General Maintenance (2% of capital)	8,000	8,500	9,500	10,300
Insurance and Taxes (1% of capital)	4,000	4,200	4,800	5,100
Total O&M costs	45,000	48,500	57,900	64,200

02[AD]CZ5020:D3100/3963/16

*The costs presented do not include costs for groundwater extracton or disposal of treated groundwater.

Table 2-9

SUMMARY OF COSTS FOR TREATMENT BY UV/OZONATION IN DOLLARS*

			Present Worth Costs		
Scenario	Capital Costs	Annual O&M Costs	5-Year Operation	10-Year Operation	30-Year Operation
100 gpm, 200 ppb	398,000	45,000	601,600	759,100	1,104,500
200 gpm, 200 ppb	423,600	48,500	643,000	812,800	1,185,600
100 gpm, 500 ppb	475,500	57,900	737,400	940,100	1,385,500
200 gpm, 500 ppb	513,100	64,200	803,500	1,028,200	1,521,000

02[AD]CZ5020:D3100/3964/16

*The costs presented do not include costs of groundwater extraction or treated groundwater disposal.

Table 2-10

CAPITAL COST ESTIMATE FOR CARBON ADSORBTION*

Item (installed, except for process equipment)	Capital Cost in Dollars (identical for all flow rates and concentration scenarios considered)
Bench-scale column treatability study	10,000
Prepiped dual column carbon system	98,000
Shipping Costs	1,000
Building with slab, electric, HVAC, lights, heat	54,500
Influent tank with foundation, dike, insulation, reinforcing	20,600
Pumps (3)	6,000
Piping, valves, fittings	4,800
Composite sampler	10,000
Tank level indicator	4,050
Level controller and recorder	12,000
Totalizing flow meter	5,000
Instrument panel	2,000
Electrical conduit	3,000
Junction/fuse box	1,500
Copper wire	300
Distribution panel	950
Power to building	10,000
Design	30,000
General services during construction	30,000
Half-time inspection	25,000
O&M Manual	5,000
Start-up	2,500
Total Capital Cost	336,200

02[AD]CZ5020:D3100/3965/23

*The costs presented do not include costs for groundwater extraction or disposal of treated groundwater.

Table 2-11

CARBON LOADING AND CARBON USAGE RATES
FOR IDEAL CONDITIONS (NO MASS TRANSFER LIMITATIONS)

Compound	Concentration (μg/L)	Carbon Loading (mg/g)	Carbon Usage Rate (mg/L)
Low Concentration Scenario			
TCE	150	31.2	4.8
DCE	25	2.8	9.0
High Concentration Scenario			
TCE	375	47.5	7.9
DCE	62.5	4.05	15.4

02[AD]CZ5020:D3100/3966/19

Table 2-12

ANNUAL OPERATION AND MAINTENANCE COST ESTIMATES FOR CARBON ADSORBTION IN DOLLARS PER YEAR*

Item	Scenario (flow rate and total containment concentration)			
	100 gpm 200 ppb	200 gpm 200 ppb	100 gpm 500 ppb	200 gpm 500 ppb
Carbon purchase/reactivation (including transportation)	17,800	35,500	30,300	60,600
Electricity for pumps	1,000	1,500	1,000	1,500
Oversight/monitoring (labor and sampling)	10,000	10,000	10,000	10,000
General Maintenance (2% of capital)	6,700	6,700	6,700	6,700
Insurance and Taxes (1% of capital)	3,400	3,400	3,400	3,400
Total Cost	38,900	57,100	51,400	82,200

02[AD]CZ5020:D3100/3967/16

*The costs presented do not include costs for groundwater extracton or disposal of treated groundwater.

Table 2-13

SUMMARY OF COSTS FOR TREATMENT BY CARBON ADSORBTION IN DOLLARS*

			Present Worth Costs		
Scenario	Capital Costs	Annual O&M Costs	5-Year Operation	10-Year Operation	30-Year Operation
100 gpm, 200 ppb	336,200	38,900	512,200	648,300	946,900
200 gpm, 200 ppb	336,200	57,100	594,500	794,400	1,232,700
100 gpm, 500 ppb	336,200	51,400	568,700	748,600	1,143,200
200 gpm, 500 ppb	336,200	82,200	708,100	995,800	1,626,700

02[AD]CZ5020:D3100/3968/15

*The costs presented do not include costs of groundwater extraction or treated groundwater disposal.

Table 2-14

COST ESTIMATE FOR DISCHARGE OF GROUNDWATER TO POTW*

Operating Costs (Dollars)	Scenario	
Item	100 gpm	200 gpm
Discharge fee	71,900	143,800
Oversight monitoring (labor and storage)	5,000	5,000
Total Cost	76,900	148,800

Present Worth Costs (Dollars)	5-Year Operation	10-Year Operation	30-Year Operation
100 gpm	347,900	617,000	1,207,300
200 gpm	673,200	1,194,000	2,336,200

02[AD]CZ5020:D3100/3970/33

*The costs presented do not include costs for groundwater extraction.

Table 2-15

IDENTIFICATION OF MOST COST-EFFECTIVE TREATMENT OPTION, ACCORDING TO FLOW RATE, CONTAMINANT CONCENTRATION, AND TREATMENT DURATION

	5-Year Operation	10-Year Operation	30-Year Operation
100 gpm, 200 ppb	POTW (carbon 47% higher)	POTW or carbon adsorption (within 5%)	Carbon adsorption (UV/ozonation 17% higher)
200 gpm, 200 ppb	Carbon adsorption (UV/ozonation 8% higher)	Carbon adsorption or UV/ozonation (within 2%)	UV/ozonation (air stripping 8% higher)
100 gpm, 500 ppb	POTW (carbon is 63% higher)	POTW (carbon is 21% higher)	Carbon adsorption (air stripping 11% higher)
200 gpm, 500 ppb	Carbon adsorption or POTW (within 5%)	Carbon Adsorption or Air Stripping or UV/ozonation (within 3%)	Air stripping or UV/ozonation (within 1%)

02[AD]CZ5020:D3100/3971/12

Draft

Table 2-16

SELECTION OF TECHNOLOGIES TO BE INCORPORATED INTO REMEDIAL ALTERNATIVES

	Alternatives Extracting Groundwater Only Upgradient of the Hydrogeologic Boundary (Lower Flow Rate)	Alternatives Extracting Groundwater Upgradient and Downgradient of the Hydrogeologic Boundary (Higher Flow Rate)
Alternatives comprising pump and treat responses only (longer duration)	Carbon adsorption	Carbon adsorption
Alternatives that include source remediation (shorter duration)	Discharge to POTW	Carbon adsorption

02[AD]CZ5020:D3100/3972/18

Table 2-17

TREATMENT STANDARDS FOR AN F002 WASTE
EXPRESSED AS CONCENTRATIONS IN THE
EXTRACT FROM THE TCLP

Chemical	Concentration (mg/L)
Acetone	0.59
n-Butyl alcohol	5.0
Carbon disulfide	4.81
Carbon tetrachloride	0.96
Chlorobenzene	0.05
Cresols (and cresylic acid)	0.75
Cyclohexanone	0.75
1,2-Dichlorobenzene	0.125
Ethyl acetate	0.75
Ethylbenzene	0.053
Ethyl ether	0.75
Isobutanol	5.0
Methanol	0.75
Methylene chloride	0.96
Methyl ethyl ketone	0.75
Methyl isobutyl ketone	0.33
Nitrobenzene	0.125
Pyridine	0.33
Tetrachloroethylene	0.05
Toluene	0.33
1,1,1-Trichloroethane	0.41
1,1,2-Trichloro-1,2,2-trifluoroethane	0.96
Trichloroethylene	0.091
Trichlorofluoromethane	0.96
Xylene	0.15

02[AD]CZ5020:D3100/3969/33

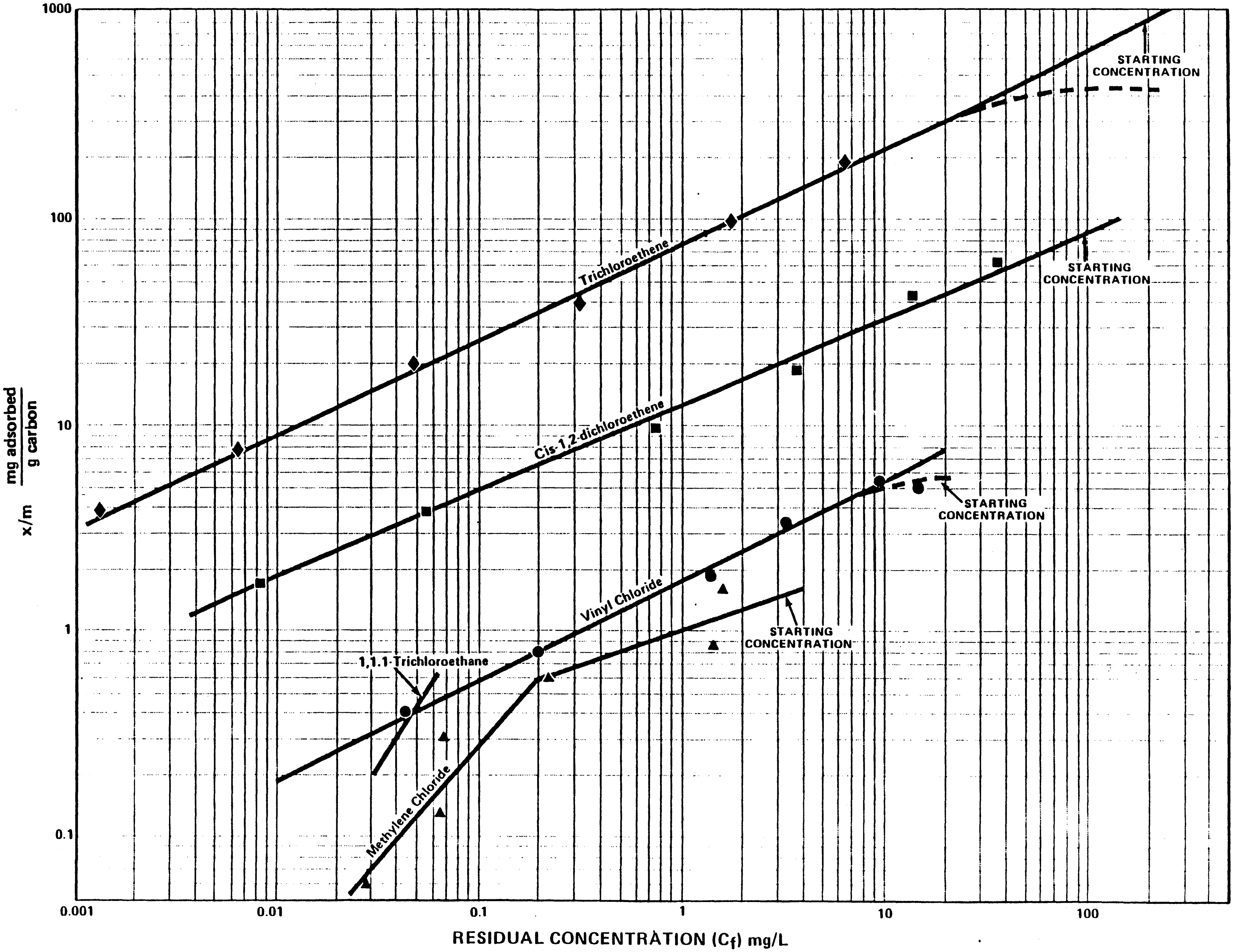


Figure 2–1 ISOTHERM PLOT

3. DETAILED ANALYSIS OF ALTERNATIVES

In this section, the relevant information necessary for the selection of a remedy is presented. First, each alternative is described in detail. Next, each alternative is evaluated on the bases of seven evaluation criteria. The first five criteria address the effectiveness of the alternative: overall protection of human health and the environment; compliance with SCGs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; and short-term impacts and effectiveness. The other two evaluation criteria are implementability and cost. Each criterion is examined both qualitatively in the text and tables as well as quantitatively in the NYSDEC alternative evaluation scoring sheets. After each alternative is individually evaluated, the alternatives are comparatively analyzed and a preferred remedy recommended.

3.1 ALTERNATIVE 1: NO ACTION

3.1.1 Detailed Alternative Description

Alternative 1 involves no remedial action at the CC facility. The only substantive component of the alternative would be the quarterly monitoring of 33 existing and planned monitoring wells to track the migration of the plume.

3.1.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

Currently, the subsurface contamination at the CC facility poses no threat to human health or the environment. Despite the fact that chlorinated organics are present in the overburden and have migrated off site through the groundwater, the lack of receptors, either human or environmental, results in an absence of significant risks, even via the air exposure pathway. A hazard would exist if a drinking water well were installed in the plume, but this is considered unlikely for several reasons. Immediately adjacent to the CC property in the direction in which the plume extends (south and west) are properties where there is little chance that wells would be installed. To the west is a Department of Defense (DOD) housing area that is served by public water and contains no private housing. To the south of the CC property are Conrail, Niagara Mohawk, and NYSEG rights-of-way. Since the DOD housing area contains no private residences and there are no residences at all on the utility and railroad rights-of-way, it is extremely unlikely a potable water well would be installed at either location. The plume does extend to the southwest past the rights-of-way to agricultural land. Residences could theoretically be constructed in the future, and they could theoretically use groundwater as a potable water source. However, this, too, is unlikely as the naturally occurring high metal and mineral content of the bedrock aquifer water makes it aesthetically unpotable. Thus, it is concluded that no risks to human health or the environment currently exist nor would they likely exist in the future.

Compliance with SCGs

With the no action alternative, the existing exceedances of groundwater standards by several chlorinated organics would continue. The presence of additional chlorinated organics in the soil indicates that additional groundwater contamination will occur from migration from these soils, resulting in an increased plume size.

Long-Term Effectiveness and Permanence

The no action alternative would never be effective in meeting the remedial action objectives. Both the soil and groundwater media would remain contaminated.

Reduction of Toxicity, Mobility, or Volume

The no action alternative provides for no reduction in the toxicity, mobility, or volume of the contaminated media.

Short-Term Effectiveness

The evaluation of the short-term effectiveness of alternatives analyzes the impacts posed by the implementation of the alternative. As the existing situation poses no significant risk and no remedial activities are proposed by the no action alternative, this alternative would have no short-term impacts.

3.1.3 Implementability Evaluation

Although there are no technical barriers to the implementation of the no action alternative, there is a significant administrative barrier to its implementation. The no action alternative makes no provisions to address the exceedances of the groundwater SCGs at the site; indeed, the groundwater plume would be expected to grow. For the adoption of this alternative, a waiver of this SCG must be granted by NYSDEC before the record of decision (ROD) can be issued. As it is possible to treat and substantially eliminate the groundwater plume via the methods presented in the other alternatives, it is unlikely that NYSDEC would issue such a waiver.

3.1.4 Cost Evaluation

The only cost items included in the no action alternative are the costs for monitoring the 33 existing and planned monitoring wells. These costs are estimated at $49,000 per year for sampling and analysis. Such monitoring would have to be conducted indefinitely. However, for the purposes of calculating the present worth of the alternative, only 30 years of monitoring are considered, as the present-worth costs of years further in the future are too discounted to be significant. The present worth of the alternative is thus $790,000.

As long as CC continues to use the land where the facility is located, no costs of future land use would be incurred. The land is currently being productively used without the need for implementation of any remedial activities. Although the groundwater plume extends beyond the facility boundaries, this degradation of the groundwater would not have economic consequences because the aquifer is not suitable as a drinking water source due to its high mineral content.

3.2 ALTERNATIVE 2: EXTRACTION OF GROUNDWATER UPGRADIENT OF THE HYDROGEOLOGIC BOUNDARY, TREATMENT BY CARBON ADSORPTION, DISCHARGE TO CAYUGA CREEK, NO SOIL TREATMENT

3.2.1 Detailed Alternative Description

Alternative 2 addresses the groundwater plume through the extraction of groundwater from the existing extraction wells P-2 and P-3. Pumping tests conducted during the RI have shown that pumping these wells at an estimated rate of 100 gpm will capture that portion of the plume located upgradient of the hydrogeologic boundary. This extraction would also capture any groundwater contaminated in the future by ongoing leaching of chlorinated organics from source areas located near the facility buildings. That portion of the plume located downgradient of the hydrogeologic barrier would not be actively remediated. However, the downgradient plume would continue to undergo natural biodegradation and naturally disperse and attenuate over time because of the "hydraulic containment" of these sources by the on-site pumping.

The extracted groundwater would be treated by carbon adsorption and discharged to Cayuga Creek through the existing SPDES outfall. Groundwater would be extracted from P-2 and P-3 by submersible pumps and pumped through heat-traced carbon steel pipe to a surge tank at a building housing the carbon treatment equipment. The treatment process equipment would consist primarily of two carbon columns in series. When breakthrough occurs in the primary column, the flow would be directed to the secondary column while the spent carbon is removed and replaced. The fresh column would then be brought on line as the new secondary column. The columns would be capable of being back-washed if pressure drops through the columns get too high. The system is fairly easy to operate; however, some controls would be required to control the flow based on pressure and tank volume levels. The treated groundwater would be discharged to the existing SPDES outfall.

The duration of this alternative can not be accurately estimated but is expected to be lengthy. For costing purposes, a treatment duration of 30 years will be assumed. The present worth of actions taken at times further in the future would not significantly affect the total present worth.

3.2.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

As discussed under the no action alternative, the subsurface contamination at the CC facility poses no threat to human health or the environment due to lack of exposure routes. Furthermore, this alternative's eventual elimination of the downgradient (off-site) plume through natural attenuation, made possible by the hydraulic containment of the upgradient (on-site) plume, eliminates risks associated with the improbable exposure scenario of potable water well installation in agricultural land beyond the railroad and power company rights-of-way.

Compliance with SCGs

The contaminant-specific SCGs consist solely of the groundwater quality standards. Regarding the downgradient plume, all hydrogeologic data and contaminant transport data for the site indicate that the groundwater in this portion of the plume will naturally attenuate to background levels prior to intercepting receptors. This natural attenuation will be accomplished by continued dispersion and biodegradation of the plume as it moves downgradient to the southwest. Credence for the natural attenuation lies in the comparison of the current downgradient position of the plume to its predicted position based on minimum plume velocities and residence times. Assuming a minimum contaminant velocity of 3 feet per day and a minimum plume residence time of 10 years, this plume should have migrated at least two miles. However, chlorinated organics attributable to the facility have not been found at any downgradient private wells, all of which are well within 2 miles of the site. Most likely, the plume lies between the current furthest downgradient wells (B-29M and B-30M) and the nearest downgradient receptors, which are the residences with domestic supply wells along Lockport Road.

The distance from the site where the chlorinated organics fall below MCLs has been predicted based on log-linear declines of these compounds versus increasing distance from the source areas in the manufacturing building. The maximum distance these compounds have traveled prior to falling below MCLs is about 2,000 feet, which is well within the distance between the furthest downgradient wells and Lockport Road. From this scenario, it is apparent that the plume disperses and biodegrades prior to reaching downgradient receptors. It is thus likely that the off-site plume will remediate itself and attain contaminant-specific SCGs through natural attenuation if the further off-site migration is stopped with on-site groundwater capture.

Upgradient of the hydrogeologic barrier, chlorinated organics would be contained and reduced in the aquifer through the constant extraction and treatment of groundwater. As source areas in the soil would remain over the short term, isolated locations of higher contaminant levels would exist beneath the "hot spot" source areas. The groundwater beneath these hot spots would exceed SCGs, as would the groundwater between these hot spots and the extraction wells. Over time (most likely, a long time), the source areas would be depleted through the constant leaching. At this point, the upgradient aquifer would meet SCGs.

The action-specific SCGs consist solely of the maximum contaminant levels allowed in the discharge to Cayuga Creek. These levels would be specified in a SPDES permit, and their expected values were presented in Section 2.2.2. As discussed in Section 2.4.1.2.2, carbon adsorption removes all adsorbable contaminants from water until the most weakly adsorbed compound breaks through. Once breakthrough occurs, the secondary column would capture these leading compounds such that effluent water remains clean, and, thus, the discharge limits would necessarily be met.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long term by virtue of the fact that it would call for long-term operation. The pumping and treatment system would need to operate for as long as chlorinated organics in the overburden source areas continue to leach into the aquifer. However, as the alternative calls for continued action until the contaminants are no longer leaching into the aquifer, it may be considered effective in the long term. As discussed above regarding compliance with SCGs, the contaminants located in the groundwater downgradient of the hydrogeologic barrier would naturally attenuate through biodegradation and dispersion.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. The groundwater extracted upgradient of the hydrogeologic boundary would be treated through carbon adsorption. Although carbon adsorption does not destroy the contaminants directly (it merely removes them from the water), the contaminants would be destroyed when the carbon is regenerated off site.

The contaminants in the downgradient plume would not be directly treated. Dispersion would play a part in the attainment of SCGs in this portion of the aquifer. However, the groundwater data show a clear pattern of natural attenuation through biodegradation that leads to the mineralization of the chlorinated organics in situ. Thus, these contaminants would be subject to a degree of treatment action, as well.

This alternative would not, however, treat the contaminants present in the soil. Although these soils do not pose a threat themselves, they do act as the source of the groundwater contamination. The remedial action objective for the soil is merely to prevent the future additional contamination of groundwater. By not treating the soils directly, this alternative, in effect, hydraulically contains the soils.

Short-Term Effectiveness

This alternative would present no adverse impacts during its implementation. The contaminants, which currently are beneath the surface, would be extracted, pumped, treated, and discharged through a closed system.

The duration of this alternative cannot be accurately estimated due to the lack of information on the total amounts of contaminants present in the overburden and their rates of leaching; however, this alternative may be expected to require more than 30 years of operation.

3.2.3 Implementability Evaluation

This alternative is readily implementable. There are no technical obstacles to constructing and operating the groundwater extraction and treatment facilities. Additionally, the remedy is easy to monitor via the existing monitoring wells, and another extraction well could readily be installed if it is determined that more efficient plume capture is required.

3.2.4 Cost Evaluation

The estimated capital and O&M costs for Alternative 2 are presented in tables 3-1 and 3-2, respectively. These costs include the detailed cost estimates for carbon adsorption presented in Section 2.4.1.2.2. This estimate includes costs for the equipment needed to pump and deliver groundwater from the wells to the treatment system, as well as the treatment system itself. The cost estimate assumes a sophisticated control system complete with interlock valves. Such a system would require only minimal maintenance. The costs do not include, however, costs for additional studies to more fully prove that the groundwater plume would not migrate to where it may pose a health hazard. Such studies would likely be required by NYSDEC before this alternative could be implemented. The estimated present worth of this alternative is $2,124,700, based on a 30-year duration of treatment and with future costs discounted 5% per year.

A sensitivity analysis was performed to evaluate the sensitivity of the costs to the following three changes in operation: first, the rate of groundwater extraction is increased by 30%; secondly, the rate of groundwater extraction is decreased by 30%; and, finally, remediation is complete in 20 years. The results of these analyses are presented in Table 3-3. These analyses show that increasing or decreasing the flow rate by 30% increases or decreases the present-worth cost by only approximately 8%, while completing remediation in 20 years would reduce the present-worth cost by 13%.

3.3 ALTERNATIVE 3: EXTRACTION OF GROUNDWATER BOTH UPGRADIENT AND DOWNGRADIENT OF THE HYDROGEOLOGIC BARRIER, TREATMENT BY CARBON ADSORPTION, DISCHARGE TO CAYUGA CREEK, NO SOIL TREATMENT

3.3.1 Detailed Alternative Description

Alternative 3 would incorporate all aspects of Alternative 2, plus extraction and treatment/disposal of groundwater located downgradient of the hydrogeologic boundary. New extraction wells would be installed in the approximate locations shown in Figure 3-1. Since these wells are located off site, each extraction well would have its own extraction pump located in a secure enclosure at the well head. The extracted groundwater would be pumped to the treatment unit that would be located on the CC property. This alternative entails crossing under the intervening railroad right-of-way and would require special drilling/construction techniques. The downgradient plume would be extracted at an estimated 100 gpm rate. Pumping of the upgradient wells would continue for quite a while. For costing purposes, a treatment duration of 30 years will be assumed. The present worth of actions taken at times further in the future would not significantly affect the total present worth. The pumping of the wells downgradient of the hydrogeologic barrier, on the other hand, would continue for only an estimated 5 years. The pumping of the upgradient wells would hydraulically contain the source areas. Without additional contributions to the downgradient plume from the upgradient sources, the downgradient extraction would proceed as if these sources were remediated or otherwise removed.

3.3.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

As discussed under the no action alternative, the subsurface contamination at the CC facility poses no threat to human health or the environment, due to lack of exposure routes. Furthermore, the elimination of the downgradient (off-site) plume through pumping and treatment eliminates the improbable theoretical exposure scenario of potable water well installation in agricultural land beyond the railroad and power company rights-of-way.

Compliance with SCGs

The contaminant-specific SCGs consist solely of the groundwater quality standards. Downgradient of the hydrogeologic barrier, this SCG would be attained within an estimated 5 years. Upgradient of the hydrogeologic boundary, the plume would be contained and eventually remediated as discussed in Section 3.2.2 for Alternative 2.

This alternative would be in compliance with all action-specific SCGs as discussed for Alternative 2.

Long-Term Effectiveness and Permanence

This alternative, like Alternative 2, would be effective in the long term by virtue of its call for long-term operation until SCGs are met.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. All contaminants in the groundwater, now or in the future, would be treated by carbon adsorption, as discussed for Alternative 2. Just as in Alternative 2, no treatment of the source soils is included in this alternative; in effect, they would be hydraulically contained.

Short-Term Effectiveness

This alternative, like Alternative 2, would present no adverse impacts during its implementation. The contaminants, which currently are beneath the surface, would be extracted, pumped, treated, and discharged through a closed system.

The duration of this alternative cannot be accurately estimated due to the lack of information on the total amount of contaminants present in the overburden and their rates of leaching. However, it may be expected to require greater than 30 years to completely remediate the groundwater upgradient of the hydrogeologic boundary. On the other hand, the groundwater downgradient of the hydrogeologic boundary, without sources of additional contamination, would be expected to be remediated within 5 years.

3.3.3 Implementability Evaluation

As with Alternative 2, also a pump-and-treatment method, this alternative is readily implementable and has no technical or administrative obstacles to its operation.

3.3.4 Cost Evaluation

The estimated capital and O&M costs for Alternative 3 are presented in Tables 3-4 and 3-5, respectively. These costs include the detailed cost estimates for carbon adsorption presented in Section 2.4.1.2.2. This estimate includes all the costs presented in Alternative 2, plus additional costs for the extraction and transport of the groundwater from the off-site wells to the on-site treatment facility. These additional costs include providing secure housing at the extraction wells and installing a pipe underneath the railroad tracks. The estimated present worth of this alternative is $3,001,700.

A sensitivity analysis was performed to evaluate the sensitivity of the costs to the following three changes in operation: first, the rate of groundwater extraction is increased by 30%; secondly, the rate of groundwater extraction is decreased by 30%; and, finally, the duration of treatment of the downgradient plume is increased to 10 years. The results of these analyses are presented in Table 3-6. These figures show that increasing or decreasing the flow rate by 30% increases or decreases the present-worth cost by only approximately 7%, while extending the duration of treatment of the downgradient plume to 10 years increases the present-worth cost by only 2%.

3.4 ALTERNATIVE 4: EXTRACTION OF GROUNDWATER UPGRADIENT OF THE HYDROGEOLOGIC BARRIER, IN SITU VAPOR EXTRACTION OF CONTAMINATED SOILS

3.4.1 Detailed Alternative Description

Alternative 4 would incorporate all the groundwater extraction actions described in Alternative 2, but it would discharge the extracted groundwater to the NCSD POTW for treatment/disposal. Additionally, it would use in situ vapor extraction to treat contaminated soils. A pilot-scale treatability study for in situ vapor extraction has been performed at the CC facility. This test has demonstrated that this technology is a viable alternative for remediating the facility soils.

The in situ vapor extraction system would be installed throughout the areas indicated in Figure 3-2 as exhibiting soil gas vapor concentrations of greater than 1 µg/L (i.e., the dotted and cross-hatched area). This area covers approximately 1.25 acres.

However, to be conservative, it is assumed up to 2 acres of area would be covered by the vapor-extraction system. The pilot study indicated that the radius of influence for each extraction well is estimated at approximately 20 feet. Depending on the actual placement of the wells, and accounting for some overlap of zones of influence, each vapor-extraction well should handle approximately 1,000 to 1,100 square feet. Over an area of 2 acres, approximately 200 vapor extraction wells would be required, providing some overlap of zones of influence. Each of these vapor extraction wells would be connected to a vacuum manifold that, in turn, would be connected to a high-vacuum pump. The extracted vapors would be passed through a treatment unit that would use carbon absorption or catalytic oxidation to remove the contaminants from the gas stream.

The treatability study has shown that, due to the low permeability of the site soils, high vacuums would be required to efficiently extract the chlorinated organics. The lower pressures more readily develop desiccation fissures through the clay soils. These fissures act as conduits through which the contaminant vapors flow. Diffusion through the intact soils to the fissures is the rate-limiting step of the extraction process. The treatability study showed that adequate fissures (as interpreted through increased air flow rates) could only be developed under high vacuums (27 inches Hg). The study also showed that such developed fissures could not be maintained at lower vacuums.

Because of the low permeability of the soils, provisions would need to be made to ensure that the fissures do not extend upward to the surface and that the air pathways are not circumvented in any other fashion. To this end, two specific actions would likely be required. First, many or all of the areas to be treated would have to be covered with a vapor-impermeable barrier. Coupled with this action, soil vents would be installed at the outer extent of the radii of influence of the vapor extraction wells. These soil vents would be small-diameter pipes with a short-length perforated section near the tip. They would be driven into the soil with the perforated section placed at the depth with highest expected levels of contaminants.

The vents will encourage fissures to develop and air to flow through the most highly contaminated sections. The extent to which these actions would be implemented is to be determined through supplementary pilot-scale treatability studies. It is thus not possible to accurately estimate the number of soil vents that would be installed. However, it may be assumed that in the absence of cost-prohibitive site-wide depth-specific soil analyses, the placement of soil vents would be governed by information generated in the field during the installation and start-up process of the vapor-extraction wells.

This alternative includes the extraction and treatment/disposal of groundwater upgradient of the hydrogeologic barrier, as described in Alternative 2. In addition, some groundwater would be removed from the overburden by the vapor-extraction system, both as water vapor (to be recovered in a gas/liquid separation upstream of the vacuum pump) and, more importantly, as liquid infiltrating the wells. This water would be pumped out of the wells with a separate pumping system, added to the groundwater extracted from the bedrock extraction wells, and discharged to the NCSD for treatment and disposal.

The vapor-extraction system would be operated for 16 to 22 months, as estimated by the treatability study contractor. The system would be shut down when the amount of chlorinated organic vapors in the air flow reaches zero or a very low level while asymptotically approaching zero. The groundwater extraction system would operate longer, taking an estimated 5 years to adequately remediate the upgradient bedrock aquifer. Once the upgradient aquifer has met the set cleanup goals or alternate cleanup levels (ACLs) based on the performance of the pumping system, the system would be shut down and the groundwater quality monitored. Should the groundwater quality deteriorate, then both the soil and groundwater treatment systems would be reactivated for a duration to be determined by the data generated during the remediation completed to that date.

3.4.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

As stated for Alternative 2, the subsurface contamination at the CC facility poses no threat to human health or the environment, due to lack of receptors.

Compliance with SCGs

The contaminant-specific SCGs consist solely of the groundwater quality standards. Upgradient of the hydrogeologic boundary, SCGs would likely be met within 5 years through the groundwater pump-and-treatment action, due to the removal of the vast majority of the contaminants in the source soils through vapor extraction. Downgradient of the hydrogeologic boundary, the aquifer is expected to attain SCGs through natural biodegradation and dispersion, as discussed in Section 3.2.2 for Alternative 2.

Several action-specific SCGs apply to this alternative. The extracted groundwater would be discharged to and treated by a POTW. For this action, no action-specific SCGs apply other than to meet the conditions of the permit to discharge to the NCSD. The proposed discharge standards of up to 1,000 ppb total chlorinated organics concentration, up to a maximum of 2.5 pounds per day (corresponding to 300,000 gallons per day), has been tentatively accepted by NCSD, pending receipt of a modification to its SPDES permit to allow the acceptance of this groundwater. Action-specific SCGs for this alternative consist principally of air emission criteria. As discussed in Section 2.2.2 on action-specific SCGs, specific discharge standards are not stated by these SCGs, but a procedure for developing levels to be put into an air permit is offered instead. The air emission control equipment that would be installed on the exhaust from in situ vacuum-extraction systems (carbon adsorption or catalytic or thermal oxidation) would remove virtually all the extracted contaminants from the exhausted air, thus assuring compliance with the requirements of the permit issued by NYSDEC.

Long-Term Effectiveness and Permanence

The alternative would be effective in the long term as it calls for the removal from the soils of the vast majority of the chlorinated organics that would otherwise have migrated to the groundwater. The residual chlorinated organics concentration in the soil at the completion of treatment is estimated to be 1 to 5 ppm. This average concentration is expected to be sufficiently low to prevent future groundwater contamination. (This concentration would certainly pose no risk to human health or the environment because no current risk is posed even without remediation).

The groundwater above the hydrogeologic boundary would be pumped and treated until the existing groundwater contaminants are removed. The chlorinated organics in the plume downgradient of the hydrogeologic boundary are expected to naturally attenuate through dispersion and biodegradation, as discussed for Alternative 2.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. All contaminants in the upgradient plume now or in the future would be discharged to the NCSD POTW for treatment by biological and physical methods. NCSD's current influent contains TCE at levels comparable or above the levels that would be expected to be found in the extracted groundwater (i.e., approximately 200 ppb total chlorinated organics), and its effluent complies with its discharge permit, thus demonstrating the effectiveness of the POTW's treatment. One of the treatment mechanisms of the POTW would be volatilization during aerobic biological treatment. Those chlorinated organics that volatilize at the POTW would likely eventually be predominately destroyed through photooxidation in the atmosphere. The soils would be treated by in situ vapor extraction. As this technology is a physical treatment, the contaminants are transferred to another phase before they are eventually destroyed. The gas-phase effluent would in turn be treated by either catalytic or thermal oxidation or carbon adsorption. Oxidation would result in direct destruction, while carbon adsorption would lead to the destruction of the contaminants when the carbon was regenerated. The carbon would be considered an F002 RCRA waste by the "derived-from" rule and thus would necessarily be treated to effectively destroy the adsorbed contaminants during regeneration at a RCRA facility.

Short-Term Effectiveness

This alternative would present no adverse impacts during its implementation. The contaminants would be extracted from the subsurface as vapors or dissolved in the groundwater. The vapors would be treated by carbon adsorption or oxidation prior to discharge to eliminate emissions. The extracted groundwater would be pumped and discharged through a closed system to the NCSD POTW. Some chlorinated organics may volatilize at the POTW, although this quantity cannot be estimated but is not expected to present a significant short-term risk.

The duration of this alternative is expected to be approximately 5 years for the upgradient groundwater remediation, 5 to 10 years for the downgradient groundwater remediation, and 16 to 22 months for the vacuum-extraction system.

3.4.3 Implementability Evaluation

The groundwater treatment component of this alternative is readily implementable. There are no technical obstacles to constructing and operating the groundwater extraction and discharge facilities. Additionally, the remedy is easy to monitor via the existing monitoring wells, and another extraction well could readily be installed if it is determined that more efficient plume capture is required. The NCSD must receive a modification to its permit to accept and treat the extracted groundwater. At the time of publication, this modification had not yet been processed, although there are no foreseeable obstacles to its approval.

The soil treatment component is also readily implementable but has a few complicating issues. Technically, there are no obstacles to implementation; the technology is uncomplicated and proven, using off-the-shelf equipment. Some difficulty may arise, however, in determining the optimal placement of soil vents to properly guide the direction of propagation of the fissures through the contaminated zones, but this would be overcome during the operation of the system. Care would also have to be taken to ensure that no air-flow circumvention was occurring at any of the wells--a problem that was encountered during the pilot study. Installation of an impermeable surface barrier would effectively prevent such problems.

Despite the positive results of the first phase of the pilot-scale treatability study, there is no way to show with absolute proof that this action will meet the remedial action objectives. The objectives are based on not impacting groundwater quality, but the remediation of the groundwater would not be complete until an estimated 3 years after the vapor extraction treatment is complete. Thus, it would not be possible to track the progress of the treatment from a strictly goal-based point of view. Nevertheless, the results of the pilot scale treatability study do show that chlorinated organics are being removed from the soil, and calculations performed by the treatability contractor show that by extrapolating the rate of contaminant removal, sufficient amounts of chlorinated organics would be removed over the expected time frame of 16 to 22 months to bring the average chlorinated organic soil concentration to between 1 and 5 ppm. At these soil concentrations, the groundwater should be protected.

3.4.4 Cost Evaluation

The capital and O&M costs for Alternative 4 are presented in tables 3-7 and 3-8, respectively. The groundwater extraction costs are developed as they were for Alternative 2 (although duration of treatment is different). The O&M cost for groundwater discharge to the POTW is from a quote from NCSD. The soil treatment costs are based on estimates provided by the pilot-study contractor, Terra Vac. The soil treatment costs, exclusive of carbon adsorption treatment and electricity consumption, turn out to be approximately $100 per cubic yard. The present worth of this alternative is estimated to be $8,442,400. The soil remediation costs are based on Terra Vac's best estimate of the cost to remediate the site. As their estimate includes a contingency factor, this report's contingency for soil remediation items was reduced to 10%, instead of 25% used for the other alternatives. Inherent in Terra Vac's estimates of these costs are many assumptions. By Terra Vac's estimation, the best-case to worst-case range of the soil treatment costs alone would vary by 35 to 40%.

In addition to the possible range of costs estimated by Terra Vac, the change in costs from three alternate scenarios were estimated in a sensitivity analysis. The first scenario assumed that the vapor extraction system would have to be operated for 30 months rather than the 16 to 22 months estimated in the base case. The scenario would increase the present-worth cost by an estimated 11.5% (see Table 3-9). The second scenario assumes that after the groundwater treatment achieves SCGs after 5 years, additional contaminants are found to leach into the groundwater, requiring an additional operation of both the soil and groundwater treatment systems for 1 year. This scenario would increase the present-worth costs by 23%. The third scenario looks at the case where the groundwater treatment system would have to be operated for 10 years rather than 5 years. This scenario would increase the present-worth costs by 11%.

3.5 ALTERNATIVE 5: EXTRACTION OF GROUNDWATER BOTH UPGRADIENT AND DOWNGRADIENT OF THE HYDROGEOLOGIC BARRIER, TREATMENT BY CARBON ADSORPTION, DISCHARGE TO CAYUGA CREEK, IN SITU VAPOR EXTRACTION OF CONTAMINATED SOILS

3.5.1 Detailed Alternative Description

Alternative 5 would incorporate all of Alternative 4, but calls for treatment by carbon adsorption of groundwater both upgradient and downgradient of the hydrogeologic barrier as described in Alternative 3.

3.5.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

This alternative, like Alternative 4, is completely protective of human health and the environment.

Compliance with SCGs

This alternative's compliance with SCGs would be identical to Alternative 4 with respect to soil treatment. Specifically, it would be in compliance with all chemical-specific and action-specific SCGs. Regarding groundwater, this alternative would also meet all chemical-specific and action-specific SCGs, as described for Alternative 3.

Long-Term Effectiveness and Permanence

This alternative, like Alternative 4, would be effective in the long term due to the active remediation of both the source soils and contaminated groundwater.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. In addition to the direct treatment of the soils and upgradient plume as described for Alternative 4, this alternative calls for the direct treatment of the groundwater of the hydrogeologic boundary, rather than passive treatment through natural biodegradation and dispersion.

Short-Term Effectiveness

This alternative, like Alternative 4, would present no adverse impacts during its implementation. Its duration of operation would also be identical to that of Alternative 4. At the end of this estimated 5-year period, however, the groundwater downgradient of the hydrogeologic boundary would have been actively remediated, whereas the passive remediation of this part of the plume as called for by Alternative 4 would be ongoing.

3.5.3 Implementability Evaluation

The implementability of this alternative is identical to that described for Alternative 4.

3.5.4 Cost Evaluation

The capital and O&M costs of Alternative 5 are presented in tables 3-10 and 3-11, respectively. These costs are estimated on the same bases as Alternative 4. The present worth of this alternative is estimated at $9,322,500. As stated for Alternative 4, the soil remediation costs are based on Terra Vac's best estimate of the cost to remediate the site. By Terra Vac's estimate, the best-case to worst-case range of the soil treatment costs could vary by 35 to 40%.

The same three alternative scenarios considered for Alternative 4 were also evaluated in a sensitivity analysis for this alternative. The results of this analysis are presented in Table 3-12.

3.6 ALTERNATIVE 6: EXTRACTION OF GROUNDWATER UPGRADIENT OF THE HYDROGEOLOGIC BOUNDARY, DISCHARGE TO AND TREATMENT BY NCSD, EXCAVATION OF SOURCE-AREA SOILS, TREATMENT BY THERMAL DESORPTION, BACKFILLING ON SITE

3.6.1 Detailed Alternative Description

Remedial actions for the soils under Alternative 6 include excavation, on-site treatment by thermal desorption, and on-site disposal of treated soils. Alternative 6 also calls for the extraction and treatment/disposal of groundwater located upgradient of the hydrogeologic boundary.

The area requiring excavation is the same as that designated for treatment by vapor extraction shown in Figure 3-2. These areas to be excavated are delineated based upon the results of the soil gas study (see Section 4 of the RI Report, E & E June 1990) and are believed to represent the source areas of TCE contamination. The source areas as shown in Figure 3-2 represent a total of approximately 1.25 acres but, due to the limited number of soil borings to confirm the areal extent of soil contamination, a conservative estimate of 2 acres will be used in this FS. The estimated average depth of excavation is 15 feet, but the upper 5 feet of soil is not expected to be contaminated due to the extensive downward migration of contaminants. Using the estimated areal extent of soil contamination of 2 acres and an average depth of 10 feet, approximately 32,500 yd^3 of soil would require excavation. The exact limits of excavation, however, would be determined during excavation using field-screening methods and laboratory verification sampling.

Additional soil would have to be excavated to provide the slopes needed to stabilize the excavations. In addition, while excavation would extend to a depth of 15 feet, the top 5 feet of soil is not, in most instances, significantly contaminated, due to the extensive downward migration of the contaminants. These slope and top soils may be backfilled into the excavation if they contain no chlorinated organics or are below NYSDEC's de minimus levels for the "contained-in" policy.

Excavation would be conducted utilizing standard earth-moving equipment such as backhoes, bulldozers, and dump trucks. No dewatering activities would be required during excavation because the concurrent groundwater pump-and-treatment action would sufficiently lower the groundwater table. Excavation activities would also need to include provisions to remove and/or relocate, if necessary, any utilities that are in the areas to be excavated. Approximately 8 lamp posts are located around the manufacturing building in areas to be excavated. These lamp posts provide only lighting and do not carry other utility lines. A storm/sanitary sewer is located beneath the lawn just north of the parking area north of the manufacturing building. Additionally, electrical supply transformers are located near the entrance of the facility between BH-11 and B-11m. In general, excavation of contaminated soil would be conducted by cells, and the slope of the cell walls would be such that no structural support techniques would be required. Structural support techniques may be required, however, to facilitate excavation of the contaminated soils immediately adjacent to the southwest side of the warehouse/manufacturing building to allow excavation to extend as closely as possible to the building. For FS costing purposes, it has been assumed that approximately 250 linear feet of sheet piling would be installed approximately 5 feet from the building to stabilize the soil supporting the building's foundation. The soil between the sheet pilings and the building would not be excavated.

To provide a limited degree of containment for these unexcavated soils, the sheet piling would remain in place permanently. The area between the sheet piling and the building would be capped with concrete and/or asphalt to discourage the infiltration of precipitation into these remaining contaminated soils.

Excavated and unexcavated soil would be screened for organic vapors using field instruments (i.e., photo-ionization vapor detector or organic vapor analyzer) or conventional gas chromatographic analysis to facilitate determination of those soils requiring excavation. (A rough correlation between laboratory-derived soil contaminant concentrations and vapor measurements of a soil sample placed in a jar could be made and used as a rough measure of soil contamination in the field). Estimating the limits of excavation would also be facilitated by the fact that contaminant migration is primarily vertical and there appear to be definite vertical horizons of contamination (based upon soil contaminant data obtained during the RI and also during the *in situ* vapor-extraction pilot study). These excavation "screening" methods would necessarily be supplemented with soil verification sampling upon the completion of excavation to verify that soil contaminated at levels above the cleanup goals is removed. The cleanup goals for the soils, as described in Section 2.2.1, are ultimately driven by the soil's impact on groundwater quality. The fact that the soil cleanup goals are driven by groundwater quality constraints would complicate the determination of the extent to which the soil must be remediated. As a guideline, the cleanup goals propose using the TCLP assay to set the cleanup standards.

However, it would not be practical to use TCLP as a screening tool due to the complex nature of the assay and its corresponding high cost, as well as the fact that it may call for greater amounts of excavation than may be necessary to protect groundwater quality. Therefore, an alternative measure of the extent of soil requiring excavation would have to be developed. This alternative measure would be a specific contaminant concentration in the soil. Such a threshold level would likely be in the range of 0.5 to 5 ppm of total chlorinated organics. The exact level would have to be negotiated with the regulatory agencies during the design phase. The alternate threshold level would not supplant the cleanup goal of no SCG-violating impact on groundwater, but rather would serve only as a tool for determining the extent of excavation. (Monitoring of on- and off-site groundwater wells would be required after the soil and groundwater remedial actions were complete to ensure the cleanup goal of no SCG-violating impacts on groundwater was being met). Excavation would be considered complete when laboratory verification samples indicate that the excavation cell meets the threshold level of chlorinated organics.

Excavated contaminated soils would be temporarily stored on site in a designated staging/dewatering area prior to treatment. The staging/dewatering area would be constructed using an impermeable liner, surface water controls, a leachate collection system, and a cover. This soil would then be transferred to the thermal desorption unit for treatment.

The thermal desorption unit would be a fully mobile system owned and operated by one of several commercial vendors. Site preparation activities such as establishment of utilities and construction of a 75-square-foot concrete pad would be required prior to set-up of the unit. The actual treatment process is relatively uncomplicated and is described in Section 2.4.2.1.2. Essentially, it consists of feeding the soils into a chamber where they are heated to 400 to 800°F and agitated. Water and volatile organic compounds volatilize. The organic vapors are treated using, most likely, carbon adsorption (although thermal or catalytic oxidation techniques may be employed). Treated soils are wetted to cool them down and minimize dust generation. Treated soils would be tested for adequacy of treatment. As discussed in Section

2.2.2, adequacy of treatment would be a de minimus concentration of chlorinated organics, to be determined by NYSDEC, such that the soil would no longer be considered to contain an F002 hazardous waste. NYSDEC may set the de minimus level at zero or non-detect. A bench-scale treatability test would be required to evaluate the effectiveness of the thermal desorption treatment process in meeting the established de minimus levels and also to determine additional design parameters such as feed rate.

Treated soils meeting the de minimus levels would be backfilled into the excavated areas. All excavated areas would be properly restored. Simultaneous with the soil treatment, the groundwater plume upgradient of the hydrogeologic boundary would be extracted and treated as described for Alternative 4. Compliance of SCGs upgradient of the hydrogeologic boundary would be achieved in an estimated 5 years.

3.6.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

As stated for the previous alternatives, the subsurface contamination at the CC facility poses no threat to human health or the environment, due to lack of receptors.

Compliance with SCGs

The contaminant-specific SCGs consist solely of the groundwater quality standards. Upgradient of the hydrogeologic boundary, SCGs would likely be met through the groundwater pump-and-treatment action within 5 years due to the removal of most of the source soils and the pumping and treatment of the groundwater. Some isolated areas of groundwater contamination may occur beneath the contaminated soil left in place adjacent to the building to provide support. Although these soils would be partially contained by the sheet piling left in place and the capping of the surface, some contaminants may slowly leak out of the soil and cause exceedances of SCGs in these areas. However, these exceedances may be remediated by additional pumping and treatment (this action is not a standard part of this alternative but is examined as a scenario for the sensitivity analysis of the cost).

Several action-specific SCGs apply to this alternative. The action-specific SCGs regarding groundwater remediation would all be met, as discussed in Section 3.4.2 for Alternative 4. Action-specific SCGs for this alternative include the land disposal restrictions stated in 40 CFR 268, the "contained-in" interpretation of these regulations (described in OSWER Directive 9347.3-05FS) for handling the soils, and air emission SCGs stated in NYSDEC's "Air Cleanup Criteria" (January 1990) and the EPA's Air/Superfund National Technical Guidance Study Series.

The alternative calls for the treatment of the excavated soils via thermal desorption. As a treatability test has not been conducted to quantify the effectiveness of this technology on CC soils, the true extent of treatment is not known. However, based on information provided by vendors of this technology, greater that 99.9% removal of volatile chlorinated organics would be expected. Treatment to such an extent may satisfy the requirement of demonstrating that the soil no longer contains chlorinated organics or, alternatively, has been treated to reduce chlorinated organic concentrations to below de minimus levels that may be set by NYSDEC. By demonstrating that the soils do not contain chlorinated organics, the RCRA land disposal restrictions would not apply and, thus, the treatment requirements are also not applicable.

The potential for air emissions would arise from two operations: the excavation of the soils and the treatment of the soils. No specific permits would be required for soil excavation, but guidance on evaluating air emissions from excavation are provided in "Air/Superfund National Technical Guidance Study Series" (EPA-450/1-89-003). This document suggests that vapor emissions can be elevated above background emission levels by factors of 2.5 to 28 for excavation with a backhoe, 42 to 72 for dumping of excavated soil, and 10 for short-term storage. However, the risk analysis conducted for this site (and incorporated into the RI) estimated that the risks posed from vapor emissions from the facility to be at least 10,000 times below the 10^6 carcinogenic risk benchmark and at least 10^8 times below the noncarcinogenic hazard index threshold of unity. Thus, the operations involved with excavation would not be expected to generate significant air emissions.

The thermal desorption system would generate vapors and a gas-phase discharge that would require an air discharge permit. As discussed in Section 2.2.2 on action-specific SCGs, specific discharge standards are not stated by the air SCGs, but a procedure for developing levels to be put into an air permit is offered instead. The air emission control equipment that would be a component of the thermal desorption system (such as carbon adsorption or catalytic or thermal oxidation) would remove virtually all the extracted contaminants from the exhausted air, thus assuring meeting the requirements of the permit issued by NYSDEC.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long term as it calls for the removal of a large majority of the chlorinated organics from the CC facility. Only those soils adjacent to the building that cannot be excavated would remain and contain significant amounts of contaminants. The chlorinated organics in the soil and the groundwater would be removed directly through excavation and extraction, respectively: the chlorinated organics in the plume downgradient of the hydrogeologic boundary are expected to naturally attenuate through dispersion and biodegradation, as discussed for Alternative 2.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. The contaminants in the groundwater would be treated as described for Alternative 4. The soils would be treated by thermal desorption. As this technology is a physical treatment, the contaminants are transferred to another phase before being destroyed eventually. The gas-phase effluent would in turn be treated by either catalytic or thermal oxidation or carbon adsorption. Oxidation would result in direct destruction, while carbon adsorption would lead to the destruction of the contaminants when the carbon was regenerated. The carbon would be considered on F002 RCRA waste by the "derived from" rule and thus would necessarily be treated to effectively destroy the adsorbed contaminants during regeneration at a RCRA facility.

Short-Term Effectiveness

This alternative would present no adverse impacts during its implementation. As discussed above with respect to action-specific SCGs, emissions during excavation or treatment would not be expected to pose a risk. The extracted groundwater would be pumped and discharged through a closed system to the NCSD POTW. Some chlorinated organics may volatilize at the POTW, although this quantity can neither be estimated nor expected to present a significant short-term risk.

The duration of the implementation of this alternative is expected to be approximately 5 years for the upgradient groundwater remediation, 5 to 10 years for the downgradient remediation, and up to 2 years for the soil treatment.

3.6.3 Implementability Evaluation

The groundwater-treatment component of this alternative is readily implemented, as described in Alternative 4. The soil-treatment component is less readily implementable. Some difficulties may be encountered in anchoring the sheet piling such that it adequately holds back the soil supporting the building foundation, although this could likely be mastered. Agreeing on a threshold contaminant level for excavation may prove difficult, as it is difficult to predict exactly what contaminant concentration level would cause future groundwater contamination. Although a treatability study would have been completed to demonstrate the effectiveness of this alternative before it is implemented, the possibility exists that some excavated soils would fail to meet the de minimus levels that would allow them to be backfilled at the site. In this case, this soil would have to be landfilled at a RCRA-permitted secure landfill. NYSDEC might set the de minimus levels at zero or non-detect. It may be difficult to obtain such levels on a routine basis. In such cases, costs could increase greatly.

As the extent of future groundwater contamination is the ultimate measure of the remedial action's success, it is difficult to gauge the progress of the remediation because the soil treatment would be completed prior to the completion of the groundwater cleanup through pumping and treatment (of the upgradient plume). The success of the remedy would only be judged after the soil treatment operations have been demobilized, making additional soil treatment more difficult if contamination returned to the groundwater after the groundwater treatment system had been shut down upon attainment of SCGs.

Regarding the soil treatment system itself, there are several commercial thermal desorption units available, and this would not be an obstacle to implementation itself.

3.6.4 Cost Evaluation

The capital and O&M costs for Alternative 6 are presented in tables 3-13 and 3-14, respectively. The cost for treatment of the soil by the system is estimated at $175 per cubic yard, based on informal vendor quotations. The estimated present worth of this alternative is $13,948,600.

Four alternate scenarios were evaluated in a sensitivity analysis. The first scenario examines the cost if 25% of the treated soil fails to meet the de minimus levels and must be disposed of in an off-site RCRA landfill. This action would dramatically increase the estimated cost by 26%, to $17,546,000 (see Table 3-15). The second and third scenarios examine the costs if 30% more or less soil is excavated and treated. These conditions would increase or decrease the cost of the alternative by approximately 23%. The fourth scenario examines the possibility that high vapor concentrations are released during excavation, creating the need to use foam to suppress them. This would increase the cost of the alternative by only 0.4%.

3.7 ALTERNATIVE 7: EXTRACTION OF GROUNDWATER BOTH UPGRADIENT AND DOWNGRADIENT OF THE HYDROGEOLOGIC BOUNDARY, TREATMENT BY CARBON ADSORPTION, DISCHARGE TO CAYUGA CREEK, EXCAVATION OF SOURCE AREA SOILS, TREATMENT BY THERMAL DESORPTION, BACK-FILLING ON SITE

3.7.1 Detailed Alternative Description

Alternative 7 would incorporate all of Alternative 6 but calls for treatment of groundwater by carbon adsorption both upgradient and downgradient of the hydrogeologic barrier, as described in Alternative 3.

3.7.2 Effectiveness Evaluation

Overall Protection of Human Health and the Environment

This alternative, like alternatives 3 and 6, is completely protective of human health and the environment.

Compliance with SCGs

This alternative's compliance with SCGs would be identical to Alternative 6's compliance. A difference between this alternative and Alternative 6 is that SCGs would be achieved in the groundwater downgradient of the hydrogeologic boundary through active treatment. Thus SCGs would be attained more rapidly in this portion of the aquifer. Also, as the groundwater would be treated on site, certain action-specific water SCGs would apply and be met, as discussed for Alternative 4.

Long-Term Effectiveness and Permanence

This alternative, like Alternative 6, would be effective in the long term due to the active remediation of the vast majority of contaminants in both the source soils and the contaminated groundwater. Only those soils adjacent to the building that cannot be excavated would remain and contain significant concentrations of contaminants.

Reduction of Toxicity, Mobility, or Volume through Treatment

Treatment is a principal component of this alternative. In addition to the direct treatment of the soils and upgradient plume as described for Alternative 6, this alternative calls for the direct treatment, rather than natural biodegradation and dispersion, of the groundwater downgradient of the hydrogeologic boundary.

Short-Term Effectiveness

This alternative, like Alternative 6, is not expected to pose any short-term risks. The duration of this alternative is expected to be approximately 5 years for the groundwater remediation and up to 2 years for the soil treatment.

3.7.3 Implementability Analysis

This alternative would be constrained by the same implementability considerations described for Alternative 6.

3.7.4 Cost Evaluation

The capital and O&M costs for Alternative 7 are presented in tables 3-16 and 3-17, respectively. The estimated present worth of this alternative is $14,828,700. The same alternate scenarios evaluated for Alternative 6 are evaluated for Alternative 7. The results of these analyses are presented in Table 3-18.

3.8 COMPARISON OF ALTERNATIVES AND RECOMMENDATION OF PREFERRED ALTERNATIVE

The results of the detailed analyses of the alternatives are summarized in Table 3-19. Also included in this table are each alternative's scores as rated by the format presented in NYSDEC's Technical and Administrative Guidance Manual (TAGM), and the completed scoring forms are provided in Appendix A. These analyses show that all the alternatives considered (except no action) would satisfy the threshold criteria of compliance with the applicable SCGs and overall protection of human health and the environment. (It should be noted, however, that with alternatives 2 and 3, the groundwater immediately adjacent to the source areas and the extraction wells would remain contaminated above SCGs, although the more distant portions of the upgradient plume would be remediated.) Thus, the selection of a preferred alternative is governed by the remaining ("balancing") criteria.

In comparing the six SCG-complying alternatives, it is useful to first compare the alternatives calling for groundwater treatment of that portion of the plume upgradient of the hydrogelogic boundary (alternatives 2, 4, and 6) with the alternatives calling for treatment of groundwater both upgradient and downgradient of the boundary (alternatives 3, 5, and 7). As discussed in the RI and restated in Section 3.2, there is evidence that the chlorinated organics downgradient of the hydrogeologic boundary are being destroyed through natural anaerobic biodegradation. Several pieces of information support this conclusion.

First, the types of chlorinated compounds in the water represent the expected degradants that would be found through biodegradation by reductive dechlorination of TCE. Specifically, TCE degrades into 1,2-DCE then VC. Interestingly, although VC is found in many samples, no accumulation of this compound is found, indicating it disperses or is further degraded to chloride and pure hydrocarbon (i.e., methane or ethane), compounds not analyzed for. In general, those portions of the plume located furthest from the facility show a contaminant distribution dominated by the degradation products. This may be due partly to the fact that the degradation products are more mobile. More likely, this is due to the fact that as the contaminants migrate downgradient, they are subject to biodegradation. This leads to a second inference. The high groundwater velocity and lower adsorptive capacity of the aquifer indicate that in the absence of any degrading mechanism, the plume would be expected to have traveled significantly further than it presently has. Due to the apparent natural biodegradation and dispersion, the chlorinated organics are attenuated before they can migrate very far. The fact the no chlorinated organics attributable to the facility have been found in residential wells along Lockport Road lends credence to this conclusion. By now, the plume should have migrated well beyond Lockport Road. Biodegradation and dispersion have caused the plume to reach nondetectable levels prior to reaching this location.

Also to be considered is the fact that the upgradient-only remediation alternatives (alternatives 2, 4, and 6) all call for the cessation of contaminant migration to the plume, either through groundwater extraction at or near the source itself or through extraction plus source treatment. Without the introduction of fresh contaminants into the downgradient plume, the following would be expected to occur: the leading edge of the plume, where the degree of biodegradation is the most advanced, will continue to be degraded to non-toxic products. At the tail of the downgradient plume, the lack of introduction of fresh contaminants means this tail would migrate downgradient, leaving a clean aquifer in its wake. As the tail of the plume migrates, biodegradation and dispersion would continue, and by the time it reached the current head of the plume, it too would likely be degraded to non-toxic products. In short, the on-site actions would cause the downgradient plume to cease or significantly reduce its overall migration while the contaminants now present are naturally destroyed. Thus, despite the lack of active, direct treatment, the volume and toxicity of the contaminants in this plume are reduced as effectively as with the alternatives calling for direct treatment, although over a longer timeframe (up to 10 years, versus 5 years for direct treatment). As the existing plume does not, and will not, pose a threat to human health or the environment, the less expensive (by approximately $875,000) passive treatment alternatives (alternatives 2, 4, and 6) are preferred over the active treatment alternatives.

The next step in the comparison of alternatives is the comparison of the remaining source treatment alternatives (i.e., alternatives 4 and 6) with the remaining alternative that includes groundwater treatment alone (i.e., Alternative 2). As discussed above, both classes of alternatives are effective in satisfying the threshold criteria of protecting human health and the environment and attaining SCGs (although some contaminated groundwater would remain adjacent to the source areas with Alternative 2). In addition, both would be effective in the long term. Alternative 2 meets the remedial action objective of clean (with respect to SCGs) groundwater through constant treatment. Despite the need for such constant groundwater extraction and treatment, the present-worth cost of this alternative is 75% to 85% less expensive than the alternatives calling for source treatment (Costs for Alternative 2 included only 30 years of operation. Although the treatment may continue for a longer duration, the discounted present worth of these future actions do not contribute greatly to the overall costs. For example, an additional 5 years of operation would only increase the present worth of Alternative 2 by 5%).

Examination of the scores of these alternatives from the NYSDEC alternative scoring system illustrates the advantage of Alternative 2's lower cost. This alternative outscored alternatives 4 and 6 (90 to 84 and 90 to 80, respectively). Its higher score reflects the much lower costs (costs count for 15% of the score).

A key issue, however, in comparing Alternative 2 to alternatives 4 and 6 is the criterion of treatment to reduce toxicity, mobility, or volume of waste or contaminated media. By one measure, Alternative 2 significantly reduces the volume of contaminated media by substantially eliminating groundwater contamination. The downgradient plume would naturally biodegrade, as described above, while the upgradient plume would be captured and treated. On the other hand, none of the source material, i.e., contaminated soil, is treated other than by the modest amounts of chlorinated organics that leach into the groundwater from the soil and are captured by the groundwater treatment system. It is unclear whether Alternative 2 satisfies the preference for treatment, although it is clear that less treatment is accomplished by this alternative. EPA's Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (EPA/540/G-88/033) states that "Groundwater contamination will typically comprise a principal threat at many Superfund sites, but if source or soil threats are also present, treatment only of groundwater would not satisfy the preference" for treatment alternatives. Although the source soils do not present a direct threat at the CC facility, it is the intent of the guidance to utilize as much treatment as possible.

An additional factor in the comparison of Alternative 2 to alternatives 4 and 6 is the issue of future land use. Although most of the land would be suitable, those parcels where the extraction and treatment operations were conducted and a few isolated hot spots in the soil would not be suitable for future use. For this reason, and those presented earlier, Alternative 2 is not a preferred alternative.

The selection of the preferred alternative thus is the choice between Alternative 4, calling for <u>in situ</u> treatment, and Alternative 6, calling for excavation, aboveground on-site treatment, and backfilling. These alternatives are expected to be equally effective in remediating the facility. Both alternatives also present a similar degree of uncertainty about certain aspects of the remediation such as ultimate soil contaminant concentration levels and the choice of various operating conditions. However, E & E recommends Alternative 4 as the preferred alternative for the following reasons.

First, once contaminated soil is excavated, it is immediately subject to RCRA regulations, including duration-of-storage requirements and land disposal restriction regulations. These may cause a problem if treatment of certain batches of excavated soil do not meet the _de minimus_ levels for backfilling. Some soil would have to be either re-treated or, if this fails, sent to an off-site RCRA facility. If NYSDEC considers the _de minimus_ levels to be zero or non-detect, this would be a very significant consideration.

Second, it is more difficult to perform additional remedial action with Alternative 6 if groundwater contamination is found to reappear after the groundwater treatment system is shut down. As the groundwater treatment is estimated to last 5 years, or 2 to 3 years after the soil remediation has been completed, additional soil remediation would entail a remobilization of the soil treatment system. This is in contrast to the _in situ_ alternative, where the soil remediation system could easily be reactivated if needed.

Alternative 4 is recommended as the preferred alternative based to a significant degree on the results of the initial phase of the pilot study. This study indicates that vacuum extraction is an effective technology to remediate soils at the facility. The pilot study, however, has been extended through February 1991 to gather further data. Design modifications from the initial study, such as a more powerful vacuum unit, a surface cover, and air injection probes, will be used and evaluated during the extended study. Evaluation of data collected during the extended period (including soil sampling) will be performed at the end of the study to provide a more complete picture of the effectiveness of vacuum extraction. Ultimately, final selection of Alternative 4 will be dependent on the results of the evaluation of the extended study.

TABLE 3-1: CAPITAL COSTS FOR ALTERNATIVE 2

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	750	$25,500
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$50,000.00	1	$50,000
SUBMERSIBLE PUMPS	EA	$3,000.00	2	$6,000
SUBTOTAL				$117,800
CONTINGENCY (25%)				$29,450
SUBTOTAL				$147,250
ENGINEERING (15%)				$22,088
CARBON ADSORPTION (SEE TABLE 2-10)				$336,200
SUBTOTAL				$505,538
OWNER'S ADMINISTRATIVE COST (10%)				$50,554
PUMPING TEST SERVICES DURING INITIATION OF REMEDIATION				$60,000
TOTAL COST				$616,091

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORTS THE WATER FROM THE INDIVIDUAL WELLS, CONTAIN MORE VALVES, FITTINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-2: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 2

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
O&M FOR CARBON ADSORPTION (SEE TABLE 2-12)	YR	$38,900.00	1	30	$38,900
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$4,000.00	1	30	$4,000
ELECTRICITY FOR PUMPS	MO	$150.00	12	30	$1,800
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	30	$16,000
ANALYSIS	EA	$150.00	140	30	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	30	$12,000

Table 3-3

SENSITIVITY ANALYSIS FOR ALTERNATIVE 2

	Costs		
Scenario	Capital	O & M	Present Worth
Base case	$616,100	$93,700	$2,124,700
Increase extraction rate by 30%	616,100	105,400	2,313,000
Decrease extraction rate by 30%	616,100	82,030	1,936,800
Complete remediation in 20 years	616,100	$93,700	1,842,300

02[AD]CZ5020:D3100/3973/26

TABLE 3-4: CAPITAL COSTS FOR ALTERNATIVE 3

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	1300	$44,200
3" DIAMETER	LF	$40.00	2000	$80,000
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$100,000.00	1	$100,000
OFFSITE INVESTIGATION	LS	$160,000.00	1	$160,000
EXTRACTION WELLS	EA	$23,000.00	2	$46,000
SUBMERSIBLE PUMPS	EA	$3,000.00	4	$12,000
WELL ENCLOSURES	EA	$7,000.00	2	$14,000
PIPE INSTALLATION BELOW RR	LS	$33,000.00	1	$33,000
SUBTOTAL				$525,500
CONTINGENCY (25%)				$131,375
SUBTOTAL				$656,875
ENGINEERING (15%)				$98,531
CARBON ADSORPTION (SEE TABLE 2-10)				$336,200
SUBTOTAL				$1,091,606
OWNER'S ADMINISTRATIVE COST (10%)				$109,161
PUMPING TEST SERVICES DURING THE INITIATION OF REMEDIATION				$100,000
TOTAL COST				$1,300,767

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORT THE WATER FROM THE INDIVIDUAL WELLS, AND THE 3" DIAMETER PIPES, WHICH TRANSPORT THE OFF-SITE GROUNDWATER ONTO THE SITE, CONTAIN MORE VALVES, FITTINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-5: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 3

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
O&M FOR CARBON ADSORPTION					
(SEE TABLE 2-12)					
YEARS 0-4	YR	$57,100.00	1	5	$57,100
YEARS 5-29	YR	$38,900.00	1	25	$38,900
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$8,750.00	1	30	$8,750
ELECTRICITY FOR PUMPS	MO	$300.00	12	30	$3,600
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	30	$16,000
ANALYSIS	EA	$150.00	140	30	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	30	$12,000

Table 3-6

SENSITIVITY ANALYSIS FOR ALTERNATIVE 3

Scenario	Costs		
	Capital	O & M	Present Worth
Base case	$1,300,800	$118,500-$100,300	$3,001,700
Increase extraction rate by 30%	1,300,800	135,600-111,900	3,212,300
Decrease extraction rate by 30%	1,300,800	101,300-88,600	2,786,800
Duration of downgradient plume remediation increased to 10 year	1,300,800	118,500-100,300	3,065,400

02[AD]CZ5020:D3100/3974/26

*O&M costs decrease once downgradient plume is remediated.

TABLE 3-7: CAPITAL COSTS FOR ALTERNATIVE 4

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
GROUNDWATER				
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	750	$25,500
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$50,000.00	1	$50,000
SUBMERSIBLE PUMPS	EA	$3,000.00	2	$6,000
SOIL				
VAPOR EXTRACTION				
DESIGN	LS	$150,000.00	1	$150,000
SITE PREPARATION	LS	$100,000.00	1	$100,000
WELL AND PROBE INSTALLATION	LS	$800,000.00	1	$800,000
VACUUM SYSTEMS	LS	$500,000.00	1	$500,000
SITE COVER	LS	$150,000.00	1	$150,000
GROUNDWATER COLLECTION	LS	$300,000.00	1	$300,000
WINTERIZATION	LS	$150,000.00	1	$150,000
SYSTEM INSTALLATION	LS	$500,000.00	1	$500,000
START-UP	LS	$200,000.00	1	$200,000
SUBTOTAL				$2,967,800
GROUNDWATER CONTINGENCY (25%)				$29,450
SOIL CONTINGENCY (10%)				$285,000
SUBTOTAL				$3,282,250
ENGINEERING (15%)				$492,338
SUBTOTAL				$3,774,588
OWNER'S ADMINISTRATIVE COSTS (10%)				$377,459
PUMPING TEST SERVICES DURING INITIATION OF REMEDIATION				$60,000
TOTAL COST				$4,212,046

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORT THE WATER FROM THE INDIVIDUAL WELLS, CONTAIN MORE VALVES, FITTIINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-8: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 4

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
NCSD FEE	1000 GAL	$1.37	52560	5	$72,007
DISCHARGE MONITORING	YR	$5,000.00	1	5	$5,000
ELECTRICITY FOR PUMPS	MO	$150.00	12	5	$1,800
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	5	$16,000
ANALYSIS	EA	$150.00	140	5	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	5	$12,000
CARBON USAGE COSTS					
FIRST YEAR	LBS CARBON	$2.80	455000	1	$1,274,000
SECOND YEAR	LBS CARBON	$2.80	152000	1	$425,600
O&M FOR VAPOR EXTRACTION UNIT	CY	$15.00	48400	1.8	$726,000
ELECTRICITY FOR VACUUM PUMPS	KW-HR	$0.0605	4000000	1.8	$242,000
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$4,000.00	1	5	$4,000

Table 3-9

SENSITIVITY ANALYSIS FOR ALTERNATIVE 4

Scenario	Present Worth Cost
Base case	$8,442,400
Soil treatment for 2.5 years	9,413,900
Soil and Groundwater treatment operated for an additional year during year 6	10,389,200
Groundwater Treatment System operated for 10 years	9,371,900

02[AD]CZ5020:D3100/3976/25

TABLE 3-10: CAPITAL COSTS FOR ALTERNATIVE 5

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
GROUNDWATER				
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	1300	$44,200
3" DIAMETER	LF	$40.00	2000	$80,000
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$100,000.00	1	$100,000
OFFSITE INVESTIGATION	LS	$160,000.00	1	$160,000
EXTRACTION WELLS	EA	$23,000.00	2	$46,000
SUBMERSIBLE PUMPS	EA	$3,000.00	4	$12,000
WELL ENCLOSURES	EA	$7,000.00	2	$14,000
PIPE INSTALLATION BELOW RR	LS	$33,000.00	1	$33,000
SOIL				
VAPOR EXTRACTION				
DESIGN	LS	$150,000.00	1	$150,000
SITE PREPARATION	LS	$100,000.00	1	$100,000
WELL AND PROBE INSTALLATION	LS	$800,000.00	1	$800,000
VACUUM SYSTEMS	LS	$500,000.00	1	$500,000
SITE COVER	LS	$150,000.00	1	$150,000
GROUNDWATER COLLECTION	LS	$300,000.00	1	$300,000
WINTERIZATION	LS	$150,000.00	1	$150,000
SYSTEM INSTALLATION	LS	$500,000.00	1	$500,000
START-UP	LS	$200,000.00	1	$200,000
SUBTOTAL				$3,375,500
GROUNDWATER CONTINGENCY (25%)				$131,375
SOIL CONTINGENCY (10%)				$285,000
SUBTOTAL				$3,791,875
ENGINEERING (15%)				$568,781
CARBON ADSORPTION (SEE TABLE 2-10)				$336,200
SUBTOTAL				$4,696,856
OWNER'S ADMINISTRATIVE COST (10%)				$469,686
PUMPING TEST SERVICES DURING INITIATION OF REMEDIATION				$100,000
TOTAL COST				$5,266,542

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORT THE WATER FROM THE INDIVIDUAL WELLS, AND THE 3" DIAMETER PIPES, WHICH TRANSPORT THE OFF-SITE GROUNDWATER ONTO THE SITE, CONTAIN MORE VALVES, FITTINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-11: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 5

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
O&M FOR CARBON ADSORPTION	YR	$38,900.00	1	5	$38,900
ELECTRICITY FOR PUMPS	MO	$300.00	12	5	$3,600
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	5	$16,000
ANALYSIS	EA	$150.00	140	5	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	5	$12,000
CARBON USAGE COSTS					
FIRST YEAR	LBS CARBON	$2.80	455000	1	$1,274,000
SECOND YEAR	LBS CARBON	$2.80	152000	1	$425,600
O&M FOR VAPOR EXTRACTION UNIT	CY	$15.00	48400	1.8	$726,000
ELECTRICITY FOR VACUUM PUMPS	KW-HR	$0.0605	4000000	1.8	$242,000
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$8,750.00	1	5	$8,750

Table 3-12

SENSITIVITY ANALYSIS FOR ALTERNATIVE 5

Scenario	Present Worth Cost
Base case	$9,322,500
Soil treatment for 2.5 years	10,294,000
Soil and Groundwater treatment operated for an additional year during year 6	11,229,100
Groundwater Treatment System operated for 10 years	10,029,500

02[AD]CZ5020:D3100/3977/24

TABLE 3-13: CAPITAL COSTS FOR ALTERNATIVE 6

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
GROUNDWATER				
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	750	$25,500
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$50,000.00	1	$50,000
SUBMERSIBLE PUMPS	EA	$3,000.00	2	$6,000
SOIL				
SURVEYING	LS	$1,800.00	1	$1,800
REMOVE LAMP POSTS	LS	$2,000.00	1	$2,000
CONTAMINATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
UNCONTAMINATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
DECON PAD	LS	$2,500.00	1	$2,500
EXCAVATION	CY	$20.00	32500	$650,000
DUST CONTROL	LS	$20,000.00	1	$20,000
REMOVE/REPLACE STORM SEWER	LS	$30,000.00	1	$30,000
SHEET PILING (WITH BRACING)	SF	$57.00	3750	$213,750
FIELD SCREENING	LS	$60,000.00	1	$60,000
VERIFICATION SAMPLING	EA	$150.00	150	$22,500
TRANSPORTING STAGED SOIL TO TREATMENT UNIT	CY	$2.00	32500	$65,000
BACKFILL OPERATION	CY	$4.50	32500	$146,250
SITE RESTORATION				
TOPSOIL (4" THICK)	CY	$15.00	1076	$16,140
SEED, MULCH, FERTILIZE	SY	$1.00	9680	$9,680
TREATMENT				
PAD CONSTRUCTION (5" THICK)	SF	$10.00	75	$750
TREATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
UTILITY HOOK-UP	LS	$10,000.00	1	$10,000
TREATABILITY STUDY	LS	$20,000.00	1	$20,000
SOIL TREATMENT	CY	$175.00	32500	$5,687,500
VERIFICATION SAMPLING	EA	$150.00	100	$15,000
SUBTOTAL				$7,120,670
CONTINGENCY (25%)				$1,780,168
SUBTOTAL				$8,900,838
ENGINEERING (15%)				$1,335,126
SUBTOTAL				$10,235,963
OWNER'S ADMINISTRATIVE COST (10%)				$1,023,596
PUMPING TEST SERVICES DURING INITIATION OF REMEDIATION				$60,000
TOTAL COST				$11,319,559

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORT THE WATER FROM THE INDIVIDUAL WELLS, CONTAIN MORE VALVES, FITTINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-14: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 6

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
CARBON USAGE COSTS					
FIRST YEAR	LBS CARBON	$2.80	455000	1	$1,274,000
SECOND YEAR	LBS CARBON	$2.80	152000	1	$425,600
NCSD FEE	1000 GAL	$1.37	52560	5	$72,007
DISCHARGE MONITORING	YR	$5,000.00	1	5	$5,000
ELECTRICITY FOR PUMPS	MO	$150.00	12	5	$1,800
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	5	$16,000
ANALYSIS	EA	$150.00	140	5	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	5	$12,000
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$4,000.00	1	5	$4,000

Table 3-15

SENSITIVITY ANALYSIS FOR ALTERNATIVE 6

Scenario	Present Worth Cost
Base case	$13,948,600
50% of treated soil landfilled off site in a RCRA facility	17,546,000
Treated soil volume increased by 30%	17,055,200
Treated soil volume decreased by 30%	10,842,100
Use of vapor-suppressing foam required	13,997,900

02[AD]CZ5020:D3100/3978/24

Draft

TABLE 3-16: CAPITAL COSTS FOR ALTERNATIVE 7

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	CAPITAL COST
GROUNDWATER				
INSTALL PIPE*				
2" DIAMETER	LF	$34.00	1300	$44,200
3" DIAMETER	LF	$40.00	2000	$80,000
4" DIAMETER	LF	$33.00	1100	$36,300
PROCESS CONTROLS/INSTRUMENTATION	LS	$100,000.00	1	$100,000
OFFSITE INVESTIGATION	LS	$160,000.00	1	$160,000
EXTRACTION WELLS	EA	$23,000.00	2	$46,000
SUBMERSIBLE PUMPS	EA	$3,000.00	4	$12,000
WELL ENCLOSURES	EA	$7,000.00	2	$14,000
PIPE INSTALLATION BELOW RR	LS	$33,000.00	1	$33,000
SOIL				
SURVEYING	LS	$1,800.00	1	$1,800
REMOVE LAMP POSTS	LS	$2,000.00	1	$2,000
CONTAMINATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
UNCONTAMINATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
DECON PAD	LS	$2,500.00	1	$2,500
EXCAVATION	CY	$20.00	32500	$650,000
DUST CONTROL	LS	$20,000.00	1	$20,000
REMOVE/REPLACE STORM SEWER	LS	$30,000.00	1	$30,000
SHEET PILING (WITH BRACING)	SF	$57.00	3750	$213,750
FIELD SCREENING	LS	$60,000.00	1	$60,000
VERIFICATION SAMPLING	EA	$150.00	150	$22,500
TRANSPORTING STAGED SOIL TO TREATMENT UNIT	CY	$2.00	32500	$65,000
BACKFILL OPERATION	CY	$4.50	32500	$146,250
SITE RESTORATION				
TOPSOIL (4" THICK)	CY	$15.00	1076	$16,140
SEED, MULCH, FERTILIZE	SY	$1.00	9680	$9,680
TREATMENT				
PAD CONSTRUCTION (5" THICK)	SF	$10.00	75	$750
TREATED SOIL STAGING AREA	LS	$10,000.00	1	$10,000
UTILITY HOOK-UP	LS	$10,000.00	1	$10,000
TREATABILITY STUDY	LS	$20,000.00	1	$20,000
SOIL TREATMENT	CY	$175.00	32500	$5,687,500
VERIFICATION SAMPLING	EA	$150.00	100	$15,000
SUBTOTAL				$7,528,370
CONTINGENCY (25%)				$1,882,093
SUBTOTAL				$9,410,463
ENGINEERING (15%)				$1,411,569
CARBON ADSORPTION (SEE TABLE 2-10)				$336,200
SUBTOTAL				$11,158,232
OWNER'S ADMINISTRATIVE COST (10%)				$1,115,823
PUMPING TEST SERVICES DURING INITIATION OF REMEDIATION				$100,000
TOTAL COST				$12,374,055

* INCLUDES COST OF CARBON STEEL PIPE, FITTINGS, INSULATION, PIPE SUPPORTS AND BALL VALVES. THE 2" DIAMETER PIPES, WHICH TRANSPORT THE WATER FROM THE INDIVIDUAL WELLS, AND THE 3" DIAMETER PIPES, WHICH TRANSPORT THE OFF-SITE GROUNDWATER ONTO THE SITE, CONTAIN MORE VALVES, FITTINGS, ETC., AND ARE THUS MORE EXPENSIVE PER FOOT.

TABLE 3-17: OPERATION AND MAINTENANCE COSTS FOR ALTERNATIVE 7

REMEDIAL ALTERNATIVE ITEM	UNITS	UNIT COST	QUANTITY	YEARS	ANNUAL COST
O&M FOR CARBON ADSORPTION	YR	$38,900.00	1	5	$38,900
O&M FOR PUMP/TRANSMISSION SYSTEM	YR	$8,750.00	1	5	$8,750
CARBON USAGE COSTS					
FIRST YEAR	LBS CARBON	$2.80	455000	1	$1,274,000
SECOND YEAR	LBS CARBON	$2.80	152000	1	$425,600
ELECTRICITY FOR PUMPS	MO	$300.00	12	5	$3,600
QUARTERLY WELL SAMPLING					
LABOR	ROUND	$4,000.00	4	5	$16,000
ANALYSIS	EA	$150.00	140	5	$21,000
DATA VALIDATION	ROUND	$3,000.00	4	5	$12,000

Table 3-18

SENSITIVITY ANALYSIS FOR ALTERNATIVE 7

Scenario	Present-Worth Cost
Base case	$14,828,700
50% of treated soil landfilled off site in a RCRA facility	18,426,100
Treated soil volume increased by 30%	17,935,300
Treated soil volume decreased by 30%	11,722,200
Use of vapor-suppressing foam required	14,878,000

02[AD]CZ5020:D3100/3979/24

Table 3-19

SUMMARY OF DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Overall protection of human health and the environment.	Subsurface contamination poses no threat to human health or the environment. The lack of receptors, either human or environmental, results in an absence of significant risks, even via the air exposure pathway. Future uses of land near the facility could theoretically include residences constructed on agricultural land southwest of the railroad and power company rights-of-way. Placing wells here for potable water is unlikely because the natural water quality of the bedrock aquifer is unsuitable for use.	See Alternative 1. Control of the upgradient plume and elimination of the downgradient plume through natural attenuation eliminates the improbable theoretical exposure scenario of potable water well installation in agricultural land beyond railroad and power company rights-of-way.	See Alternative 2. Elimination of downgradient plume through pumping and treatment eliminates the possible theoretical exposure scenario of potable waterwell installation in agricultural land beyond the railroad and power company company rights-of-way.	Elimination of source (through in-situ treatment) and groundwater plume (through extraction upgradient and attenuation downgradient) eliminates theoretical risk of potable well contamination.

02[AD]CZ5020:D3100/3981/0

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Down-gradient of the Hydro-geologic Barrier, Treat-ment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydro-geologic Boundary, Dis-charge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Back-filling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Overall Protection of Human Health and the Environment	See Alternatives 3 and 4	See Alternative 4 (Note: treatment would be ex-situ, not in-situ)	See Alternatives 3 and 4

02[AD]CZ5020:D3100/3981/0

recycled paper

ecology and environment

Draft

Table 3 (Cont.)

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorbtion, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorbtion, No soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Compliance with SCGs				
- Chemical Specific	Existing exceedances of groundwater standards will continue. Continuing migration of groundwater will result in an increased plume size.	Upgradient, SCGs would be met in a portion of the aquifer. Isolated hot spots would remain beneath source areas. The contaminant levels would drop off away from source areas due to the pumping system's capture area. Over time, the source areas may be depleted through constant leaching, at which time the localized hot spot SCGs would no longer exist. Downgradient, SCGs would eventually be met through natural biodegradation and attenuation.	Upgradient, see Alternative 2; downgradient SCGs would be attained within an estimated 5 years.	Contaminant-specific SCGs consist solely of the groundwater quality standards. Upgradient SCGs would likely be met within 5 years due to the removal of source contaminants via vapor extraction and groundwater extraction. Downgradient plume would be eliminated through natural biodegradation and attenuation.
- Action Specific	N/A	Extracted water would be treated by carbon adsorption. This treatment would meet the discharge standards to be set by NYSDEC in a SPDES permit.	See Alternative 2	Extracted water would be discharged to and treated by a POTW. Hence, no action-specific SCGs apply, other than to meet the conditions of the permit to discharge to the sewer district. The SCGs provide a procedure for developing air emission permit levels. Since control equipment such as carbon adsorption or catalytic or thermal oxidation will be installed on the vapor extraction system, removing virtually all the contaminants, meeting the requirements of the permit issued by NYSDEC will be assured.

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Compliance with SCGs			
- Chemical Specific	Upgradient: see Alternative 4 Downgradient: through active removal, SCGs in this area will be met more quickly than through natural biodegradation.	Upgradient of the hydrogeologic boundary, SCGs would be met within 5 years due to removal of most of the source soils and the pumping and treatment of this portion of the plume. Downgradient plume would be eliminated through natural biodegradation and attenuation.	Upgradient: see Alternative 6 Downgradient: through active removal of groundwater, SCGs in this area will be met more quickly than through natural biodegradation.
- Action Specific	Groundwater: See Alternative 3	Groundwater: See Alternative 4 ...	Groundwater: see Alternative 3
	Soil: See Alternative 4	A treatability test of the facility's soil has not been conducted using thermal desorption; thus, the true extent of treatment is not known. Based on information by vendors of thermal desorption technology, greater than 99% removal of volatile chlorinated organics would be expected. Treatment to such levels may demonstrate that the soil no longer contains chlorinated organics or the chlorinated organics concentrations fall below <u>de minimus</u> levels set by NYSDEC. If it were demonstrated that the soils do not contain chlorinated organics, the RCRA land disposal restrictions would not apply; thus, treatment requirements are not applicable.	Soil: see Alternative 6.
- Action Specific		Potential for air emissions arise from excavated soils and treatment of soils.	

Table 3-19 (Cont.)

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Long-Term Effectiveness and Permanence	This alternative would at no time be effective in meeting the remedial action objectives. Both the soil and groundwater media would remain contaminated.	As groundwater extraction would continue until the contaminants stop leaching into the aquifer, this alternative may be considered effective in the long term by virtue of its call for long-term operations until SCGs are met.	See Alternative 2	Since removal of the vast majority of chlorinated organics that would have migrated to the groundwater will be accomplished, this alternative would be considered effective in the long-term.
Reduction of Toxicity, Mobility, and Volume	No reduction in the toxicity, mobility, or volume of the contaminated media.	Upgradient: groundwater extracted from this portion of plume would be treated by carbon adsorption. The contaminants on the carbon would eventually be destroyed when the carbon is regenerated. Downgradient: no treatment would be employed. However, the plume would be passively treated through natural biodegradation. Groundwater data show a clear pattern of natural anaerobic biodegradation leading to the mineralization of the chlorinated organics <u>in situ</u>. Soil: no treatment.	Upgradient: see Alternative 2. Downgradient: extracted water will be combined with upgradient water for active, rather than passive, treatment. Soil: no treatment.	Groundwater: all contamination in the upgradient plume would be discharged to the NCSD POTW for treatment by biological and physical methods. Currently, the NCSD's influent contains TCE at levels comparable or above the levels that would be expected in the extracted groundwater, and its effluent complies with its discharge permit. One treatment mechanism of the POTW would be volatilization during aerobic biological treatment. Chlorinated organics that volatilize at the POTW would eventually be destroyed through photo-oxidation in the atmosphere. The downgradient portion of the aquifer would be passively treated through natural biodegradation. Groundwater data shows a clear pattern of natural anaerobic biodegradation leading to the mineralization of the chlorinated organics <u>in situ</u>.

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Long-Term Effectiveness and Permanence	See Alternative 4. Plus, downgradient groundwater would be actively remediated.	Active remediation of the vast majority of contaminants in both the source soils and upgradient contaminated groundwater would be effective in the long term.	See Alternative 6. Plus, downgradient groundwater would be actively remediated.
Reduction of Toxicity, Mobility, and Volume	Groundwater: see Alternative 3 Soil: see Alternative 4	Groundwater: see Alternative 4 Excavated soil will be treated by thermal desorption, which will transfer contaminants from soil to vapor. These vapors will be treated by either oxidation or carbon adsorption. Oxidation results in directly destroying the contaminants, while the contaminants in the spent carbon will be destroyed during the regeneration of the carbon. Spent carbon prior to regeneration will be considered an F002 RCRA waste and would have to be handled by a RCRA permitted facility.	Groundwater: see Alternative 3 Soil: see Alternative 6

02[AD]CZ5020:D3100/3981/0

Table 3-[illegible] (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Reduction of Toxicity, Mobility, and Volume (Cont.)			During vapor extraction, the contaminants are transferred from the soil to another phase. The gas-phase effluent will be treated by either catalytic or thermal oxidation or carbon adsorption. Oxidation would result in immediate destruction, while carbon adsorption would lead to destruction of the contaminants when the carbon is being regenerated. The carbon must be considered an F002 RCRA waste and therefore must be regenerated at a RCRA facility.

02[AD]CZ5020:D3100/3981/0

Table 3-19 (Cont.)

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, No soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Short-Term Effectiveness				
- Protection of Community During Remediation	As there is no significant risk to the community by the contamination, the no action alternative would not have any short-term impacts.	No adverse impacts during implementation. Extracted contaminants remain in a closed system until after treatment by carbon adsorption.	See Alternative 2	Groundwater: no adverse impacts during implementation. Extracted contaminants remain in a closed system until treatment at POTW. Soil: contaminated vapors generated by the vapor extraction will be treated with carbon adsorption or oxidation prior to discharge to eliminate emissions.

02[AD]CZ5020:D3100/3981/0

recycled paper

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Short Term Effectiveness			
-Protection of Community During Remediation	Groundwater: see Alternative 3	Groundwater: see Alternative 4	Groundwater: see Altern-tive 3
	Soil: see Alternative 4	Soil: potential for generation of vapors during excavation. Although a preliminary estimate of the impacts, using EPA guidance, indicates no adverse effects, they may occur.	Soil: see Alternative 6

02[AD]CZ5020:D3100/3981/0

Draft

Table 3-19 (Cont.)

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, No soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Short Term Effectiveness (Cont.)				
- Time Until Remedial Response Objectives Are Achieved	NA	Exact duration of this alternative is not known due to lack of information regarding total amounts of contaminants and leachate rates, but it is expected to operate for at least 30 years. However, upgradient of the hydrogeologic boundary, the plume would be contained within months of the start of extraction. Downgradient of the boundary, the response objectives would be met in 5 to 10 years	Upgradient: see Alternative 2 Downgradient: without a source of additional contamination, would be expected expected to be remediated within 5 years.	Soil: 16 to 22 months Upgradient: 5 years Downgradient: 5 to 10 years
Implementability Evaluation				
- Technical Feasibility	There are not any technical obstacles for this alternative since it required no action.	Readily implementable, technical obstacles to construction and operation are non-existent. Remedy is easily monitored via the existing monitoring wells. Additional extraction wells could readily be installed if needed.	See Alternative 2	Groundwater: see Alternative 2 Soil Treatment using vapor extraction is readily implementable since it requires proven techniques and off-the-shelf equipment. Difficulty may arise determining the optimum placements of soil vents to direct air from fissures through the contaminated zones. Installation of an impermeable surface over soil will prevent air flow short-circuiting.

Draft

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Short Term Effectiveness			
- Time Until Remedial Response Objectives are Achieved	Soil: see Alternative 4 Upgradient: see Alternative 4. Downgradient: 5 years.	Groundwater: see Alternative 4 Soil: treatment and backfilling of all contaminated soils is expected to take approximately 2 years.	Groundwater: see Alternative 5 Soil: see Alternative 6
Implementability Evaluation			
- Technical Feasibility	See Alternative 4	Groundwater treatment: see Alternative 2. Soil excavation is possible; however, some difficulties may arise. Anchoring the sheet piling so that it adequately holds the soil around the building foundation could pose some problems. Setting a threshold level for excavated soil may be difficult since it requires knowledge of the concentration needed to prevent future groundwater contamination. Additional soil treatment may be difficult if contaminated groundwater is found exceeding SCGs after soil treatment operations are concluded. It may be difficult to achieve de minimus levels, especially if they are set at zero or non-detect.	See Alternative 6

Table 3-19 (Cont.)

Criterion	Alternative 1 No Action	Alternative 2 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Treatment by Carbon Adsorption, No Soil Treatment	Alternative 3 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, No soil Treatment	Alternative 4 Extraction of Groundwater Upgradient of the Hydrogeologic Barrier, Discharge to and Treatment by NCSD, In-Situ Vapor Extraction of Source Area Soils
Implementability Evaluation (Cont.)				
- Administrative Feasibility	This alternative has no provisions to address the exceedances of the groundwater SCGs; thus, in order to adopt this alternative, a waiver of the SCGs must be granted by NYSDEC before the record of decision can be issued. NYSDEC is unlikely to grant such a waiver since it is possible to substantially eliminate the groundwater plume using other alternatives. Therefore, this is a significant barrier for implementation of this alternative.	Carborundum Co. must renew its SPDES permit to discharge to Cayuga Creek, with the flow rate and contaminant types and concentrations based on what is expected from groundwater remediation. This permit is expected to be granted.	See Alternative 2	Groundwater: NCSD must receive a modification to its permit to accept and treat the extracted groundwater; there are no foreseeable obstacles to its approval at this time. Soil: effluent vapor from the vapor extraction will be treated either by oxidation or carbon adsorption, thus assuring compliance with air permit to be issued by NYSDEC.
- Availability of Services	NA	NA	NA	All equipment for vapor extraction is readily available.
Cost	Capital: 0 O&M: $49,000 Present worth: $790,900	Capital: $616,100 O&M: $93,700 Present worth: $2,124,700	Capital: $1,300,800 O&M: ranges from $100,300 to $118,500 Present Worth: $3,001,700	Present Worth: $8,442,400
Rating score	62	90	89	84

02[AD]CZ5020:D3100/3981/0

Draft

Table 3-19 (Cont.)

Criterion	Alternative 5 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, In-Situ Vapor Extraction of Source Area Soils	Alternative 6 Extraction of Groundwater Upgradient of the Hydrogeologic Boundary, Discharge and Treatment by NCSD, Excavation of Source Area Soils, Treatment by Thermal Desorption, Backfilling On Site	Alternative 7 Extraction of Groundwater both Upgradient and Downgradient of the Hydrogeologic Barrier, Treatment by Carbon Adsorption, Excavation of Source-Area Soils, Treatment by Thermal Desorption, Backfilling On Site
Implementability Evaluation (Cont.)			
- Administrative Feasibility	Groundwater: see Alternative 3	Groundwater: see Alternative 4	Groundwater: see Alternative 3
	Soil: see Alternative 4	Soil: air emissions from thermal desorption will not pose any administrative problems since contaminants will be removed from effluent via oxidation or carbon adsorbtion. An air permit would be required.	Soil: see Alternative 6
- Availability of Services	See Alternative 4	There are several commercial thermal desorption units available.	See Alternative 6
Cost			
	Present Worth: $9,332,500	Present Worth: $13,948,600	Present Worth: $14,828,700
Rating Score	83	80	79

02[AD]CZ5020:D3100/3981/0

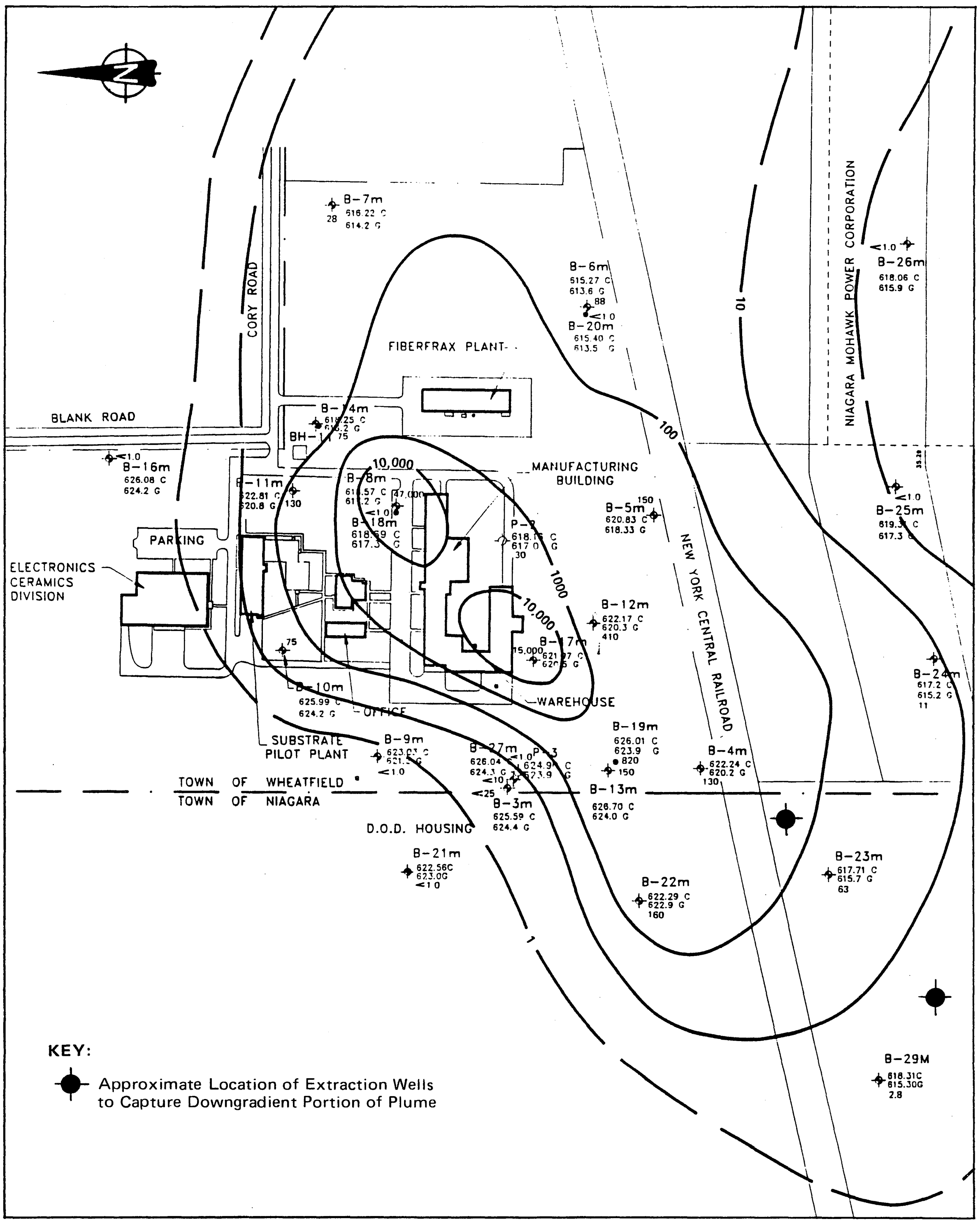
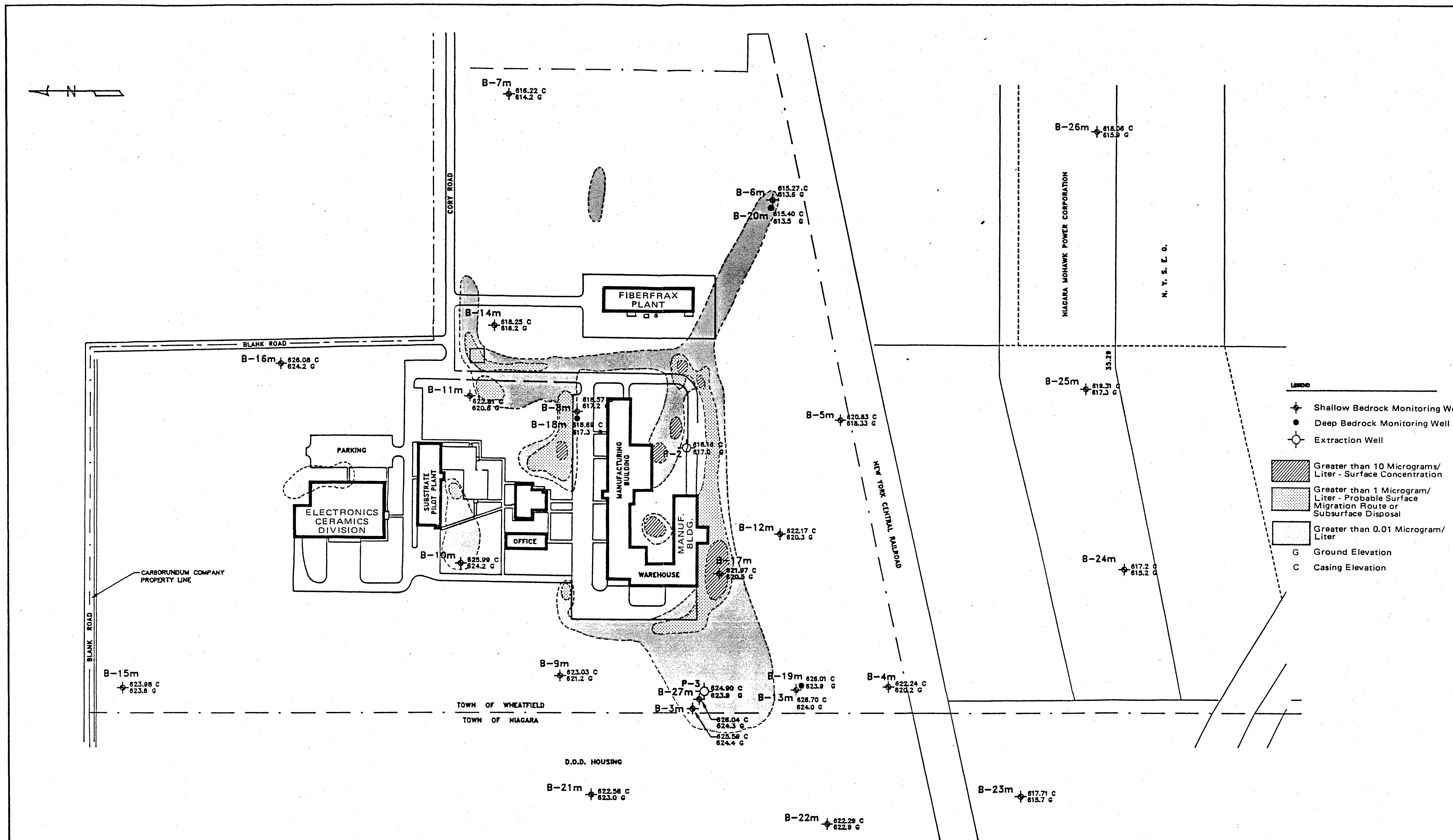


Figure 3—1
APPROXIMATE LOCATION OF PROPOSED EXTRACTION WELLS TO CAPTURE DOWNGRADIENT PORTION OF PLUME



Data Collected by Tracer Research

ecology and environment, inc.
International Specialists in the Environment

Figure 3-2 LOCATION OF CONTAMINATED SOIL AS INDICATED BY TCE SOIL GAS CONCENTRATIONS MEASURED AUGUST 1986

SCALE 1" = 100'

CZ2MWLOC

APPENDIX A

SCORE SHEETS FOR REMEDIATION ALTERNATIVES

ALTERNATIVE 1

	Score
Compliance with SCGs	6
Protection of Human Health and the Environment	16
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	3
Reduction of Toxicity, Mobility, or Volume	0
Implementability	13
Cost	15
TOTAL	62

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scoi
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	**Yes**	___	4
		No	X	0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	**Yes**	X	3
		No	___	0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	**Yes**	X	3
		No	___	0
TOTAL (Maximum = 10)				6

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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**	X	5
	ii) Health risk	**≤ 1 in 100,000**	___	2
Subtotal (maximum = 5)				5
4. Magnitude of residual environmental risks 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)				16

Note: Only potential exposure to contamination via groundwater is unacceptable. Such actual exposure is unlikely (see text), and, thus, the health risk is set at less than 1 in 1,000,000.

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	**Yes** **No**	___ ___	1 0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes** **No**	___ ___	0 2
Subtotal (maximum = 4)				4
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? **(If answer is no, go to Factor 3.)**	**Yes** **No**	___ _X_	0 4
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 4)				4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.** **> 2yr.**	___ _X_	1 0
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.** **> 2yr.**	_X_ ___	1 0
Subtotal (maximum = 2)				1
TOTAL (maximum = 10)				9

Draft

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*		3
	° Off-site treatment*		1
	° On-site or off-site land disposal		0
Subtotal (maximum = 3)			0
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** ___	3
		No X	0
Subtotal (maximum = 3)			0
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy. N.A.	25-30yr. ___	3
		20-25yr. ___	2
		15-20yr. ___	1
		< 15yr. ___	0
Subtotal (maximum = 3)			0
4. 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 5.)**	**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)			2

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
5. 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_	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** ___	2
		Moderate ___	1
		Extensive _X_	0
Subtotal (maximum = 4)			1
TOTAL (maximum = 15)			[illegible]

Draft

Table 5 6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.** NA	i)	Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%**	____	8
			90-99%	____	7
			80-90%	____	6
			60-80%	____	4
			40-60%	____	2
			20-40%	____	1
			< 20%	____	0
	ii)	Are there uncreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes**	____	0
			No	____	2
Subtotal (maximum = 10) If subtotal = 10, go to Factor 3	iii)	After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal**	____	0
			On-site land disposal	____	1
			Off-site destruction or treatment	____	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3** NA	i)	Quality of Available Wastes Immobilized After Destruction/Treatment	**90-100%**	____	2
			60-90%	____	1
			< 60%	____	0
	ii)	Method of Immobilization			
		- Reduced mobility by containment		____	0
		- Reduced mobility by alternative treatment technologies		____	3
Subtotal (maximum = 5)					
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste NA		Completely irreversible		____	5
		Irreversible for most of the hazardous waste constituents.		____	3
		Irreversible for only some of the hazardous waste constituents		____	2
		Reversible for most of the hazardous waste constituents.		____	0
Subtotal (maximum = 5)					
TOTAL (maximum = 15)					0

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
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.		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.	X	2
	ii) Required coordination is normal.		1
	iii) Extensive coordination is required.		C
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 **No**	: (
	ii) Will more than one vendor be available to provide a competitive bid?	**Yes** X **No**	: (

Draft

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes ✓	1
		No ___	0
			3
Subtotal (maximum = 3)			
			13
TOTAL (maximum = 15)			

ALTERNATIVE 2

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	12
Long-term Effectiveness and Permanence	3
Reduction of Toxicity, Mobility, or Volume	11
Implementability	14
Cost	14
TOTAL	90

Draft

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	X	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	X	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	X	3
		No		0
TOTAL (Maximum = 10)				10

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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)				
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 risks 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

Note: The site would require an extensive period of groundwater extraction and would not be available for unrestricted use while extraction was continuing.

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	**Yes**	___	1
		No	___	0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes**	___	0
		No	___	2
Subtotal (maximum = 4)				4
2. Environmental Impacts	° 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
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes**	___	3
		No	___	0
Subtotal (maximum = 4)				4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.**	___	1
		> 2yr.	X	0
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.**	X	1
		> 2yr.	___	0
Subtotal (maximum = 2)				1
TOTAL (maximum = 10)				9

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*	X	3
	° Off-site treatment*		1
	° 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			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** X	3
		No ___	0
Subtotal (maximum = 3)			3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr. X	3
		20-25yr. ___	2
		15-20yr. ___	1
		< 15yr. ___	0
Subtotal (maximum = 3)			3
4. 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 5.)**	**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)			2

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
5. 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	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**	___	2
		Moderate	___	1
		Extensive	X	0
Subtotal (maximum = 4)				1
TOTAL (maximum = 15)				12

Draft

Table 5 6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i)	Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%**	___	8
			90-99%	___	7
			80-90%	___	6
			60-80%	X	4
			40-60%	___	2
			20-40%	___	1
			< 20%	___	0
	ii)	Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes**	X	0
			No	___	2
Subtotal (maximum = 10)					4
If subtotal = 10, go to Factor 3	iii)	After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal**	___	0
			On-site land disposal	___	1
			Off-site destruction or treatment	X	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i)	Quality of Available Wastes Immobilized After Destruction/ Treatment	**90-100%**	___	2
			60-90%	___	1
			< 60%	X	0
	ii)	Method of Immobilization			
		- Reduced mobility by containment		X	0
		- Reduced mobility by alternative treatment technologies		___	3
Subtotal (maximum = 5)					0
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste		Completely irreversible		X	5
		Irreversible for most of the hazardous waste constituents.		___	3
		Irreversible for only some of the hazardous waste constituents		___	2
		Reversible for most of the hazardous waste constituents.		___	0
Subtotal (maximum = 5)					5
TOTAL (maximum = 15)					11

Note: The quantity of hazardous waste destroyed is an estimate assuming most of the plume is removed and some soil contaminants leach into the groundwater, are extracted, and are treated.

Draft

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. <u>Technical Feasibility</u>				
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.		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.		___	2
	ii) Some future remedial actions may be necessary.		X	1
Subtotal (maximum = 10)				9
2. <u>Administrative Feasibility</u>				
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. <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	X	[illegible]
		No	___	[illegible]
	ii) Will more than one vendor be available to provide a competitive bid?	Yes	X	
		No	___	[illegible]

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	✓	1
		No		0
Subtotal (maximum = 3)				3
TOTAL (maximum = 15)				14

Draft

ALTERNATIVE 3

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	12
Reduction of Toxicity, Mobility, or Volume	11
Implementability	13
Cost	13
TOTAL	89

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	X	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	X	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	X	3
		No		0
TOTAL (Maximum = 10)				10

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

alysis Factor	Basis for Evaluation During Detailed Analysis			Score
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)				
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
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)				
Magnitude of residual environmental risks 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)				10

Note: The site would require an extensive period of groundwater extraction and would not be available for unrestricted use while extraction was continuing.

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

ıalysis Factor	Basis for Evaluation During Detailed Analysis			Score
. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	Yes No		1 0
	° Does the mitigative effort to control risk impact the community life-style?	Yes No		0 2
Subtotal (maximum = 4)				4
Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? **(If answer is no, go to Factor 3.)**	Yes No	 X	0 4
	° Are the available mitigative measures reliable to minimize potential impacts?	Yes No		3 0
Subtotal (maximum = 4)				4
Time to implement the remedy.	° What is the required time to implement the remedy?	≤ 2yr. > 2yr.	 X	1 0
	° Required duration of the mitigative effort to control short-term risk.	≤ 2yr. > 2yr.	X 	1 0
Subtotal (maximum = 2)				1
TOTAL (maximum = 10)				9

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. On-site or off-site treatment or land disposal	° On-site treatment*		✓	3
	° Off-site treatment*			1
	° 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				
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes**	X	3
		No		0
Subtotal (maximum = 3)				3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	**25-30yr.**	X	3
		20-25yr.		2
		15-20yr.		1
		< 15yr.		0
Subtotal (maximum = 3)				3
4. 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 5.)**	**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)				2

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
5. 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	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**	___	2
		Moderate	___	1
		Extensive	X	0
Subtotal (maximum = 4)				1
TOTAL (maximum = 15)				12

Draft

Table 5 6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Volume of hazardous waste reduced (reduction in volume or toxicity). If Factor 1 is not applicable, go to Factor 2.	i) Quantity of hazardous waste destroyed or treated. Immobilization technologies do not score under Factor 1.	99-100%		8
		90-99%		7
		80-90%		6
		60-80%	X	4
		40-60%		2
		20-40%		1
		< 20%		0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2	Yes	X	0
		No		2
				4
Subtotal (maximum = 10) If subtotal = 10, go to Factor 3	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	Off-site land disposal		0
		On-site land disposal		1
		Off-site destruction or treatment	X	2
2. Reduction in mobility of hazardous waste. If Factor 2 is not applicable, go to Factor 3. NA	i) Quality of Available Wastes Immobilized After Destruction/Treatment	90-100%		2
		60-90%		1
		< 60%		0
	ii) Method of Immobilization			
	- Reduced mobility by containment			0
	- Reduced mobility by alternative treatment technologies			3
Subtotal (maximum = 5)				
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible		X	5
	Irreversible for most of the hazardous waste constituents.			3
	Irreversible for only some of the hazardous waste constituents			2
	Reversible for most of the hazardous waste constituents.			0
Subtotal (maximum = 5)			5	
TOTAL (maximum = 15)			11	

Note: The quantity of hazardous waste destroyed is an estimate assuming most of the plume is removed and some soil contaminants leach into the groundwater, are extracted, and are treated.

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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.		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.			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

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	✓	1
		No		0
				3
Subtotal (maximum = 3)				14
TOTAL (maximum = 15)				

ALTERNATIVE 4

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	14
Reduction of Toxicity, Mobility, or Volume	14
Implementability	12
Cost	5
TOTAL	84

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	X	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	X	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	X	3
		No		0
TOTAL (Maximum = 10)				10

Table 5.3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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)				20
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	**Yes** **No**	___ ___	3 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	**Yes** **No**	___ ___	4 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 10)				
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)				
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable		___	5
	ii) Slightly greater than acceptable		___	3
	iii) Significant risk still exists		___	0
Subtotal (maximum = 5)				
TOTAL (maximum = 20)			20	

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis				Score
1. Protection of community during remedial actions.	° 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	
	° Can the risk be easily controlled?	**Yes**	___	1	
		No	___	0	
	° Does the mitigative effort to control risk impact the community life-style?	**Yes**	___	0	
		No	___	2	
Subtotal (maximum = 4)					4
2. Environmental Impacts	° 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	
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes**	___	3	
		No	___	0	
Subtotal (maximum = 4)					4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.**	___	1	
		≥ 2yr.	X	0	
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.**	X	1	
		≥ 2yr.	___	0	
Subtotal (maximum = 2)					1
TOTAL (maximum = 10)					9

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*	X	3
	° Off-site treatment*		1
	° 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			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** X	3
		No ___	0
Subtotal (maximum = 3)			3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr.___	3
		20-25yr.___	2
		15-20yr.___	1
		< 15yr.___	0
Subtotal (maximum = 3)			
4. 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 5.)**	**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

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
5. 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 = 15)				14

Table 5 6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i)	Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%**		8
			90-99%	X	7
			80-90%		6
			60-80%		4
			40-60%		2
			20-40%		1
			< 20%		0
	ii)	Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes**		0
			No	X	2
Subtotal (maximum = 10) **If subtotal = 10, go to Factor 3**					9
	iii)	After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal**		0
			On-site land disposal		1
			Off-site destruction or treatment		2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i)	Quality of Available Wastes Immobilized After Destruction/ Treatment	**90-100%**		2
			60-90%		1
			< 60%		0
	ii)	Method of Immobilization			
		- Reduced mobility by containment			0
		- Reduced mobility by alternative treatment technologies			3
Subtotal (maximum = 5)					
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste		Completely irreversible		X	5
		Irreversible for most of the hazardous waste constituents.			3
		Irreversible for only some of the hazardous waste constituents			2
		Reversible for most of the hazardous waste constituents.			0
Subtotal (maximum = 5)					5
TOTAL (maximum = 15)					14

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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		___	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)				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	[illegible]
		No	___	[illegible]
	ii) Will more than one vendor be available to provide a competitive bid?	**Yes**	X	[illegible]
		No	___	[illegible]

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes No	X ___	1 0
				3
Subtotal (maximum = 3)				
TOTAL (maximum = 15)				12

ALTERNATIVE 5

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	14
Reduction of Toxicity, Mobility, or Volume	14
Implementability	12
Cost	4
TOTAL	83

Alt. 5 Score 7?

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	**Yes**	✓	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	**Yes**	✓	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	**Yes**	✓	3
		No		0
TOTAL (Maximum = 10)				10

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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)				20
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	**Yes** **No**	___ ___	3 0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	**Yes** **No**	___ ___	4 0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 10)				
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)				
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable		___	5
	ii) Slightly greater than acceptable		___	3
	iii) Significant risk still exists		___	0
Subtotal (maximum = 5)				20
TOTAL (maximum = 20)				

Draft

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	**Yes**	___	1
		No	___	0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes**	___	0
		No	___	2
Subtotal (maximum = 4)				4
2. Environmental Impacts	° 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
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes**	___	3
		No	___	0
Subtotal (maximum = 4)				4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.**	___	1
		> 2yr.	X	0
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.**	___	1
		> 2yr.	___	0
				1
Subtotal (maximum = 2)				
TOTAL (maximum = 10)				9

Draft

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*	X	3
	° Off-site treatment*		1
	° 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			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** X	3
		No ___	0
Subtotal (maximum = 3)			3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	**25-30yr.** ___	3
		20-25yr. ___	2
		15-20yr. ___	1
		< 15yr. ___	0
Subtotal (maximum = 3)			
4. 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 5.)**	**Yes** ___	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

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Score
5. Adequacy and reliability of controls.	i)	Operation and maintenance required for a period of:	< 5yr.	✓	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**	✓	2
			Moderate		1
			Extensive		0
Subtotal (maximum = 4)					4
TOTAL (maximum = 15)					17

Table 5-6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i) Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%**	___	8
		90-99%	_/_	7
		80-90%	___	6
		60-80%	___	4
		40-60%	___	2
		20-40%	___	1
		< 20%	___	0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes**	_X_	0
		No	___	2
Subtotal (maximum = 10) **If subtotal = 10, go to Factor 3**				7
	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal**	___	0
		On-site land disposal	___	1
		Off-site destruction or treatment	_X_	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i) Quality of Available Wastes Immobilized After Destruction/ Treatment	**90-100%**	___	2
		60-90%	___	1
		< 60%	___	0
	ii) Method of Immobilization			
	- Reduced mobility by containment		___	0
	- Reduced mobility by alternative treatment technologies		___	3
Subtotal (maximum = 5)				
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible		_X_	5
	Irreversible for most of the hazardous waste constituents.		___	3
	Irreversible for only some of the hazardous waste constituents		___	2
	Reversible for most of the hazardous waste constituents.		___	0
Subtotal (maximum = 5)				5
TOTAL (maximum = 15)				14

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
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	___	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)			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 **No** ___	1
	ii) Will more than one vendor be available to provide a competitive bid?	**Yes** X **No** ___	

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			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)				12

Draft

ALTERNATIVE 6

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	14
Reduction of Toxicity, Mobility, or Volume	14
Implementability	12
Cost	1
TOTAL	80

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	✓	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	✓	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	X	3
		No		0
TOTAL (Maximum = 10)				10

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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
				0
TOTAL (Maximum = 20)				
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)				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 risks 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

Note: Some contaminated soils would remain on site, adjacent to buildings. Future use would have to consider these soils. However, no risk is posed by the soils themselves.

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	**Yes** **No**	___ ___	1 0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes** **No**	___ ___	0 2
Subtotal (maximum = 4)				4
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? **(If answer is no, go to Factor 3.)**	**Yes** **No**	___ X	0 4
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes** **No**	___ ___	3 0
Subtotal (maximum = 4)				4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	**≤ 2yr.** **≥ 2yr.**	___ X	1 0
	° Required duration of the mitigative effort to control short-term risk.	**≤ 2yr.** **≥ 2yr.**	X ___	1 0
				1
Subtotal (maximum = 2)				
TOTAL (maximum = 10)				9

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*	X	3
	° Off-site treatment*		1
	° 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			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** X	3
		No ___	0
Subtotal (maximum = 3)			3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr. ___	3
		20-25yr. ___	2
		15-20yr. ___	1
		< 15yr. ___	0
Subtotal (maximum = 3)			
4. 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 5.)**	**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

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
5. 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 = 15)			14

Draft

Table 5.6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i) Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%** ____	8
		90-99% _X_	7
		80-90% ____	6
		60-80% ____	4
		40-60% ____	2
		20-40% ____	1
		< 20% ____	0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes** ____	0
		No _X_	2
Subtotal (maximum = 10)			9
If subtotal = 10, go to Factor 3	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal** ____	0
		On-site land disposal ____	1
		Off-site destruction or treatment ____	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i) Quality of Available Wastes Immobilized After Destruction/ Treatment	**90-100%** ____	2
		60-90% ____	1
		< 60% ____	0
	ii) Method of Immobilization		
	- Reduced mobility by containment	____	0
	- Reduced mobility by alternative treatment technologies	____	3
Subtotal (maximum = 5)			
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible	_X_	5
	Irreversible for most of the hazardous waste constituents.	____	3
	Irreversible for only some of the hazardous waste constituents	____	2
	Reversible for most of the hazardous waste constituents.	____	0
Subtotal (maximum = 5)			5
TOTAL (maximum = 15)			14

Draft

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis		Score
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	___	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)				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	[illegible]
		No	___	[illegible]
	ii)	Will more than one vendor be available to provide a competitive bid? **Yes**	X	
		No	___	[illegible]

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			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) 12

ALTERNATIVE 7

	Score
Compliance with SCGs	10
Protection of Human Health and the Environment	20
Short-term Effectiveness	9
Long-term Effectiveness and Permanence	14
Reduction of Toxicity, Mobility, or Volume	14
Implementability	12
Cost	0
TOTAL	79

Table 5.2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND
APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	✓	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	✓	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	✓	3
		No		0
TOTAL (Maximum = 10)				10

Table 5 3

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
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)				
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 risks 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

Note: Some contaminated soils would remain on site, adjacent to buildings. Future use would have to consider these soils. However, no risk is posed by the soils themselves.

Table 5.4

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Protection of community during remedial actions.	° 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
	° Can the risk be easily controlled?	**Yes**	___	1
		No	___	0
	° Does the mitigative effort to control risk impact the community life-style?	**Yes**	___	0
		No	___	2
Subtotal (maximum = 4)				4
2. Environmental Impacts	° 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
	° Are the available mitigative measures reliable to minimize potential impacts?	**Yes**	___	3
		No	___	0
Subtotal (maximum = 4)				4
3. Time to implement the remedy.	° What is the required time to implement the remedy?	$\le$ **2yr.**	___	1
		$\ge$ **2yr.**	X	0
	° Required duration of the mitigative effort to control short-term risk.	$\le$ **2yr.**	X	1
		$\ge$ **2yr.**	___	0
Subtotal (maximum = 2)				1
TOTAL (maximum = 10)				9

Draft

Table 5.5

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Scor
1. On-site or off-site treatment or land disposal	° On-site treatment*		X	3
	° Off-site treatment*			1
	° 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				
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	Yes	X	3
		No		0
Subtotal (maximum = 3)				3
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr.		3
		20-25yr.		2
		15-20yr.		1
		< 15yr.		0
Subtotal (maximum = 3)				
4. 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 5.)**	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

Table 5.5 (cont'd)

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Score
5. 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 = 15)					14

Table 5 6
REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Sco
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i) Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%** ____	8
		90-99% [X]	7
		80-90% ____	6
		60-80% ____	4
		40-60% ____	2
		20-40% ____	1
		< 20% ____	0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to** Factor 2	**Yes** [X]	0
		No ____	2
Subtotal (maximum = 10) If subtotal = 10, go to Factor 3			[7]
	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal** ____	0
		On-site land disposal ____	1
		Off-site destruction or treatment [X]	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i) Quality of Available Wastes Immobilized After Destruction/ Treatment	**90-100%** ____	2
		60-90% ____	1
		< 60% ____	0
	ii) Method of Immobilization		
	- Reduced mobility by containment	____	0
	- Reduced mobility by alternative treatment technologies	____	3
Subtotal (maximum = 5)			
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible	[✓]	5
	Irreversible for most of the hazardous waste constituents.	____	3
	Irreversible for only some of the hazardous waste constituents	____	2
	Reversible for most of the hazardous waste constituents.	____	0
Subtotal (maximum = 5)			[5]
TOTAL (maximum = 15)			[14]

Table 5.7

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Score
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		___	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)					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	___	(
	ii)	Will more than one vendor be available to provide a competitive bid?	**Yes**	X	:
			No	___	(

Table 5.7 (cont'd)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes No	X	1 0
Subtotal (maximum = 3)				3
TOTAL (maximum = 15)				15