PROPOSED REMEDIAL ACTION PLAN
TAPPAN TERMINAL

Hastings-on-Hudson, Westchester County, New York
Site No. 3-60-015

December 2005

Prepared by:

Division of Environmental Remediation
New York State Department of Environmental Conservation

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SECTION 1: SUMMARY AND PURPOSE OF THE PROPOSED PLAN

The New York State Department of Environmental Conservation (NYSDEC), in consultation with the New York State Department of Health (NYSDOH), is proposing a remedy for the Tappan Terminal site. The presence of hazardous waste has created significant threats to human health and/or the environment that are addressed by this proposed remedy. As more fully described in Sections 3 and 5 of this document, past industrial activities have resulted in the disposal of petroleum and hazardous wastes, including chlorobenzene, benzene, and dye-related contaminants. These wastes have contaminated the soil and groundwater at the site, and have resulted in:

- a significant threat to human health associated with potential exposure to surface and subsurface soils, and groundwater.
- a significant environmental threat associated with the impacts of contaminants to the Hudson River.

To eliminate or mitigate these threats, the NYSDEC proposes the following remedy:

- Groundwater and soil remediation using air sparging and soil vapor extraction,
- Excavation of grossly contaminated soil above the groundwater table, particularly soil that contains visible dye or petroleum contamination,
- A soil cover consisting of a demarcation layer and two feet of clean soil,
- Restoration of the site by grading and seeding of excavated and/or filled areas.
- Development of a site management plan to address residual contamination and any use restrictions.
- Imposition of an environmental easement.
- Periodic certification of the institutional and engineering controls.

The proposed remedy, discussed in detail in Section 8, is intended to attain the remediation goals identified for this site in Section 6. The remedy must conform with applicable (or relevant and appropriate) standards and criteria with consideration given to guidance, as appropriate. This term is hereafter called SCGs.

This Proposed Remedial Action Plan (PRAP) identifies the preferred remedy, summarizes the other alternatives considered, and discusses the reasons for this preference. The NYSDEC will select a final remedy for the site only after careful consideration of all comments received during the public comment period.

The NYSDEC has issued this PRAP as a component of the Citizen Participation Plan developed pursuant to the New York State Environmental Conservation Law and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR) Part 375. This document is a summary of the information that can be found in greater detail in the September 1999 "Remedial Investigation (RI) Report", the November 2002 "Feasibility Study" (FS) , and other relevant documents. The public is encouraged to review the project documents, which are available at the following repositories:

Hastings Public Library
7 Maple Avenue
Hastings-on-Hudson, NY 10706
Mon, Tues, Thurs: 9:30 - 8:30
Wed: 9:30 - 6:30,
Sat: 9:30 - 5:00, Sun 1:00 - 5:00
Phone: (914) 478-3307
http://hastingslibrary.org

Village Clerk
Municipal Offices
7 Maple Avenue
Hastings on Hudson, NY 10706
Mon - Wed: 8:30 - 4:00
Thurs: 8:30 - 8:00, Fri 8:30 - 12:00
Phone (914) 478-3400

NYSDEC Region 3 Office
21 South Putt Corners Road
New Paltz, NY 12561-1696
Attn: Mr. Michael Knipfing
Monday - Friday: 8:30 - 4:30
Phone: (845) 256-3154

NYSDEC Albany Office
625 Broadway, 12th Floor
Albany, NY 12233-7013
Attention: Mr. George Heitzman
Monday - Friday: 8:00 - 4:00
Phone: (518) 402-9818

The NYSDEC seeks input from the community on all PRAPs. A public comment period has been set from December 19, 2005 to February 2, 2006 to provide an opportunity for public participation in the remedy selection process. A public meeting is scheduled for Tuesday, January 17, 2006 in the Hastings High School Auditorium beginning at 7:30 pm.

At the meeting, the results of the RI/FS will be presented along with a summary of the proposed remedy. After the presentation, a question-and-answer period will be held, during which verbal or written comments may be submitted on the PRAP. Written comments may also be sent to Mr. Heitzman at the above address through February 2, 2006.

The NYSDEC may modify the preferred alternative or select another of the alternatives presented in this PRAP, based on new information or public comments. Therefore, the public is encouraged to review and comment on all of the alternatives identified here.

Comments will be summarized and addressed in the responsiveness summary section of the Record of Decision (ROD). The ROD is the NYSDEC's final selection of the remedy for this site.

SECTION 2: SITE LOCATION AND DESCRIPTION

The Tappan Terminal site is located on 15 acres along the Hudson River waterfront in the Village of Hastings-on-Hudson, Westchester County, New York. The site comprises two properties, the Exxon/Mobil property, which is located adjacent to the Hudson River, and the Uhlich Color Company, which is located along the railroad tracks that define the eastern boundary of the site. The Uhlich property is a former pigment manufacturing facility, and the Exxon/Mobil property was most recently used as a petroleum distribution terminal. The Uhlich Color Company was recently acquired by the Magruder Color Company, and has discontinued operations at the site. A small portion of the southern end of the Exxon/Mobil property is leased to the Pioneer Boat Club for use as a marina. Figure 1 shows the location of the site, and Figure 2 shows the boundaries and main features of the site.

Uhlich Plant Operations (2002)

Limited access to the site is from Railroad Avenue at the southeast corner of the site and over the Zinsser Bridge that crosses the railroad tracks. Both portions of the site are surrounded by a chain link fence that is in good repair. This bridge has fallen into disrepair, and is no longer open to vehicular traffic.

The site is adjacent to the Harbor-at-Hastings site, a Class 2 inactive hazardous waste disposal site that is contaminated with polychlorinated biphenyls (PCBs), metals and polycyclic aromatic hydrocarbons (PAHs).

SECTION 3: SITE HISTORY

3.1: Operational/Disposal History

The Tappan Terminal site has a long history of manufacturing and chemical use by several owners and occupants. The landmass of the site itself was also created by disposal of manmade fill into the Hudson River between 1868 and 1970. This fill material typically consisted of sand and gravel mixed with bricks, concrete, stone, timber, ash, slag, shells, and other debris. The history of the site is summarized below:

1868: The site comprises two acres at the northern end of the current site.

1897-1955: The site was owned by Zinsser & Company for the manufacture of dyes, pigments and photographic chemicals.

1920: Filling progressed to the current Uhlich / Exxon/Mobil property line

1955-1961: Harshaw purchased the Zinsser Company and continued operations at the site.

1961-1967: Tappan Tanker Terminal purchased the property and began operating a petroleum distribution facility on the western portion of the site.

1964-2002: Paul Uhlich & Company leased, then purchased, the eastern portion of the site for the manufacture of pigments. This operation later became the Uhlich Color Company. The site layout during the recent operational period is shown on Figure 3.

1975-1985: Mobil Oil Co. purchased the western portion of the site and continued petroleum distribution operations.

In addition to the site operators identified above, several corporate mergers and acquisitions have occurred. The Harshaw Chemical Company was purchased by Kewanee Industries in 1966, which was acquired by the Gulf Oil Corporation in 1977. Gulf Oil Corporation merged with the Chevron Chemical Corporation in 1985. Mobil Oil Corporation merged with Exxon Corporation to form Exxon/Mobil in 1999.

The Uhlich Color Company ceased operations at the site in 2002, and most buildings at the site were demolished in early 2003.

3.2: Remedial History

When Mobil ceased operations on their property in 1985, a number of oil spills and bulk storage violations were discovered. Sampling various media at the site was performed between 1985 and 1989. In 1987, the NYSDEC listed the site as a Class 2 site in the Registry of Inactive Hazardous Waste Disposal Sites in New York. A Class 2 site is a site where hazardous waste presents a significant threat to the public health or the environment and action is required.

During a 1992 repair of a sewer pipe at the site, evidence of a petroleum release on both properties was discovered. Contaminated soil was stockpiled and later sent off site for disposal. The extent of petroleum contamination was investigated between 1992 and 1994. In 1994, an oil remediation plan was approved by the NYSDEC, and Mobil and Uhlich entered into a Stipulation Agreement to remediate this spill.

In 1996 Mobil entered into a Voluntary Agreement with the NYSDEC to investigate petroleum contamination on the western portion of the site. Because none of the potentially responsible parties agreed to perform a comprehensive investigation of the entire site, the site was referred for a State-funded investigation in 1998. However, after 1998 Mobil conducted some focused investigations and pilot studies on contamination located on their portion of the site, as described in Section 5.1.

SECTION 4: ENFORCEMENT STATUS

Potentially Responsible Parties (PRPs) are those who may be legally liable for contamination at a site. This may include past or present owners and operators, waste generators, and haulers.

The PRPs for the site, documented to date, include:

- Exxon/Mobil Corporation
- Uhlich Color Corporation
- Chevron Chemical Corporation

The PRPs declined to implement the RI/FS at the site when requested by the NYSDEC. After the remedy is selected, the PRPs will again be contacted to assume responsibility for the remedial program. If an agreement cannot be reached with the PRPs, the NYSDEC will evaluate the site for further action under the State Superfund. The PRPs are subject to legal actions by the State for recovery of all response costs the State has incurred.

SECTION 5: SITE CONTAMINATION

A remedial investigation/feasibility study (RI/FS) has been conducted to evaluate the alternatives for addressing the significant threats to human health and the environment.

5.1: Summary of the Remedial Investigation

The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site.

The RI was conducted between July 1998 and September 1999. The field activities and findings of the investigation are described in the "September 1999 Remedial Investigation Report". The following activities were conducted during the RI:

- A compilation of historic site data and preparation of a comprehensive site map,

- Collection of soil samples from 25 surface and 10 subsurface locations,

- Water level measurements in 32 existing monitoring wells to determine groundwater flow characteristics. To evaluate tidal impacts, continuous water level monitoring in 6 wells through three Hudson River tide cycles.

- Sampling of groundwater in 33 existing wells and 5 temporary well points.

- Analysis of all soil and groundwater samples for a comprehensive list of contaminants.

- Collection and analysis of 10 sediment samples adjacent to the site and 2 background locations.

As part of the Feasibility Study (FS), additional soil and groundwater sampling was conducted to determine the volume of soil requiring remediation. The results of this Supplemental Investigation are reported in Section 3 of the FS Report.

In 2002, Exxon/Mobil performed a pilot test of air sparging, soil vapor extraction and enhanced bioremediation at the site. Subsequently, Exxon/Mobil performed a pilot test of biosparging technology at the site beginning in 2004. These studies were performed to further evaluate technologies under consideration in the draft Feasibility Study, and were performed under the provisions of Mobil's 1996 Voluntary Cleanup Agreement. These technologies, and the results of the pilot tests, are described in more detail in Section 7 below.

To determine whether the soil and groundwater contains contamination at levels of concern, data from the investigation were compared to the following SCGs:

- Groundwater, drinking water and surface water SCGs are based on NYSDEC "Ambient Water Quality Standards and Guidance Values" and Part 5 of the New York State Sanitary Code.

- Soil SCGs are based on the NYSDEC "Technical and Administrative Guidance Memorandum (TAGM) 4046; Determination of Soil Cleanup Objectives and Cleanup Levels".

- Sediment SCGs are based on the NYSDEC "Technical Guidance for Screening Contaminated Sediments."

Based on the RI results, in comparison to the SCGs and potential public health and environmental exposure routes, certain media and areas of the site require remediation. These are summarized below. More complete information can be found in the RI report.

5.1.1: Site Geology and Hydrogeology

The site is underlain by four geologic units, the upper fill layer, the Marine Grey Silt, the Basal Sand unit, and bedrock. The upper fill layer ranges from 11 to 32 feet in thickness, and consists of sand, silt and gravel variably mixed with ash, slag, glass, metal debris, wood, crushed stone, paper, coal, sawdust and brick fragments. This material is typical of historic waterfront fill material deposited during the late 19th and early 20th centuries. The historic fill is considered to be relatively permeable, with hydraulic conductivity measurements between $9.0\text{x}10^{-2}$ and $3.7\text{x}10^{-1}$ centimeters per second (cm/s). However, intermediate bulkheads were built in stages along the shoreline as filling proceeded. These bulkheads are now buried beneath the site, and in some places act to restrict the flow of groundwater towards the river.

Groundwater flows through the fill layer from east to west and discharges to the Hudson River. However, this flow is affected by the tide stage of the river. At high tide, the groundwater flow direction reverses along the immediate shoreline, and water enters the site from the river. Generally, tidal fluctuations in the river affect groundwater levels within 100 feet of the shoreline.

Beneath the fill unit lies the Marine Grey Silt unit that represents the historic sediment of the Hudson River. This unit consists of grey to black silt with a trace of fine sand and layers of shell fragments. The Marine Grey Silt is at least 8 feet thick beneath this site, and ranges from 10 to 62 feet thick at the adjacent Harbor at Hastings site. The silt unit acts as a confining layer, with hydraulic conductivity measurements at the adjacent site between $1.0\text{x}10^{-7}$ and $7.7\text{x}10^{-8}$. This unit is believed to be continuous beneath the site.

The Basal Sand Unit that underlies the silt layer consists of permeable, medium to coarse sands and gravels. Although this unit was not investigated at the Tappan Terminal site, measurements in the vicinity of the site indicate that the Basal Sand Unit is a confined aquifer under artesian conditions. That is, groundwater pressure in the Basal Sand is greater than in the fill unit, and flow would be upward in the absence of the confining silt unit.

5.1.2: Nature of Contamination

As described in the RI report, many soil, groundwater and sediment samples were collected at the site to characterize the nature and extent of contamination. The main categories of contaminants which exceed their SCGs are inorganics (metals), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs).

The primary VOC of concern is chlorobenzene in groundwater and subsurface soils. The source of this contamination appears to be the former chlorobenzene storage tank on the Zinsser property. Chlorobenzene was historically used as a solvent in the manufacture of dyes. Benzene and dichlorobenzenes are also present in groundwater in the same area as the chlorobenzene contamination. In the northern portion of the site, two types of ether were found in groundwater: diethyl ether and diisopropyl ether. These ethers are highly soluble in groundwater, and are associated with chemical production by the Zinsser Company.

The SVOCs found at the site can be divided into three categories: contaminants associated with chemical manufacturing at the site, contaminants related to petroleum spills, and contaminants associated with the historic fill used to create the site. Certain SVOCs may be associated with more than one category. Generally, SVOCs have a moderate to low solubility in water, and do not readily evaporate into air.

The SVOCs associated with the historic site fill are polycyclic aromatic hydrocarbons (PAHs), such as pyrene, chrysene, and substituted anthracenes, pyrenes and fluoranthenes. These PAHs are commonly associated with coal, ash, heavy petroleum oils and products of incomplete combustion. Seven of these compounds are known or suspected human carcinogens, and are designated as carcinogenic PAHs (cPAHs).

Certain of the PAHs are also ingredients and by-products of dye manufacturing, and were found in areas containing dye-related contaminants. These include chemicals related to the production of aniline and anthraquinone dyes, including, aniline, chlorinated anilines, toluidines and anthraquinones. These contaminants were found primarily in surface soils on or near the current Uhlich property. Many of these dye-related contaminants are Tentatively Identified Compounds (TICs) in the laboratory analysis. TICs are not targeted by the standard analysis, but their presence was identified by a search of the 30 highest non-target compounds present in the sample. Standard analytical procedures provide a method to give a rough estimate of their concentration, which may be orders of magnitude higher or lower than the actual concentration. Based on the history of the site, the NYSDEC is reasonably certain of the presence of these contaminants, but considers their values to be rough estimates.

The inorganic contaminants of concern include the metals arsenic, beryllium, copper, mercury, nickel and zinc. These were found throughout the surface and subsurface fill, and are commonly associated with historic fill containing ash and furnace slag. Barium was found in some surface soil samples, and may be associated with current pigment manufacturing activities.

Polychlorinated biphenyls (PCBs) were found in low concentrations in two limited areas of site surface soil. The specific PCBs detected were Aroclors 1254 and 1260, which are the primary mixtures found at the neighboring Harbor at Hastings site. PCBs were also found in low concentrations in sediments adjacent to the site. However, the only Aroclor detected in sediment was Aroclor 1248, which is commonly associated with sources in the upper Hudson River, and was not found at the adjacent site.

The specific levels and areal extent of these contaminants are discussed below.

5.1.3: Extent of Contamination

This section describes the findings of the investigation for all environmental media that were investigated.

Chemical concentrations are reported in parts per billion (ppb) for water and parts per million (ppm) for soil and sediment. For comparison purposes, where applicable, SCGs are provided for each medium.

Table 1 summarizes the degree of contamination for the contaminants of concern in soil and groundwater, and compares the data with the SCGs for the site. The following are the media which were investigated and a summary of the findings of the investigation.

Soil

For the following discussion, soil sample results are separated into surface, near-surface, and subsurface horizons. This distinction is made to provide a reasonable estimate of the current and potential future exposures to contaminants from various activities at the site. Surface soil samples were taken from zero to three inches (0"-3") in areas where no pavement was present, generally on the Mobil property and eastern boundary of the Uhlich property. Near-surface soil samples were taken from below asphalt surfaces on the Uhlich property, ranging in depth from three to eleven inches (3"-11"). Subsurface samples were taken from depths below twelve inches (>12"). Note that Table 1 lists soil results separately for surface, near-surface, and subsurface samples.

Surface Soil (0-3")

Semivolatile organic contaminants (SVOCs) found in surface soils include the carcinogenic PAHs discussed in section 4.1.2 above. The highest levels of SVOCs in surface soils were found in five samples collected along the eastern boundary of the Uhlich property, adjacent to the railroad tracks. Sample SS-24, located in the northeast corner of the property, contained the highest levels of most of the SVOCs listed in Table 1.

PCBs were found to slightly exceed the1 ppm cleanup guideline in 8 surface soil samples, mostly located along the Harbor at Hastings site boundary and the access road that formerly connected the two properties. The highest detected concentration was 5 ppm of combined Aroclors 1254 and 1260 at a location along the Harbor at Hastings property boundary. The location and results of all PCB samples are shown on Figure 4.

The highest levels of beryllium, copper, lead, nickel, and zinc were found in sample SS-20, located in the southeastern corner of the Uhlich property, near the Zinsser Bridge and railroad tracks. At this location beryllium was found at 8.1 ppm, compared to its cleanup guideline of 0.16 ppm, copper was found at 648 ppm compared to its cleanup guideline of 25 ppm, lead was found at 972 ppm, compared to its cleanup guideline of 400 ppm, and zinc was found at 3,200 ppm, compared to its cleanup guideline of 20 ppm. Throughout the site, beryllium, copper, mercury, nickel and zinc were found at levels exceeding their cleanup guidelines in surface soil.

Near-Surface Soil

The highest SVOC concentrations at the site were found beneath paved surfaces on the Uhlich property, and elevated CaPAHs may be partially attributable to the asphalt pavement. The highest levels were found at location SS-16, in the southern portion of the Uhlich property, where total SVOCs were 286 ppm, compared to their cleanup guideline of 500 ppm. The maximum values for individual SVOC contaminants, particularly the CaPAHs listed in Table 1, are also from this location.

Several dye-related SVOCs were found in surface soils beneath the pavement of the Uhlich property and within 50 feet of the Uhlich property line on the Mobil property. The highest levels of aniline, chloro- and dichloro-aniline, toluidines and anthraquinones were found beneath the eastern portion of the Uhlich site, where the former Zinsser dye manufacturing operation occurred. These areas generally correspond to areas of visibly discolored soil.

Subsurface Soil

The volatile organic contaminants (VOCs) of concern in soils were all found in subsurface soil samples. These include chlorobenzene, which was found throughout the central portion of the site at a maximum value of 31 ppm, compared to its cleanup guideline of 1.7 ppm. Other VOCs include tetrachloroethene (PCE) in three widely spaced samples taken beneath the Uhlich property, with a maximum concentration of 50 ppm and a cleanup guideline of 1.4 ppm. A supplemental investigation was conducted in the area around the highest detection, and no other PCE was found. Trichloroethene (TCE), 1,2-dichloroethene (DCE) and vinyl chloride (VC) were found sporadically beneath the Uhlich property. The data indicates that detections of PCE, TCE, DCE and VC in subsurface soil are isolated.

Levels of semivolatile organic contaminants (SVOCs) were generally lower in subsurface soils than in surface soils. One notable execption was at location SB-3, on the Mobil property, where a thick, oil-like material was encountered that exhibited a strong petroleum odor. Samples from that location contained many TICs that were identified generally as hydrocarbon SVOCs, which is consistent with the presence of a residual petroleum product. Dye-related TICs were also found in subsurface soil samples, at lower levels than in surface soil samples. Elevated PAHs were found in soil samples collected from beneath the paved area of the Uhlich property, and in sample SB-1 beneath the paved southwestern corner of the Mobil property.

PCBs were not detected in subsurface soils at levels exceeding the cleanup guideline.

The highest levels of metals were found in sample SB-4, located in the southeastern corner of the Uhlich property, near the Zinsser Bridge and railroad tracks. This is the same portion of the site where metals were highest in surface soils. At this location copper was found at 28,700 ppm, lead was found at 3,090 ppm, and cadmium was found at 122 ppm. Throughout the site, beryllium, copper, mercury and zinc were found at levels exceeding their cleanup guidelines in subsurface soil.

Sediments

Polychlorinated biphenyls (PCBs) were found in low concentrations, ranging from non-detectable to 0.14 ppm, in most sediment samples. The only PCB mixture found was Aroclor 1248, which is commonly associated with sources in the upper Hudson River, and is found at low concentrations throughout the lower river. Aroclor 1260, which is associated with the adjacent Harbor at Hastings site, was not found in the sediment samples taken for this investigation.

Groundwater

The highest levels of chlorobenzene in groundwater were found near the suspected source area in the central portion of the site, and along the abandoned sewer line that runs along the approximate Mobil/Uhlich property line. In these areas, chlorobenzene was found at concentrations up to 11,000 ppb. The groundwater standard for chlorobenzene is 5 ppb. As shown in Figure 5, the plume of groundwater contaminated with chlorobenzene above 5 ppb extends to the shoreline of the Hudson River, where it appears to discharge into the river.

Within the chlorobenzene plume, in the area of the abandoned sewer line, is an area of benzene groundwater contamination. In this area concentrations range from 5 ppb to 170 ppb, compared to the SCG of 1 ppb. Also within the chlorobenzene plume are zones of naphthalene, chlorophenol, 4-chloroaniline, and dichlorobenzene contamination. The maximum levels of these contaminants are 650 ppb of naphthalene, 61 ppb of 2-chlorophenol, 25 ppm of 4-chloroaniline, and 170 ppb of 1,4-dichlorobenzene, compared to their SCGs of 10 ppb, 3 ppb, 5 ppb and 1 ppb, respectively.

In the northern part of the site, separate from the chlorobenzene plume, is an area of ethyl ether and diisopropyl ether contamination. The highest concentration of combined ethers, which are tentatively identified compounds (TICs), is estimated to be 770 ppb in the northwest corner of the site. There is currently no ambient groundwater standard or guidance value for ethyl- or diisopropyl ether in ambient groundwater.

Metal contaminants were found at greater frequencies and higher concentrations in unfiltered samples compared to filtered samples. This indicates that, to some degree, metals are present in particulate rather than dissolved form. Iron and manganese were found to exceed their SCGs in a high percentage (68% to 79%) of filtered samples taken from the site. Barium, antimony and selenium were found to exceed their SCGs in 26% to 37% of filtered samples. Concentrations of lead and copper in only one well (OW-17) exceeded their SCGs. At this location, along the Uhlich/Mobil property line and sewer line, lead and copper were 261 ppb and 506 ppm, compared to their respective water quality standards of 25 ppb and 200 ppb.

5.3: Summary of Human Exposure Pathways:

This section describes the types of human exposures that may present added health risks to persons at or around the site. A more detailed discussion of the human exposure pathways can be found in the May 2000 "Baseline Human Health Risk Assessment", which is available for review at the document repositories listed in Section 1.

An exposure pathway describes the means by which an individual may be exposed to contaminants originating from a site. An exposure pathway has five elements: [1] a contaminant source, [2] contaminant release and transport mechanisms, [3] a point of exposure, [4] a route of exposure, and [5] a receptor population.

The source of contamination is the location where contaminants were released to the environment (any waste disposal area or point of discharge). Contaminant release and transport mechanisms carry contaminants from the source to a point where people may be exposed. The exposure point is a location where actual or potential human contact with a contaminated medium may occur. The route of exposure is the manner in which a contaminant actually enters or contacts the body (e.g., ingestion, inhalation, or direct contact). The receptor population is the people who are, or may be, exposed to contaminants at a point of exposure.

An exposure pathway is complete when all five elements of an exposure pathway are documented. An exposure pathway is considered a potential pathway when one or more of the elements currently does not exist, but could in the future.

There are no known completed exposure pathways at the site. The potential exposure pathways currently of concern at this site and those related to the future use or development of the site include the following:

- Inhalation of contaminated dust or vapors by on-site workers, Pioneer Boat Club members and recreational users of the site during on-site excavation activities. Inhalation of contaminated vapors in indoor air by future occupants of buildings that may be constructed on the site;

- Incidental ingestion of contaminated surface soil by on-site workers, Pioneer Boat Club members and recreational users of the site. Incidental ingestion of contaminated sub-surface soil by on-site workers involved in excavation activities; and

- Dermal contact with contaminated groundwater by on-site workers involved with site excavation, dermal contact with contaminated surface soil and river sediments by site workers, recreation users and Pioneer Boat Club members and dermal contact with contaminated sub-surface soil by on-site workers during excavation activities.

5.4: Summary of Environmental Impacts

This section summarizes the existing and potential future environmental impacts presented by the site. Environmental impacts include existing and potential future exposure pathways to fish and wildlife receptors, as well as damage to natural resources such as aquifers and wetlands.

The Fish and Wildlife Impact Analysis, which is included in the RI report, presents a detailed discussion of the existing and potential impacts from the site to fish and wildlife receptors. The following environmental exposure pathways and ecological risks have been identified:

- Exposure of biota in the Hudson River to contaminants discharged to the river via groundwater.
- Exposure of wildlife to contaminants in surface soils, particularly on the unpaved portion of the property owned by Mobil.

Site contamination has also impacted the groundwater resource in the upper water bearing unit. This unit, and the contamination it carries, discharges directly to the Hudson River.

SECTION 6: <u>SUMMARY OF THE REMEDIATION GOALS</u>

Goals for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375-1.10. At a minimum, the remedy selected must eliminate or mitigate all significant threats to public health and/or the environment presented by the hazardous waste disposed at the site through the proper application of scientific and engineering principles.

The remediation goals for this site are to:

- Prevent ingestion of and direct contact with contaminated soil,
- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards,
- Prevent inhalation of volatile organic chemicals from contaminated soil and groundwater,
- Remove the source of groundwater contamination,
- Prevent the discharge of contaminants to the Hudson River.

Further, the remediation goals for the site include attaining to the extent practicable:

- Soil cleanup guidelines that are protective of human health and groundwater quality.
- Class GA Ambient Water Quality Standards for contaminants of concern in groundwater.

SECTION 7: SUMMARY OF THE EVALUATION OF ALTERNATIVES

The selected remedy must be protective of human health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies or resource recovery technologies to the maximum extent practicable. Potential remedial alternatives for the Tappan Terminal site were identified, screened and evaluated in the November 2002 Feasibility Study report, which is available at the document repositories listed in Section 1.

A summary of the remedial alternatives that were considered for this site are discussed below. The present worth represents the amount of money invested in the current year that would be sufficient to cover all present and future costs associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth costs for alternatives with an indefinite duration. This does not imply that operation, maintenance, or monitoring would cease after 30 years if remediation goals are not achieved.

7.1: Description of Remedial Alternatives

The following potential remedies were considered to address the contaminated soils and groundwater at the site.

SOIL REMEDIATION ALTERNATIVES

S1 - No Action

The No Action alternative is evaluated as a procedural requirement and as a basis for comparison. It would allow the site to remain in an unremediated state, with no restrictions or monitoring. This alternative would leave the site in its present condition and would not provide any additional protection to human health or the environment.

Present Worth:	$ 0
Capital Cost:	$ 0
Annual O&M:	$ 0
Time to Implement	0 months

S2 - Fencing and Institutional Controls

This alternative provides for the maintenance of the existing fencing along the northern, southern and eastern boundaries of the site, installation of a fence along the western (Hudson River) boundary, and posting of signs to warn the public of the presence of contaminated soil. Institutional and land use controls, in the form of an environmental easement, would be placed on the property to ensure that future use of the property would not create unacceptable exposures to contaminated soils.

Present Worth:	$ 65,000
Capital Cost:	$ 31,000
Annual O&M:	$ 2,200
Time to Implement	6 months

S3 - Low Permeability Capping

This alternative provides for the placement of a low permeability cap over the site. This cap would be designed to meet the relevant requirements for a solid waste landfill cap under 6NYCRR Part 360. Such caps are designed to prevent precipitation from infiltrating through contaminated wastes, or the soil beneath them, and carrying contaminants into groundwater. A Part 360 cap would consist of, from bottom to top:

- A variable thickness of grading fill to achieve desired final slopes.
- Six inches of cushioning fill
- A synthetic membrane liner, such as high density polyethylene (HDPE)
- A geocomposite drainage layer
- An 18-inch barrier protection layer (12 inches if pavement or concrete is above)
- A 6-inch vegetated topsoil layer or asphalt pavement.

Grading fill would be necessary as the first layer to achieve a minimum slope for drainage of rainfall and snowmelt off the top surface and the membrane. Although Part 360 landfill regulations specify a 4% final grade due to expected settlement of solid waste, a 1%-2% final grade is appropriate at this site due to the known stability of the fill.

Depending on the designated future uses of the site, the final layer would be vegetated topsoil or asphalt pavement. The thickness of the barrier protection layer could be reduced beneath paved surfaces, depending on the drainage requirements of the site. The thickness of the barrier protection layer could also be increased to enable the planting of shallow-rooted trees and shrubs.

An environmental easement would be necessary to prevent excavation that would penetrate the membrane barrier or create exposure to the contaminated soil beneath it. This would limit the use of the property to greenspace and paved areas. New buildings requiring extensive foundation systems would not be permitted because they would involve excessive penetrations of the barrier layer.

Present Worth:	$ 4,700,000
Capital Cost:	$ 4,500,000
Annual O&M:	$ 13,400
Time to Implement	1 year

S4 - Demarcation Layer and Soil Cover System

This alternative provides for the installation of a 2-foot thick soil cover system over areas of contaminated soil at the site. A demarcation layer consisting of existing asphalt or concrete, where it is in good condition; or a synthetic material, such as a geogrid or geocomposite, would be placed above existing soil. The demarcation layer would identify the presence of contaminated fill beneath it, and provide a physical barrier against unintended penetration. Where existing asphalt or concrete is in disrepair, it would be repaired or replaced with a synthetic demarcation layer. The demarcation layer would then be covered with an 18-inch layer of clean soil and a 6-inch layer of soil capable of supporting vegetation. Alternative surfaces, such as new pavement or building slabs, would be considered as a substitute for the soil cover system, in conjunction with the final site development plan.

Although the demarcation layer is not intended to be a infiltration barrier, large areas of subsurface asphalt or concrete would

Remedial Technologies for Volatile Organic Contamination in Soil and Groundwater: Soil Vapor Extraction and Air Sparging

The Feasibility Study and subsequent pilot studies evaluated three distinct, but related, technologies for removing volatile organic chemicals from the subsurface. These technologies, and their applicability to the Tappan Terminal site are summarized below and on the following page:

Soil Vapor Extraction

Soil vapor extraction (SVE), also known as "soil venting" or "vacuum extraction", is a remedial technology that reduces concentrations of volatile contaminants adsorbed to soils above the groundwater table. In this technology, a vacuum is applied to wells near the source of soil contamination. Volatile contaminants evaporate, and the vapors are drawn toward the extraction wells. Extracted vapor is then treated as necessary, usually with carbon adsorption, before being released to the atmosphere. At this site, the efficiency of SVE is reduced by the shallow groundwater table, requiring an increased number of extraction wells, a horizontal extraction system, and/or an impermeable surface barrier to improve collection efficiency. The specific need for and layout of these elements would be determined during the remedial design phase. Although SVE does not fully remediate semivolatile contaminants, some reduction may occur due to the stimulation of biological activity as oxygen is delivered to the subsurface.

Air Sparging

Air sparging is a remedial technology that reduces concentrations of volatile contaminants that are adsorbed to soils below the water table and dissolved in groundwater. This technology involves the injection of clean air into groundwater, causing the contaminants to move from a dissolved state to the vapor phase. The air is then vented through the unsaturated zone. Air sparging is usually used together with SVE to treat both groundwater and soil, and to prevent the migration of vapors. This combined system, which consists of a series of air injection and vapor extraction wells, is called AS/SVE. Air sparging at this site is made more difficult by the shallow groundwater and tidal fluctuations in groundwater levels near the river. Air sparging causes groundwater to “mound” in the vicinity of injection wells, and can blow water into the vapor collection wells. Air flow rates in the injection and collection wells must be reduced and carefully controlled to avoid water entrainment in the collection system.

collect significant rainfall and snow melt, which could create ponded areas or soil instability. The soil cover system would include measures to promote runoff and/or infiltration, including grading, drainage swales, infiltration zones, and/or other controls. Because it would allow rainfall to infiltrate, a geosynthetic would not cause water to collect above the barrier and create ponded or wetland conditions.

To ensure that future activity at the site would not compromise the integrity of the soil cover, and to prevent future exposure to contaminated fill, an environmental easement would be obtained by the NYSDEC. This easement would specify the requirements for conducting intrusive activities beneath the cover system. These requirements would include NYSDEC, NYSDOH and Village notification and approval, health and safety planning, soil management and disposal, and barrier repair procedures. New structures would be permitted at the site, provided that an effective barrier to subsurface contamination is maintained, and building foundations are properly ventilated to prevent exposure to contaminated soil vapors.

Present Worth:	$ 2,370,000
Capital Cost:	$ 2,170,000
Annual O&M:	$ 13,400
Time to Implement	1 year

<u>S5 - Excavation of Chlorobenzene, Petroleum and Dye-Contaminated Soil and Installation of a Soil Cover System</u>

Chlorobenzene-contaminated soil located in the source area and along the sewer line would be excavated to the water table and disposed off-site. In addition, soil that is grossly contaminated with petroleum and dye would also be excavated. Grossly contaminated soil is soil which contains free product or mobile contamination that is identifiable either visually, through strong odor, by elevated contaminant levels, or is otherwise readily detectable without analytical sampling. The excavated soil, estimated to be 7,100 cubic yards, would be disposed off-site and replaced with clean backfill.

In addition to excavation of source areas, a 2-foot soil cover and demarcation layer would be placed over residually contaminated soils, and an environmental easement would be obtained, as described in Alternative S4.

Present Worth:	$ 4,125,000
Capital Cost:	$ 3,920,000
Annual O&M:	$ 13,400
Time to Implement	2 years

<u>S6 - Soil Vapor Extraction, Excavation of Petroleum and Dye-Contaminated Soil, and Installation of a Soil Cover System</u>

As described in the “Remedial Technologies” section above, soil vapor extraction (SVE) uses a vacuum to capture volatile contaminants from unsaturated soils. To overcome the effects of shallow groundwater at the site, horizontal collection wells and/or an impermeable surface layer in the SVE area would be evaluated during the remedial design.

Because SVE is not effective at removing semivolatile organic contaminants, an estimated 100 cubic yards of soil that is grossly contaminated with dye-related compounds and weathered petroleum would be excavated and removed from the site.

Remedial Technologies for Volatile Organic Contamination in Soil and Groundwater: Bio-Sparging

Bio-Sparging

Biosparging is a remedial technology that uses indigenous microorganisms to biodegrade organic constituents in the saturated zone (below the groundwater table). In biosparging, air (or oxygen) and nutrients (if needed) are injected into the saturated zone to increase the biological activity of naturally-occurring microorganisms. In many cases, biological activity is limited by the amount of oxygen that is dissolved in groundwater. Biosparging provides a steady supply of oxygen to sustain biodegradation, at a relatively low rate as compared to air sparging. Biosparging can be used to reduce concentrations of organic contaminants that are dissolved in groundwater and/or adsorbed to soil below the water table.

Biodegradation processes typically take longer to achieve remedial goals, and may create degradation products that are equally problematic. During the 18-month pilot study at the Tappan Terminal site, biosparging decreased chlorobenzene moderately in only 4 out of 11 monitoring wells, from an average level of 1727 ppb before the test to 1354 ppb afterward. However, in the 7 other wells in the study area, average chlorobenzene levels increased from 2923 ppb to 3529 ppb. In the study area as a whole, chlorobenzene increased from 2488 ppb to 2738 ppb.

Although chlorobenzene levels increased on average, biodegradation was considered to have occurred due to the presence of its byproduct, 2-chlorophenol, at low levels. However, the rate of degradation appears to be very slow. In addition, 2-chlorophenol is equally problematic as a contaminant as chlorobenzene. The groundwater standard for 2-chlorophenol is 1.0 ppb, compared to the 5.0 ppb standard for chlorobenzene. Because biosparging does not appear to be capable of achieving groundwater quality standards for chlorobenzene and its degradation products in a reasonable time frame, it was not retained as a feasible remedial technology.

Grossly contaminated soil is soil which contains free product or mobile contamination that is identifiable either visually, through strong odor, by elevated contaminant levels, or is otherwise readily detectable without analytical sampling. Soil that contains lower levels of petroleum could achieve some reduction in contamination by biodegradation processes that are often associated with SVE.

The remainder of the site, which contains residual site-related contamination and historic fill, would be covered with a demarcation layer and soil cover, as described in Alternative S4 above. An environmental easement would also be obtained by the NYSDEC.

Present Worth:	$ 3,746,000
Capital Cost:	$ 2,748,000
Annual O&M:	
Years 1-5	$ 209,000
Years 6-30	$ 8,600

S7 - Excavation of all Contaminated Soil above the Water Table

Soil across the entire site would be excavated to the depth of the water table to remove petroleum, chlorobenzene, dye and fill-related contamination from above the water table. Approximately 121,000 cubic yards of soil would be excavated, transported and disposed off-site. Any buildings or abandoned structures, such as tank pads or platforms, would be removed as part of this excavation. All excavations would be backfilled with clean soil to existing grade. Because soil beneath the groundwater table is contaminated, a demarcation layer would be placed beneath the clean soil backfill.

Present Worth:	$ 17,250,000
Capital Cost:	$ 17,100,000
Annual O&M:	$ 8,600
Time to Implement	3 years

GROUNDWATER REMEDIATION ALTERNATIVES

G1 - No Action with Long Term Monitoring

Under this alternative, no active remediation of groundwater would be performed, and contamination would remain in place. If the source of groundwater contamination were to be remediated by a soil remediation alternative, some natural attenuation of groundwater contamination may occur, but not to a sufficient degree to achieve SCGs. Groundwater monitoring would be performed in the long term to evaluate the degree of attenuation.

Present Worth:	$ 98,000
Capital Cost:	$ 0
Annual O&M:	$ 6,400
Time to Implement	3 months

G2 - Air Sparging with Soil Vapor Extraction

As described in the “Remediation Technologies” section above, air sparging (AS) is the injection of air below the water table to transfer volatile contaminants from water to the vapor phase. Soil vapor extraction (SVE) uses a vacuum to capture volatile contaminants from the unsaturated zone as they are stripped from the groundwater.

The AS/SVE system would be installed in two locations, in the chlorobenzene source area, and along the sewer line where the contamination has spread laterally. Conceptually, the AS/SVE system would consist of several zones (see Figure 6), each containing a series of vertical air sparging wells and a horizontal vapor extraction well. Due to the shallow groundwater table, an impermeable layer at the ground surface, such as plastic sheeting, may be necessary to prevent short circuiting of the collection system to air at the surface.

It is estimated that the AS/SVE system would be operated for 5 years until soil and groundwater achieve cleanup goals. This would be followed by a period of long term monitoring to ensure the cleanup was effective.

Present Worth:	$ 2,060,000
Capital Cost:	$ 991,000
Annual O&M:	
Years 1-5	$ 231,000
Years 6-30	$ 6,400
Time to Implement	1 year

G3 - Hydraulic Barrier, Groundwater Extraction and Treatment

Under this alternative, contaminated groundwater would be pumped from the ground and treated prior to discharge into the Hudson River. A series of extraction wells located along both the sewer line and the Hudson River would be installed, as shown in Figure 7. To isolate the shoreline wells from the tidal fluctuations of the river and to prevent them collecting river water, a hydraulic barrier would be installed. This slurry wall would be about 20 feet deep , and would be keyed into the Marine Silt unit.

Extracted groundwater would be treated to remove the VOCs, SVOCs and metals that currently exceed surface water discharge standards. In addition, pretreatment for iron and manganese would likely be required to prevent fouling of the air stripping system used to treat VOCs.

It is estimated that the groundwater extraction and treatment system would require 15 years to achieve groundwater standards, and that this would be followed by a period of long term monitoring.

Present Worth:	$ 3,660,000
Capital Cost:	$ 1,840,000
Annual O&M:	
Years 1-15	$ 156,000
Years 16-30	$ 6,400
Time to Implement	2 years

G4 - In-situ Chemical Oxidation

In-situ chemical oxidation is an in-place treatment technology that uses an oxidant such as peroxide or permanganate to destroy contaminants in both soil and groundwater. The oxidant would be injected through a series of wells into the subsurface, where it would migrate through the aquifer and break down contaminants that are amenable to oxidation. In-situ oxidation is effective for the VOCs of concern at this site, and would fully break down these contaminants without creating by-products of concern. This technology is not effective for treating many SVOCs or any metals. To determine the best oxidant and optimal injection rate for the specific contaminants and site conditions, a pilot study would be necessary.

One limitation to this technology is the presence of organic matter in the soil matrix that would consume the oxidant and require frequent re-injection to destroy the targeted contamination. The organic content of the soils at the site is significantly high, averaging 10%, due to the ash and other man-made materials used to construct the landmass. Interference by fill-related organic matter on the oxidation technology would require investigation during the pilot study. The effect of this interference would be to significantly increase the amount and duration of oxidant required to achieving the remedial goals for the site.

For comparison purposes, oxidation is estimated to require 2 years to design and implement, followed by a long term monitoring period. However, due to the unknown effect of fill-related interference, the cost estimate and time frame have significant uncertainty.

Present Worth:	$ 1,840,000
Capital Cost:	$ 1,660,000
Annual O&M:	$ 6,400
Time to Implement	2 years

7.2 Evaluation of Remedial Alternatives

The criteria to which potential remedial alternatives are compared are defined in 6 NYCRR Part 375, which governs the remediation of inactive hazardous waste disposal sites in New York State. A detailed discussion of the evaluation criteria and comparative analysis is included in the FS report.

The first two evaluation criteria are termed "threshold criteria" and must be satisfied in order for an alternative to be considered for selection.

1. Protection of Human Health and the Environment. This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

Alternatives S1 and G1 (No Further Action for soil and groundwater, respectively) would not protect human health and the environment because contamination would remain at the site in an uncontrolled condition. Alternative S2 (Fencing and Institutional Controls) would not fully protect public health because trespassers could continue to access the site and contact contaminated soil. Alternative S2 would also not protect the environment because soil would continue to be a source of groundwater contamination. Alternatives S3 (Low Permeability Capping) and S4 (Soil Cover System) would protect public health by eliminating the potential for direct contact with contaminated soil. The environmental easement and associated requirement for soil vapor mitigation systems on any new structures would prevent unacceptable exposures to contaminated vapors. However, Alternatives S3 and S4 alone would not fully protect the environment because contaminated soil below the water table would continue to affect groundwater.

Alternatives S5 and S6 would provide a high degree of health and environmental protection with respect to contaminated soils. Both alternatives would remove petroleum and dye-contaminated soils from the site, and thereby eliminate the potential for exposure to these contaminants. Alternative S5 would remove chlorobenzene-contaminated soil by excavation, while Alternative S6 would remove it using a soil vapor extraction system. Both alternatives would prevent exposure to residual contamination through the use of a soil cover system. Alternative S7 would provide the highest degree of protection from contaminated soils by excavating all contaminated soils above the water table and removing them from the site.

To be fully protective of the environment, all soil alternatives must be combined with a groundwater alternative. Alternatives G2 and G3 provide a high degree of environmental protection through proven technologies. It is uncertain whether Alternative G4 can effectively treat groundwater at this site and achieve a high degree of environmental protection.

2. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether or not a remedy will meet applicable environmental laws, regulations, standards, and guidance.

The No Action alternatives S1 and G1 would not achieve applicable standards and guidance values for groundwater and soil at this site; nor would Alternative S2. Alternative S3 would meet the standards for a landfill cap.

Alternative S4 would not meet the requirements for a cap for the levels of contamination that would remain at the site. Alternatives S5 and S6 would meet the guidance values for contaminated soil by excavation and/or soil vapor extraction. Residual contamination, particularly Tentatively Identified Compounds for which there are no specific guidance values and historic fill, would be covered with a soil cover that would not be fully compliant with landfill capping regulations. Alternative S7 would achieve soil cleanup guidance values for soils located above the water table. For the excavation portions of alternatives S5, S6 and S7, off-site transportation and disposal of excavated material would comply with applicable solid and hazardous waste management regulations and land disposal restrictions.

Groundwater alternatives G2, G3 and G4 would comply with the requirements for air and surface water discharges from their respective treatment systems. They are also expected to meet the ambient groundwater quality standards for volatile organic contaminants. However, only alternative G3 would meet the ambient water quality standards for semivolatile organic chemicals and inorganics assiciated with the historic fill at the site.

The next five "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial strategies.

3. <u>Short-term Effectiveness</u>. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

Alternatives S1, S2 and G1 would not have any short-term construction-related impacts, and could be readily implemented in a short time frame. Alternatives S3 and S4 would require a longer time frame, approximately 1 year each, but would not require excavation of any contaminated soil that could cause short-term exposures to workers and residents. Alternative S5 would have a high degree of short-term impact because a large volume of soil, containing volatile organic contaminants, would be excavated over a 2-year time frame. Alternative S6 would have less short-term impact than S5, because a much smaller volume of soil, containing less volatile contaminants, would be excavated over a shorter time period. Alternative S7 would have a severe short-term impact because a very large volume of contaminated soil would be excavated over an estimated 3-year construction period.

The groundwater treatment alternatives G2, G3 and G4 would have similar, minimal short-term impacts. Alternative G2 would require careful balancing of the air sparging and vapor extraction processes to ensure that contaminant vapors are fully collected. Alternatives G3 and G4 would require worker protections to prevent exposure to chemicals associated with their respective treatment processes. Alternatives G2 and G4 would require a similar amount of time to achieve the remedial goals for the site. Alternative G2 would require a shorter design period because some pilot testing has already been done, and because AS/SVE is a well-established technology. Alternative G4 would require a longer design period due to the need for extensive pilot testing, but a shorter implementation time frame.

4. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

Alternatives S1, S2 and G1 would not provide long-term effectiveness or permanence because contaminants would remain in soil and groundwater at the site and would continue to be accessible to human and environmental receptors. Alternative S3 would provide long-term effectiveness by isolating contaminants and controlling the exposure to, and release of, contaminants in soil. The components of the Part 360 landfill cap would require inspection and maintenance to be effective. Alternative S4 alone would provide less long-term effectiveness than S3 because the soil cover would provide less protection of groundwater than the landfill cap.

Alternative S5 would provide more long-term effectiveness and permanence by removing the highly contaminated soil above the water table that is impacting groundwater. The potential contact with residual contamination would be minimized with a soil cover system. Alternative S6 would provide a high degree of long-term effectiveness and permanence by stripping volatile organic contaminants from soil and excavating the highest levels of non-volatile contaminants. Alternative S7 would provide the highest degree of long-term effectiveness and permanence by removing all highly contaminated and residually contaminated soil from above the water table.

For groundwater, Alternatives G2 and G3 would provide a high degree of long-term effectiveness and permanence by removing contaminants from the subsurface. The effectiveness of alternative G4 is uncertain due to the potential interference of the fill matrix on the chemical oxidation technology.

5. Reduction of Toxicity, Mobility or Volume. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

Alternatives S1, S2, and G1 would not reduce the toxicity, mobility or volume of contaminants in soil or groundwater. Alternative S3 would reduce the mobility of contaminants in soil and groundwater by isolating contaminated soil under an impermeable cap. Alternative S4 would somewhat reduce the mobility of contaminants by eliminating dust and surface runoff migration with a soil cover. However, neither Alternative S3 or S4 would reduce the volume or toxicity through treatment. Alternative S5 would reduce the mobility and volume of contaminated soil at the site by excavation and off-site disposal, and the mobility of residual contamination would be reduced by a soil cover system. Alternative S6 would provide a similarly high degree of mobility and volume reduction by a combination of excavation and soil vapor extraction. Alternative S7 would provide the highest degree of mobility and volume reduction by excavating all soil above the water table and removing it from the site.

None of the soil alternatives under consideration would reduce contaminant toxicity through treatment. Alternatives G2 and G3 would reduce the mobility and volume of contamination in the groundwater phase by removing it from the subsurface. If Alternative G4 could be successfully implemented, it would reduce toxicity by breaking down organic contaminants into non-toxic or less toxic chemicals.

6. Implementability. The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

Alternatives S1, G1 and S2 could both be readily constructed, and Alternative S1 would not require an institutional control, so it would be the easiest alternative to implement. In addition to their varying technical implementability, Alternatives S2 through S7 would require an environmental easement, which could require extensive legal negotiations for the two properties that comprise the site. Alternative S4 would be relatively easy to implement because a soil cover requires less specialized equipment and installation methods than a landfill cap. Alternative S3 would be somewhat more difficult to implement due to the need to re-grade the fill and properly seam the impermeable barrier material. Alternatives S5 and S6 would be more difficult to implement due to the need to excavate areas of contamination, particularly where building foundations and/or utilities are present. Alternative S7 would be the most difficult alternative to implement because a large volume of contaminated soil would have to be excavated and removed from the site. Because this soil would contain volatile organic contaminants, strict air emission controls would be required to prevent exposures to workers and the community.

Alternatives G2 and G3 would be moderately difficult to implement due to the presence of abandoned structures, utility lines and subsurface bulkheads that could interfere with the installation of horizontal wells or collection trenches. However, the technologies associated with these alternatives are well established and readily available. Alternative G4 would be somewhat more difficult to implement because it is a recently developed technology, and would require extensive pilot testing before it could be applied to this site.

7. Cost-Effectivness. Capital costs and operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision. The costs for each alternative are presented in Table 2.

Alternatives S1 and S2 would be the least costly alternatives to implement, with S2 requiring a low annual cost to verify that fencing and institutional controls are effective. Alternative G1 would also require only low periodic groundwater monitoring costs. Alternative S4 is the least costly of the two containment options, with the full landfill cap (S3) requiring an additional $2.33 million, or nearly double, the soil cover system. Excavating VOC, petroleum and visible dye contamination (Alternative S5) would add $1.76 million (74%) to the cost of the soil cover alone. Removing the VOC contamination with an SVE system rather than excavation would add another $1.38 million (58%) to the soil cover remedy. Removing all soil above the water table is more than $12.5 million more costly than any of the other alternatives under consideration.

Alternative G4 is the least costly of the active groundwater alternatives, with a large component of capital cost for the chemical oxidant injections. Alternative G2 is slightly (12%) more expensive than G4, but would achieve cost savings if used in combination with soil vapor extraction Alternative S6. Alternative G3 is the most costly groundwater alternative, an additional $1.6 million (78%) more than Alternative G2.

This final criterion is considered a “modifying criterion” and is taken into account after evaluating those above. It is evaluated after public comments on the Proposed Remedial Action Plan have been received.

8. <u>Community Acceptance</u> - Concerns of the community regarding the RI/FS reports and the PRAP are evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the NYSDEC will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

SECTION 8: SUMMARY OF THE PROPOSED REMEDY

The NYSDEC is proposing a combination of Alternatives S6 and G2, consisting of excavation of grossly contaminated soil containing petroleum and dye contaminants, a soil cover with air sparging and soil vapor extraction, as the remedy for this site.

The proposed remedy is based on the results of the RI and the evaluation of alternatives presented in the FS.

Air sparging and soil vapor extraction (SVE/AS) are expected to effectively remove volatile organic contamination, including chlorobenzene and benzene, from soil and groundwater beneath the site. Soil containing the highest levels of semivolatile organic contaminants (SVOCs), particularly petroleum and dyes, would be excavated and removed from the site. Although SVE/AS would not remove SVOCs from groundwater, these have not migrated significantly from their source areas. The additional cost and time necessary to extract and treat contaminated groundwater is not justified by the removal of SVOCs. For some SVOCs in soil, the soil vapor extraction component of the remedy would promote biodegradation by introducing oxygen into the subsurface. The soil cover would prevent exposure to the remaining, low levels of SVOCs and metals in soil, including those associated with the historic fill used to create the site. An environmental easement would be placed on the site to ensure that the soil cover is maintained, and that any excavations conducted beneath the demarcation layer are conducted safely.

The estimated present worth cost to implement the remedy is $ 4,226,000. The cost to construct the remedy is estimated to be $ 3,021,000 and the estimated average annual operation and maintenance cost is $240,000 for the first five years and $15,000 thereafter.

The elements of the proposed remedy are as follows:

- A remedial design program would be implemented to provide the details necessary for the construction, operation, maintenance, and monitoring of the remedial program.

- Installation and operation of an air sparging and soil vapor extraction system in areas of VOC-contaminated soil and groundwater.

- Excavation and off-site disposal of soil that is visibly contaminated with dye or petroleum or is otherwise grossly contaminated.

- Construction of a soil cover over all vegetated areas to prevent exposure to contaminated soils. The two-foot thick cover would consist of clean soil underlain by an indicator such as orange plastic snow fence or existing asphalt or concrete surfaces to demarcate the cover soil from the subsurface soil. The top six inches of soil would be of sufficient quality to support vegetation. Clean soil would constitute soil with no analytes in exceedance of NYSDEC TAGM 4046 soil cleanup objectives or local site background as determined by the procedure in DER 10 ("Tech Guide"). Non-vegetated areas (buildings, roadways, parking lots, etc) would be covered by a paving system or concrete at least 6 inches in thickness.

- The site would be restored by grading, placement of soil capable of supporting vegetative growth, and seeding of excavated and/or filled areas.

- Development of a site management plan to: (a) address residually contaminated soils that may be excavated from the site during future redevelopment. The plan would require soil characterization and, where applicable, disposal/reuse in accordance with NYSDEC regulations; (b) evaluate the potential for vapor intrusion for any buildings developed on the site, including provision for mitigation of any impacts identified; (c) identify any use restrictions; and (d) provide for the operation and maintenance of the components of the remedy.

- Imposition of an institutional control in the form of an environmental easement that would (a) require compliance with the approved site management plan; (b) limit the use and development of the property to restricted residential, recreational, commercial or industrial uses only; (c) restrict the use of groundwater as a source of potable water, without necessary water quality treatment as determined by NYSDOH; and (d) require the property owner to complete and submit a certification to the NYSDEC on a periodic basis.

- Periodic certification by the property owner, prepared and submitted by a professional engineer or such other expert acceptable to the NYSDEC, until the NYSDEC notifies the property owner in writing that this certification is no longer needed. This submittal would contain certification that the institutional controls and engineering controls, are still in place, allow the NYSDEC access to the site, and that nothing has occurred that would impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the site management plan.

- The operation of the components of the remedy would continue until the remedial objectives have been achieved, or until the NYSDEC determines that continued operation is technically impracticable or not feasible.

- Since the remedy results in residually contaminated soils remaining at the site, a long term monitoring program would be instituted as part of the Site management plan. This would include monitoring the soil cover to ensure that it continues to effectively prevent exposures to subsurface contamination. Groundwater at the site would also be monitored to verify the effectiveness of the groundwater treatment process, and to ensure that residual contamination does not pose an unacceptable threat to public health or the environment. This program would allow the effectiveness of the soil cover to be monitored, and would be a component of the operation, maintenance, and monitoring for the site.

Table 1
Nature and Extent of Contamination

MEDIUM	CATEGORY	CONTAMINANT OF CONCERN	CONCENTRATION RANGE (ppm)	FREQUENCY of EXCEEDING SCGs/Background	SCG/ Bkgd. (ppm)
Surface Soils (0-3")	Semivolatile Organic Compounds (SVOCs)	Benzo(a)anthracene	ND (0.027) to 5.4	13 of 18	0.224
		Chrysene	ND (0.030) to 6.2	12 of 18	0.400
		Benzo(b)fluoranthene	ND (0.021) to 7.1	7 of 18	1.1
		Benzo(k)fluoranthene	ND (0.019) to 5.2	6 of 18	1.1
		Benzo(a) pyrene	ND (0.027) to 6.5	16 of 18	0.061
		Dibenzo(a,h) anthracene	ND (0.014) to 1.3	13 of 18	0.014
	Polychlorinated Biphenyls	Total PCBs	ND (0.001) to 5.0	7 of 33	1.0
	Metals	Arsenic	ND (3.0) to 90	11 of 18	7.5
		Barium	ND (1.0) to 8,120	7 of 18	300
		Beryllium	ND (1.0) to 8.1	17 of 18	0.160
		Chromium	ND (1.0) to 97	3 of 18	50
		Copper	ND (1.0) to 1,110	17 of 18	25
		Lead	ND (2.0) to 1,320	8 of 18	400
		Mercury	ND (0.2) to 2.8	16 of 18	0.100
		Nickel	ND (2.0) to 119	15 of 18	13
		Selenium	ND (4.0) to 2.5	2 of 18	2.0
		Vanadium	ND (1.0) to 2,190	3 of 18	150
		Zinc	ND (1.0) to 3,200	24 of 24	20

MEDIUM	CATEGORY	CONTAMINANT OF CONCERN	CONCENTRATION RANGE (ppm)	FREQUENCY of EXCEEDING SCGs/Background	SCG/ Bkgd. (ppm)
Near Surface Soils (3"-11")	Semivolatile Organic Compounds (SVOCs)	Benzo(a)anthracene	ND (0.027) to 23	5 of 6	0.224
		Chrysene	ND (0.030) to 25	4 of 6	0.400
		Benzo(b)fluoranthene	ND (0.021) to 23	2 of 6	1.1
		Benzo(k)fluoranthene	ND (0.019) to 25	2 of 6	1.1
		Benzo(a) pyrene	ND (0.027) to 25	5 of 6	0.061
		Indeno (1,2,3-cd) pyrene	ND (0.020) to 12	1 of 6	3.2
		Dibenzo(a,h) anthracene	ND (0.014) to 7.9	5 of 6	0.014
	Polychlorinated Biphenyls	Total PCBs	ND (0.001) to 4.4	1 of 6	1.0
	Metals	Arsenic	ND (3.0) to 19.8	2 of 6	7.5
		Barium	ND (1.0) to 954	3 of 6	300
		Beryllium	ND (1.0) to 0.39	6 of 6	0.160
		Copper	ND (1.0) to 428	6 of 6	25
		Lead	ND (2.0) to 403	1 of 6	400
		Mercury	ND (0.2) to 2.0	5 of 6	0.100
		Nickel	ND (2.0) to 35.9	5 of 6	13
		Zinc	ND (1.0) to 1,620	6 of 6	20

MEDIUM	CATEGORY	CONTAMINANT OF CONCERN	CONCENTRATION RANGE (ppm)	FREQUENCY of EXCEEDING SCGs/Background	SCG/ Bkgd. (ppm)
Subsurface Soils	Volatile Organic Compounds (VOCs)	Chlorobenzene	ND (0.10) to 31	6 of 33	1.7
		Trichloroethylene	ND (0.01) to 15	2 of 33	0.700
		Tetrachloroethylene	ND (0.01) to 50	3 of 33	1.4
		1,2-Dichloroethene	ND (0.01) to 23	1 of 33	0.300
		Vinyl Chloride	ND (0.01) to 1.8	1 of 33	0.200
	Semivolatile Organic Compounds (SVOCs)	Benzo(a)anthracene	ND (0.064) to 2.4	5 of 10	0.224
		Chrysene	ND (0.11) to 2.4	3 of 10	0.400
		Benzo(b)fluoranthene	ND (0.12) to 2.8	3 of 10	1.1
		Benzo(k)fluoranthene	ND (0.11) to 1.9	3 of 10	1.1
		Benzo(a) pyrene	ND (0.060) to 1.7	7 of 10	0.061
		Dibenzo(a,h) anthracene	ND (0.069) to 0.330	4 of 10	0.014
	Metals	Arsenic	ND (3.0) to 14.6	5 of 10	7.5
		Barium	ND (1.0) to 3,650	4 of 10	300
		Beryllium	ND (1.0) to 0.290	8 of 10	0.160
		Cadmium	ND (1.0) to 122	1 of 10	10
		Chromium	ND (1.0) to 120	1 of 10	50
		Copper	ND (1.0) to 28,700	9 of 10	25
		Lead	ND (2.0) to 3,090	2 of 10	40
		Mercury	ND (0.2) to 1.1	9 of 10	0.10
		Nickel	ND (2.0) to 1,120	5 of 10	13
		Selenium	ND (2.0) to 2.7	3 of 10	2
		Zinc	ND (1.0) to 43,500	10 of 10	20

MEDIUM	CATEGORY	CONTAMINANT OF CONCERN	CONCENTRATION RANGE (ppm)	FREQUENCY of EXCEEDING SCGs/Background	SCG/ Bkgd. (ppm)
Sediments	Volatile Organic Compounds (VOCs)	1,1,2,2-Tetrachloroethane	ND (1.0) to 5	1 of 12	0.45
	Polychlorinated Biphenyls	Total PCBs	ND (1.0) to 0.140	0 of 12	1.0
Groundwater	Volatile Organic Compounds (VOCs)	Chlorobenzene	ND (0.1) to 11,000	40 of 72	5.0
		Benzene	ND (0.1) to 170	18 of 72	1.0
		Ethyl Ether	ND (0.1) to 360	1	1
		Diisopropyl Ether	ND (0.1) to 410	1	1
	Semivolatile Organic Compounds (SVOCs)	2-Chlorophenol	ND (0.1) to 61	6 of 38	1.0
		1,4-Dichlorobenzene	ND (0.1) to 170	5 of 38	3.0
		4-Chloroaniline	ND (0.1) to 25	4 of 38	5.0
		Naphthalene	ND (0.1) to 650	8 of 72	10
	Metals (in filtered samples)	Antimony	ND (4.0) to 47	10 of 38	3.0
		Arsenic	ND (3.0) to 40	1 of 38	25
		Barium	ND (1.0) to 2,180	10 of 38	1,000
		Copper	ND (1.0) to 506	1 of 38	200
		Iron	ND (20) to 261,000	26 of 38	300
		Lead	ND (1.0) to 261	1 of 38	25
		Manganese	ND (4.0) to 8140	30 of 38	300
		Selenium	ND (4.0) to 17	14 of 38	10
		Thallium	ND (5.0) to 8.0	2 of 38	0.5

ND - Not detected at the detection limit listed in parenthesis

[1] - There are no ambient groundwater standards or guidance values for ethyl and diisopropyl ether

Table 2
Remedial Alternative Costs

Remedial Alternative	**Capital Cost**	**Annual O&M**	**Total Present Worth**
Soil Alternatives			
S1 - No Action	$0	$0	$0
S2 - Fencing and Institutional Controls	$31,000	$2,200	$65,000
S3 - Low Permeability Capping	$4,500,000	$13,400	$4,700,000
S4 - Soil Cover System	$2,170,000	$13,400	$2,370,000
S5 - Contaminant Excavation and Soil Cover System	$3,920,000	$13,400	$4,125,000
S6 - Soil Vapor Extraction, Partial Excavation and Soil Cover System	$2,748,000	Years: 1-5 $ 209,000 6-30 $ 8,600	$3,746,000
S7 - Excavation above the Water Table	$17,100,000	$8,600	$17,250,000
Groundwater Alternatives			
G1 - No Action with Long Term Monitoring	$0	$6,400	$98,000
G2 - Air Sparging and Soil Vapor Extraction	$991,000	Years: 1-5 $ 231,000 6-30 $ 6,400	$2,060,000
G3 - Groundwater Extraction and Treatment	$1,840,000	Years: 1-15 $ 156,000 16-30 $ 6,400	$3,660,000
G4 - In-Situ Chemical Oxidation	$1,660,000	$6,400	$1,835,000
Proposed Remedy - Alternatives S6 and G3 Combined			
Air Sparging / Soil Vapor Extraction, Partial Excavation, Soil Cover	$3,021,000	Years: 1-5 $ 240,000 6-30 $ 15,000	$4,226,000