FINAL REPORT

Three Star Anodizing Site
Wappingers Falls, New York
Feasibility Study
NYSDEC Site 314058

New York State Department of
Environmental Conservation
Albany, New York

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Vice President

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ENGINEERS, INC.

TABLE OF CONTENTS

1. Introduction 1
1.1. Purpose 1
1.2. Conceptual Site Model 1
1.3. Summary of Exposure Assessment 3
1.4. Feasibility Study Approach 4
2. Development of Remedial Alternatives 5
2.1. Development of Remedial Action Objectives 5
2.1.1. Identification of Potential Standards, Criteria and Guidance (SCGs) 5
2.1.2. Physical and Technical Limits to Remediation 5
2.1.3. Technical Impracticability Evaluation 6
2.1.4. Remedial Action Objectives 7
2.2. Identification of General Response Actions 7
2.3. Identification of Areas and Volumes of Media 7
2.4. Identification and Screening of Remedial Technologies and Process Options 8
2.4.1. Soil 8
2.4.2. Ground Water 12
2.4.3. Lagoon Sediment 15
2.4.4. Soil Vapor 15
2.5. Evaluation of Remedial Technologies 16
2.6. Assembly of Remedial Alternatives 16
2.6.1. Common Components of Alternatives 16
2.6.2. Alternative 1 19
2.6.3. Alternative 2 19
2.6.4. Alternative 3 19
2.6.5. Alternative 4 20
3. Detailed Analysis of Alternatives 22
3.1. Individual Analysis of Alternatives 22
3.1.1. Overall Protection of Human Health and the Environment 22
3.1.2. Compliance with SCGs 23
3.1.3. Long-Term Effectiveness and Permanence 23
3.1.4. Reduction of Toxicity, Mobility, or Volume through Treatment 23
3.1.5. Short-Term Effectiveness 23
3.1.6. Implementability 23
3.1.7. Cost 23
3.1.8. Community Acceptance 23
3.2. Comparative Analysis of Alternatives 24
3.2.1. Overall Protection of Human Health and the Environment 24
3.2.2. Compliance with SCGs 24
3.2.3. Long-Term Effectiveness and Permanence 24
3.2.4. Reduction of Toxicity, Mobility, or Volume though Treatment 24
3.2.5. Short-Term Effectiveness 25
3.2.6. Implementability 25
3.2.7. Cost 25
3.2.8. Community Acceptance 25
References 26

List of Tables

1 Evaluation of Potential SCGs
2 Screening of Remedial Technologies and Process Options
3 Evaluation of Process Options
4 Remedial Alternatives Matrix
5 Detailed Analysis of Alternatives
6 Alternative 2 Cost Estimate – Institutional and Engineering Controls, and Monitoring
7 Alternative 3 Cost Estimate – *In Situ* Treatment
8 Alternative 4 Cost Estimate – Excavation and Off-Site Disposal

List of Figures

1 Site Location Map
2 Site Map
3 Alternative 3 – *In Situ* Treatment
4 Alternative 4 –Excavation and Off-Site Disposal

1. Introduction

1.1. Purpose

This document presents a Feasibility Study (FS) for a portion of the Three Star Anodizing Site (Three Star Site, Site #314058) that was completed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of the New York State Department of Environmental Conservation (NYSDEC). The portion of the Three Star Site that is addressed by this FS is the Main Plant Site (including the Former Raceway) and the MGP Site (Figure 1). Wappingers Creek adjacent to and downstream of the Three Star Site is addressed in a separate document (O'Brien & Gere 2007a).

The FS process consists of development and screening of remedial action alternatives followed by a development of a detailed analysis of options to establish a basis for selecting a remedy for the Three Star Site. The FS was completed according to guidance provided by the United States Environmental Protection Agency (USEPA) for the evaluation of Sites under Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA) (USEPA 1988). NYSDEC's Department of Environmental Restoration (DER)-10 draft guidance entitled *Technical Guidance for Site Investigation and Remediation* (NYSDEC 2002) was also considered for this analysis.

1.2. Conceptual Site Model

The Conceptual Model presented below summarizes the results of the Remedial Investigation (RI) and the Supplemental Remedial Investigation (SRI) of the Three Star Site (Site RI and Site SRI, respectively). Additional background information is provided in the Three Star Site RI Report (O'Brien & Gere 2007b). Supporting information associated with the evaluation of former metal plating vats that were exposed to the environment after a fire that occurred at the Three Star Site in May 2004 is presented in the Three Star Site SRI Report (O'Brien & Gere 2007c).

- The Three Star Site has been the location of industrial and commercial activities since the 1830s. Past industrial activities include dye manufacturing, metal plating, felt hat and leather manufacturing, ammunition production, and plastic mold injection. Currently, uses of the Three Star Site include a commercial warehouse and an area used for tractor trailer storage (NYSDEC 2003). For the RI, the Three Star Site was subdivided into three areas consisting of the Main Site, the manufactured gas plant (MGP) Site, and the Three Star lagoon.

- The Main Site is occupied by the Axton-Cross Building and four additional buildings designated as buildings 17, 21, 12, and Page Print. Three additional buildings (buildings 15, 16, and 22) were destroyed by a fire at the Three Star Site in 2004. Other areas of the Main Site include paved parking areas and a grassed area adjacent to Wappingers Creek. A retaining wall borders the Main Site along the creek, except bordering the Axton-Cross Building and the MGP Site where there is soil exposed along the creek bank. A former raceway borders the Main Site to the south and drains toward the Three Star lagoon.

- The 2004 fire exposed to the environment twenty-three former metal plating vats (the vats) that were formerly contained in Building 16. The vats contain miscellaneous materials including

wood, metal, insulation, and shingles. Liquids that were in the vats following the fire were primarily non-hazardous, although chromium was detected as a characteristic hazardous waste in an aqueous sample collected from Vats 1, 7, and 8. Sludge in the bottoms of the vats is presumed to consist of non-hazardous and hazardous wastes. Mastic adhesives used to affix foam glass insulation material to the walls of the vats included non-friable asbestos containing materials (ACM). Both the glass foam scattered around the vat area and some of the vat walls contained the mastic adhesives with ACM. Roof shingles intermingled with the debris associated with the fire were presumed to be non-friable ACM. The west and north walls of Building 16 remain in place. However, the heat from the fire and the loss of the rest of the building has destabilized those walls.

- The Three Star lagoon historically received industrial discharges. The sediment in the Three Star lagoon ranges from approximately 2 to 11 feet thick with concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganic constituents above sediment screening values but below levels that would classify it as a characteristically hazardous waste. The Three Star lagoon is located at the terminal end of the former raceway and it drains to Wappingers Creek.

- The MGP Site is undeveloped with ruins of two gas holders and miscellaneous debris scattered on portions of it. Concrete debris is located on the MGP Site. The creek bank bordering the MGP Site is exposed soil.

- There is a widespread presence of fill material throughout the Three Star Site containing inorganic constituents and polyaromatic hydrocarbons (PAHs). Historical accounts indicate coal cinders from the MGP were used to fill portions of the Three Star Site. Fill materials extend to at least 10 ft below grade. Test pits excavated during the Three Star Site RI identified the presence of coal cinders in fill materials.

- On the Main Site, two primary areas of contaminated soil were identified as potential sources. These areas, consisting of the lower portion of the former raceway and the drywell area, were identified by the link between concentrations detected in shallow ground water, associated soil, and site history. The lower portion of the former raceway exhibits inorganic constituents and PAHs (primarily consisting of naphthalene) that appear to be associated with the documented discharge of industrial wastes to the ground surface in this area of the Three Star Site. The soil and ground water samples collected in the vicinity of the drywell located in the former drum storage area next to the south side of the Axton-Cross Building, exhibited chlorinated VOCs that appear to be associated with past industrial uses. The VOC plume likely extends under the Axton-Cross building.

- Deep ground water also contains inorganic constituents at elevated levels. Although the source of these constituents may be the concentrated material observed in the lower portion of the former raceway or the vats, the mechanism for vertical migration of inorganic constituents to deep ground water is unknown. Furthermore, transport of inorganic constituents to deep ground water from the former raceway or the vats may not be currently active.

- The presence of elevated concentrations of inorganic constituents in deep ground water adjacent to the creek suggests that the creek channel may provide a migration pathway with the potential for ground water to emerge into Wappingers Creek or the Hudson River down gradient of the Three Star Site. The loading of constituents from ground water seepage to the creek or river may

not be detected in creek and river due to relative flows that reduce the ability to observe these interactions.

- Sporadic detections of constituents above 6 NYCRR Part 375 Soil Cleanup Objectives for Unrestricted Use (considered for the RI and SRI), as well as sporadic detections of constituents above 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use (considered for the FS) in individual samples of soil may be associated with heterogeneous fill material and do not appear to represent source areas. Comparison of data from such samples with samples of soil and ground water collected from nearby locations were used to corroborate this inference.

- Current and future uses of the Three Star Site are expected to be commercial. Potential human exposure pathways are primarily associated with the inhalation of indoor air by workers inside the Axton-Cross Building due to the VOC plume located in the vicinity of it and indoor air of other buildings on the Three Star Site. Additional pathways include potential human contact with surface soil and fugitive dust at the Three Star Site, and surface water and sediment of the Three Star lagoon. The potential for contact with surface soil on the Main Site is limited by the size of the soil area and uses of the Three Star Site. Surface water and sediment of the Three Star lagoon are potential exposure routes for trespassers, site workers, or recreational visitors. Exposure to subsurface materials is a potential pathway for construction workers. Potable water use of ground water is prohibited by the village due to the availability of a public water supply. Other potential uses of the Three Star Site are recreational uses primarily associated with the proximity to the creek, and future residential uses, if they were permitted.

- The Three Star Site contains limited ecological habitat. Most of the Main Site is occupied by buildings, ruins of buildings, and paved parking areas that represent poor quality ecological habitat. However, wildlife that may be present on the Main Site may be exposed to metals, PAHs, and VOCs that were detected in surface soil above ecological screening values. The Three Star lagoon provides limited aquatic habitat on the Three Star Site. Aquatic receptors that visit the Three Star lagoon may be exposed to metals, PAHs, and chlorobenzene concentrations that were detected in surface water or sediment above ecological screening values. The MGP Site consists primarily of vegetated areas with grasses, trees, and shrubs that may be suitable habitat for wildlife. Wildlife that may be present on the MGP Site may be exposed to PAHs and metals concentrations that were detected in surface soil above ecological screening values.

1.3. Summary of Exposure Assessment

The following exposure pathways associated with the Three Star Site represent potentially complete pathways, as presented in the Exposure Pathway Analysis Report (O'Brien & Gere 2007b):

- Current and future dermal contact and incidental ingestion of Three Star Site surface soil for adult, adolescent, and child human receptors

- Current and future dermal contact and incidental ingestion of Three Star Site subsurface soil for adult construction workers

- Current and future inhalation of site-wide outdoor ambient air for adult, adolescent, and child human receptors

- Current (Main Site) and future (Main and MGP sites) inhalation of fugitive dust for adult site workers

- Current (Main Site) inhalation of indoor air for adult site workers

- Future (Main Site and MGP Site) inhalation of indoor air for adult site workers, adult commercial workers, and residents

- Current and future dermal contact and incidental ingestion of lagoon sediment for adult, adolescent, and child human receptors

In addition, the Fish and Wildlife Impact Analysis identified the following potentially complete exposure pathways (O'Brien & Gere 2002):

- Current and future direct contact and incidental ingestion of soil and lagoon surface water and sediment for ecological receptors, and associated food chain exposures.

1.4. Feasibility Study Approach

The FS was completed in two steps. Section 2 presents the development of remedial alternatives consisting of the development of remedial action objectives, identification of general response actions, evaluation of areas and volumes of media, and identification and screening of remedial technologies. Section 3 presents the detailed analysis of alternatives that consists of individual and comparative analyses.

2. Development of Remedial Alternatives

The objective of this phase of the FS was to develop a range of remedial alternatives for the Three Star Site. The process of development of alternatives included the development of remedial action objectives; development of general response actions; identification of volumes or areas of media; identification and screening of remedial technologies and process options; evaluation of remedial technologies and process options; and the assembly of remedial alternatives.

2.1. Development of Remedial Action Objectives

Remedial action objectives are media-specific goals for protecting human health and the environment. These remedial action objectives form the basis of the FS by providing overall goals for site remediation. The remedial action objectives are considered to identify appropriate remedial technologies and formulate alternatives for the Three Star Site, and later to evaluate remedial alternatives.

Remedial action objectives are based on engineering judgement, risk-based information established in the qualitative risk assessments (Section 1.6), and potentially applicable or relevant and appropriate standards, criteria and guidance (SCGs).

2.1.1. Identification of Potential Standards, Criteria and Guidance (SCGs)

There are three types of SCGs, consisting of chemical-, location-, and action-specific SCGs. Chemical-specific SCGs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable concentration of a chemical that may be found in, or discharged to, the ambient environment. Location-specific SCGs set restrictions on activities based on the characteristics of the Three Star Site or immediate environs. Action-specific SCGs set controls or restrictions on particular types of remedial actions once the remedial actions have been identified as part of a remedial alternative. The identification of potential SCGs is documented in Table 1.

2.1.2. Physical and Technical Limits to Remediation

Site conditions limit the alternatives available for remediation of ground water at the Three Star Site. Specifically, the following physical and hydrogeologic conditions limit the technical practicability of ground water remediation technologies at this site:

- The interaction between the surface water and ground water at the Three Star Site complicates remediation options. Wappingers Creek, adjacent to the Three Star Site, interacts with the ground water under the Three Star Site. It is difficult to pump and treat ground water without treating excessive quantities of extracted water. Although a cutoff wall is typically useful to control plume migration, the thickness of the aquifer (50 to 70 ft) and the presence of cobbles would make construction of a wall difficult.

- The high permeability of the soil and fill coupled with the proximity of the surface water body makes it difficult to remove potential sources located below the ground water table because of the extensive pumping required for dewatering.

- The site-wide presence of fill material at the Main Site (the presence of cinders, particularly along the north portion of the Main Site) and MGP Site (cinders prevalent in fill) make PAH and inorganic constituent source removal impracticable and thereby remediation to ground water standards impracticable. Inorganic contamination in shallow ground water at the Main Site correlates to the general presence of surface and subsurface contamination. Furthermore, the fill material itself is likely a contributor to the impacts observed. This fill was historically placed at the Three Star Site to raise the ground surface above the creek level to facilitate construction of the structures at the Three Star Site. It is impractical to remove this fill without demolition of the existing structures and devising significant structures to keep the creek water from flooding the property. As discussed above, extensive pumping would be required to dewater the area to address the removal of fill material.

- For the potential source of chlorinated VOCs in the shallow ground water in the Axton-Cross building area, the potential source material is not completely accessible due to the presence of the currently occupied building over a portion of the primary suspected source area. Although *in situ* technologies can be used to reduce concentrations of source material, they have not demonstrated the ability to remediate sources to meet ground water standards (Fountain 1998; ITRC 2002; and USEPA 2004).

2.1.3. Technical Impracticability Evaluation

USEPA's September 1993 *Guidance for Evaluating the Technical Impracticability of Ground Water Restoration* recognizes that some sites will not attain chemical-specific SCGs and provides for implementation of Technical Impracticability (TI) waivers. Under CERCLA, a "…TI waiver must be invoked when either of the following specific criteria are met:

- Engineering feasibility. The current engineering methods necessary to construct and maintain an alternative that will meet the SCGs cannot reasonably be implemented.

- Reliability. The potential for the alternative to continue to be protective into the future is low, either because the continued reliability of technical and institutional controls is doubtful, or because of inordinate maintenance costs."

Similarly, under NYSDEC environmental regulations (6 NYCRR 375-1.10 (1) (i) a-d) "…conformity with an SCG can be dispensed with if a good cause such as the following exists:

- The proposed action is only part of a complete program that will conform to such standard or criterion [of *[sic]* guidance] upon completion;

- Conformity with such standard or criterion will result in greater risk to the public health or to the environment than alternatives; or

- Conformity with such standard or criterion is technically impracticable from an engineering perspective; or

- The program will maintain a level of performance that is equivalent to that required by the standard or criterion through the use of another method or approach."

At the Three Star Site, a TI waiver is applicable to the NYSDEC Class GA ground water standards due to technical impracticability from an engineering perspective. Engineering options to address ground water contamination typically consist of source removal, plume concentration reduction, or plume migration control. The first two have the potential to reduce concentrations to the ground water standards.

As discussed above, it is technically impracticable at this Site to restore ground water to NYSDEC Class GA ground water standards for inorganic constituents in shallow and deep ground water, and for chlorinated VOCs and PAHs in shallow ground water.

2.1.4. Remedial Action Objectives

Given this information, the following remedial action objectives have been established:

- Minimize to the extent practicable potentially unacceptable human health risks associated with direct contact and incidental ingestion of soil, ground water, and lagoon sediment
- Minimize to the extent practicable potentially unacceptable human health risks associated with current and future inhalation of outdoor ambient air and indoor air
- Mitigate to the extent practicable existing and potential adverse impacts to wildlife resources
- Mitigate to the extent practicable sources of VOCs, PAHs, and inorganic constituents to Wappingers Creek sediment and surface water.

2.2. Identification of General Response Actions

General response actions are media-specific actions that may be combined into alternatives to satisfy the remedial action objectives. General response actions that address the remedial action objectives related to the Three Star Site media include institutional controls, containment, removal, disposal, reuse, and treatment.

2.3. Identification of Areas and Volumes of Media

Site conditions, the nature and extent of contamination, and preliminary remediation goals were taken into consideration to estimate the volumes and areas of media to be addressed by the general response actions. The aerial extent of the areas described below is depicted in Figure 2.

Lower Portion of the Former Raceway. As identified in Section 1.2, one potential source area is the lower portion of the former raceway. The lower portion of the former raceway is characterized by concentrations of inorganic constituents greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use to an approximate depth of 22 ft below ground surface (bgs). The footprint of the lower portion of the former raceway is approximately 31,000 square ft (0.7 acres). The estimated volume is approximately 25,000 cubic yards.

Drywell Area. As identified in Section 1.2, the second potential source area is the drywell area. The drywell area is characterized by elevated VOC concentrations to an approximate depth of 22 ft bgs.

The footprint of the drywell area is approximately 9,500 square ft. The estimated volume is approximately 7,800 cubic yards.

Surface Soil at Concentrations Greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use. The estimated footprint of surface soil exhibiting concentrations of site-related constituents greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use is approximately 3.2 acres on the Main Site and the MGP Site. However, additional sampling is recommended to more accurately delineate the extent of surface soil areas at concentrations greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use. Specifically, additional information is required to fill in the following data gaps:

- the south border of the MGP Site,
- the area between buildings 15/16/17 and the raceway, the area adjacent to the eastern side of the lower half of the lagoon, and
- the area along the creek bank north of the Axton-Cross Building.

Lagoon Sediment. Sediment thickness was measured in the Three Star lagoon. The total volume of sediment continuously under water in the Three Star lagoon is approximately 2,100 cubic yards.

Former Gas Holders. Two former gas holders constructed of brick are present at the MGP Site. Based on the exposed brick structures, an estimated 15 cubic yards of brick would result from demolition of these structures to approximately 2 ft below grade.

Former Metal Plating Vats. Twenty-three vats constructed of poured concrete or concrete block are present in the ruins of Building 16 at the Main Site that contain varying amounts of contaminated liquid and sludge. Based on field measurements taken September 20, 2006, an estimated 62,000 gallons of liquid and 100 cubic yards of sludge (assuming 75% liquid and 25% sludge) would result from decommissioning these structures. However, since these vats are exposed to the environment, the amount of liquid may vary considerably due to precipitation and evaporation. The total capacity of the vats is approximately 245,000 gallons. As part of the vat decommissioning, an estimated 550 cubic yards of asbestos-containing material (AMC) will also be generated.

2.4. Identification and Screening of Remedial Technologies and Process Options

Potentially applicable remedial technology types and process options for each general response action were identified during this step. Process options were screened on the basis of technical implementability. The technical implementability of each identified process option was evaluated with respect to site contaminant information, site physical characteristics, and areas and volumes of affected media.

Descriptions and screening comments for technologies and process options identified for the Three Star Site are presented in Table 2. Process options that were viewed as not implementable for the Three Star Site were not considered further in the FS. Following are descriptions of technologies that were considered potentially implementable for the Three Star Site.

2.4.1. Soil

No Action. The no action general response action must be considered in the FS, as specified in the National Contingency Plan (NCP) (40 CFR Part 300.430).

Institutional Actions. The remedial technology associated with the institutional general response action that was identified for the Three Star Site was access restrictions. Access restrictions identified consist of an environmental easement and fencing. The process options considered potentially applicable are described as follows.

Environmental Easement. With respect to the soil, land use restrictions would be reflected in the property deed. An environmental easement would preclude activities which would potentially expose contaminated materials (and require health and safety precautions) or impair the integrity of a cover without prior review and approval by NYSDEC.

Fencing. A fence would be constructed to provide site security to limit access to the areas and thereby minimize contact, and protect against activities that might adversely affect the integrity of a remedy.

Containment Actions. The remedial technologies that were identified for the Three Star Site related to the containment general response action were capping and erosion control. Capping and erosion control process options that were considered potentially applicable were a vegetated soil cover, low permeability cover, and creek bank stabilization. These process options are described below.

Vegetated Soil Cover. A soil cover consisting of 24 inches of soil with vegetation is one technology that would address the objective of minimizing contact with impacted surface soil. Grading and cover installation would be performed such that drainage is promoted, erosion is minimized, and cover integrity is protected. Routine cover maintenance, consisting of mowing of vegetation and inspections for integrity, would be necessary. An asphalt cover (such as parking lots) and buildings would be functionally equivalent to a vegetated soil cover, and could be used to support alternative land uses.

Low Permeability Cover. A low permeability cover would minimize surface water infiltration, encourage runoff and control erosion, and isolate and contain soil. This would involve the construction of a low permeability layer over the impacted soil. Low permeability covers are typically constructed of clay and soil, or multi-media.

A clay and soil cover would be a three-layer system consisting of an upper topsoil layer for the support of vegetation, a barrier protection layer and a low permeability layer. The low permeability layer would consist of 18 inches of compacted clay with a maximum permeability of 1×10^{-7} cm/sec. The barrier protection layer would consist of 24 inches of soil. The upper layer would consist of 6 inches of topsoil for vegetative growth. The maximum allowable grade of the cap would be 33%, and the minimum grade would be 4%.

The multimedia cap would consist of a 6-inch vegetated topsoil layer, a 24-inch soil barrier protection layer, and a 40 mil geomembrane. The minimum final grade would be 4% and the maximum final grade would be no greater than 33%.

In addition to the low permeability cover, a cover system would include a drainage layer and drainage control structures. The drainage layer would be positioned above the low permeability layer. A layer of filter fabric would be placed between the two layers. Drainage control structures function to protect the cover from surface run-on and run-off.

Routine cover maintenance, consisting of mowing of vegetation and inspections for integrity, would be necessary.

Creek Bank Stabilization. Creek bank stabilization would involve consolidation of material on-site, placement of clean fill, and installation of a combination of vegetative or structural bank stabilization technology such as brush mattresses with a rock toe, or a retaining wall along Wappingers Creek. The technology selected would be highly dependent on the velocity of Wappingers Creek. Creek bank stabilization is necessary to reduce potential erosion of fill material and Site soil into the creek.

Removal Actions. The remedial technology related to the removal general response action that was identified for the Three Star Site was excavation.

Excavation. Excavation would involve the removal of soil using construction equipment such as backhoes and front-end loaders.

Disposal Actions. The remedial technology related to the disposal general response action that was identified for the Three Star Site was off-site commercial landfill. The off-site commercial landfill process option is described below.

Off-site Commercial Landfill. Excavated soil would be transported to a NYSDEC-approved permitted commercial landfill for disposal, provided the soil meets land disposal restrictions (LDRs). Based on sample results, soil excavated at the Three Star Site may be hazardous waste.

Treatment Actions. The remedial technologies related to the treatment of soil at the Three Star Site were physical, chemical, biological, and thermal treatment technologies. The process options considered potentially applicable are both *in situ* and *ex situ*, and are described as follows. The effectiveness of *in situ* technologies may be limited if subsurface soil conditions are heterogeneous.

Soil Flushing. Soil flushing is a physical treatment process that involves the separation/segregation and volumetric reduction of contaminants in soil. The process involves high energy contacting and mixing of excavated soil with an aqueous-based washing solution in a series of mobile washing units. The soil washing process separates fine-grained soil, which constituents are typically concentrated in, from coarser-grained soil. Soil washing would likely be effective for soil containing VOCs and inorganic constituents. The aqueous-based washing solution would require further management.

In situ Soil Venting. In situ soil venting, or soil vapor extraction, involves removal of VOCs in the unsaturated zone. The soil is decontaminated in place by pulling air through the soil. Air removed from the soil by an extraction vent and vacuum blower may be resupplied passively via infiltration from the surface, or through injection vents, either passively or by pumping. The air flow displaces the soil gas, disrupting the equilibrium existing between VOCs that are (1) sorbed on the soil, (2) dissolved in soil-pore water, (3) present in a separate hydrocarbon phase, and (4) present as vapor. This air causes volatilization and subsequent removal of the contaminants in the air stream. Depending on the flow rate, contaminant type and concentration, as well as federal, state, and local environmental regulations, the extracted gas stream may be discharged directly to the atmosphere or sent to an emissions-control device. *In situ* soil venting would likely be an effective treatment technology for site-related VOCs. However, this technology would not treat inorganic constituents.

Dual Phase Extraction. Dual-phase extraction wells remove ground water and soil vapor, and in some cases, product that is present, simultaneously. A pumping test performed at the Three Star Site

would be required to identify appropriate locations to place the extraction wells and evaluate appropriate pumping rates and/or levels to minimize migration of contaminated ground water from the potential source areas and maximize contaminant removal. Dual-phase extraction would likely be an effective treatment technology for site-related VOCs. However, this technology would not treat inorganic constituents.

Solidification/Stabilization. Solidification/stabilization is a process that involves the addition of cement or pozzolanic materials to soil to produce a stable and inert mass. This process renders constituents in the soil less leachable, but does not destroy or reduce the toxicity of contaminants. Encapsulation of contaminants via solidification could be accomplished through the addition of cement or lime, and mixing with soil. Bonding of the contaminant via stabilization could be accomplished through the addition of a modified clay or other binder, and mixing with soil. Solidification/stabilization would likely be effective for site-related inorganic constituents but may not be effective for VOCs. The solidified/stabilized matrix would require further management.

Chemical Dechlorination. Chemical reagents prepared from polyethylene gycol and potassium hydroxide have been demonstrated to dechlorinate chlorinated VOCs through a nucleophilic substitution process. The products of the reaction have been proven to be non-toxic, non-mutagenic, and non-bioaccumulative. In this process, regents are mixed with soil and heated in a reactor. Chemical dechlorination would not be effective for site-related inorganic constituents. Wash water management is required for this treatment. This treatment must be monitored carefully such that sufficient reaction time is allowed. The treated residuals would then be either placed at the Three Star Site or transported for off-site disposal.

In situ Chemical Oxidation. In situ chemical oxidation involves the injection of oxidation agents such as ozone or Fenton's Reagent (an iron catalyst combined with hydrogen peroxide) to destroy VOCs in the subsurface. These oxidants are effective for the VOCs and selected site-related inorganic constituents present at the Three Star Site.

Ex situ Biological Treatment. Ex situ biological treatment is a process in which excavated contaminated material is treated biologically in a reactor, composting system, or landfarming process. In this process, naturally occurring microorganisms are stimulated to degrade organic contaminants. Nutrients, oxygen, and co-metabolites are injected to enhance the process. This innovative technology allows the microorganisms to reduce the contaminant into a less toxic constituent. *Ex situ* biological treatment would likely be effective for selected VOCs. Inorganic constituents, however, would not be treated.

In situ Biological Treatment. In situ biological treatment involves the degradation of soil contaminants in place by naturally occurring microorganisms. *In situ* biological treatment of surface soil at the Three Star Site could consist of a modified landfarming process in which nutrients and/or enhanced naturally occurring microbial populations are applied to surface soil to enhance biodegradation. Tilling of surface soil could also be performed to enhance oxygen availability to microbes. *In situ* biological treatment would require a treatability study to evaluate its effectiveness to treat site related VOCs. Inorganic constituents would likely not be treated by *in situ* biological treatment.

Thermal Desorption. Thermal desorption is an *ex situ* process that uses either direct or indirect heat exchange to volatilize organic contaminants from soil. Thermal desorption is a physical separation (volume reduction) process and not an organic decomposition (incineration) process. Operating

temperatures are in the 200 to 1000 degrees Fahrenheit range. The relatively low operating temperatures tend to make thermal desorption less energy intensive and thus, less costly, than incineration. The primary technical factors affecting thermal desorption performance are the contaminant concentration, the maximum soil temperature achieved, total soil residence time, and soil moisture content. The volatilized contaminants from the thermal desorption process are typically directed to a secondary system for incineration (*i.e.*, an afterburner), adsorption on activated carbon, or recovery by condensation. If the volatilized contaminants are incinerated, an air emissions control system is employed to remove acid gases and particulates in the exhaust gas. Thermal desorption would likely treat VOCs. Inorganic constituents, however, would not be treated by this technology.

Incineration. Incineration is a thermal destruction treatment method which uses high temperature oxidation under controlled conditions to combust organic substances into products that generally include carbon dioxide (CO_2), water vapor, sulfur dioxide (SO_2), nitrogen oxides (NO_x), hydrochloric acid (HCl), and ash. Products of thermal destruction/incineration such as particulates, SO_2, NO_x, HC1, and products of incomplete combustion require air pollution control equipment to prevent release of undesirable species into the atmosphere. Ash disposal is also required. Incineration methods can be used to effectively destroy VOCs in soil. Inorganic constituents would be contained in the ash, which may require stabilization prior to disposal.

In situ Vitrification. In situ vitrification (ISV) is a thermal process that transforms the chemical and physical characteristics of soil in place such that it becomes a glassy solid matrix, which is resistant to leaching. Soil reaction time is allowed. The treated residuals could then be either placed at the Three Star Site or transported for off-site disposal. Dewatering activities must be employed for effective treatment of soil with a high moisture content.

2.4.2. Ground Water

No Action. The no action general response action must be considered in the FS, as specified in the NCP (40 CFR Part 300.430).

Institutional Actions. The remedial technologies associated with the institutional general response action that was identified for the Three Star Site were monitoring and access restrictions. Access restrictions identified consist of ground water use restrictions. Ground water monitoring was identified as the monitoring process option. The process options considered potentially applicable are described as follows.

Ground Water Monitoring. Ground water monitoring would involve periodic sampling and analysis of ground water at the Three Star Site to provide a means to detect changes in concentrations of VOCs and inorganic constituents in the ground water.

Ground Water Use Restrictions. Currently, ground water at Wappingers Falls is not permitted for potable use. Ground water use restrictions would include an environmental easement that would preclude the use of ground water at the Three Star Site as a potable source of water. In addition, an environmental easement would preclude the use of ground water from the Site without prior review and approval by NYSDEC.

Containment Actions. The remedial technology that was identified for the Three Star Site related to the containment general response action for ground water was a vertical barrier. The vertical barrier process options considered applicable were a slurry wall and sheet piles.

Slurry Wall. Slurry wall(s) can intercept ground water, thus minimizing migration off-site. A trench is excavated with construction equipment (*i.e.,* backhoe) from the ground surface to the hard till or bedrock layer. A low permeability wall, constructed of cement/bentonite or soil/bentonite, replaces the native soil from the excavated trench. Ground water collection is necessary to maintain ground water levels within the slurry wall.

Sheet Piles. Sheet piles could be used to construct walls to intercept ground water, thus minimizing migration off-site. The sheet piles would be installed from the ground surface to the hard till or bedrock layer. Ground water collection is necessary to maintain ground water levels within the sheet piles.

Collection Actions. The remedial technology that was identified for the Three Star Site related to the collection general response action for ground water was ground water extraction. The ground water extraction process options considered applicable were recovery wells and interceptor trenches.

Recovery Wells. As part of the potential source area removal, contaminated ground water would be collected by pumping from recovery wells. A pumping test performed on the Three Star Site would be required to identify appropriate locations to place the extraction wells and evaluate appropriate pumping rates and/or levels to minimize migration of contaminated ground water from the potential source areas.

Interceptor Trenches. Interceptor trenches are buried conduits that would intercept and/or collect ground water at the Three Star Site. Interceptor trenches are installed perpendicular to ground water flow and generally consist of pipe drains, gravel, backfill material and low permeability membranes on the downgradient side. Excavation of an interceptor trench requires the use of construction equipment (*i.e.*, front end loader or backhoe). Temporary sheet piling and dewatering would likely be required.

In situ Treatment Actions. The remedial technologies that were identified for the Three Star Site related to *in situ* treatment general response action for ground water were physical and biological. The *in situ* ground water treatment process options considered applicable were air sparging and bioremediation.

Air Sparging. Air sparging is an *in situ* technology used primarily to treat VOCs in the saturated zone. Air sparging, when used in conjunction with an *in situ* air stripping system, enables ground water to be stripped of VOCs. Contaminant-free air is introduced into the affected aquifer system in the form of minute bubbles utilizing microporous bubblers (or sparge points). VOCs below the water table are removed by volatilization, and often, biodegradation, as the air percolates through the water column and into the unsaturated zone. The movement of the air bubbles tends to facilitate the transfer of VOCs into soil pore spaces in the unsaturated zone where they can be removed by an *in situ* air stripping system. Air sparging is not effective for treating inorganic constituents.

Bioremediation. Natural microbial degradation of organic contaminants *in situ* can be enhanced through injection of necessary nutrients and/or cometabolites to the subsurface. Injection wells can be used to supply the needed nutrients and/or cometabolites to the indigenous microbial organisms in the subsurface which are capable of destroying the contaminants. A treatability study would likely be necessary to evaluate the effectiveness of biological treatment on site-related VOCs. Biological treatment is not effective in treating inorganic constituents.

Ex situ Treatment Actions. The remedial technologies that were identified for the Three Star Site related to *ex situ* treatment general response action for ground water were physical, chemical and biological. The ground water extraction process options considered applicable are described below.

Air Stripping. Air stripping involves the contact of ground water with air in a countercurrent packed column or tray or bulk reactor to transfer volatile contaminants from the ground water to the air. Air stripping would be effective to treat site-related VOCs. Inorganic constituents, however, are often oxidized and foul air strippers; hence organics are generally pretreated. Depending on the resulting characteristics of the discharging air stream, air pollution controls may be required.

Carbon Adsorption. Activated carbon can adsorb organic contaminants from ground water onto its surfaces during contact. Carbon adsorption would likely be an effective treatment for site-related VOCs. Inorganic constituents, however, would not be treated effectively. The carbon must be periodically replaced, regenerated, treated and/or disposed. Regeneration may be accomplished at the Three Star Site or off-site at a permitted commercial hazardous waste carbon regeneration facility. Carbon disposal would be off-site at a permitted commercial hazardous waste facility.

Adsorptive Resins. Commercial resins are available which can adsorb organic contaminants from the ground water during contact. Adsorptive resins would likely be an effective treatment for site-related VOCs. Inorganic constituents, however, would not be treated effectively. Such resins are typically regenerated on the Three Star Site on a periodic basis.

Settling. Settling would involve pumping of ground water into a holding tank to settle solids, if present, in the extracted ground water. Separation of solids from ground water improves the effectiveness of subsequent treatment. Solids would be transported off-site for treatment and/or disposal at a permitted commercial hazardous waste facility.

Filtration. A trickling filter is a biological treatment technology which involves passing water over a bed of media which supports microbial film growth. The filter bed typically consists of media with large surface area to sustain an environment suitable for biological growth. Contaminated water is percolated through the media and comes in contact with the microbial film before discharge. A treatability study would likely be necessary to evaluate the effectiveness of biological treatment on site-related VOCs. Biological treatment is not effective in treating inorganic constituents. Sludge management would be required.

Chemical Oxidation. Chemical oxidation involves the addition of oxidation agents such as hydrogen peroxide or ozone to the ground water in the presence of ultraviolet light to oxidize organic contaminants to non-toxic byproducts. Chemical oxidation would likely be an effective treatment for site-related VOCs. Site-related inorganic constituents, however, would not be treated effectively. Chemical oxidation is typically performed in a closed reactor system.

Precipitation. Precipitation is a chemical treatment technology which alters the pH of ground water in order to separate contaminants from the water particles. This technology would effectively remove site-related inorganic constituents from the ground water stream. Site-related VOCs would not be treated effectively. The precipitate residue would require further management.

Ion Exchange. Ion exchange is a chemical treatment technology for ground water. Contaminants, particularly heavy metals, would be chemically altered on a molecular level into non-hazardous material. Ion exchange would not treat site-related VOCs effectively.

Biological Reactor. A biological reactor could be used to enhance conditions for co-metabolic degradation of chlorinated organics. Nutrients, cometabolites, and aeration would be provided as necessary to optimize degradation. Sludge management would be required.

2.4.3. Lagoon Sediment

No Action. The no action general response action must be considered in the FS, as specified in the NCP (40 CFR Part 300.430).

Containment Actions. Filling in the Three Star lagoon with sand and other granular backfill was identified as a remedial action for the containment of sediment. The process option considered potentially applicable is described as follows.

Containment. Sediment would be covered with sand and granular backfill using a backhoe and a culvert would be installed along the former lagoon to convey storm water from the Three Star Site to Wappingers Creek.

Removal Actions. Excavation was identified as the remedial technology for the removal of sediment at the Three Star Site. The process option considered potentially applicable is described as follows.

Excavation. Sediments would be removed in the dry following lagoon drainage using construction equipment such as backhoe excavators.

Treatment Actions. Physical treatment was identified as the remedial technology for the treatment of sediment at the Three Star Site. The process option considered potentially applicable is described as follows.

Stabilization. Solidification/stabilization is a process that involves the addition of cement or pozzolanic materials to the sediment to produce a solid, stable and inert mass. This process renders constituents in the sediment less leachable, but does not destroy or reduce the toxicity of contaminants. Sediment stabilization can be accomplished *in situ* or *ex situ*. Stabilized mass would require additional management.

Disposal Actions. Off-site commercial landfill was identified as the remedial technology for the disposal of sediment at the Three Star Site. The off-site commercial landfill process option is described below.

Off-site Commercial Landfill. Excavated sediment would be transported to a NYSDEC-approved permitted commercial landfill for disposal, provided the soil meets LDRs. Excavated sediment may require dewatering, depending on the excavation method. Testing of sediment from the Three Star lagoon indicated that the sediment is non-hazardous. Disposal of sediment in a non-hazardous waste landfill is anticipated.

2.4.4. Soil Vapor

Control Actions. Vapor control was identified as the remedial technology for control actions for soil vapor in the vicinity of the Axton-Cross Building. The process option considered potentially applicable is described as follows.

Pumping/Ventilation. Pumping/ventilation would consist of the installation of suction points and ventilation fans to mitigate sub-slab and indoor vapor.

2.5. Evaluation of Remedial Technologies

The process options remaining after the initial screening were evaluated further according to the criteria of effectiveness, implementability, and cost. The effectiveness criterion included the evaluation of:

- potential effectiveness of the process options in meeting remedial objectives and handling the estimated volumes or areas of media;
- potential effects on human health and the environment during construction and implementation;
- reliability of the process options for site contaminants and conditions.

Technical and institutional aspects of implementing the process options were assessed for the implementability criterion.

The capital and operation and maintenance (O&M) costs of each process option were evaluated as to whether they were high, medium, or low relative to the other process options of the same technology type.

Based on the evaluation, the more favorable process options of each technology type were chosen as representative process options. The selection of representative process options simplifies the assembly and evaluation of alternatives, but does not eliminate other process options. The process option actually used to implement remediation may not be selected until the remedial design phase. A summary of the evaluation of process options and selected representative process options is presented in Table 3.

2.6. Assembly of Remedial Alternatives

Four remedial alternatives were developed for the Three Star Site by assembling the general response actions and applying combinations of the process options chosen to represent the various technology types. A summary of the alternatives and their components is presented in Table 4. A description of each alternative is included in the following subsections.

2.6.1. Common Components of Alternatives

Ground water monitoring and a Site Management Plan are common elements to each of the active alternatives being evaluated for the Three Star Site. Vapor control, erosion control, removal and disposal of surface debris, demolition and off site disposal of the former gas holders, decommissioning of the former metal holding vats, and soil containment are common elements of Alternatives 3 and 4. A description of these elements is included below.

Ground Water Monitoring. Ground water monitoring would be implemented to track concentrations of VOCs and inorganic constituents in ground water and would be instrumental in detecting changes in concentrations. Ground water monitoring would consist of quarterly sampling of wells with analysis of VOCs and inorganic constituents.

Site Management Plan. Since impacted soil would remain onsite, each alternative would include periodic site management reviews as part of a Site Management Plan. The periodic reviews would focus on evaluating the Three Star Site with regard to the continuing protection of human health and the environment as provided by information such as ground water monitoring results and documentation of field inspections.

In addition to the elements described above, vapor control, erosion control, removal and off-site disposal of surface debris, demolition and off-site disposal of the former gas holders, decommissioning of the vats, and removal of sediment from the Three Star lagoon are common components of Alternatives 3 and 4. A description of these elements is provided below.

Vapor Control. Due to the presence of a chlorinated VOC plume under and in the vicinity of the currently occupied Former Axton-Cross Building, a vapor control system has been included as a component of each active remedial alternative. Prior to installation of such a vapor control system, an assessment of sub-slab and indoor air conditions would be performed. Following this, a vapor control system would be installed, if warranted. The vapor control system would consist of ventilation fans and suction points aimed at depressurizing sub-slab vapor conditions.

Erosion Control. Due to the presence of cinder-containing site soil along the banks of Wappingers Creek, erosion control measures are included in each active remedial alternative. Presently, a portion of the bank is protected from erosion by a retaining wall. The balance of the bank (approximately 850 ft in length) would be stabilized to provide erosion control from Wappingers Creek, which has documented mean velocities over 6 feet per second (fps) (USGS 2007) dating back to 1973 with two particularly high peak flow events in 1939 and 1955 where velocities were not recorded that had peak flows of 15,900 and 18,600 cubic feet per second. The average mean velocity estimated from the available mean velocity from the United States Geological Survey (USGS), which is measured upstream of Wappingers Lake by USGS, is approximately 2 fps. These velocities were considered in selection of the bank stabilization technology.

For cost estimation purposes it was assumed that, a 850 ft bank section of Wappingers Creek would be covered in an approximately 2.5-ft thick layer of embankment material supplemented with a brush mattress with rock toe and 6 inches of topsoil with selective live stake/whip placement and plantings to prevent erosion. Prior to the placement of the embankment material, and brush mattress sections with rock toe and topsoil, a silt curtain would be installed within the creek.The creek bank (approximately 13 feet in length to the creek bed with 3 feet submerged) would then be excavated to remove a 3-ft thick layer of cinder-containing site soil. The excavated site soil would be disposed off-site. A 2.5ft layer of embankment material would be placed over the exposedexcavated site soil , with the exception of a three foot wide section at the toe of the slope that would only receive 1.5 ft of embankment material. Following placement of the embankment material, a 1.5 ft thick layer of rip-rap, underlain with a geotextile, would be placed in a 3 foot wide section at the toe of the slope to provide protection from wave action, undercutting, and scouring of the embankment material, brush mattress, and topsoil. Above the rock toe, brush mattress sections would be placed on the remaining 10-ft section of the bank from the bottom of the slope up. The brush mattress sections would be filled with a minimum of 6 inches of topsoil. The brush mattress sections would consist of live brush that would act as an immediate sediment trap and mature into a shrubby protective barrier for the bank. Live stakes/whips and other native wetland and riparian plants (tolerant to salinity due to tidal influence of Wappingers Creek) would be planted within the brush mattress sections at varying locations to provide vegetative diversity for restoration of the creek bank. A monitoring plan would

be developed outlining inspection and stabilization/restoration success criteria and invasive species management for the stabilized and restored area of the creek bank.

Removal and Disposal of Surface Debris. Miscellaneous debris is present on the ground surface at the MGP Site. Removal of this debris is included as a component in each of the active remedial alternatives. Removal would consist of gathering the material and consolidating it for off-site disposal. It is anticipated that this debris would be disposed in a Construction & Demolition (C&D) debris landfill.

Demolition and Off-site Disposal of the Former Gas Holders. The ruins of two former gas holders are present on the MGP Site consisting of two circular brick structures that are approximately 40 ft in diameter and extend approximately 8-ft above ground surface. Removal of these former gas holders is anticipated to be completed using an excavator. The brick debris would be disposed in a C&D landfill.

Decommissioning of Former Metal Plating Vats. Twenty-three vats are present within the footprint of the original Building 16, which was burned during the fire that occurred at the Three Star Site in May 2004. The vats consist of poured concrete or concrete block structures extending approximately 9 ft deep, with approximately 7 ft below existing grade and 2 ft above grade, each having an approximate footprint of 5 ft by 38 ft. As a result of the fire, a brick wall associated with Building 16 would require stabilization. The debris left from the fire primarily consists of bricks and wood timbers, but it also contains other miscellaneous debris such as roof shingles, tar paper, mortar, and metal. Roof shingles and tar paper present across the Three Star Site, including within vats, are presumed to be non-friable ACM. It is anticipated that the debris will be containerized, transported, and disposed in a C&D debris landfill. Removal of the liquid would be performed with a vac truck. Sludge would be removed from the vats using a specialty excavator (*e.g*., long stick excavator). Based on existing data, it is anticipated that the liquid and sludge would be disposed of off-site as hazardous waste and non-hazardous waste at a NYSDEC-approved landfill. Following liquid and sludge removal, the vats will have non-friable ACM mastic spots that can be removed and then the vats can be pressure washed. Following pressure washing, the soil under the vats and the vat concrete would be investigated to identify if metals detected in the vats have impacted the subsurface soil or vat concrete. For this FS, it was assumed that the soil under the vats has not been impacted to an extent that would require excavation and removal. Following the subsurface investigation, the vat walls will be demolished to grade and the vats will be filled with sand and capped with concrete.

Soil Containment. A vegetated soil cover would be used to contain surface soil areas with concentrations of constituents greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use. The soil cover would consist of a 24-inch thick soil vegetated layer. Based on the concentrations detected in soil samples collected across the Three Star Site, it is anticipated that the vegetated soil cover would cover approximately 3.2 acres of the Three Star Site, including areas of the MGP Site and Main Site. However, additional sampling is recommended to more accurately delineate the extent of surface soil areas at concentrations greater than 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use. Specifically, additional information is required to fill in data gaps for the south border of the MGP Site, the area between buildings 15/16/17 and the raceway, the area adjacent to the eastern side of the lower half of the Three Star lagoon, and the area along the creek bank north of the Axton-Cross Building.

As indicated on the Three Star Site map (Figure 2), surface soil sample SS-4 was the only isolated location exhibiting concentrations above 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives

for Commercial Use that would not be included in the soil cover area. This location would not be included in the soil cover area because it only slightly exceeded 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use for Cadmium (the Cadmium concentration was 11 mg/kg compared to the Part 375 screening value of 9.3 mg/kg) and because the neighboring surface soil sample location SS-3 did not exceed the screening values. Presently, SS-4 is isolated from surface contact by debris associated with the fire.

Prior to installation of the vegetated soil cover, the ground surface would be graded and surface debris would be removed. The vegetated soil cover would be graded to promote drainage and minimize erosion of the cover. The vegetated soil cover would be routinely inspected to verify integrity.

Because the MGP Site is currently a heavily vegetated area with value as a natural resource, the soil cover would incorporate a 100-ft wide buffer area along Wappingers Creek on the MGP Site. This portion of the soil cover would be constructed by excavating the soil to a depth of approximately 6.5 ft.The excavated cinder-containing fill material would be disposed off site. The excavation would be backfilled with clean fill. The ground surface would be restored using appropriate native plantings.

2.6.2. Alternative 1

Alternative 1 is the no further action alternative. The no further action alternative is required by the NCP and serves as a benchmark for the evaluation of action alternatives. This alternative provides for an assessment of the environmental conditions if no remedial actions are implemented.

2.6.3. Alternative 2

Alternative 2 is the institutional and engineering controls, and ground water monitoring alternative. Alternative 2 consists of ground water monitoring, an environmental easement, and a Site Management Plan, as described in Section 2.6.1. In addition, this alternative incorporates access restrictions, as described below.

Access Restrictions. Fencing would be installed around the perimeter of the Three Star Site to restrict access. An environmental easement would consist of land use restrictions and ground water use restrictions. Land use restrictions would preclude the conduct of activities that would potentially disturb or expose contaminated materials or impair the integrity of a cover over contaminated materials without prior notification and approval from the NYSDEC. Ground water use restrictions would preclude the use of ground water at the Three Star Site without prior notification and approval from the NYSDEC.

2.6.4. Alternative 3

Alternative 3 is the on-site treatment and containment alternative. Alternative 3 consists of the following passive remedial actions: ground water monitoring, an environmental easement, and a Site Management Plan. Alternative 3 also consists of the following active remedial actions that are common to remedial alternatives 3 and 4: vapor control, erosion control, removal and off-site disposal of surface debris, demolition and off-site disposal of the former gas holders, decommissioning of the vats, and soil containment as described in Section 2.6.1. In addition, this alternative considers on-site treatment and containment of soil and the containment of lagoon sediment as active remedial actions, as described separately below.

On-site treatment and containment of soil
The on-site treatment and containment of soil would consist of treatment of soil from the lower portion of the former raceway and the drywell area and containment of soil in the MGP Site and areas of the Main Site. These elements are described below. Figure 3 depicts the approximate limits of the common and alternative-specific elements for this alternative.

Treatment of Potential Source Areas. Soil treatment in Alternative 3 would consist of treatment of the lower portion of the former raceway and the former drywell area:

- An estimated 25,000 cubic yards of soil in the lower portion of the former raceway would be treated *in situ* for metals under Alternative 3 by stabilization through the addition of a stabilizing agent, such as a sulfide-based reagent, into the subsurface.

- An estimated 7,800 cubic yards of soil from the former drywell area would be treated *in situ* for VOCs under Alternative 3 by chemical oxidation through the injection of ozone into the subsurface.

On-site Containment of Lagoon Sediment /Decommissioning of Lagoon
Lagoon sediment would be left in place and contained using granular material stabilized with a geotextile layer. An estimated 700 cubic yards of sand will be used to mix with the lagoon sediment to increase material stability for placement of geotextile and backfill. Approximately 9,000 square feet of lagoon area would be capped using geotextile, various depths of backfill, and 6-inches of topsoil (from sediment surface to new cap surface). A 500 foot long, 24-inch diameter culvert would be installed along the eastern edge of the former lagoon to convey stormwater to the Creek from the former raceway. A swale would be established along the centerline of the capped area to convey storm water from the cap area to the creek. The entire cap area will be re-vegetated with grasses and the existing inlet culvert from the raceway would be rehabilitated and connected to the new piping.

2.6.5. Alternative 4

Alternative 4 is the limited excavation and off-site disposal, and containment alternative. Alternative 4 consists of the following passive remedial actions: ground water monitoring, an environmental easement, and a Site Management Plan. Alternative 4 also consists of the following active remedial actions that are common to each active remedial alternative: vapor control, erosion control, removal and off-site disposal of surface debris, demolition and off-site disposal of the former gas holders, decommissioning of the vats, and soil containment as described in Section 2.6.1.

In addition to the common elements listed above, Alternative 4 consists of sediment removal from the Three Star lagoon, limited soil excavation, and off-site disposal. These elements are described below. Figure 4 depicts the approximate limits of the common and alternative-specific elements for this alternative.

Sediment Removal and Restoration of the Lagoon. The Three Star lagoon contains sediment with site-related constituents that varies from approximately 2 to 11 ft in thickness and has an estimated total volume of approximately 2,100 cubic yards. The sediment has the consistency of pudding. Removal of the sediment would be accomplished using excavators to apply and mix portland cement to solidify sediment material *in situ* then remove the solidified material. The existing lagoon would be pumped dry, and well points would be installed to draw down the water table locally such that excavation work can be performed "in the dry" to the target depths which are below the observed

water table. Solidification and excavation would then proceed incrementally across the lagoon to remove soft sediments unsuitable for support of excavation equipment. Following sediment removal, the sediments would be staged for dewatering as necessary. Following dewatering, the sediment would be characterized and transported off-site for disposal at a NYSDEC-approved landfill.

Restoration of the Three Star lagoon would consist of replacing the contaminated sediment with clean backfill to establish a maximum water depth of approximately 8 ft at along the midsection of the lagoon. Along the shorelines, clean sand would be added to a 10-ft width to develop a shallow water maximum depth of approximately 2 ft at average conditions next to the shore sloping toward the midsection. The outlet to the Three Star lagoon would be maintained at the current elevation which would allow discharge during storm events, but would not be connected to Wappingers Creek at low water conditions. Native wetland and riparian plants would be planted along soil banks and in the shallow area along the shorelines. A monitoring plan would be developed for the Three Star lagoon that outlines success criteria and invasive species management.

Subsurface Soil Excavation and Off-Site Disposal. Soil excavation in Alternative 4 would consist of excavation of the lower portion of the former raceway and the former drywell area:

- Based on analytical results, it is anticipated that excavation of the soil from the lower portion of the former raceway would extend to approximately 22 ft below grade and would encompass an approximately 0.7 acre area. An estimated 25,000 cubic yards of soil from the lower portion of former raceway would be removed under Alternative 4.

- Based on analytical results, it is anticipated that excavation of the former drywell area soil would extend to approximately 22 ft below grade and would encompass an approximately 0.2 acre area. An estimated 7,800 cubic yards of soil from the drywell area would be removed under Alternative 4.

Excavation would be accomplished using excavators. Due to the depth of the excavations, it is anticipated that shoring would be necessary. In addition, due to the presence of ground water at depths of less than 24 ft, it is anticipated that dewatering would be necessary during excavation. In order to minimize excessive dewatering, it was assumed that shoring would extend to bedrock. Based on concentrations of constituents present in ground water collected from the Three Star Site, it is anticipated that the water generated from dewatering activities would require treatment prior to discharge to Wappingers Creek. Following characterization, excavated soil would be transported off-site for disposal in a NYSDEC-approved landfill.

3. Detailed Analysis of Alternatives

This section documents the detailed evaluation of the alternatives developed for the Three Star Site. The objective of the detailed analysis of alternatives was to analyze and present sufficient information to allow the alternatives to be compared and a remedy selected. The analysis consisted of an individual assessment of each alternative with respect to nine evaluation criteria that encompass statutory requirements and overall feasibility and acceptability. The detailed evaluation of alternatives also included a comparative evaluation designed to consider the relative performance of the alternatives and identify major trade-offs among them. The eight evaluation criteria are listed below:

- Overall protectiveness of human health and the environment
- Compliance with SCGs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance.

The preamble to the NCP (Federal Register 1990) indicates that, during remedy selection, these eight criteria should be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The two threshold criteria, overall protection of human health and the environment, and compliance with SCGs, must be satisfied in order for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implemetability; and cost are primary balancing criteria that are used to balance the trade-offs between alternatives. The modifying criterion is community acceptance, which is formally considered after public comment is received on the Proposed Remedial Action Plan. The NYSDEC Environmental Remedation Programs 6 NYCRR Part 375 (NYSDEC 2006) and NYSDEC's Department of Environmental Restoration (DER)-10 draft guidance entitled *Technical Guidance or Site Investigation and Remediation* were also considered during this evaluation (NYSDEC 2002).

3.1. Individual Analysis of Alternatives

In the individual analysis of alternatives, each of the remedial alternatives was evaluated with respect to the evaluation criteria. A summary of the individual analysis of alternatives is presented in Table 4.

3.1.1. Overall Protection of Human Health and the Environment

The analysis of each alternative with respect to this criterion provides an evaluation of whether the alternative achieves and maintains adequate protection and a description of how site risks are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.2. Compliance with SCGs
Potential SCGs for the Three Star Site are presented in Table 1 and the individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.3. Long-Term Effectiveness and Permanence
This criterion assesses the magnitude of residual risk remaining from untreated material or treatment residuals at the Three Star Site. The adequacy and reliability of controls used to manage untreated material or treatment residuals are also evaluated. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.4. Reduction of Toxicity, Mobility, or Volume through Treatment
The evaluation of this criterion addressed the expected performance of treatment technologies in each alternative. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.5. Short-Term Effectiveness
The evaluation of short-term effectiveness addressed the protection of workers and the community during construction and implementation of each alternative, and potential environmental effects resulting from implementation of each alternative. The time required to achieve remedial objectives was also evaluated under this criterion. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.6. Implementability
The analysis of implementability involved an assessment of the ability to construct and operate the technologies, the reliability of the technologies, the ease of undertaking additional remedial action, the ability to monitor the effectiveness of each remedy, and the ability to obtain necessary approvals from other agencies. Additionally, the availability of services, capacities, equipment, materials, and specialists necessary for implementation of the alternative was also assessed. The individual analysis of each remedial alternative with respect to this criterion is presented in Table 5.

3.1.7. Cost
For the cost analysis, cost estimates were prepared for each alternative based on vendor information and quotations, cost estimating guides, and experience. Cost estimates were prepared for the purpose of alternative comparison and were based on information currently known about the study area. The cost estimates include capital costs, annual operation and maintenance costs, and present worth cost. The present worth cost for these alternatives was calculated for the expected duration of the remedy at a 7% discount rate. The individual cost estimates for the remedial alternatives are included in Tables 6 through 9.

3.1.8. Community Acceptance
Community acceptance will be addressed during the preferred alternative public comment period prior to the Record of Decision (ROD).

3.2. Comparative Analysis of Alternatives

In the comparative analysis of alternatives, the performance of each alternative relative to the others was evaluated for each criterion.

As discussed in the following subsections, Alternatives 3 and 4 satisfy the threshold criteria by providing protection to human health and the environment and by complying with the identified SCGs; therefore, each active alternative is eligible for selection as the final remedy. The primary balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implemetability; and cost) were used for balance in the comparative evaluation of alternatives.

3.2.1. Overall Protection of Human Health and the Environment

Each alternative would be protective of human health with respect to potential soil and ground water exposure pathways. Alternatives 3 and 4 would provide for protection of the environment through isolation of soil and sediment, and erosion control from ecological receptors. None of the alternatives would be expected to restore ground water to NYS Class GA ground water standards. As described in Section 2.1.3, a waiver of the NYS Class GA ground water standards may be applicable due to technical impracticability for this Site.

3.2.2. Compliance with SCGs

None of the alternatives would likely attain the NYS Class GA ground water standards. As described in Section 2.1.2, it is technically impracticable to achieve ground water standards at this Site. As described in Section 2.1.3, a waiver of the NYS Class GA ground water standards may be applicable due to technical impracticability for this Site.

Alternatives 3 and 4 would achieve 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use for portions of the Three Star Site. Soil present above 6 NYCRR Part 375 Restricted Use Soil Cleanup Objectives for Commercial Use on other portions of the Three Star Site would be addressed through risk management (containment). Each of the alternatives would be implemented in such a manner that location and action-specific SCGs would be met.

Alternatives 3 and 4 would address the NYS Sediment Criteria through containment or removal of the sediments.

3.2.3. Long-Term Effectiveness and Permanence

For each of the alternatives residual risk to human health would be adequately managed. Residual risk to the potential ecological receptors would be adequately managed in alternatives 3 and 4. Controls to be implemented as part of each of the alternatives are considered adequate and reliable controls for Site hazards.

3.2.4. Reduction of Toxicity, Mobility, or Volume though Treatment

Alternative 3 would include containment of the impacted volume of lagoon sediment and would provide a reduction in mobility for constituents present in soil through irreversible treatment. Alternative 4 would include the removal of the impacted volume of sediment in the lagoon and the reduction of the volume of impacted soil would be accomplished through soil removal.

3.2.5. Short-Term Effectiveness

Each of the alternatives would be implemented in such a manner that adverse impacts to the community, workers, and the environment would be minimized. With the exception of Alternatives 1 and 2, each alternative would achieve the remedial action objectives upon implementation. Alternatives 1 and 2 would not achieve protectiveness of ecological receptors.

3.2.6. Implementability

Each of the alternatives is readily constructable, operable, and consists of reliable technologies. For each of the alternatives, additional remedial actions, if necessary, would be readily implementable. Each remedy can be effectively monitored for effectiveness. Coordination with other agencies would be necessary to implement each alternative.

3.2.7. Cost

Alternative 1 is the least cost alternative, followed by Alternatives 2, 3, and 4, respectively.

3.2.8. Community Acceptance

Community acceptance will be addressed during the preferred alternative public comment period prior to the ROD.

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Table 1. Evaluation of potential SCGs

Medium/Location/ Action	Citation	Requirements	Comments	SCG	Alternative
Potential chemical-specific SCGs					
Ground water	6 NYCRR 703 - Class GA ground water quality standards	Fresh ground waters of the state must attain Class GA standards if intended for potable use or discharge to surface waters. There are no specific standards for other ground water classifications.	Potentially applicable to site ground water.	Yes	1,2, 3, & 4
Surface water	6 NYCRR 703 - Class C surface water standards	Outlines surface water quality standards and guidance values for Class C surface waters.	Potentially applicable to site surface water.	Yes	1,2, 3, & 4
Soil	6 NYCRR Part 375 commercial values. HWR-94-4046 - Recommended soil cleanup objectives	Provides recommended soil cleanup objectives for commerical properties.	Potentially applicable to site soil.	Yes	1,2, 3, & 4
Sediment	NYSDEC Technical Guidance for Screening Contaminated Sediments (1999)	Provides recommended sediment screening criteria for evaluation of potential impacts to human and fish and wildlife receptors recognizing site-specific limitations.	Potentially applicable to site sediments.	Yes	1,2, 3, & 4
Potential location-specific SCGs					
Wetlands	6 NYCRR 663 - Freshwater wetland permit requirements	Actions occurring in a designated freshwater wetland (within 100 ft) must be approved by NYSDEC or its designee. Activities occurring adjacent to freshwater wetlands must: be compatible with preservation, protection, and conservation of wetlands and benefits; result in no more than insubstantial degradation to or loss of any part of the wetland; and be compatible with public health and welfare.	Not applicable or relevant and appropriate since the Site is not within 100 ft of a NYS designated freshwater wetland, as shown on available mapping provided in the FWIA for the Site (O'Brien & Gere 2002).	No	None
	Executive Order 11990 - Protection of Wetlands	Activities occurring in wetlands must avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands. The procedures also require USEPA to avoid direct or indirect support of new construction in wetlands wherever there are practicable alternatives or minimize potential harm to wetlands when there are no practicable alternatives.	Potentially applicable based on available mapping which shows National Wetland Inventory (NWI) habitat within 100 ft of the Site (O'Brien & Gere 2002). However, delineation of Federal Wetlands has not been conducted at this site.	Yes	3 & 4
100-year flood plain	6 NYCRR 373-2.2 - Location standards for hazardous waste treatment, storage, and disposal facilities -100-yr floodplain	Hazardous waste treatment, storage, or disposal facilities located in a 100-yr floodplain must be designed, constructed, operated and maintained to prevent washout of hazardous waste during a 100-yr flood.	Not applicable or relevant and appropriate since not treating, storing, or disposing hazardous waste at the Site.	No	None
	Executive Order 11988 - Floodplain Management	EPA is required to conduct activities to avoid, to the extent possible, the long- and short- term adverse impacts associated with the occupation or modification of floodplains. The procedures also require EPA to avoid direct or indirect support of floodplain development wherever there are practicable alternatives and minimize potential harm to floodplains when there are no practicable alternatives.	Potentally applicable		3 & 4
Within 61 meters (200 ft) of a fault displaced in Holocene time	40 CFR Part 264.18	New treatment, storage, or disposal of hazardous waste is not allowed.	Not applicable or relevant and appropriate., since not treating, storing, or disposing hazardous waste at the Site. Site is not located within 200 ft of a fault displaced in Holocene time, as listed in 40 CFR 264 Appendix VI.	No	None
River or stream	16 USC 661 - Fish and Wildlife Coordination Act	Requires protection of fish and wildlife in a stream when performing activities that modify a stream or river.	Not applicable. Potentially relevant and appropriate to erosion control measure construction activities along Wappingers Creek banks.	Yes	3 & 4

Table 1. Evaluation of potential SCGs

Medium/Location/ Action	Citation	Requirements	Comments	SCG	Alternative
Habitat of an endangered or threatened species	6 NYCRR 182	Provides requirements to minimize damage to habitat of an endangered species.	Not applicable or relevant and appropriate, as no endangered or threatened species or their habitat were found at the Site.	No	None
	Endangered Species Act	Provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction.	Not applicable or relevant and appropriate, as no endangered or threatened species or their habitat were found at the Site.	No	None
Historical property or district	National Historic Preservation Act	Remedial actions are required to account for the effects of remedial activities on any historic properties included on or eligible for inclusion on the National Register of Historic Places.	Potentially applicable or relevant and appropriate, if Site found to be a historical property.	Yes	3 & 4
Potential action-specific SCGs					
Construction in a floodplain	6 NYCRR 500 - Floodplain management regulations development permits	Hazardous waste treatment, storage, or disposal facilities located in a 100-yr floodplain must be designed, constructed, operated and maintained to prevent washout of hazardous waste during a 100-yr flood.	Not applicable or relevant and appropriate since not treating, storing, or disposing hazardous waste at the Site.	No	None
General excavation	6 NYCRR 257-3 - Air Quality Standards	Provide limitations for generation of constituents including particulate matter.	Not applicable or relevant and appropriate because dust emissions would not be from a point source. May be useful for consideration during dust generating activities such as earth moving, grading and excavation of soil.	Yes	4
	40 CFR 50.1 through 50.12 - National Ambient Air Quality Standards.	Provides air quality standards for pollutants considered harmful to public health and the environment. The six principle pollutants include carbon monoxide, lead, nitrogen dioxide, particulates, ozone, and sulfur oxides.	Potentially applicable during dust generating activities such as earth moving, grading, and excavation of soil.	Yes	4
Generation and disposal of hazardous material and treatment residuals	6 NYCRR 360 - Solid Waste Management Facilities	Provides requirements for management of solid wastes, including disposal and closure of disposal facilities.	Not applicable or relevant and appropriate since not disposing hazardous waste at the Site.	No	None
Land disposal	6 NYCRR 376 - Land disposal restrictions	Provides treatment standards to be met prior to land disposal of hazardous wastes.	Potentially applicable.	Yes	3 & 4
Construction	29 CFR Part 1910 - Occupational Safety and Health Standards - Hazardous Waste Operations and Emergency Response	Remedial activities must be in accordance with applicable OSHA requirements.	Applicable for construction phase of remediation	Yes	3 & 4
	29 CFR Part 1926 - Safety and Health Regulations for Construction	Remedial construction activities must be in accordance with applicable OSHA requirements.	Applicable for construction phase of remediation	Yes	3 & 4

Table 1. Evaluation of potential SCGs

Medium/Location/ Action	Citation	Requirements	Comments	SCG	Alternative
Transportation	6 NYCRR 364 - Waste Transporter Permits	Hazardous waste transport must be conducted by a hauler permitted under 6 NYCRR 364.	Potentially applicable.	Yes	None
	6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	Substantive hazardous waste generator and transportation requirements must be met when hazardous waste is generated for disposal. Generator requirements include obtaining an EPA Identification Number and manifesting hazardous waste for disposal.	Potentially applicable.	Yes	None
	49 CFR 172-174 and 177-179 - Department of Transportation Regulations	Hazardous waste transport to offsite disposal facilities must be conducted in accordance with applicable DOT requirements	Potentially applicable.	Yes	None
Generation of air emissions	NYS Air Guide 1	Provides annual guideline concentrations (AGLs) and short-term guideline concentrations (SGCs) for specific chemicals. These are property boundary limitations that would result in no adverse health effects.	Potentially applicable.	Yes	3 & 4
	NYS TAGM 4031 - Dust Suppressing and Particle Monitoring at Inactive Hazardous Waste Disposal Sites	Provides limitations on dust emissions.	Potentially applicable.	Yes	3 & 4

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Soil				
NO ACTION	None	Natural attenuation	No remedial action.	Required for consideration by NCP.
INSTITUTIONAL ACTIONS	Access restrictions	Environmental easement	Land use restrictions for site soil.	Potentially applicable.
		Fencing	Installation of fencing surrounding area(s) of contamination.	Potentially applicable.
CONTAINMENT ACTIONS	Capping	Vegetated soil cover	Vegetated soil layer covering impacted surface soil.	Potentially applicable.
		Low-permeability cover	Vegetated soil layer used in conjunction with low permeability and protective layers.	Potentially applicable.
	Erosion control	Creek bank stabilization	Construction of a retaining wall or gabion basket/live cutting bank to minimize erosion of surface soil to Wappingers Creek.	Potentially applicable.
REMOVAL ACTIONS	Excavation	Excavation	Use of construction equipment, such as backhoes, bulldozers, clamshells, draglines, or conveyors to remove site soils.	Potentially applicable.
DISPOSAL ACTIONS	Land disposal	Off-site commercial landfill	Off-site disposal of soil.	Potentially applicable.
TREATMENT ACTIONS	Physical	Soil flushing	Flushing of ground water through contaminated soil zone to desorb and mobilize constituents, which are collected with a ground water recovery system.	Potentially applicable for potential source areas (inorganic constituents in lower portion of the former raceway and chlorinated VOCs in drywell area). Potentially applicable for PAHs.

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
TREATMENT ACTIONS (Continued)	Physical (Continued)	*In situ* soil venting	Volatilizes contaminants from soil particles by pulling air through extraction wells.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Source area dual-phase extraction	Removes soil vapor and ground water simultaneously from soil by pulling through extraction wells.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Solidification/stabilization	Addition and mixing of solidifying/stabilizing agents with soil to immobilize inorganic constituents.	Potentially applicable for lower portion of former raceway (inorganic constituents).
	Chemical	Chemical dechlorination	Use of chemical reagents to dechlorinate chlorinated VOCs through a nucleophilic substitution process, producing non-toxic, non-mutagenic, non-bioaccumulative products.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		In situ chemical oxidation	Injection of oxidants such as ozone, hydrogen peroxide, or potassium permanganate to oxidize/destroy organic contaminants.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
	Biological	*Ex situ* biological treatment	Degradaion of VOCs in soil by biological organisms.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		In situ enhanced biological treatment	Natural degradation of VOCs in soil by biological organisms naturally present in the soil enhanced by external application of oxygen and/or nutrients.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
TREATMENT ACTIONS (Continued)	Thermal	Thermal desorption	*Ex situ* treatment of soils by volatilizing VOCs with low temperature heat processes.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Six-phase heating	*In situ* treatment of soils by volatilizing VOCs with anodes installed within a grid of wells. A grid of suction wells would also be installed to collect vapors.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Incineration	Combustion of organic contaminants present in soil either on-site or off-site incinerator.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		In situ vitrification	In place melting of soil into a solid, glass-like monolith using electrical power. VOCs would be destroyed and inorganic constituents would be entrained within the glassy matrix.	Potentially applicable for potential source areas (inorganic constituents in lower portion of the former raceway and chlorinated VOCs in drywell area). Potentially applicable for PAHs.
Ground water				
NO ACTION	None	Natural attenuation	In-place reduction of VOCs, PAHs, and inorganic constituents in ground water over the long-term by biological and abiotic attenuation processes.	Required for consideration by NCP. Potentially applicable.
INSTITUTIONAL ACTIONS	Monitoring	Ground water monitoring	Periodic sampling and analysis of ground water.	Potentially applicable.
	Use restrictions	Environmental easement	Restriction of ground water use at the site.	Partially implemented.

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT ACTIONS	Vertical barrier	Slurry wall	Soil- or cement-bentonite slurry wall placed around the area of contamination to contain ground water.	Potentially applicable.
		Sheet piles	Sheet piles installed around the area of contamination to contain ground water.	Potentially applicable.
COLLECTION ACTIONS	Ground water extraction	Recovery wells	Removal of ground water by pumping from recovery wells for hydraulic containment or mass removal.	Potentially applicable.
		Recovery trench	Removal of ground water by pumping from recovery trenches for hydraulic containment or mass removal.	Potentially applicable.
IN SITU TREATMENT ACTIONS	Physical	Air sparging	Injection of air into the saturated soil zone to volatilize constituents, which are collected in the unsaturated zone by an *in situ* air stripping system.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
	Biological	Bioremediation	Injection of oxygen and nutrient sources to the aquifer to enhance biological degradation or organic constituents by indigenous microbes.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
	Chemical	Treatment wall	Construction of an iron wall, biobarrier, or carbon wall to treat ground water as it flows through the treatment zone.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
EX SITU TREATMENT ACTIONS	Physical	Air stripping	Contact of air with water in countercurrent column or bulk reactor to transfer VOCs from water to air.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Carbon adsorption	Adsorption of organic constituents from water to activated carbon.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Adsorptive resin	Adsorption of organic constituents from water to commercial adsorptive resin.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Settling	Retention of aqueous stream in tank to settle/separate light or heavy components.	Not applicable for dissolved constituents. Potentially applicable for organics in combination with precipitation.
		Filtration	Separation of solids from water phase using semipermeable filter medium.	Not applicable for dissolved constituents. Potentially applicable for organics in combination with precipitation.
	Chemical	Chemical oxidation	Addition of oxidation agents such as hydrogen peroxide and ultraviolet light to water to oxidize/destroy organic contaminants.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
		Precipitation	pH adjustment of ground water to separate out dissolved metal contaminants.	Potentially applicable for inorganic constituents.
		Ion exchange	Chemical alternation of a hazardous to a non-hazardous constituent.	Potentially applicable for inorganic constituents.

Table 2. *Screening of remedial technologies and process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
EX SITU TREATMENT ACTIONS (Continued)	Biological	Biological reactor	Addition of oxygen, nutrients, and cometabolites to ground water in reactor to enhance co-metabolic degradation of organic constituents.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.
Sediment				
CONTAINMENT ACTION	Capping	Sediment cap	Cover sediment, install culvert, vegetate soil cover.	Potentially applicable for lagoon sediment.
REMOVAL ACTION	Pumping	Hydrovacuuming	Removal of the lagoon sediment using a vac truck.	Potentially applicable for lagoon sediment.
	Excavation	Excavation	Use of construction equipment, such as backhoes, bulldozers, clamshells, draglines, or conveyors to remove site soils.	Potentially applicable for lagoon sediment.
TREATMENT ACTION	Physical	Solidification/stabilization	Addition and mixing of solidifying/stabilizing agents with sediment to immobilize inorganic constituents.	Potentially applicable for lagoon sediment.
Vapor				
CONTROL ACTIONS	Vapor control	Pumping/ventilation	Removal of subsurface soil vapors beneath the building slab to prevent intrusion of vapors to the building.	Potentially applicable for drywell area (chlorinated VOCs) in vicinity of Axton-Cross building.

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Soil					
NO ACTION	None	Natural attenuation	Relies on long-term biological and abiotic degradation. Effectiveness is not certain.	Readily implementable.	No capital No O&M
INSTITUTIONAL ACTIONS	Access restrictions	Environmental Easement	Effectively minimizes access to the site.	Readily implementable.	Low capital No O&M
		Fencing	Effectively minimizes access to the site.	Readily implementable.	Low capital Low O&M
CONTAINMENT ACTIONS	Capping	Vegetated cover	Effectively minimizes human and ecological contact with impacted soil.	Readily implementable for Main Site. Would require clearing of extensive treed area at MGP Site.	Low capital Low O&M
		Low-permeability cover	Effectively minimizes human and ecological contact with impacted soil.	Readily implementable. Would require clearing of extensive treed area at MGP Site.	Medium capital Low O&M
	Erosion control	Creek bank stabilization	Effectively minimizes impacted surface soil from entering Wappingers Creek.	Partially implemented. Stabilization of remaining portion of creek bank is readily implementable.	Low capital Low O&M
REMOVAL ACTIONS	Excavation	Excavation	Effectively removes impacted soil.	Readily implementable for unsaturated soil. Difficult to implement for soil below ground water table due to dewatering needs in highly permeable soil.	Medium capital No O&M
DISPOSAL ACTIONS	Land disposal	Off-site commercial landfill	Effective method of disposal. Minimizes constituent migration.	Readily implementable.	High capital No O&M
TREATMENT ACTIONS	Physical	Soil flushing	Effectively removes constituents from saturated soil zone over time.	Readily implementable.	Low capital Medium O&M
		In situ soil venting	Effectively volatilizes VOCs in the unsaturated zone.	Potential source of VOCs likely extends below the water table. VOC-rich air stream would likely require management.	Medium capital Low O&M

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
TREATMENT ACTIONS (Continued)	Physical (Continued)	Source area dual-phase extraction	Effectively extracts soil vapor from soil.	Readily implementable. VOC-rich air stream would likely require management.	High capital Medium O&M
		Solidification/stabilization	Effectively reduces mobility of inorganic constituents in saturated and unsaturated soil. Does not destroy inorganic constituents.	Readily implementable.	Medium capital No O&M
	Chemical	Dechlorination	Effectively detoxifies chlorinated VOCs.	Readily implementable.	Medium capital No O&M
		In situ chemical oxidation	Effective for VOCs.	Readily implementable.	Medium capital Medium O&M
	Biological	*Ex situ* biological treatment	Potentially effective for destruction of some VOCs. Not expected to reduce concentrations to standards. Treatability studies would be necessary as certain properties of soil could limit effectiveness.	Difficult to implement due to the presence of a currently occupied building over a portion of the potential source area. Not a demonstrated source remediation technology.	High capital Medium O&M
		In situ enhanced biological treatment	Potentially effective for destruction of some VOCs. Not expected to reduce concentrations to standards. Treatability studies would be necessary as certain properties of soil could limit effectiveness.	Not a demonstrated source remediation technology.	Medium capital Medium O&M
	Thermal	*In Situ t*hermal desorption	Effectively removes chlorinated VOCs.	Difficult to implement due to the presence of a currently occupied building over a portion of the potential source area.	High capital Low O&M
		In situ six-phase heating	Effectively removes chlorinated VOCs.	Implementable.	High capital Medium O&M
		Incineration	Effectively destroys chlorinated VOCs.	Difficult to excavate soil beneath a currently occupied building for *ex situ* treatment.	High capital No O&M

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
TREATMENT ACTIONS (Continued)	Thermal (Continued)	*In situ* vitrification	Effective destruction of chlorinated VOCs and effective encapsulation of inorganic constituents and PAHs. Soil moisture may limit efficiency of process.	Implementable.	High capital Low O&M
Ground water					
NO ACTION	None	Natural attenuation	Relies on long-term biological and abiotic degradation. Effectiveness is not certain.	Readily implementable.	No capital No O&M
INSTITUTIONAL ACTIONS	Monitoring	Ground water monitoring	Effective method for monitoring changes in VOC, PAH, and inorganic constituents over time. Useful for evaluating remedy effectiveness.	Readily implementable.	Low capital Low O&M
	Use restrictions	Ground water use restriction	Effectively minimizes potable water use of ground water.	Already implemented.	Low capital No O&M
CONTAINMENT ACTIONS	Vertical barrier	Slurry wall	Effectively reduces ground water contaminant migration.	Difficult to implement due to the thickness of the aquifer (50 – 70 ft) and the presence of cobbles.	High capital Low O&M
		Sheet piles	Effectively reduces ground water contaminant migration.	Difficult to implement due to the thickness of the aquifer (50 – 70 ft) and the presence of cobbles.	High capital Low O&M
COLLECTION ACTIONS	Ground water extraction	Recovery wells	Effectively removes contaminated ground water.	Difficult to implement due to the permeability of the soil/fill coupled with the proximity of Wappingers Creek.	Low capital Medium O&M
		Recovery trench	Effectively removes contaminated ground water.	Difficult to implement due to the permeability of the soil/fill coupled with the proximity of Wappingers Creek and the presences of cobbles.	High capital Medium O&M

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
IN SITU TREATMENT ACTIONS	Physical	Air sparging	Effective for removal of chlorinated VOCs. Not effective for removal of PAHs and inorganic constituents.	May be difficult to implement due to the thickness of the aquifer (50 – 70 ft) and potential for mobilization of VOCs under occupied Axton-Cross Building.	High capital Medium O&M
	Biological	Bioremediation	Likely effective for destruction of chlorinated VOCs in saturated zone. Treatability study would be necessary. Not effective for removal of PAHs and inorganic constituents.	May be difficult to implement due to the thickness of the aquifer (50 – 70 ft).	Medium capital Medium O&M
	Chemical	Treatment wall	Likely effective for destruction of chlorinated VOCs in saturated zone. Not effective for removal of PAHs and inorganic constituents.	May be difficult to implement due to the thickness of the aquifer (50 – 70 ft).	High capital Medium O&M
EX SITU TREATMENT ACTIONS	Physical	Air stripping	Effective for removal of chlorinated VOCs. No effective for removal of PAHs and inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Low capital Medium O&M
		Carbon adsorption	Effective for removal of chlorinated VOCs. Not effective for removal of PAHs and inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Medium capital High O&M
		Adsorptive resin	Effective for removal of chlorinated VOCs. Not effective for removal of PAHs and inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	High capital Medium O&M

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
EX SITU TREATMENT ACTIONS (Continued)	Physical (Continued)	Settling	Not effective for removal of dissolved constituents. May be effective with precipitation of inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Low capital Low O&M
		Filtration	Not effective for removal of dissolved constituents. May be effective with precipitation of inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Low capital Low O&M
	Chemical	Chemical oxidation	Effective for destruction of chlorinated VOCs. Not effective for removal of PAHs and inorganic constituents.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Medium capital Medium O&M
		Precipitation	Effective for removal of inorganic constituents. Not effective for removal of chlorinated VOCs and PAHs.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Low capital Medium O&M
		Ion exchange	Potentially effective for removal of inorganic constituents. Not effective for removal of chlorinated VOCs and PAHs.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Medium capital Medium O&M
	Biological	Biological reactor	Likely effective for destruction of chlorinated VOCs. Not likely effective for removal of inorganic constituents and PAHs.	Difficult to implement due excessive quantities of extracted water as a result of the permeability of the soil/fill and proximity of Wappingers Creek.	Medium capital Medium O&M

Table 3. *Evaluation of process options*

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Sediment					
CONTAINMENT ACTION	Capping	Sediment Cap	Effectively minimizes human and ecological contact with impacted sediment.	Readily implementable.	Medium capital Low O&M
REMOVAL ACTION	Pumping	Hydrovacuuming	Effective method for removal of lagoon sediments.	Difficult to implement due to lagoon dimensions and sediment stability characteristics	Medium capital No O&M.
	Excavation	Excavation	Effective method for removal of lagoon sediments.	Readily implementable.	Medium capital No O&M
TREATMENT ACTION	Physical	Solidification/stabilization	Effective method of immobilizing constituents in lagoon sediments.	Readily implementable.	Low capital No O&M
Vapor					
CONTROL ACTIONS	Vapor control	Pumping/ventilation	Effective method of removing organic vapors from beneath the Axton-Cross building slab, and mitigating indoor organic vapor impacts.	Readily implementable.	Medium capital Medium O&M

Table 4. *Components of remedial alternatives*

General Response Actions	Remedial technology - process option	1	2	3	4
Institutional actions	Access restrictions (environmental easement, site inspection)		x	x	x
	Access restrictions (fencing)		x		
	Ground water monitoring		x	x	x
Control actions	Vapor Control (Pumping/ventilation)			x	x
Containment actions	Soil Cover (Vegetated)			x	x
	Lagoon Sediment Cover (Vegetated)			x	
	Erosion Control (creek bank stabilization)			x	x
Removal actions	Removal (Soil excavation)				x
	Removal (Sediment excavation)				x
	Removal (Surface debris)			x	x
Demolition	Demolition (Gas holders, former metal plating vats)			x	x
Disposal actions	Offsite disposal (Soil)				x
	Offsite disposal (Surface debris)			x	x
	Offsite disposal (Gas holder, former metal plating vats debris)			x	x
	Offsite disposal (former metal plating vat liquid and sludge)			x	x
	Offsite disposal (Sediment)				x
Treatment actions	*In situ* stabilization (Lower portion of former raceway soil)			x	
	In situ oxidation (Drywell area soil)			x	

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Overall protection of human health and the environment				
Overall protection of human health	Not protective of human health.	Somewhat protective of human health through access and land use restrictions.	Protection of human health is provided through soil treatment of drywell area and lower portion of former raceway, containment of remaining impacted soil by use of a soil cover, and covering of lagoon sediment. Protection of human health is also provided through mitigation of vapor intrusion in Axton-Cross building, removal of gas holders and plating vats, and an environmental easement. Current and future use of the site ground water as a potable water supply are prohibited by the Village. Future use of ground water would be further restricted through an environmental easement.	Protection of human health is provided through soil removal in drywell area and lower portion of former raceway and removal of lagoon sediment, containment of remaining impacted soil by use of a soil cover, mitigation of vapor intrusion in Axton-Cross building, removal of gas holders and plating vats, and an environmental easement. Current and future use of the site ground water as a potable water supply are prohibited by the Village. Future use of ground water would be further restricted through an environmental easement.

Table 5. Detailed analysis of alternatives

Criterion	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Overall protection of the environment	Not protective of the environment.	Somewhat protective of the environment through access restrictions.	Protection of the environment is provided through treatment of drywell area and the lower portion of former raceway, lagoon sediment and soil covers, removal of gas holders & plating vats, and erosion control.	Protection of the environment is provided through soil removal in drywell area and lower portion of former raceway, removal of lagoon sediment, a soil cover, removal of gas holders & plating vats, and erosion control.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Compliance with standards, criteria, and guidance (SCGs)				
Compliance with chemical-specific SCGs	Attainment of NYS Class GA ground water standard is technically impractical. SCG waiver may be necessary.	Attainment of NYS Class GA ground water standard is technically impractical. SCG waiver may be necessary.	Attainment of NYS Class GA ground water standard is technically impractical. SCG waiver may be necessary.	Attainment of NYS Class GA ground water standard is technically impractical. SCG waiver may be necessary.
Compliance with location-specific SCGs	Complies with location-specific SCGs.	Complies with location-specific SCGs.	Creek bank erosion control and lagoon remediation would need to be conducted in a manner consistent with Fish and Wildlife Coordination Act requirements for protection of rivers and streams. Cultural resources assessment should be conducted. Depending on outcome, site activities may need to be conducted in a manner such that archeological and historical resources are not damaged. Remedial actions in the lagoon and in the vicinity of wetlands would need to be completed in accordance with Federal wetland regulations.	Creek bank erosion control and lagoon remediation would need to be conducted in a manner consistent with Fish and Wildlife Coordination Act requirements for protection of rivers and streams. Cultural resources assessment should be conducted. Depending on outcome, site activities may need to be conducted in a manner such that archeological and historical resources are not damaged. Remedial actions in the lagoon and in the vicinity of wetlands would need to be completed in accordance with Federal wetland regulations.

Table 5. Detailed analysis of alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Criterion	**No further action.**	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Compliance with action-specific SCGs	No actions.	No actions.	Excavation activities would be conducted consistent with air quality standards. Site construction activities would be conducted in accordance with OSHA safety requirements.	Excavation activities would be conducted consistent with air quality standards. Site construction activities would be conducted in accordance with OSHA safety requirements.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Long-term effectiveness and permanence				
Magnitude of residual risk	Impacted soil/sediment would remain onsite.	Impacted soil/sediment would remain onsite; however, risks would be managed by fencing, site inspection, an environmental easement, and a Site Management Plan.	Soil in drywell area and lower portion of former raceway would be treated to minimize mobility of constituents. Lagoon sediment would be covered to reduce potential contact. A soil cover would be placed over impacted soil to minimize contact. Gas holders and plating vats would also be removed. Mitigation of vapor intrusion in the Axton-Cross building would address associated risks.	Soil in drywell area and lower portion of former raceway would be removed and remaining impacted soil at the site would be covered to minimize contact. Gas holders and plating vats would also be removed. Mitigation of vapor intrusion in the Axton-Cross building would address associated risks. Lagoon sediment would be removed.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Adequacy and reliability of controls	This alternative does not include controls.	Fencing, a site inspection, an environmental easement, and a Site Management Plan are adequate controls for site hazards.	*In situ* treatment of drywell area and lower portion of former raceway may not be an adequate and reliable control of site hazards since it may be difficult to properly mix or deliver treatment reagents throughout the drywell area and lower portion of former raceway area due to the presence of cobbles. Mitigation of vapor intrusion at the Axton-Cross building is an adequate control. Restrictions on site ground water use are already implemented. Further restrictions on ground water use through an environmental easement are adequate and reliable controls for site ground water hazards. Covering the lagoon sediment is a reliable control.	Removal of drywell area and lower portion of former raceway and soil cover are adequate controls for site hazards. Mitigation of vapor intrusion at the Axton-Cross building is also an adequate control. Restrictions on site ground water use are already implemented. Further restrictions on ground water use through an environmental easement are adequate and reliable controls for site ground water hazards. Removal of lagoon sediment is a reliable control.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Reduction of toxicity, mobility, or volume through treatment				
Treatment process used and materials treated	No treatment processes are used in this alternative.	No treatment processes are used in this alternative.	*In situ* oxidation would be used to treat VOCs in drywell area and *in situ* stabilization would be used to treat inorganics in lower portion of former raceway soil.	No treatment processes are used in this alternative.
Amount of hazardous material destroyed or treated	No treatment processes or removal are used in this alternative.	No treatment processes or removal are used in this alternative.	Approximately 33,000 CY of impacted soil will be treated *in situ*.	Approximately 33,000 CY of impacted soil will be removed in this alternative. Lagoon sediment will be removed.
Degree of expected reduction in toxicity, mobility, or volume	No treatment processes or removal are used in this alternative.	No treatment processes or removal are used in this alternative.	The reduction in toxicity and mobility of drywell area and lower portion of former raceway soils will need to be evaluated through treatability studies.	Approximately 33,000 CY of soil would be removed and appropriately disposed off-site. Lagoon sediment will be removed and appropriately disposed off-site (approximately 2100 CY).
Degree to which treatment is irreversible	No treatment processes are used in this alternative.	No treatment processes are used in this alternative.	*In situ* stabilization is an irreversible treatment method.	No treatment processes are used in this alternative; however, removal of impacted soil and sediment is irreversible.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Type and quantity of residuals remaining after treatment	No treatment processes or removal are used in this alternative.	No treatment processes or removal are used in this alternative.	Type and quantity of residuals remaining after treatment will need to be evaluated through treatability studies. Impacted soil remaining at the site following treatment of drywell area and lower portion of former raceway will be covered to reduce potential contact. Residual VOC contamination beneath Axton Cross Building may exist and would remain onsite. Impacted sediment will remain on-site under a cover to reduce potential contact.	Impacted soil remaining at the site following drywell area and lower portion of former raceway removal will be covered to reduce potential contact. Residual VOC contamination beneath Axton Cross Building may exist and would remain onsite.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Short-term effectiveness				
Protection of community during remedial actions	This alternative does not include remedial actions.	Access and use restrictions provide some protection to the community. No treatment process or removal are used in this alternative.	Dust and volatile emissions will be controlled during *in situ* treatment, removal of lagoon sediment, removal of gas holders, and removal of plating vats.	Dust and volatile emissions will be controlled during excavation, removal of gas holders, and removal of plating vats.
Protection of workers during remedial actions	This alternative does not include remedial actions.	Proper health and safety measures would be implemented during site inspection activities.	Proper health and safety measures will be established and implemented during remedial activities.	Proper health and safety measures will be established and implemented during remedial activities.
Environmental impacts	There are no environmental impacts expected as a result of implementation of this alternative.	There are no environmental impacts expected as a result of implementation of this alternative.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative.	Dust, volatile emissions, and surface runoff controls will be instituted to minimize impacts to the environment during implementation of this alternative.
Time until remedial action objectives are achieved	Remedial objectives related to human health and ecological receptors will not be met upon completion of the remedy.	Remedial objectives related to human health will be achieved upon completion of the remedy. Remedial objectives related to ecological receptors will not be met upon completion of the remedy.	Remedial action objectives would be achieved upon completion of the remedy.	Remedial action objectives would be achieved upon completion of the remedy.

Table 5. Detailed analysis of alternatives

Criterion	**Alternative 1** **No further action.**	**Alternative 2** **Site inspection, fencing, environmental easement, and Site Management Plan.**	**Alternative 3** ***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Alternative 4** **Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Implementability				
Ability to construct and operate the technology	There are no technologies to be constructed in this alternative.	There are no technologies to be constructed in this alternative.	Vegetated soil covers, gas holder & plating vat removal, erosion control, vapor control are readily constructable and operable technologies. Treatability studies would be required to evaluated the ability to treat drywell area and lower portion of former raceway areas *in situ*.	Vegetated soil covers, lagoon sediment removal, gas holder & former metal plating vat demolition, erosion control, vapor control are readily constructable and operable technologies. The permeability of the soil coupled with the proximity of the creek make soil removal below the water table difficult due to extensive pumping efforts required for dewatering and/or deep sheet pile needs.
Reliability of technology	There are no technologies to be constructed in this alternative.	Fencing and an environmental easement are reliable to restrict site access and activities.	Soil cover is a reliable technology to minimize contact with impacted soil. Erosion control measures are reliable technologies to minimize impacted surface soil from entering the creek.	Removal of impacted soil, lagoon sediment, gas holders, and former metal plating vats are reliable technologies. A soil cover is a reliable technology to minimize contact with impacted soils. Erosion control measures are reliable technologies to minimize impacted surface soil from entering the creek.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Ease of undertaking additional remedial actions, if necessary	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.	Additional remedial actions, if necessary, would be readily implementable.
Ability to monitor effectiveness of remedy	None required.	Remedy effectiveness could be monitored with periodic site inspection.	Effectiveness of remedy could be monitored through ground water monitoring, cover inspection, and creek bank inspection.	Effectiveness of remedy could be monitored by confirmation sampling and ground water monitoring, cover inspection, and creek bank inspection.
Coordination with other agencies and property owners	Coordination with local authorities would be necessary to implement environmental easement.	Coordination with local authorities would be necessary to implement environmental easement.	Coordination with local authorities would be necessary to implement environmental easement.	Coordination with local authorities would be necessary to implement environmental easement.
Availability of off-site treatment storage and disposal services and capacities	None required.	None required.	Off-site treatment, storage and disposal facilities for debris generated by removal of gas holders and former metal plating vats are available.	Off-site treatment, storage and disposal facilities for drywell area and lower portion of former raceway material and debris generated by removal of gas holders and former metal plating vats are available.

Table 5. Detailed analysis of alternatives

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No further action.	**Site inspection, fencing, environmental easement, and Site Management Plan.**	***In situ* treatment of the potential source areas, vegetated soil cover, covering of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site**	**Soil removal in the potential source areas, vegetated soil cover, removal of lagoon sediment, removal of former gas holders & demolition of former metal plating vats, erosion control, vapor control, ground water monitoring, environmental easement, and Site Management Plan.**
Availability of necessary equipment, specialists, and materials	None required.	None required.	Treatability studies are necessary to evaluate equipment and materials needed.	Due to the extensive dewatering efforts required during soil removal, availability of necessary equipment, specialists, and materials may be limited.
Costs				
Capital cost	$0	$200,000	$13,070,000	$33,780,000
Present worth of operation and maintenance cost	$0	$420,000	$2,690,000	$6,120,000
Approximate total net present worth cost	$0	$620,000	$15,760,000	$39,900,000

Three Star Anodizing Site,
Wappingers Falls, NY

Table 6: Alternative #2
Institutional and Engineering Controls, and Monitoring
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
Monitoring Well Installation (Shallow)	Each	5	$2,500.00	$12,500	
Monitoring Well Installation (Deep)	Each	1	$3,500.00	$3,500	
Site Fencing	LF	3,100	$25.00	$77,500	
Environmental Easement	LS	1	$20,000	$20,000	
Site Management Plan	LS	1	$20,000	$20,000	
				SUBTOTAL:	**$133,500**
			TOTAL DIRECT CAPITAL COST:		**$133,500**
Indirect Capital Costs					
Contingency (30% Direct Capital Costs)	LS	1	$40,050	$40,050	
Engineering (15% of Direct Capital Costs)	LS	1	$20,025	$20,025	
Legal Fees (5% Direct Capital Costs)	LS	1	$6,675	$6,675	
			TOTAL INDIRECT CAPITOL COSTS:		**$66,750**
			TOTAL CAPITAL COSTS ROUNDED:		**$200,000**
Annual Operation & Maintenance Costs					
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$2,000	$2,000	
Ground Water Monitoring	LS	1	$20,800	$20,800	
Periodic Site Review (Annual Cost)	LS	1	$5,000	$5,000	
Insurance (1% Direct Capital Cost)	LS	1	$1,335	$1,335	
Reserve Fund (1% Direct Capital Cost)	LS	1	$1,335	$1,335	
			SUBTOTAL:	**$33,670**	
		PRESENT WORTH OF ANNUAL O&M:			**$417,812**
		COSTS FOR 30 YEARS (I=7%)(ROUNDED)			**$420,000**
		APPROXIMATE TOTAL PRESENT WORTH COST:			**$620,000**

Assumptions:
Site maintenance will include fence repair and mowing.

Three Star Anodizing Site,
Wappingers Falls, NY

Table 7: Alternative #3
***In-situ* Treatment**
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Equipment and Site Facilities	LS	1	$555,000	$555,000	
				SUBTOTAL:	**$555,000**
2) Site Preparation					
Site Survey and Topography	ACRE	9.7	$1,000	$9,727	
Clearing and Grubbing	ACRE	3.5	$15,300	$53,550	
Erosion and Sediment Control - Silt Fence	LF	3,700	$1	$3,700	
				SUBTOTAL:	**$66,977**
3) In Situ Treatment					
In Situ Chemical Oxidation of VOCs in Drywell Area	LS	1	$150,000	$150,000	
In Situ Stabilization in Lower Portion of Former Raceway	LS	1	$2,625,000	$2,625,000	
Topsoil on Lower Portion of Former Raceway	CY	580	$22	$12,760	
Seeding/Mulching on Lower Portion of Former Raceway	SF	31,285	$0.50	$15,643	
				SUBTOTAL:	**$2,803,403**
4) Vegetative Soil Cover					
Pre-design Surface Soil Sampling	LS	1	$5,000	$5,000	
Mirafi 140N Indicator Layer	SF	160,000	$0.08	$12,800	
Backfill Material	CY	8,889	$12	$106,667	
Topsoil	CY	2,963	$22	$65,185	
Seeding/Mulching	SF	160,000	$0.50	$80,000	
				SUBTOTAL:	**$269,652**
5) Lagoon Sediment Capping					
Pre-construction sampling - northern channel	LS	1	$20,000	$20,000	
Placement of stone access way	CY	450	$50	$22,500	
Stabilization with Sand	CY	670	$25	$16,750	
Backfill lagoon to surrounding grade	CY	1200	$71	$85,400	
Backfill downstream channel to surrounding grade	cy	889	$90	$80,111	
Installation of Stormwater Culvert	LF	500	$66	$32,870	
				SUBTOTAL:	**$257,631**
6) Former Gas Holder Removal					
Demolition	LS	1	$8,800	$8,800	
Debris Removal & Offsite Disposal	Ton	30	$150	$4,500	
				SUBTOTAL:	**$13,300**
7) Former Plating Vats Decommisioning					
Wall stabilization	LS	1	$49,500	$49,500	
Asbestos abatement	LS	1	$150,000	$150,000	
Vat decommissioning	LS	1	$200,000	$200,000	
Subsurface investigation	LS	1	$28,500	$28,500	
				SUBTOTAL:	**$428,000**
8) Creek Bank Stabilization					
Brush mattress with rock toe bank stabilization	LF	850	$230	$195,500	
Transportation & Offsite Disposal - Nonhazardous	TON	1,500	$150.00	$225,000	
				SUBTOTAL:	**$420,500**
9) Creek Bank Buffer Zone					
Excavation	CY	12,037	$15	$180,556	
Transportation & Offsite Disposal as Non-Hazardous	TON	21,667	$150	$3,250,000	
Backfill	CY	13,333	$12	$160,000	
Topsoil	CY	1,111	$22	$24,444	
Seeding including wildlife and riparian seed mixes	LS	1	$2,000	$2,000	
Plantings - Includes materials and labor	LS	1	$12,000	$12,000	
				SUBTOTAL:	**$3,629,000**
10) Vapor Control System					
Vapor Intrusion Evaluation	LS	1	$12,000	$12,000	
Vapor Intrusion Mitigation	LS	1	$100,000	$100,000	
				SUBTOTAL:	**$112,000**
11) Ground Water Monitoring					
Monitoring Well Installation (Shallow)	Each	5	$2,500	$12,500	
				SUBTOTAL:	**$12,500**
12) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Contractor Bond (1%)	LS	1	$50,701	$50,701	
Project Photography	LS	1	$10,000	$10,000	
Environmental Easement	LS	1	$20,000	$20,000	
Site Management Plan	LS	1	$20,000	$20,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$146,701**
				TOTAL DIRECT CAPITAL COST:	**$8,714,664**

Three Star Anodizing Site,
Wappingers Falls, NY

Table 7: Alternative #3
***In-situ* Treatment**

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Indirect Capital Costs					
Contingency (30% Direct Capital Costs)	LS	1	$2,614,399	$2,614,399	
Engineering (15% of Direct Capital Costs)	LS	1	$1,307,200	$1,307,200	
Legal Fees (5% Direct Capital Costs)	LS	1	$435,733	$435,733	
			TOTAL INDIRECT CAPITAL COSTS:		**$4,357,332**
			TOTAL CAPITAL COSTS ROUNDED:		**$13,070,000**
Annual Operation & Maintenance Costs					
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$10,000	$10,000	
Periodic Site Review (Annual Cost)	LS	1	$5,000	$5,000	
Insurance (1% Direct Capital Cost)	LS	1	$87,146.64	$87,147	
Reserve Fund (1% Direct Capital Cost)	LS	1	$87,146.64	$87,147	
Ground Water Monitoring	LS	1	$20,800	$20,800	
Vapor Control System	LS	1	$3,500	$3,500	
			SUBTOTAL:	**$216,793**	
		PRESENT WORTH OF ANNUAL O&M:			**$2,690,197**
		COSTS FOR 30 YEARS (I=7%)(ROUNDED)			**$2,690,000**
		APPROXIMATE TOTAL PRESENT WORTH COST:			**$15,760,000**

Assumptions:
Areas requiring clearing and grubbing are heavily vegetated with trees up to 24" diameter and surface debris removal cost will be covered by the clearing and grubbing cost.
Ruins of the Main Site Buildings (11, 15, 16, and 21) will be cleared to ground elevation and no demolition will be required.
Silt fence will be placed around the perimeter of the site.
All areas will be cleared of building debris and handled as asbestos containing debris, as appropriate.
The water table is approximately 3 feet below the surface based on the remedial investigation data.
The porosity of the soil is 30% and 100% saturated.
The vegetative soil cover will be placed on existing grade.
The former gas holders are free of debris.
The excavated area for the former gas holders will be blended into existing grade. No backfill material will be placed.
The shallow ground water monitoring wells will be installed to a depth of approximately 15 feet below grade.
The vapor intrusion evaluation includes a Field Activities Plan, 11 air samples, questionnaire, and Letter Report.
The vapor mitigation evaluation includes diagnostic testing, design/installation of sub-slab depression system,
commission system /conduct performance testing, and report/documentation.
Site maintenance will include fence repair, mowing, soil cover repair, and bank stabilization repair.
The extents of the former raceway are identifiable by ground surface features.
The site survey will consist of 2 feet contours.
The wall stabilization includes design and implementation to stabilize the wall adjacent to the former metal plating vats (approximately 185 linear feet)
The wall stabilization design will be implemented by a licensed asbestos contractor due to asbestos containing material (ACM) in the area.
Asbestos abatement to address the presence of ACM:friable/non-friable required to be removed to complete tasks for the former metal plating vat decommissioning.
The asbestos abatement includes associated variances, air monitoring, material handling, transportation, and disposal of ACM debris (non-friable: 450 CY and friable:50 CY).
The vat decommissioning includes liquid/sludge removal, charaterization and disposal, vat debris staging and disposal, pressure washing and
waste handling/disposal, backfilling with sand, and 6-inch concrete cap construction.
Liquid/sludge quantities based on field measurements obtained in September 2006, but are likely to change because the vats are exposed to the environment.
Non-hazardous liquid/sludge quantity, including pressure washing liquids estimated to total 76,000 gallons
Hazardous liquid/sludge quantity, including pressure washing liquids estimated to total 11,000 gallons
Subsurface investigation costs consist of drilling ($6000), disposal ($500), laboratory analysis ($15,000), and engineering/oversight ($7000).
Bank stabilization includes turbidity curtain, material consolidation, geotextile, topsoil, and gabion basket placement, and live cutting installation along 900 feet of the creek.
In situ chemical oxidation to consist of ozone injection system.
In situ stabilization to consist of Molecular Bonding System and Raito Deep Mixing for treatment of 25,000 cubic yards of soil.
Assumes capping of lagoon sediments is limited to the area continuously underwater, approx. 9000 sf.
Assumes backfill of downstream channel that conducts water to Wappingers creek only during high water periods.
Assume the channel north of the existing lagoon will be filled to grade (assume 4-ft fill 60 ft wide x 200 ft long)
Pump from dewatering pad (paid for under separate item) will be used to remove existing water from lagoon.
- Ground water table is below existing surface of sediments within the lagoon; I.e. lagoon will not recollect water by exfiltration
- Lagoon water will be discharged directly to Wappingers Creek; no treatment necessary.
Assume 15-ft wide stone access way = 12-inch run-of-crush stone (or similar) surface
Estimate sand needed as 2-ft thickness over lagoon surface area of 9,000 sf. (670 cy)
Assume closed pipe culvert installed from raceway discharge at south end of lagoon to Wappingers Creek.

Three Star Anodizing Site,
Wappingers Falls, NY

Table 8: Alternative #4
Excavation and Off-site Disposal
COST ESTIMATE

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Direct Capital Costs					
1) Mobilization					
Equipment and Site Facilities	LS	1	$555,000	$555,000	
				SUBTOTAL:	**$555,000**
2) Site Preparation					
Site Survey and Topography	ACRE	9.7	$1,000	$9,727	
Clearing and Grubbing	ACRE	3.5	$15,300	$53,550	
Erosion and Sediment Control - Silt Fence	LF	3,700	$1	$3,700	
				SUBTOTAL:	**$66,977**
3) Soil Excavation & Offsite Disposal					
Soil Precharacterization	LS	1	$3,500	$3,500	
Sheet Piling	SF	95,550	$26	$2,484,300	
Waler System	LF	1,365	$33	$45,045	
Dewatering Pad	LS	1	$85,000	$85,000	
Water Treatment System	LS	1	$2,000,000	$2,000,000	
Excavation of Lower Portion of Former Raceway & Drywell Area	CY	33,800	$15	$507,000	
Soil Management and Staging	LS	1	$25,000	$25,000	
Confirmatory Sampling	LS	1	$2,500	$2,500	
Offsite Disposal - Hazardous	TON	14,962	$250	$3,740,500	
Offsite Disposal - Nonhazardous	TON	44,886	$150	$6,732,900	
Backfill Material	CY	33,045	$12	$396,540	
Gravel for Former Drum Storage Area	CY	176	$18	$3,168	
Topsoil	CY	579	$22	$12,738	
Seeding/Mulch	SF	31,285	$0.50	$15,643	
				SUBTOTAL:	**$16,053,834**
4) Vegetative Soil Cover					
Pre-design Surface Soil Sampling	LS	1	$5,000	$5,000	
Mirafi 140N Indicator Layer	SF	160,000	$0.08	$12,800	
Backfill Material	CY	8,889	$12	$106,667	
Topsoil	CY	2,963	$22	$65,185	
Seeding/Mulching	SF	160,000	$0.50	$80,000	
				SUBTOTAL:	**$269,652**
5) Lagoon Sediment Excavation					
Water table control	Day	60	$1,500	$90,000	
Placement of stone access way	CY	250	$50	$12,500	
Stabilization with Portland	CY	2100	$70	$147,000	
Excavation	CY	2400	$15	$36,000	
Transportation & Offsite Disposal	CY	1920	$150	$288,000	
Backfill/Restore lagoon	CY	1200	$79	$95,300	
				SUBTOTAL:	**$668,800**
6) Former Gas Holder Removal					
Demolition	LS	1	$8,800	$8,800	
Debris Removal & Offsite Disposal	TON	30	$150	$4,500	
				SUBTOTAL:	**$13,300**
7) Former Plating Vats Decommisioning					
Wall stabilization	LS	1	$49,500	$49,500	
Asbestos abatement	LS	1	$150,000	$150,000	
Vat decommissioning	LS	1	$200,000	$200,000	
Subsurface investigation	LS	1	$28,500	$28,500	
				SUBTOTAL:	**$428,000**
8) Creek Bank Stabilization					
Brush mattress with rock toe bank stabilization	LF	850	$230.00	$195,500	
Transportation & Offsite Disposal - Nonhazardous	TON	1,500	$150.00	$225,000	
				SUBTOTAL:	**$420,500**
9) Creek Bank Buffer Zone					
Excavation	CY	12,037	$15	$180,556	
Transportation & Offsite Disposal as Non-Hazardous	TON	21,667	$150	$3,250,000	
Backfill	CY	13,333	$12	$160,000	
Topsoil	CY	1,111	$22	$24,444	
Seeding including wildlife and riparian seed mixes	LS	1	$2,000	$2,000	
Plantings - Includes materials and labor	LS	1	$12,000	$12,000	
				SUBTOTAL:	**$3,629,000**
10) Vapor Control System					
Vapor Intrusion Evaluation	LS	1	$12,000	$12,000	
Vapor Intrusion Mitigation	LS	1	$100,000	$100,000	
				SUBTOTAL:	**$112,000**
11) Ground Water Monitoring					
Monitoring Well Installation (Shallow)	Each	5	$2,500	$12,500	
				SUBTOTAL:	**$12,500**
12) Other Costs					
Winter Shutdown	LS	1	$30,000	$30,000	
Contractor Bond (1%)	LS	1	$184,952	$184,952	
Project Photography	LS	1	$20,000	$20,000	
Environmental Easement	LS	1	$20,000	$20,000	
Site Management Plan	LS	1	$20,000	$20,000	
Final Site Survey	LS	1	$16,000	$16,000	
				SUBTOTAL:	**$290,952**
				TOTAL DIRECT CAPITAL COST:	**$22,520,514**

Three Star Anodizing Site,
Wappingers Falls, NY

Table 8: Alternative #4
Excavation and Off-site Disposal

ITEM	UNIT	ESTIMATED QUANTITY	ESTIMATED UNIT COST	ESTIMATED COST	
Indirect Capital Costs					
Contingency (30% Direct Capital Costs)		1	$6,756,154	$6,756,154	$6,756,154
Engineering (15% of Direct Capital Costs)		1	$3,378,077	$3,378,077	$3,378,077
Legal Fees (5% Direct Capital Costs)		1	$1,126,026	$1,126,026	$1,126,026
				TOTAL INDIRECT CAPITOL COSTS:	**$11,260,257**
				TOTAL CAPITAL COSTS ROUNDED:	**$33,780,000**
Annual Operation & Maintenance Costs					
Site Inspection	DAYS	4	$800	$3,200	
Site Maintenance	LS	1	$10,000	$10,000	
Periodic Site Review (Annual Cost)	LS	1	$5,000	$5,000	
Insurance (1% Direct Capital Cost)	LS	1	$225,205.14	$225,205	
Reserve Fund (1% Direct Capital Cost)	LS	1	$225,203.14	$225,203	
Ground Water Monitoring	LS	1	$20,800	$20,800	
Vapor Control System	LS	1	$3,500	$3,500	
			SUBTOTAL:	**$492,908**	
		PRESENT WORTH OF ANNUAL O&M:			**$6,116,519**
		COSTS FOR 30 YEARS (I=7%)(ROUNDED)			**$6,120,000**
		APPROXIMATE TOTAL PRESENT WORTH COST:			**$39,900,000**

Assumptions:
Areas requiring clearing and grubbing are heavily vegetated with trees up to 24" diameter and surface debris removal cost will be covered by the clearing and grubbing cost.
Ruins of the Main Site Buildings (11, 15, 16, and 21) will be cleared to ground elevation and no demolition will be required.
All areas will be cleared of building debris and handled as asbestos containing debris, as appropriate.
Sheet piles will be driven to 70 feet and will encounter bedrock at this depth.
Sheet piles into bedrock will be sufficient with respect to excavation stability concerns.
High frequency hammer will be used to minimize liquefaction potential and building settlement during sheet pile installation.
The water treatment system assumed to have a capacity of approximately 200 gpm for a duration of 4.5 months.
The system would include a pH adjustment system, Polymer feed system, Alum feed system, GAC tanks, multimedia filtration, and solids dewatering.
The water table is approximately 3 feet below the surface based on the remedial investigation data.
The porosity of the soil to be 30% and 100% saturated.
Excavated soil will be staged within the limits of the excavation and allowed to dewater.
Soil that cannot be staged within the excavation limits and allowed to dewater, will be staged on a dewatering pad.
The vegetative soil cover will be placed on existing grade.
The dewatering pad will be placed on existing grade.
The former gas holders are free from debris.
The excavated area for the former gas holders will be blended into existing grade. No backfill material will be placed.
The precharacterization of soil will include one boring for every 100 LF of perimeter for the excavation.
The standing water on the lagoon will be dewatered prior to solidification.
The ground water in the lagoon will be pumped down utilizing the pump from the dewatering pad.
Shallow ground water monitoring wells will be installed to a depth of approximately 15 feet below grade.
The lagoon restoration will consist of placing 6 inches of topsoil with an excavator.
The extents of the former raceway are identifiable by ground surface features.
The drywell area will be analyzed for inorganics and VOCs. The former raceway and main site is assumed to be analyzed for inorganics and SVOCs.
Confirmatory sampling will include one floor sample per 5,000 sf of floor area.
25% of the excavated material will be hauled offsite as hazardous waste and the remaining 75% will be hauled off as nonhazardous waste.
Site maintenance will include fence repair, mowing, soil cover repair, and bank stabilization repair.
Vapor intrusion evaluation includes a Field Activities Plan, 11 air samples, questionnaire, and Letter Report.
Vapor mitigation evaluation includes diagnostic testing, design/installation of sub-slab depression system, commission system /conduct performance testing, and report/documentation.
The site survey will consist of 2 feet contours.
The wall stabilization includes design and implementation to stabilize the wall adjacent to the former metal plating vats (approximately 185 linear feet)
The wall stabilization design will be implemented by an licensed asbestos contractor due to asbestos containing material (ACM) in the area.
Asbestos abatement to address the presence of ACM. Friable/non-friable required to be removed to complete tasks for the former metal plating vat decommissioning.
The asbestos abatement includes associated variances, air monitoring, material handling, transportation, and disposal of ACM debris (non-friable: 450 CY and friable: 50 CY).
The vat decommission includes liquid/sludge removal, charaterization and disposal, vat debris staging and disposal, pressure washing and waste handling/disposal, backfilling with sand, and 6-inch concrete cap construction.
Liquid/sludge quantities based on field measurements obtained in September 2006, but are likely to change because the vats are exposed to the environment.
Non-hazardous liquid/sludge quantity, including pressure washing liquids estimated to total 76,000 gallons
Hazardous liquid/sludge quantity, including pressure washing liquids estimated to total 11,000 gallons
Subsurface investigation costs consist of drilling ($6000), disposal ($500), laboratory analysis ($15,000), and engineering/oversight ($7000).
Bank stabilization includes turbidity curtain, material consolidation, geotextile, topsoil, and gabion basket placement, and live cutting installation along 900 feet of the creek.
Assumes removal of lagoon sediments is limited to the area continuously underwater, approx. 9000 sf.
Assumes no improvement of downstream channel that conducts water to Wappingers creek only during high water periods.
Lagoon and extracted groundwater water will be discharged directly to Wappingers Creek; no treatment necessary.
Assumes two well points sufficient for depression of water table below target elevations.
Assume 15-ft wide stone access way = 12-inch run-of-crush stone (or similar) surface
Assume portland as stabilizing agent at 12% by volume.
Assume 20% volume reduction when dewatered.
Assumed approx 50% refill of material to achieve maximum water depth = 8-ft.

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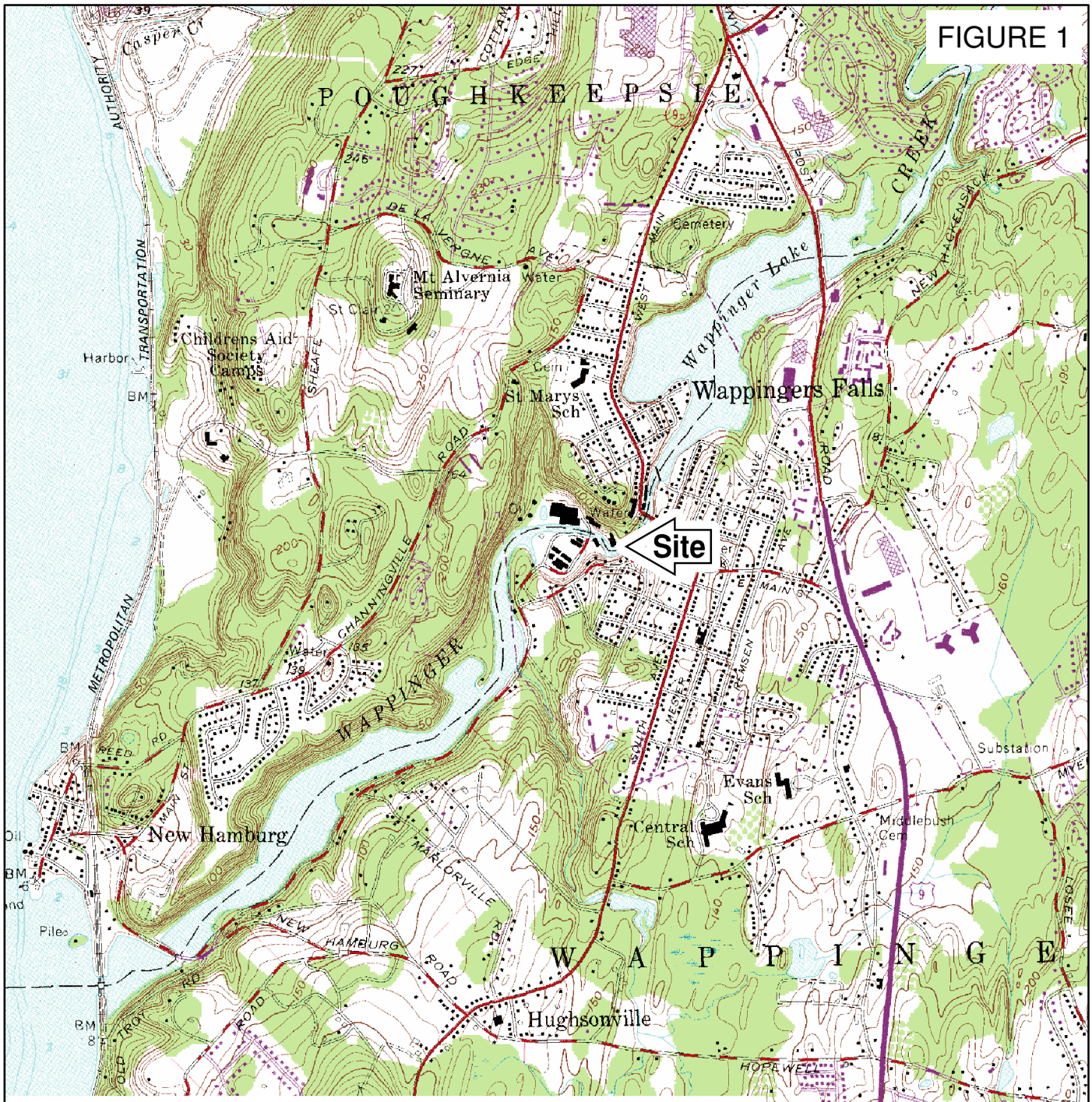
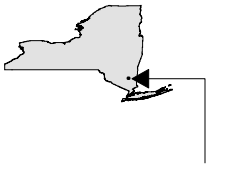


PLOT DATE: 02/09/05 DIV. 84 JPS

ADAPTED FROM: WAPPINGER FALLS,NY USGS QUADRANGLE



QUADRANGLE LOCATION

NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
THREE STAR ANODIZING SITE
WAPPINGERS FALLS, NEW YORK

SITE LOCATION

0 1,000 2,000 4,000 6,000 8,000

Feet

10653.27258
NOVEMBER 2007

1:24,000

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Nov 14, 2007 – 9:29am

FIGURE 2

LEGEND

- SITE BOUNDARY
- SURFACE SOIL AREAS ABOVE PART 375 COMMERCIAL VALUES
- ISOLATED SURFACE SOIL LOCATION ABOVE PART 375 COMMERCIAL VALUES
- LAGOON SEDIMENT LIMITS
- EXISTING BUILDING
- LOWER RACEWAY
- DRY WELL AREA

NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

THREE STAR
ANODIZING SITE
WAPPINGERS FALLS,
NEW YORK

SITE MAP

1"=80' 80 0 80

FILE NO.10653.27258.016
NOVEMBER 2007

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FIGURE 3

LEGEND

- SOIL COVER LIMITS
- LAGOON FILL LIMITS
- EXISTING BUILDING
- *IN–SITU* TREATMENT AREA
- BUFFER ZONE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

THREE STAR ANODIZING SITE WAPPINGERS FALLS, NEW YORK

ALTERNATIVE 3
IN–SITU
TREATMENT

1"=80' 80 0 80

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FIGURE 4

LEGEND

- EXCAVATION/DREDGING LIMITS
- SOIL COVER LIMITS
- LAGOON FILL LIMITS
- EXISTING BUILDING
- BUFFER ZONE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

THREE STAR ANODIZING SITE WAPPINGERS FALLS, NEW YORK

ALTERNATIVE 4 SOIL EXCAVATION AND DISPOSAL

1"=80' 80 0 80

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NOVEMBER 2007

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