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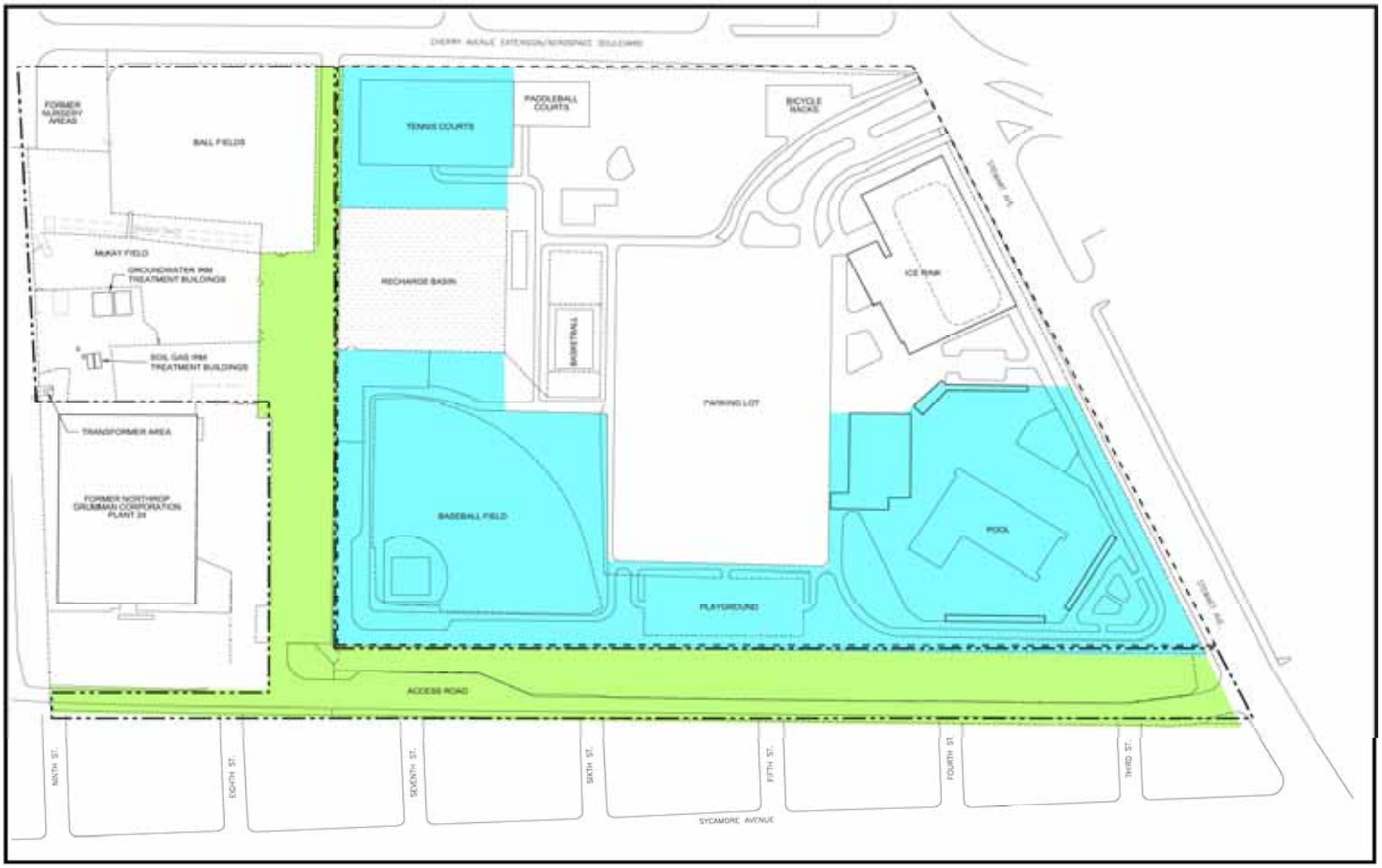
Site Area Feasibility Study

Operable Unit 3 (Former Grumman Settling Ponds),

Bethpage, New York

NYSDEC Site # 1-30-003A

May 12, 2010, revised March 4, 2011



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Site Area Feasibility Study
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York
NYSDEC Site # 1-30-003A

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B Remedial Alternatives Detailed Cost Estimates

ARCADIS

Certification

I, William Wittek, certify that I am currently a NYS registered professional engineer and that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC 2010).

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1. Executive Summary

This Feasibility Study (FS) was prepared by the Northrop Grumman Systems Corporation (Northrop Grumman) to identify and screen remedial technologies and evaluate Remedial Alternatives for constituents in soil, soil gas, and groundwater at the Operable Unit 3 (OU3) (Former Grumman Settling Ponds) Site Area located in Bethpage, New York. As used herein, the term Site Area refers to a portion of the Bethpage Community Park (Park) and the Former Grumman Plant 24 Access Road (Access Road) (see colored areas on Figure 3-1).

Previous investigations conducted within the Site Area (including the Northrop Grumman Site Area Remedial Investigation [RI]) identified site-related impacts to the following media: vadose zone soils, soil gas, groundwater, and various source areas (defined herein as contaminated media displaying a concentration of total volatile organic compounds [VOCs] greater than 10 parts per million [ppm]). The primary contaminants of potential concern (COPCs) identified include VOCs, polychlorinated biphenyls (PCBs), and metals (see Table 4-1 and Figure 4-1 for details).

In 2007, Northrop Grumman implemented two interim remedial measures (IRMs) in the Site Area, i.e., the Soil Gas IRM and the Groundwater IRM, which began operations in February 2008 and July 2009, respectively.

Consistent with New York State Department of Environmental Conservation (NYSDEC) requirements, potential remedial technologies for each impacted media were screened using applicable Standards, Criteria, and Guidelines (SCGs) (see Table 5-1), including the NYSDEC Commissioner's Policy on Soil Cleanup (NYSDEC 2009). The technologies that were retained after screening were assembled into remedial alternatives and evaluated against the remedy selection criteria provided in Part 375-1.8(f) of the Title 6 of the official compilation of New York Codes, Rules, and Regulations (6 NYCRR) (see Table 7-1). Based on the evaluation conducted, the Northrop Grumman Site Area Recommended Remedy is presented in Table 8-1 and summarized below:

<u>Alternative S-P2 (Park Soils):</u>

Excavate soils in the upper two feet with site-related contaminants of potential concern (COPCs) greater than their Restricted Residential SCOs and implement an environmental easement (see Table 7-3).

Alternative S-AR2 (Access Road Soils): Install gravel cap; environmental easements to limit future land use and control future activities (see Table 7-4).

Alternative SA-3 (Source Areas): Remediate VOC Source Areas using In-situ Thermal Desorption (see Table 7-5).

Alternative GW-2 (Groundwater): Operation of OU3 Groundwater IRM to prevent off-site migration of groundwater that exceeds 5 micrograms per liter (ug/L) total VOCs in the upper 20 ft of the aquifer and 50 ug/L of total VOCs below the upper 20 ft of aquifer, transition to natural attenuation with monitoring to address residual VOC impacts once the Groundwater IRM system shutdown criteria are met; an environmental easement to control on-site groundwater use (see Table 7-6).

Alternative SG-2 (Soil Gas): Operation of Soil Gas IRM to prevent offsite migration of onsite soil gas until Soil Gas IRM shutdown criteria are met; an environmental easement requiring engineering controls to address vapor intrusion for all future on-site structures (see Table 7-7).

Northrop Grumman prepared a Human Health Risk Assessment (HHRA) (ARCADIS U.S. Inc. [ARCADIS] 2009a) to address NYSDEC's requirement to "eliminate or mitigate all significant threats to human health," as related to subsurface soils at the Park and the Access Road. Based on the conclusions in the HHRA, there are no significant threats to human health from subsurface soils and Northrop Grumman's recommended remedial alternative is fully protective of human health under current and expected future site use conditions.

2. Purpose

The purpose of this Site Area FS is to identify and screen remedial technologies and evaluate remedial alternatives for contaminants in soil, soil gas, and groundwater at the OU3 Site Area (see Figure 2-1). This report was prepared by ARCADIS on behalf of Northrop Grumman. It is being submitted pursuant to Section II of the Administrative Order on Consent (AOC) between the NYSDEC and Northrop Grumman, effective July 4, 2005 (NYSDEC 2005). A number of figures are included in this FS from the Site Area RI report (ARCADIS 2008) and HHRA (ARCADIS 2009a).

3. Site Description and History

3.1 Site Description

For the purposes of this FS, the Site Area is defined as consisting of the following two sub-areas (see Figure 3-1):

- The portion of the Bethpage Community Park that was not subject to soil removal during the Town of Oyster Bay's redevelopment activities, hereinafter referred to as the "Park" (see colored area within the Bethpage Community Park on Figure 3-1). The Park includes tennis courts in the northwest, a baseball field in the southwest, a playground in the south-central area, and a swimming pool in the southeast. The Park does not include the Town of Oyster Bay's recharge basin. The term "Bethpage Community Park" is used hereinafter to refer to the entire area that constitutes the present day Bethpage Community Park property. The Bethpage Community Park is bordered by commercial properties to the north, Bethpage High School to the east, residential areas to the south, and the former Grumman Plant 24 to the west. Also located to the west are unoccupied properties owned by Northrop Grumman, including the McKay Field property, ball field, and former nursery areas. Further to the west is the former Naval Weapons Industrial Reserve Plant (NWIRP) Site and former Occidental Chemical Corporation RUCO Polymer Site.

- The former Plant 24 Access Road (hereinafter referred to as the Access Road) is owned by Northrop Grumman and is located along the southern and western perimeters of the Park. This industrial property is partially paved with asphalt and partially grassed over. While the paved portion is accessible to the public, the grassy portions are fenced and not publicly accessible.

The approximate location/layout of utilities at the Site Area is provided in Figure 3-2.

3.2 Site History

The land that comprises the present day Bethpage Community Park was primarily farmland prior to its purchase in 1941 by the Grumman Aircraft Engineering Corporation (Grumman), a predecessor of Northrop Grumman, who owned the property until October 1962. In October 1962, Grumman donated the property to the Town of Oyster Bay (Town) for exclusive use as a park. Shortly thereafter, the Town began site development activities (without any Grumman involvement), including

construction of an ice rink, parking lot, picnic and playground areas, a basketball court and baseball field, paddleball courts, shuffleboard courts, horseshoe pits, tennis courts, pool, bicycle rack areas, and a recharge basin.

In 2005, the Town initiated redevelopment of approximately 11 acres of the Bethpage Community Park property (referred to herein as the construction area; see uncolored areas within the Bethpage Community Park on Figure 3-1). The Town executed an AOC with the NYSDEC in 2005 for implementation of an IRM to address contaminated soils in the construction area. In accordance with the AOC, the Town performed an investigation of soil, soil gas, and groundwater in the construction area in 2005 and then submitted work plans to the NYSDEC for excavation and off-site disposal of impacted soil. In their February 10, 2006 comment letter on the Town's IRM work plan, the NYSDEC stated "Based on our experience, the magnitude of the work and the level of effort for this proposed IRM is very extensive and well beyond what the NYSDEC would normally require." The Town implemented the IRM from October 2006 to May 2007, and site redevelopment was completed in early 2008. As part of the IRM, the Town excavated soil from the central, northern, and northeastern portions of the Bethpage Community Park to depths ranging from 2 to 20 feet below ground surface (ft. bgs). In those areas, excavated soil was replaced with clean fill and selected areas were covered with impermeable materials, such as asphalt.

Most of the Bethpage Community Park features were removed during the Town's IRM. Presently, the redeveloped Bethpage Community Park contains two swimming pools, offices, and an ice rink on the eastern side, a parking lot in the center, tennis courts, a basketball court, and a playground on the north side, a baseball field and stormwater recharge basin on the west side, and a playground to the south. Some parts of the Bethpage Community Park are fenced and gated, allowing no public access (e.g., recharge basin and baseball diamond). The publicly accessible parts of the Bethpage Community Park include the swimming pools, offices, ice rink, parking lot, tennis courts, basketball courts, and the small playground on the south side.

In 2007, Northrop Grumman initiated two IRMs in the Site Area to address soil gas and groundwater. A soil gas remediation system (referred to herein as the soil gas IRM) was started up in February 2008 and a groundwater remediation system (referred to herein as the groundwater IRM) was started up in July 2009. These IRMs are further described in Section 4.5 of this report.

4. Summary of Remedial Investigation and Interim Remedial Measures

4.1 Previous Investigations

Investigations conducted within the Site Area prior to the RI include a number of investigations conducted by Northrop Grumman prior to 2004, and preceding investigations completed by the US Navy and the Town. Data from these early investigations were used for scoping the RI and were also incorporated, as applicable, into the conceptual site model and the RI Report (ARCADIS 2008).

This section summarizes the geology and hydrogeology of the Site Area, the nature and extent of Site Area impacts, and the Conceptual Site Model. More detailed discussions of these topics are provided in the Site Area RI Report (ARCADIS 2008).

4.1.1 Site Area Geology

The lithologic sequence within the Site Area, starting at land surface, generally consists of anthropogenic fill material underlain by native soils, which consist primarily of interbedded fine to medium sands. The Site Area soils within the unsaturated zone contain two discrete low permeability zones (i.e., a shallow zone and a deep zone). These zones generally consist of interbedded silts, silty clay, and clay with interbedded sand lenses. The deeper of the low permeability zones (hereinafter referred to as the LPZ) is generally present between 68 and 88 feet above mean sea level (ft msl) and is more widespread and continuous than the shallow zone. The clayey portion of the LPZ thickens and becomes deeper and more prevalent toward the northwest portion of the Site Area. In contrast, the silty portion of the LPZ thins out and becomes shallower toward the southern portion of the Site Area. The LPZ is most prevalent in the central portion of the Site Area and underlying the recharge basin in the northwestern portion of the Site Area.

4.1.2 Site Area Hydrogeology

Shallow groundwater exists under unconfined conditions in the Site Area. Groundwater elevation data indicate a general south-southeasterly flow direction (consistent with the regional flow direction) and a slightly downward vertical gradient. Water table elevations and groundwater flow direction do not appear to be influenced by nearby recharge basins or off-site pumping wells. The elevation of groundwater within the Site Area varies seasonally from 65 to 70 ft msl. The hydraulic gradient across the Site Area was calculated at 0.0016 feet per foot (ft/ft), and the average horizontal

groundwater velocity at the water table was calculated at 1.4 to 2.8 feet per day (ft/day). A localized zone of perched water was encountered between 77 and 82 ft msl, overlying the LPZ in the western portion of the Site Area.

No potable supply wells have been identified within the Site Area. The Bethpage Community Park and all residents in the vicinity of the Site Area reportedly receive potable water from Bethpage Water District municipal wells.

Potential impacts to downgradient potable water supply wells by Site Area contamination are assessed in the Study Area RI Report (ARCADIS 2009 (b)) and identified impacts will be addressed, if needed, in the Study Area FS (currently being written).

4.2 Nature and Extent of Site Area Impacts

Table 4-1 summarizes the nature and extent of the Site Area impacted media including:

- Vadose zone soils (i.e., soils above the water table).
- Soil gas.
- Groundwater.
- Source areas, for the purposes of this FS, are defined as areas of contaminated media that display a concentration of total VOCs greater than 10 parts per million (ppm). Source areas have been identified in vadose zone soils, in the LPZ/perched water, and in groundwater (groundwater includes soils below the water table) within the Park (see Figure 4-1).

The COPCs identified during the RI in soil, soil gas, perched water, the LPZ and groundwater include:

- VOCs primarily trichloroethene (TCE), cis-1, 2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), toluene, ethyl benzene, and xylenes.
- PCBs.
- Metals, primarily cadmium and chromium.

4.3 Conceptual Site Model (CSM)

The CSM developed for the Site Area is shown in Figure 4-2 and is summarized below:

- COPCs have been released within the Site Area (see Figures 3-1, 4-1, and 4-3 through 4-15; primarily VOCs and PCBs, and to a limited extent, metals) over time to soil, soil gas, perched water/LPZ and groundwater.

- Metals identified in soils at the Park and Access Road (referred to as blue-green material; see Figure 4-6) are relatively immobile and have not migrated (vertically or horizontally) to any significant degree.

- PCBs are present in soils throughout the Park and in shallow soils on the Access Road.

- VOCs in Park and Access Road soils, perched water, and groundwater migrate via diffusion to soil gas in the Site Area.

- VOCs in soil gas migrate via diffusion.

- VOCs in Park and Access Road soils migrate via leaching to the LPZ/perched water and groundwater. Migration of VOCs from the LPZ/perched water to groundwater also occurs via leaching and by diffusion during periods of hydraulic contact between the LPZ/perched water and groundwater. In groundwater, VOCs migrate downgradient primarily via advection and, to a lesser extent, by diffusion.

- The potential pathways for, and the rate of, migration of COPCs are directly related to the hydrogeologic conditions underlying the Site Area. The presence and lateral extent of the LPZ, the anisotropy of the saturated zone, as well as differing vertical and horizontal permeabilities in the vadose zone soils have limited the rate of vertical migration of VOCs from soils to other media in the Site Area. Off-site, in the saturated zone, localized, discontinuous zones of lower permeability have comparatively little influence on the downgradient migration of VOCs in groundwater.

- Exposure pathways via dermal contact, ingestion, and inhalation potentially exist from Site Area soils. The Site Area IRMs for soil gas and groundwater (see Section 4.5 of this FS) and existing wellhead protection of downgradient water suppliers prevent other potential exposures.

4.4 Volumes of Impacted Media

The estimated volumes of impacted media are summarized in Table 4-1.

4.5 Interim Remedial Measures (IRMs)

Between 2007 and 2009, Northrop Grumman implemented two IRMs to mitigate potential impacts from Site Area COPCs.

4.5.1 Soil Gas Interim Remedial Measure (Soil Gas IRM)

The soil gas IRM, which was started up in February 2008, was designed to protect off-site properties to the south and southwest of the Park from migration of site-related VOCs in soil gas (see Figure 4-16). A negative pressure gradient is generated and maintained by extraction of soil gas from 18 strategically-located depressurization wells along the southern and southwestern borders of the Access Road property using regenerative blowers. The depressurization wells are connected to the blowers by an underground pipe network. Operational data for the soil gas IRM indicate that the system achieves its design goal and meets RAOs by establishing and maintaining a negative pressure gradient that prevents the off-site migration of site-related VOCs in soil gas. Additional details regarding the soil gas IRM are provided in the Soil Gas 95 Percent Design Report (ARCADIS 2007).

4.5.2 Groundwater Interim Remedial Measure (Groundwater IRM)

The groundwater IRM, which was started up in July 2009, is designed to prevent off-site migration of site-related COPCs in groundwater that exceed 5 micrograms per liter (µg/L) total VOCs in the upper 20 feet of the aquifer, and 50 µg/L below the upper 20 feet of the aquifer (see Figure 4-17). This is accomplished by extracting groundwater from four strategically installed wells along the southern boundary of the Access Road property. The extracted groundwater is conveyed to a treatment plant located on McKay Field via an underground pipe network where the VOCs are removed from the groundwater via an air stripper and iron and other oxidized metals are removed from the treated water stream prior to discharge to the neighboring Nassau County recharge basins. The air stripper off-gas is treated by vapor phase granular activated carbon (VPGAC) and potassium permanganate impregnated zeolite (PPZ) to remove the VOCs prior to discharge to the atmosphere. Additional details regarding the groundwater IRM are provided in the Groundwater IRM Final Design Report (ARCADIS 2008).

Groundwater modeling was conducted as part of this FS to evaluate the impact of expanding the groundwater IRM to capture dissolved-phase TVOCs between 5 and 50 ug/L that are not currently being captured by the Groundwater IRM. The particle tracking and solute-transport models that were originally developed during the Groundwater IRM design were used in this evaluation. The modeling results indicate that expanding the current Groundwater IRM to achieve the additional capture would require a substantially greater volume of groundwater to be extracted and treated but would result in only a marginal improvement in TVOC mass removal (see Appendix A).

5. Remedial Goals and Remedial Action Objectives

This section summarizes the remedial goals and the remedial action objectives (RAOs) for the Site Area.

5.1 Standards, Criteria, and Guidance (SCGs)

Understanding potentially applicable or relevant and appropriate federal, state, and local SCGs helps to identify remedial objectives for the project, potentially appropriate remedial alternatives, and the scope and extent to which retained remedial alternatives can be implemented. The SCGs identified for this FS are summarized in Table 5-1.

“Standards and criteria” are cleanup standards, standards of control, and other substantive environmental requirements, criteria or limitations that are generally applicable, consistently applied, and officially promulgated under federal or state law that are either directly applicable to a contaminant, remedial action, location or other circumstance, or that are not directly applicable but are relevant and appropriate. “Guidance” consists of non-promulgated criteria, advisories, and/or other guidance that are not legal requirements and do not have the same status as “standards and criteria; however, remedial alternatives should consider guidance that, based on professional judgment, may be applicable to the project.

5.2 Remedial Goals

Section 27-1301 of the Environmental Conservation Law states that the goals of the inactive hazardous waste disposal site remedial program are to "eliminate, remove, abate, control or monitor health and/or environmental hazards or potential hazards."

Pursuant to NYSDEC Part 375-2.8(a), (b), and (c), remedial goals for all remedial actions should include:

- Restoring the site to pre-disposal/pre-release conditions, to the extent feasible,
- Eliminating or mitigating all significant threats to public health and the environment through proper application of scientific and engineering principles,
- Removing sources of contamination to the extent feasible. "Feasible" is defined as suitable to site conditions, capable of being successfully carried out with available technology, implementable, and cost effective. (NYSDEC Part 375-1.2)

5.3 Remedial Action Objectives (RAOs)

RAOs developed for the Site Area are medium-specific, risk-based objectives for eliminating or mitigating all significant threats to public health and the environment by the COPCs present in the Site Area.

The RAO identified for Site Area soils is:

- **Prevent exposure** (ingestion, inhalation, dermal contact) to site-related COPCs in soils that exceed SCOs or implement other approved approaches to eliminate or mitigate all significant threats to public heath and the environment.

The RAOs identified for Site Area groundwater are as follows:

- **Prevent ingestion** of groundwater within the Site Area exceeding applicable drinking water standards.
- **Prevent exposure** (direct contact, inhalation) to site-related COPCs in groundwater within the Site Area.
- **Prevent off-site migration** of site-related COPCs in groundwater that exceed 5 µg/L total VOCs in the upper 20 feet of the aquifer, and 50 µg/L below the upper 20 feet of the aquifer.

The RAOs identified for Site Area soil gas are as follows:

- **Prevent off-site migration** of site-related VOCs in soil gas exceeding ambient background concentrations and, in turn, prevent off-site exposure (inhalation) to site-related VOCs in soil gas exceeding NYSDOH air guidelines.

- **Prevent on-site exposure** (inhalation) to site-related VOCs in soil gas exceeding NYSDOH air guidelines.

The RAOs identified for Site Area source areas are as follows:

- **Reduce total VOC concentrations** to 1 mg/kg or less (or stabilize the contaminant mass) in vadose zone VOC source areas (i.e., total VOCs greater than 10 mg/kg) to minimize potential migration of VOCs to groundwater and soil gas.

- **Reduce total VOC concentrations** to 1 mg/L or less in groundwater and perched water VOC source areas (i.e., total VOCs greater than 10 mg/L) to minimize potential migration of VOCs to surrounding groundwater.

6. Identification and Screening of Remedial Technologies

The purpose of this section is to identify and screen a range of remedial technologies to address impacted soil, soil gas, groundwater, and source areas. Select technologies are further evaluated during the detailed analysis of the remedial alternatives presented in Section 7 of this report.

The list of remedial technologies was developed in cooperation with the NYSDEC and is focused on those technologies that are best suited to address the COPCs and impacted media. In accordance with NYSDEC guidance (2006), the identified technologies were screened using the following criteria:

- Effectiveness – Potential effectiveness in achieving RAOs; reliability of technology; and potential impacts to human health and the environment.

- Implementability – Technical and administrative feasibility of implementing the technology at the site.

- Relative cost – Relative cost to implement the technology, including capital cost and cost for operation, maintenance, and monitoring (OM&M).

The results of the remedial technology screening conducted for Site Area soils, source areas, and groundwater are presented in Tables 6-1 through 6-3, respectively. Screening of soil gas remediation technologies was not necessary because the existing soil gas IRM already achieves the soil gas RAOs and a detailed evaluation of the soil gas IRM is presented in Section 7.

7. Development and Analysis of Remedial Alternatives

Using the remedial technologies retained from the screening process described in Section 6 of this FS, remedial alternatives were developed and evaluated against the following general criteria in 6 NYCRR Part 375 1.8:

a. Source Removal and Control Measures: Preference is for source removal and/or treatment. All sources, concentrated liquid or semi-solid hazardous substances, dense non-aqueous phase liquid, light non-aqueous phase liquid, and or grossly contaminated media shall be removed and/or treated; provided however, if the removal and/or treatment is not feasible, such contamination shall be removed or treated to the greatest extent possible.

b. Groundwater Protection and Control Measures: Restoration of groundwater shall be evaluated to determine measures required to restore groundwater quality to applicable standards and guidance.

The remedial alternatives were then evaluated against the seven remedial selection criteria identified in 6NYCRR Part 375 – 1.8 (f). Definitions of those remedy selection criteria are provided in Table 7-1.

Table 7-2 provides a summary of the remedial alternatives evaluated. Detailed analyses of the remedial alternatives are presented in Table 7-3 (Park Soils), Table 7-4 (Access Road Soils), Table 7-5 (Source Areas), Table 7-6 (Groundwater), and Table 7-7 (Soil Gas). The Northrop Grumman-recommended remedial alternatives are also identified in Tables 7-3 through 7-7, along with the rationale for their selection.

8. Northrop Grumman Recommended Remedy

This section summarizes Northrop Grumman's Recommended Remedy and summarizes the Human Health Risk Assessment (HHRA) that was performed as part of this FS.

8.1 Summary of Northrop Grumman's Recommended Remedy

Based on the analyses conducted in this FS, Northrop Grumman's Site Area recommended remedy is summarized below.

Park Soils Alternative S-P2

- Excavation of soils in the upper 2 feet that have Site-related COPCs greater than Restricted Residential SCOs and replace with clean fill.
- A demarcation layer will be placed between clean fill and remaining soils, where applicable.
- An environmental easement to limit current and future site uses and activities.

Access Road Soils Alternative S-AR2

- Installation of a gravel cap over surface soils that exceed Restricted Residential SCOs.
- Fencing and signs to control access.
- An environmental easement to limit future site uses and activities.

Groundwater Alternative GW-2

- Operation, maintenance, and monitoring of the existing Groundwater IRM to prevent offsite migration of site-related VOCs in groundwater that exceed 5 ug/L TVOCs in the upper 20 feet of the aquifer and 50 ug/L below the upper 20 feet.
- An environmental easement to prevent use of groundwater from within the Site Area.
- After IRM system shutdown criteria are achieved (shutdown criteria will be provided in the OM&M Manual), transition from active system operation to natural attenuation with monitoring to address residual COPCs.

Source Areas Alternative SA-3

- Treat Source Areas (i.e., total VOCs greater than 10 mg/kg and 10 mg/L) in soil and groundwater, respectively, using in-situ thermal desorption (ISTD) to reduce soil and groundwater TVOC concentrations to 1 mg/kg and 1 mg/l or less, respectively, (groundwater includes soils below the water table).

Soil Gas Alternative SG-2

- Operation, maintenance, and monitoring of the existing Soil Gas IRM to prevent the offsite migration of onsite soil gas until IRM shutdown criteria are achieved (shutdown criteria will be provided in the OM&M Manual).

- An environmental easement to require engineering controls on all future onsite structures to address potential vapor intrusion.

A more detailed summary of the recommended remedy is presented in Table 8-1, along with estimated costs for the recommended alternatives.

As presented in Tables 7-3 through 7-7, the Northrop Grumman Site Area Recommended Remedy meets the following criteria:

- Protects human health and the environment under current and future land uses.

- Prevents exposure to constituents in Site Area soil, soil gas, and groundwater under current and future land uses.

- Capable of achieving RAOs.

- Complies with SCGs, to the extent feasible.

- Technically and administratively implementable.

- Effective in short term and long term.

- Reduces the toxicity, volume, and mobility of contaminants through treatment, to the extent feasible.

- Cost effective.

Where applicable, environmental easements have been incorporated into the recommended alternatives to help ensure that the Northrop Grumman Recommended Remedy is protective of human health for reasonably anticipated future land uses for the Park and Access Road. Per Northrop Grumman's agreement with the Town, the Bethpage Community Park must continue to be used as a public park by the Town, otherwise ownership of the Park will revert back to Northrop Grumman. Northrop Grumman currently owns the Former Plant 24 Access Road and expects that it will continue to be used as an access road.

In addition to the above regulatory-driven selection criteria, Northrop Grumman has considered alternatives that conserve limited energy and other resources, for example, discontinuing operation of active remediation systems once they achieve shutdown criteria and transitioning to natural attenuation with monitoring.

8.2 Summary of Human Health Risk Assessment (HHRA)

An HHRA (ARCADIS 2009) was prepared in general accordance with applicable NYSDEC (NYSDEC 2008) and U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1989, 1992, 1997, 2001, 2002, and 2004) to evaluate human health risks posed by COPCs in Site Area soils and to confirm that the recommended remedy is protective of human health. The HHRA differed slightly from a standard baseline risk assessment in that certain exposure assumptions were made (e.g., limited surface soil removal or cover placement in portions of the Park and cover placement on portions of the Access Road).

The HHRA was developed to provide a site-specific assessment of risk associated with exposure to soils in the Park and Access Road properties because NYSDEC's Soil Cleanup Objectives (NYSDEC 2006) were developed using standard exposure assumptions that differ from site-specific exposures and conditions in these areas. Several VOCs, semi-volatile organic compounds (SVOCs [primarily PAHs]), PCBs, and metals were identified as COPCs that were quantitatively evaluated for Park soils. PCBs, arsenic, cadmium, and chromium were identified as COPCs that were quantitatively evaluated for the Access Road soils. Potentially complete exposure pathways that were quantitatively evaluated as part of the HHRA included exposure of utility workers and construction workers to soils at the Park and exposure of utility workers to soils within the Access Road. Potential soil exposure routes included ingestion, dermal contact, and inhalation of volatiles and particulates.

The HHRA indicates that both carcinogenic and non-carcinogenic risks associated with Site Area soils are within USEPA's acceptable risk range. Specifically, cancer risks for utility workers and construction workers are on the low end of USEPA's risk management range of 1×10^{-4} to 1×10^{-7}, and the non-cancer risks for utility workers and construction workers are less than a Hazard Index of 1. In summary, the results of the HHRA confirmed that the Northrop Grumman recommended remedy (see Section 8 above) is protective of human health.

9. References

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Table 4-1. Nature, Extent, and Volumes of Site Area Impacts, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Media/Sub Area	COPCs			Nature and Extent of COPCs [2]	Impacted [3] Volumes (yds)
	VOCs	Metals	PCBs		
Soil					
Park	X	X	X	• VOCs exceeding Restricted Residential Soil Cleanup Objectives (SCOs), including VC, cis-1,2-DCE, TCE, toluene, Xylenes and ethyl benzene, were found in localized areas within the Park (Figures 4-3 and 4-4) • Primary metals exceeding Restricted Residential SCOs are chromium and, to a lesser degree, cadmium. Exceedances range up to two orders of magnitude above SCOs (Figure 4-5). • Discrete pockets of metal-containing Blue-Green Material were detected in Park Soils (Figure 4-6). • PCBs exceed Restricted Residential SCO by up to three orders of magnitude in the southwest portion of the Park (Figure 4-7).	~230,000
Access Road	X	X	X	• VOCs exceeding Restricted Residential SCOs, including toluene and Xylenes, were found in localized areas within the western portion of the Access Road (Figure 4-3). • Metals and PCBs exceeding Restricted Residential SCOs are widespread on the access road, with generally higher concentrations and most exceedances found on the easternmost portion (Figures 4-5, 4-8 and 4-9).	~17,000
Soil Gas					
	X			• VOCs in soil gas underlie the Park area, with concentrations decreasing substantially in all directions away from the Park (Figures 4-10 and 4-11). • The primary sources of VOCs in soil gas in the Park appear to be VOCs in soil and, to a lesser extent, VOCs in perched water and shallow groundwater. TCE was the most representative of the VOCs found in soil gas and the highest concentrations were generally found in the southwest portion of the Park, the parking lot, and the pool area. • Freons-12 and -22, found in soil gas near the former ice rink, have been attributed to Town of Oyster Bay operations in the Park (Figures 4-12 and 4-13)	~2,000,000

Table 4-1. Nature, Extent, and Volumes of Site Area Impacts, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Media/Sub Area	COPCs			Nature and Extent of COPCs [2]	Impacted [3] Volumes (yds)
	VOCs	Metals	PCBs		
Groundwater					
	X	X [1]		• VOCs exceeding SCGs (i.e., Technical and Operational Guidance Series [TOGs] [1.1.1]) in groundwater, including toluene, TCE, cis-1,2-DCE, and VC, were found primarily in the Park (Figure 4-14). • A groundwater plume approximately 1,200 feet wide and 150 feet deep was delineated within the Site Area. Groundwater data indicate that the VOC plume extends downgradient of the Site Area and that it is migrating vertically downward (Figure 4-14). • Freon-22, found in groundwater near the former ice rink, has been attributed to Town of Oyster Bay operations in the Park (Figure 4-15).	~73,000,000 [4]
Source Areas					
Park Vadose Zone Soils	X			• Park soils contain total VOCs at concentrations greater than 10 mg/kg in some areas (Figure 4-1). • The areas with the greatest VOC mass in Park soils are shown on Figure 4-1. In the VOC source area located in the northeast corner of the ball field, VOC concentrations generally increase with depth with the highest concentrations found within the LPZ, at depths of 40 ft bls to the water table.	~25,000
Perched Water/ Low	X			• Perched water/LPZ contains total VOCs greater than 10 ppm in some areas (Figure 4-1). • Perched water and LPZ are present in the southwest portion of the Park but the LPZ extends beyond the limits of the perched water (Figure 4-1). The LPZ is seasonally in contact with the water table • The highest concentration of total VOCs found in perched water was 120 mg/L. The primary VOCs in perched water include TCE, cis-1,2-DCE, VC, Xylenes, toluene, and ethyl benzene. The primary VOCs in the LPZ include toluene, Xylenes, ethyl benzene, TCE, cis-1,2-DCE, 1,1,1-TCA, and VC.	~23,000
Groundwater/ Saturated Soils	X			• Total VOC concentrations greater than 10 mg/L were found in groundwater downgradient of the northeast corner of the ball field. The VOC detected at the highest concentration in that area is cis-1,2-DCE (210 mg/L) (Figure 4-1) .	~4,000

Table 4-1. Nature, Extent, and Volumes of Site Area Impacts, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

NOTES:

(1) Chromium was the only metal exceeding SCGs in groundwater in a limited area south of the northeast corner of the ball field.

(2) For Standards, Criteria, and Guidance Values (SCGs) that were used to evaluate the data, please refer to the OU3 Site Area RI Report. (ARCADIS 2008).

(3) Volumes of impacted materials were estimated for the different Media/Sub Area as follows:
- Park Soils: estimated using Figures 4-1, and 4-3 thru 4-7, where possible (e.g. PCBs) impacted volumes were calculated using unrestricted use SCOs.
- Access Road: estimated using Figures 4-3, 4-5, 4-8 and 4-9, where possible (e.g. PCBs) impacted volumes were calculated using unrestricted use SCOs.
- Soil Gas: entire site (1,100 ft x 900 ft) down to watertable (55' bls), includes Town of Oyster Bay Area (Figures 4-10 thru 4-13).
- Groundwater: From groundwater model in Appendix A, includes Town of Oyster Bay Area.
- Vadose Zone Source Area: areal extent estimated using Figure 4-1 and an assumed thickness of 45'.
- Low Permeability Zone and Perched Water Source Area: areal extent estimated using Figure 4-1 and an assumed thickness of 10'.
- Groundwater and Saturated Soils Source Area: areal extent estimated using Figure 4-1 and an assumed thickness of 7'.

(4) Volume in gallons.

DEFINITIONS:

COPCs	Constituents of Potential Concern
VOCs	Volatile Organic Compounds
SVOCs	Semi-Volatile Organic Compounds
PCBs	Polychlorinated Biphenyls
LPZ	Low Permeability Zone
SCGs	Standards, Criteria, and Guidance Values
VC	Vinyl Chloride
TCE	Trichloroethene
cis-1,2-DCE	cis-1,2-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
ft bls	feet below land surface
mg/L	milligrams per Liter

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
Chemical-Specific SCGs				
Clean Water Act (CWA) - Ambient Water Quality Criteria	40 CFR Part 131; EPA 440/5-86/001 "Quality Criteria for Water - 1986", superseded by EPA-822-R-02-047 "National Recommended Water Quality Criteria: 2002"	S	Criteria for protection of aquatic life and/or human health depending on designated water use.	Potentially applicable depending on designated water use.
CWA Section 136	40 CFR 136	G	Identifies guidelines for test procedures for the analysis of pollutants.	Potentially applicable depending on designated water use.
CWA Section 404	33 USC 1344	S	Regulates discharges to surface water or ocean, indirect discharges to POTWs, and discharge of dredged or fill material into waters of the U.S. (including wetlands).	Potentially applicable for remedial activities that include dredging or capping and/or the treatment of water generated during excavation and dewatering activities.
National Primary Drinking Water Standards	40 CFR Part 141	S	Establishes maximum contaminant levels (MCLs) which are health-based standards for public water supply systems.	Potentially applicable for groundwater related remedial actions.
RCRA-Regulated Levels for Toxic Characteristics Leaching Procedure (TCLP) Constituents	40 CFR Part 261	S	These regulations specify the TCLP constituent levels for identification of hazardous wastes that exhibit the characteristic of toxicity.	Potentially applicable to remedial activities that generate waste materials that may require sampling/analysis for TCLP constituents to determine if the materials are hazardous (based on the characteristic of toxicity) prior to disposal.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
Universal Treatment Standards/Land Disposal Restrictions (UTS/LDRs)	40 CFR Part 268	S	Identifies hazardous wastes for which land disposal is restricted and provides a set of numerical constituent concentration criteria at which hazardous waste is restricted from land disposal (without treatment).	Applicable if waste material is determined to be hazardous and is designated for off-site land disposal.
New York State Environmental Remediation Programs	6 NYCRR Part 375, as amended 12/14/06	S/G	Describes process for the development and execution of remedial programs in New York State (NYS), and provides soil cleanup objectives (SCOs) for various site usages.	Applicable for site investigation, remedy selection, and site remediation.
NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 (6/98, revised 4/00)	S/G	Provides a compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in the NYSDEC programs.	These standards and guidance values are applicable to site remedial programs and should be considered in evaluating groundwater and surface water quality and remediation.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and subject to regulation under 6 NYCRR Parts 370 thru 376.	Applicable for determining if waste material generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
New York State Surface Water and Groundwater Quality Standards	6 NYCRR Parts 700 thru 706	S	Establishes quality standards for surface water and groundwater.	Applicable for assessing water quality at the site during remedial activities.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
Potential Action-Specific SCGs				
Occupational Safety and Health Act (OSHA) - General Industry Standards	29 CFR Part 1910	S	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Applicable where on-site activities have the potential to exposure workers to site-related contaminants.
OSHA - Safety and Health Standards	29 CFR Part 1926	S	These regulations specify the type of safety equipment and procedures to be followed during site remediation.	Applicable where on-site activities have the potential to exposure workers to site-related contaminants.
OSHA - Record-keeping, Reporting and Related Regulations	29 CFR Part 1904	S	These regulations outline record-keeping and reporting requirements for an employer under OSHA, and apply to the company(s) contracted to install, operate, and maintain remedial actions at hazardous waste sites.	Applicable where on-site activities have the potential to exposure workers to site-related contaminants.
RCRA - Preparedness and Prevention	40 CFR Part 264.30 - 264.31	S	These regulations outline requirements for safety equipment and spill control when treating, handling and/or storing hazardous wastes.	Potentially applicable to remedial activities.
RCRA - Contingency Plan and Emergency Procedures	40 CFR Part 264.50 - 264.56	S	Provides requirements for emergency contingency planning and procedures to be used following explosions, fires, etc. when storing hazardous wastes.	Potentially applicable to remedial activities.
CWA - Discharge to Waters of the U.S., and Section 404	40 CFR Parts 403, and 230 Section 404 (b) (1); 33 USC 1344	S	Establishes site-specific pollutant discharge limitations and performance standards that are designed to protect surface water quality. Types of discharges regulated under CWA include: indirect discharge to a POTW, and discharge of dredged or fill material into U.S. waters.	Potentially applicable to remedial activities.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
RCRA - General Standards	40 CFR Part 264.111	S	General performance standards requiring minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Also requires decontamination or disposal of contaminated equipment, structures and soils.	Potentially applicable to decontamination activities conducted for remedial activities (if applicable).
Standards Applicable to Transporters of Applicable Hazardous Waste - RCRA Section 3003	40 CFR Parts 170-179, 262, and 263	S	Establishes the responsibility of off-site transporters of hazardous waste in the handling, transportation and management of the waste. Requires manifesting, recordkeeping and immediate action in the event of a discharge.	These requirements are applicable to any company(s) contracted to transport hazardous material from the site.
United States Department of Transportation (USDOT) Rules for Transportation of Hazardous Materials	49 CFR Parts 107 and 171.1 - 172.558	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	These requirements are applicable to any company(s) contracted to transport hazardous material from the site.
Clean Air Act-National Ambient Air Quality Standards	40 CFR Part 50	S	Establishes ambient air quality standards for protection of public health.	Applicable to remedial systems that generate air emissions.
USEPA-Administered Permit Program: The Hazardous Waste Permit Program	RCRA Section 3005; 40 CFR Part 270.124	S	Covers the basic permitting, application, monitoring and reporting requirements for off-site hazardous waste management facilities.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the site remedy will include consideration of these requirements.
New York Air Quality Classification System	6 NYCRR Part 256	S	Outlines the air quality classifications for different land uses and population densities.	Air quality classification system will be considered during the treatment process design.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
National Emission Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 61	S	Provides air emission standards for hazardous air pollutants.	Applicable to remedial systems that generate air emissions. Remedial system design will consider appropriate air emissions controls to meet these regulations.
New York Permits and Certificates	6 NYCRR Part 201	S	Provides instructions and regulations for obtaining a permit to operate an air emission source. Also provides instructions on what to do in case of malfunction.	NYS permits are not required for remedial actions implemented under Consent Order at NYS Inactive Hazardous Waste sites; however, documentation will be developed to assure relevant and appropriate permit conditions are complied with.
New York Emissions Testing, Sampling, and Analytical Determinations	6 NYCRR Part 202	S	Outlines requirements for emissions testing for air emission sources. States that independent emissions testing can be ordered by the Commissioner of the NYSDEC.	Applicable to remedial systems as emissions from treatment procedure must be analyzed.
New York Regulations for General Process Emissions	6 NYCRR Part 212	S	Outlines the procedure of environmental rating. The Commissioner determines a rating of emissions based on sampling.	The Commissioner will issue an environmental rating for emissions based on this regulation.
Protection of Significant Deterioration of Air Quality (PSD)	40 CFR Part 51.2	S	New major stationary sources may be subject to PSD review [i.e., require best available control technology (BACT), lowest achievable detection limit (LAEL), and/or emission off-sets.	If necessary, PSD procedures will be included in the remedial design/remedial action process. The procedures could be expanded to BACT and LAEL evaluations.
New York Air Quality Standards	6 NYCRR Part 257	S	Provides air quality standards for different chemicals (including those found at the site), particles, and processes.	Applicable to remedial systems and emissions from treatment processes will meet the air quality standards.
Land Disposal Facility Notice in Deed	40 CFR Parts 264/265	S	Establishes provisions for a deed notation for closed hazardous waste disposal units to prevent land disturbance by future owners.	The regulations are potentially applicable because closed areas may be similar to closed RCRA units.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
Land Disposal Restrictions	40 CFR Part 268	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous waste must be treated prior to land disposal.	Waste materials that display the characteristic of hazardous waste or that are re-characterized after generation must be treated to 90% constituent concentration reduction capped at 10 times the UTS.
RCRA Subtitle C	40 U.S.C. Section 6901 et seq.; 40 CFR Part 268	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes UTSs to which hazardous wastes must be treated prior to land disposal.	Potentially applicable to remedial activities that include disposal of generated waste material from the site.
NYSDEC's Monitoring Well Decommissioning Guidelines	NPL Site Monitoring Well Decommissioning dated May 1995	G	This guidance presents procedure for abandonment of monitoring wells at remediation sites.	This guidance is applicable for remedial alternatives that require the decommissioning of monitoring wells onsite.
Guidelines for the Control of Toxic Ambient Air Contaminants	DAR-1 (Air Guide 1)	G	Provides guidance for the control of toxic ambient air contaminants in New York State and outlines the procedures for evaluating sources of air pollution	This guidance may be applicable for remedial alternatives that result in certain air emissions.
New York Hazardous Waste Management System - General	6 NYCRR Part 370	S	Provides definitions of terms and general instructions for the Part 370 series of hazardous waste management.	Applicable where hazardous waste is to be managed.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste subject to regulation under 6 NYCRR Parts 370 thru 376.	Applicable for determining if solid waste generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	6 NYCRR Part 372	S	Provides guidelines relating to the use of the manifest system and its recordkeeping requirements. It applies to generators, transporters and facilities in New York State.	This regulation is applicable to any company(s) contracted to do treatment work at the site or to transport or manage hazardous material generated at the site.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
New York Regulations for Transportation of Hazardous Waste	6 NYCRR Part 372.3 a-d	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous waste.	These requirements are applicable to any company(s) contracted to transport hazardous material from the site.
Waste Transporter Permits	6 NYCRR Part 364	S	Governs the collection, transport and delivery of regulated waste within New York State.	These requirements are applicable to any company(s) contracted to transport hazardous material from the site
NYSDEC Technical and Administrative Guidance Memorandums (TAGMs)	NYSDEC TAGMs	G	TAGMs are NYSDEC guidance that are to be considered during the remedial process.	Appropriate TAGMs will be considered during the remedial process.
New York Regulations for Hazardous Waste Management Facilities	6 NYCRR Part 373.1.1 - 373.1.8	S	Provides requirements and procedures for obtaining a permit to operate a hazardous waste treatment, storage and disposal facility. Also lists contents and conditions of permits.	These requirements are applicable to any off-site facility accepting waste from the site.
Land Disposal of a Hazardous Waste	6 NYCRR Part 376	S	Restricts land disposal of hazardous wastes that exceed specific criteria.	New York defers to USEPA for UTS/LDR regulations.
National Pollutant Discharge Elimination System (NPDES) Program Requirements, Administered Under New York State Pollution Discharge Elimination System (SPDES)	40 CFR Parts 122 Subpart B, 125, 301, 303, and 307 (Administered under 6 NYCRR 750-758)	S	Establishes permitting requirements for point source discharges; regulates discharge of water into navigable waters including the quantity and quality of discharge.	Applicable to site remedial activities that involve treatment/disposal of water.

Table 5-1. Potential Chemical-, Action-, and Location-Specific Standards, Criteria, and Guidelines (SCGs), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/ Remedial Action
NYSDEC Division of Environmental Remediation (DER) Numbered Technical Guidance Series Documents	DER-10 (Technical Guidance for Site Investigation and Remediation); NYSDEC Commissioner's Policy on "Soil Clean-Up Guidance"; and other applicable documents	G	DER-10: Provides guidance on NYSDEC-accepted site investigation and remediation processes. Commissioner's Soil Clean-up Guidance Policy: Provides a uniform process for the evaluation and cleanup of contaminated soil.	Applicable to remedy evaluation process and site remedial activities.
Potential Location-Specific SCGs				
New York Preservation of Historic Structures or Artifacts	Section 14.09	Applicable	Requirements for preservation of historical/archeological artifacts.	Activities must be done to identify, preserve, and recover artifacts if the site has been identified as containing significant historical artifacts.
Local Building Permits	N/A	S	Local authorities may require a building permit for any permanent or semi-permanent structure, such as an on-site water treatment system building.	Substantive provisions are potentially applicable to remedial activities that require construction of permanent or semi-permanent structures.

DEFINITIONS:

CFR Code of Federal Regulations
EPA US Environmental Protection Agency
NYCRR Official Compilation of New York Code, Rules and Regulations
NYSDEC New York State Department of Environmental Conservation

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Table 6-1. Screening of Remedial Technologies: Soils,
Site Area Feasibility Study, Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
No Action	None	Not Applicable	No institutional or engineering controls implemented.	**Ineffective** - Does not control exposure to impacted soil. Not capable of achieving Soil RAO.	**Implementable** - No new measures would be implemented.	Low	Yes	Detailed evaluation of No Action alternative required in FS.
Environmental Easement	Institutional Controls/Engineering Controls	Fences and Signs	Fencing and posted signs used to restrict exposure to impacted soil and access to remedial systems.	**Effective** - Effective in limiting site access and direct contact with impacted soil. No contamination reduction. When used in conjunction with other remedial actions is capable of achieving Soil RAO.	**Implementable** - Some fencing and signs already in place. Readily implementable.	Low	Yes	
		Land Use Restriction	Legal controls used to restrict future land uses and control activities involving contact with impacted soil.	**Effective** - Effective in limiting exposure to impacted soils. No contamination reduction. When used in conjunction with other remedial actions is capable of achieving Soil RAO.	**Implementable** - Readily implementable. Will require time and coordination with the property owner. Restrictions on future land use.	Low	Yes	
Containment Action	Cap	Gravel Cap	Gravel cap used to cover impacted soil.	**Effective** - Effective in eliminating exposure to impacted soils; conventional technology. Susceptible to erosion. No contamination reduction. With long-term maintenance, capable of achieving Soil RAO.	**Implementable** - Readily implementable; conventional construction; restrictions on future land use.	Low	Yes	
		Asphalt or Concrete Cap	Asphalt or concrete pavement used to cover impacted soil.	**Effective** - Effective in eliminating exposure to impacted soils; conventional technology. Susceptible to weathering and cracking. No contamination reduction. With long-term maintenance, capable of achieving Soil RAO.	**Implementable** - Readily implementable; conventional construction; restrictions on future land use. Impermeable surface would result in generation of stormwater runoff requiring management and discharge.	Moderate	No	Not retained for detailed evaluation because no added benefit over gravel cap and would result in significant stormwater runoff production.
Removal Action	Excavation	Excavation	Physical removal of impacted soil.	**Effective** - Effective in eliminating exposure to impacted soils; conventional technology. Achieves permanent contamination reduction on-site. In combination with off-site disposal, vapor collection/treatment (if needed), and long term groundwater monitoring, capable of achieving Soil RAO.	**Implementable** - Readily implementable for shallow soils; conventional construction (previously used at the site under Town of Oyster Bay soil IRM). Very difficult to implement at greater depths. Short term impact to site usage while excavation activities are underway. May require collection/treatment of fugitive air emissions and groundwater monitoring.	Low to Very High	Yes	

Table 6-1. Screening of Remedial Technologies: Soils, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
Disposal Action	Off-site Disposal/Treatment	Off-site Disposal/Treatment Facility	Off-site disposal of excavated materials at permitted off-site facility.	**Effective** - Effective in proper management of excavated soils; conventional technology. In conjunction with soil excavation, capable of achieving Soil RAO.	**Implementable** - Readily implementable (previously used at the site under Town of Oyster Bay soil IRM). Requires detailed characterization (waste profiling), segregation, and management of excavated soil for disposal.	Moderate to Very High	Yes	
Treatment Actions	In-Situ Chemical / Physical	Stabilization/Solidification	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	**Effective -** Effective at reducing the mobility of metals; conventional technology. Capable of achieving Soil RAO.	**Implementable** - Readily implementable for metals.	Low to Moderate	Yes	
		Enhanced Stabilization/Solidification/ Treatment (ZVI/Clay)	ZVI/Clay treatment is designed to 1) physically encapsulate contaminants within stabilized mass (solidification); 2) chemically react with contaminants to reduce their mobility (stabilization); and 3) reduce contaminant concentrations through reductive dechlorination.	**Effective -** Effective in solidification of SVOCs, PCBs, and metals; partially effective for solidification of VOCs. Effective for treatment of leachable VOCs and stabilization of leachable metals. Effectiveness in treating PCBs not determined. May not be capable of achieving Soil RAO.	**Implementable** - Readily implementable for VOCs, SVOCs, and metals. Short term site usage restrictions due to loss of soil structural integrity while the ZVI/Clay/Soil mixture consolidates; long term site usage restrictions can be mitigated through the inclusion of portland cement within the ZVI/Clay/Soil mixture. Additional testing required to determine treatability of PCBs.	Very High	No	Not retained for further evaluation because technology is not cost effective for shallow soils (0 to 2 ft), treatability of PCBs is questionable, and restrictions on post-construction site use.
	In-Situ Thermal Treatment	In-Situ Thermal Desorption (ISTD)	ISTD uses convective heating to increase the volatilization rate of PCBs. Heat is applied to the site soils via numerous vertical wells. System also incorporates a site cap and vapor extraction system to capture volatilized PCBs.	**Effective** - Effective in treating PCBs. When combined with off-gas treatment, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Requires off-gas treatment for air emissions. Restricts site usage in short term due to large quantity of infrastructure needed (e.g., electrical generator/power supply, site cap, large quantities of off-gas treatment media).	High	Yes	Applicable to: - PCBs in soils between 2' and 6' below land surface.

DEFINITIONS:

COPCs	Contaminants of Potential Concern
FS	Feasibility Study
GW IRM	Groundwater Interim Remedial Measure
IRM	Interim Remedial Measure
PCBs	Polychlorinated Biphenyls
Soil RAO	Remedial Action Objectives
SCGs	Standard, Criteria and Guidelines
SCOs	Soil Cleanup Objectives
SG IRM	Soil Gas Interim Remedial Measure
VOC	Volatile Organic Compounds
ZVI	Zero Valent Iron

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Appendix A

Groundwater Modeling Memo

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MEMO

To:
Carlo San Giovanni
Mike Wolfert
Bill Wittek

Copies:
File

From:
Doug Smolensky and Robert Porsche

Date:
August 14, 2009
Revised October 19, 2010

ARCADIS Project No.:
NY001493.1109.00001

Subject:
Results of Groundwater Modeling Simulations and Environmental Visualization System Estimates conducted in support of the OU-3 Site Area Feasibility Study, Northrop Grumman Systems Corporation, Bethpage, New York.

Summary

Results of modeling performed indicates that to capture all groundwater with total volatile organic compound (TVOC) concentrations greater than 5 micrograms per liter (µg/L) migrating beneath the Access Road would require supplementing the existing groundwater interim remedial measure (GW IRM) with four additional/deeper wells and pumping nearly double the GW IRM design flow rate.

Over the 30-year evaluation period, the Enhanced IRM (8 well system) removes approximately 10 percent more mass than the GW IRM (4 well system), but requires a system-wide groundwater extraction rate increase of approximately 86 percent.

Introduction

This memo summarizes the results of groundwater modeling simulations conducted in support of the OU-3 Site Area Feasibility Study (FS) for the Northrop Grumman Systems Corporation, Bethpage, New York. This memo describes the scenarios simulated, the applied modeling methodology, and simulation results.

Groundwater modeling was conducted using the IRM-design model, which was previously configured for flow and transport evaluation of the 4-well interim remedial system. The distribution of contaminant mass used for the modeling simulations was consistent with the TVOC mapped data as presented in the OU-3 Site Area Remedial Investigation Report (ARCADIS, 2008).

Purpose

The groundwater modeling simulations described in this memo were conducted to support:

- The development of system design/costs for the implementation of the remedial alternatives being considered.
- The evaluation of model-predicted clean-up times.

Method

The two remedial scenarios under consideration and evaluated here are:

1. GW IRM
    a. Containment of TVOCs> 5 ug/L in the upper 20 ft of aquifer and containment of TVOCs>50 µg/L below the upper 20 ft of aquifer.
2. Enhanced IRM (GW IRM + 4 additional deep extraction wells)
    a. Containment of TVOCs> 5 µg/L.

Each scenario was evaluated over an assumed 30-year operational period.

Table 1 provides additional detail with respect to the elevations of remedial well screens and the pumping rates assigned to the remedial wells. For Scenario No. 1, only Remedial Wells RW-1 through RW-4 were active, at the rates shown on Table 1. For Scenario No. 2, all eight remedial wells were active at the rates shown on Table 1.

Results

Model-predicted mass loading rates (i.e., time-concentration plots for each of the remedial wells) were developed by summing the time-based model-predicted concentrations of TVOCs over the 30-year evaluation period for each remedial scenario.

Table 2 summarizes the model-predicted mass removed for each remedial scenario (by well and as a system total). **Table 3** summarizes the model-predicted TVOC concentration in extracted groundwater at each remedial well after 30 years.

Figures 1 and 2 are plots of TVOC concentrations vs. time for each of the remedial wells active in the two remedial scenarios. At the top of these plots are lines indicating the status of the remedial well network (whether 4 or 8 wells are active).

The summary tables and time-concentration plots indicate that the Enhanced IRM results in a negligible increase in mass removed over the 30-year evaluation period when compared to the model predicted

mass removed for the GW IRM. The GW IRM was predicted to extract 7,770 pounds of TVOCs from groundwater, while the Enhanced IRM was predicted to extract 8,606 pounds of TVOCs, an increase of only 10%. Likewise, at the conclusion of the 30-year simulation, the model-predicted TVOC concentrations in each of the Enhanced IRM wells (RW-5 through RW-8) were less than 1 ppb.

In addition to the modeling scenarios described above, EVS (Environmental Visualization System) was used to estimate the mass and volume of impacted groundwater beneath the Site Area and average TVOC concentrations within specific areas of the plume (**Table 4)**.

Reference

ARCADIS, 2008. Figure 4. Suspected Groundwater Source Areas, Northrop Grumman Systems Corporation, Former Grumman Settling Ponds, Bethpage, New York, Operable Unit 3. September 11, 2008.

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Table 1. Remedial Well Screen Zones and Pumping Rates, OU-3 Site Area Feasibility Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.

Well ID	Well Screen Elevation		Pumping Rate
	Top (ft msl)	Bottom (ft msl)	(gpm)
RW-1	20	-2	30
RW-2	41	22	75
RW-3	41	22	75
RW-4	18	-5	30
RW-5	-120	-140	75
RW-6	-200	-220	38
RW-7	-10	-25	30
RW-8	-200	-220	38

ft msl feet relative to mean sea level.
gpm gallons per minute.

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Table 2. Model-predicted Mass Removed[1] by remedial Scenario OU-3 Site Area Feasability Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.

Well ID	Scenario 1	Scenario 2
RW-1	2	2
RW-2	7,357	7,868
RW-3	401	482
RW-4	10	10
RW-5	NA	72
RW-6	NA	22
RW-7	NA	114
RW-8	NA	36
Total Mass Removed [1,2]	**7,770**	**8,606**

NA - well not active in this scenario.
Scenario No.1 IRM (containment of all TVOCs>5 µg/L in the upper 20 ft of aquifer and containment of all TVOC>50 µg/L below the upper 20 ft of aquifer).
Scenario No.2 IRM + 4 additional wells (containment of all TVOCs>5 µg/L).
(1) Mass removed is expressed in pounds.
(2) Total model-predicted mass removed by remedial system after 30 years of operation.

TVOC: total volatile organic compounds.
µg/L: micrograms per Liter.
OU3: Operable Unit 3.

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Table 3. Model-predicted TVOC Concentrations[1] in Extracted Water after 30 years of Remedial System Operation, OU-3 Site Area Feasability Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.

Well ID	Scenario 1	Scenario 2
RW-1	0.06	0.03
RW-2	716	795
RW-3	26	28
RW-4	0.00	0.00
RW-5	NA	0.76
RW-6	NA	0.04
RW-7	NA	0.86
RW-8	NA	0.69

NA - well not active in this scenario.
Scenario No.1 IRM (containment of all TVOCs>5 µg/L in the upper 20 ft of aquifer and containment of all TVOC>50 µg/L below the upper 20 ft of aquifer).
Scenario No.2 IRM + 4 additional wells (containment of all TVOCs>5 µg/L).
(1) Model-predicted TVOC concentations are given in micrograms per Liter.

TVOC: total volatile organic compounds.
µg/L: micrograms per Liter.
OU3: Operable Unit 3.

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Table 4. EVS-based estimate of TVOC plume mass and volume above referenced iso-concentrations, OU-3 Site Area Feasibility Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.

Iso-concentration Range • g/liter (ppb)	Soil Vol gallons	Soil Mass Pounds	TVOC Vol gallons	TVOC Mass Pounds	Water Vol gallons	Water Mass Pounds	Average TVOC Conc • g/liter (ppb)
>10	365,671,300	6,598,995,000	17	145	73,134,260	610,311,700	237
>100	104,775,300	1,890,801,000	16	131	20,955,060	174,871,800	748
>1,000	12,040,940	216,752,500	10	83	2,402,189	20,046,470	4,161
>10,000	1,045,216	18,862,230	4	35	209,043	1,744,484	19,835
>50,000	14,952	269,827	0.18	1.51	2,990	24,955	60,393
>90,000	0	1	0.00	0.00	0	0	90,124

This estimate is based on the modeled groundwater concentration (i.e., mass dissolved in groundwater) and does not account for any continuing source of groundwater contamination that may be present.
EVS: Environmental Visualization System.
TVOC: total volatile organic compounds.
µg: micrograms.
ppb: parts per billion.

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Figure 1. Model-predicted TVOC concentrations for Remedial Scenario 1, OU-3 Site Area Feasibility Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.

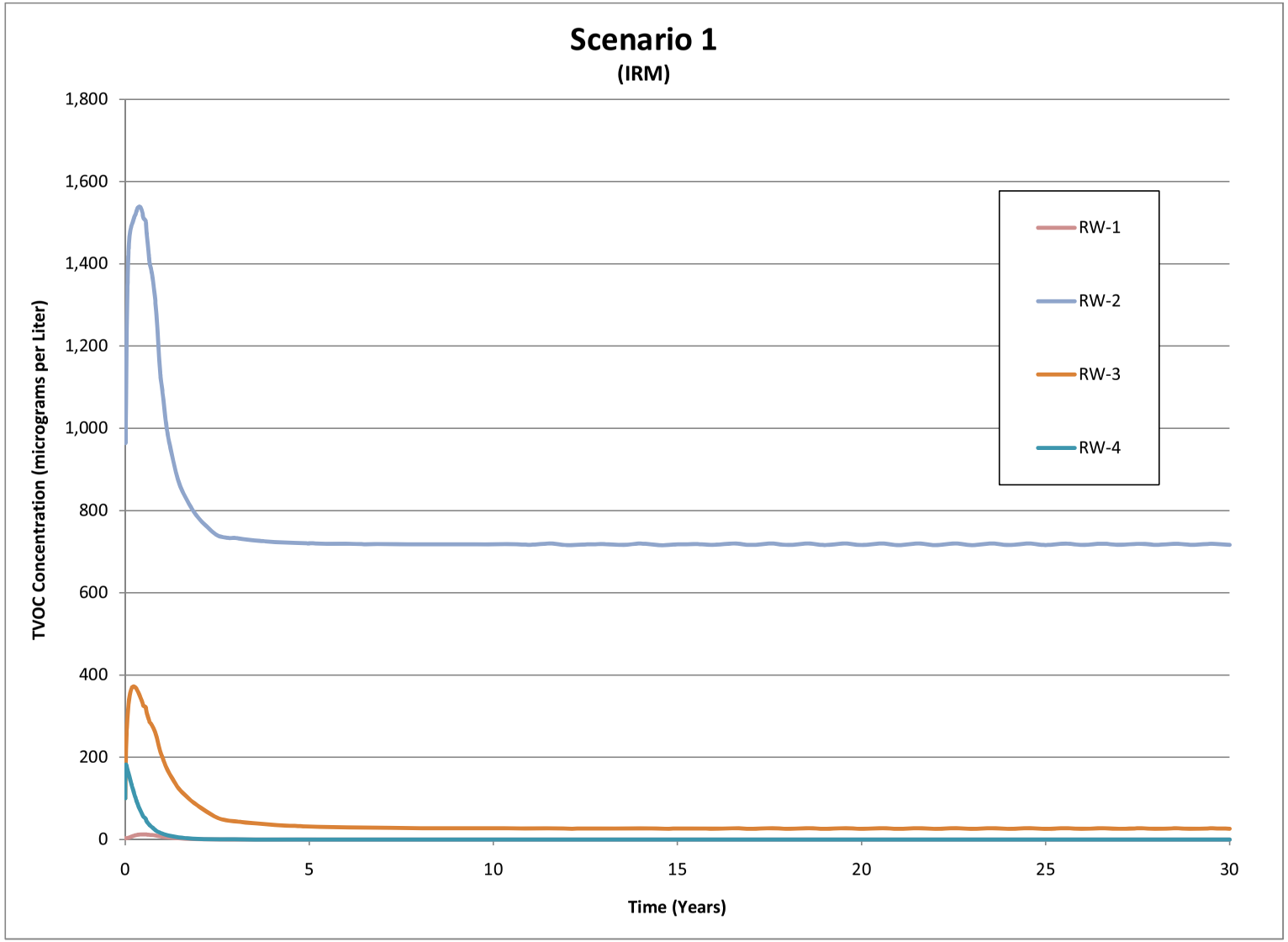

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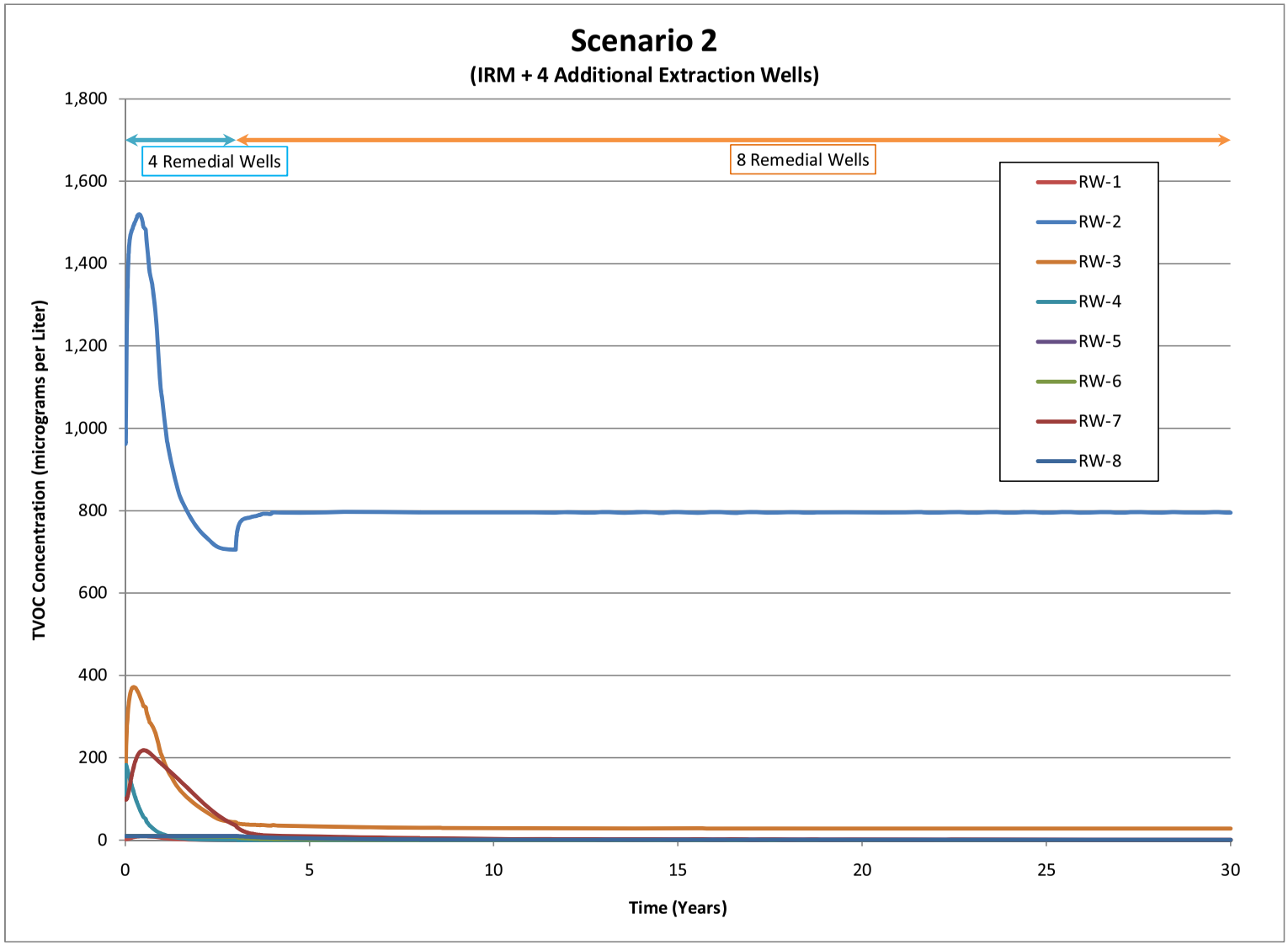
Figure 2. Model-predicted TVOC concentrations for Remedial Scenario 2, OU-3 Site Area Feasibility Study, Northrop Grumman Systems Corporation (Former Grumman Settling Ponds), Bethpage, New York.



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Appendix B

Remedial Alternatives Detailed Cost Estimates

Table B1. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Shallow (0' - 2') Excavation Costs:					
Impacted Area	130,235	SF			Area to be affected by remedial activities requiring site restoration.
Unfactored Excavation Volume	8,926	CY			Total excavation volume assumed straight wall side slopes.
Unfactored Excavation Weight	13,858	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	60	Days			Assumes average excavation/load out rate is 150 CY per day.
Pre-Excavation Investigation	1	LS	$250,000	$250,000	Pre-characterization soil boring program further define boundaries.
Mobilization/Demobilization	1	LS	$350,000	$350,000	
Site preparation	3	Acres	$4,000	$12,000	Clearing, grubbing, establishment of control zones, etc.
Excavation and loading	15,300	Tons	$25	$382,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal (Incineration + Encapsulation)	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal (Incineration)	196	Tons	$1,000	$195,500	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal (Encapsulation)	4,600	Tons	$400	$1,840,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	460	Tons	$250	$115,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	8,602	Tons	$150	$1,290,300	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	9,900	CY	$25	$247,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	18	Each	$1,200	$21,600	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	53	Each	$300	$15,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	3	Acres	$5,000	$15,000	Restoration in-kind for vegetated areas.
Pavement	12,000	SF	$13	$150,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
Erosion and Sediment Control Program	3	Acres	$10,000	$30,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	12	Weeks	$2,500	$30,000	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	12	Weeks	$17,500	$210,000	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	12	Weeks	$3,000	$36,000	Assumes 2 days per week for site-related verification surveying.
Shallow Excavation Subtotal:				**$5,462,000**	

Table B1. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (5% of capital cost)	5.0%	of	$5,462,000	$273,100	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$5,462,000	$382,340	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$5,462,000	$546,200	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$1,202,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$160,000	$160,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$80,000	$80,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$80,000	$80,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$320,000**	
Project Capital Contingency:	10%	of	$6,984,000	**$699,000**	
Capital Cost Total:				**$7,700,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$15,000	$15,000	30-year present worth cost for annual site verification inspections and reporting by NYS PE.
Annual OM&M Cost Total (Year 1):				**$16,000**	
Present Worth O&M Cost Total:				**$260,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-P2 :				**$8,000,000**	(rounded up to nearest $100,000)

Table B2. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs, soils between 2 ft and 6 ft/10 ft bls with PCB impacts >50mg/kg, and Blue-Green Material in Area 4; solidify/stabilize Blue-Green Material in Areas 2 and 3; and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement,
- bench-scale feasibility tests, and
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Shallow (0' - 2') Excavation Costs:					
Impacted Area	130,235	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	8,926	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	13,858	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	60	Days			Assumes average excavation/load out rate is 150 CY per day.
Pre-Excavation Investigation	1	LS	$280,000	$280,000	Pre-characterization soil boring program further define boundaries and $30,000 for the Blue-Green Sludge areas.
Mobilization/Demobilization	1	LS	$350,000	$350,000	
Site preparation	3	Acres	$4,000	$12,000	Clearing, grubbing, establishment of control zones, etc.
Excavation and loading	15,300	Tons	$25	$382,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	196	Tons	$1,000	$195,500	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	4,600	Tons	$400	$1,840,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	460	Tons	$250	$115,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	8,602	Tons	$150	$1,290,300	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	9,900	CY	$25	$247,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	19	Each	$1,200	$22,800	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	54	Each	$300	$16,200	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	4	Acres	$5,000	$20,000	Restoration in-kind for vegetated areas.
Pavement	12,000	SF	$13	$150,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
Erosion and Sediment Control Program	4	Acres	$10,000	$40,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	13	Weeks	$2,500	$32,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	4	Months	$40,000	$160,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	13	Weeks	$17,500	$227,500	Subcontractors in-house project management fees.
Construction Oversight	4	Months	$50,000	$200,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	13	Weeks	$3,000	$39,000	Assumes 2 days per week for site-related verification surveying.
Shallow Excavation Subtotal:				**$5,621,000**	

Table B2. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs, soils between 2 ft and 6 ft/10 ft bls with PCB impacts >50mg/kg, and Blue-Green Material in Area 4; solidify/stabilize Blue-Green Material in Areas 2 and 3; and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement,
- bench-scale feasibility tests, and
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Middle (2' - 6'/10') Excavation Costs:					
Impacted Area	130,719	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	4,806	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	7,462	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	33	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	8,500	Tons	$25	$212,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	81	Tons	$1,400	$112,700	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	276	Tons	$1,000	$276,000	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	1,178	Tons	$400	$471,200	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	5,520	Tons	$250	$1,380,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	172	Tons	$150	$25,800	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	5,300	CY	$25	$132,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	10	Each	$1,200	$12,000	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	53	Each	$300	$15,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	0	Acres	$5,000	$0	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	4	Acres	$10,000	$40,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	7	Weeks	$2,500	$17,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	2	Months	$40,000	$80,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	7	Weeks	$17,500	$122,500	Subcontractors in-house project management fees.
Construction Oversight	2	Months	$50,000	$100,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	7	Weeks	$3,000	$21,000	Assumes 2 days per week for site-related verification surveying.
Middle Excavation Subtotal:				**$3,020,000**	

Table B2. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs, soils between 2 ft and 6 ft/10 ft bls with PCB impacts >50mg/kg, and Blue-Green Material in Area 4; solidify/stabilize Blue-Green Material in Areas 2 and 3; and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement,
- bench-scale feasibility tests, and
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
In-Situ Soil Solidification Pre-Design Investigation:					
Bench Testing/Summary Report	1	LS	$50,000	$50,000	Bench scale test to determine proper solidification recipe for encapsulation of sludges.
Supplemental Soil Investigation					
Hollow Stem Auger Drill Rig	3	Days	$2,500	$7,500	Pre-design investigation to focus target area and establish baseline for remediation.
Laboratory Analytical	30	Each	$200	$6,000	Pre-design investigation to focus target area and establish baseline for remediation.
Oversight	1	Weeks	$0	$0	Pre-design investigation to focus target area and establish baseline for remediation.
Work plan and Summary Report	1	LS	$75,000	$75,000	Pre-design investigation to focus target area and establish baseline for remediation.
ISS Pre-Design Investigation Subtotal:				**$138,500**	
In-Situ Soil Solidification Construction Contractor:					
Contractor Mobilization / Demobilization	1	LS	$197,000	$197,000	Engineer's estimate based on previous work at similar site. Cost for mobilization of specialized equipment.
Clearing, Erosion, and Sediment Control	400	LF	$80	$32,000	Site preparation for site activities, establish control zones, E&S establishment/maintenance.
Dust Suppression, Vapor Control, and Monitori	10	Days	$200	$2,000	Implementation of a dust suppression program and OM&M of VPGAC.
Miscellaneous Site Preparation	1	LS	$30,000	$30,000	Materials management/storage fee for duration of the project.
Drilling Costs	517	CY	$174	$89,980	Based on actual contractor fees for similar project using a 9% PC recipe for volume to 0.5 ft sludge line. Total sludge quantity solidified considers about 20% overlap due to grid layout and depth coverage
Vapor Control VPGAC	1	LS	$70,000	$70,000	Cost for installation of a temporary 10,000 lb VPGAC unit to treat collected soil gas during work.
Site Utility Survey	1	LS	$20,000	$20,000	Utility clearance for underground work. Assumes three (3) lines of evidence required.
Site Restoration	38,400	SF	$5	$192,000	Restoration of all disturbed areas in-kind. Higher fee due to intrusive/disruptive nature of the work.
ISS Construction Contractor Subtotal:				**$633,000**	
In-Situ Soil Solidification Post-Construction Verification:					
System Decommissioning					
Geoprobe	5	Days	$2,500	$12,500	Post-remediation soil investigation to document achievement of RAO.
Laboratory Analytical	30	Each	$200	$6,000	Post-remediation soil investigation to document achievement of RAO.
Oversight	1	Weeks	$0	$0	Post-remediation soil investigation to document achievement of RAO.
Work plan and Summary Report	1	LS	$50,000	$50,000	Post-remediation soil investigation to document achievement of RAO.
ISS Post-Construction Verification Total:				**$69,000**	
Total ISS Pre-Design and Installation Total:				**$840,500**	
Engineering/Project Management:					
Engineering (5% of capital cost)	5.0%	of	$9,481,500	$474,075	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$9,481,500	$663,705	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$9,481,500	$948,150	All fees associated with management of construction related aspects of the project.

Table B2. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs, soils between 2 ft and 6 ft/10 ft bls with PCB impacts >50mg/kg, and Blue-Green Material in Area 4; solidify/stabilize Blue-Green Material in Areas 2 and 3; and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement,
- bench-scale feasibility tests, and
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management Subtotal:				**$2,086,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$160,000	$160,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$80,000	$80,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$80,000	$80,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$320,000**	
Project Capital Contingency:	10%	of	$11,887,500	**$1,189,000**	
Capital Cost Total:				**$13,100,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$15,000	$15,000	30-year present worth cost for annual site verification inspections and reporting by NYS PE.
Annual OM&M Cost Total (Year 1):				**$16,000**	
Present Worth O&M Cost Total:				**$260,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-P3 :				**$13,400,000**	(rounded up to nearest $100,000)

Table B3. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs and subsurface soils with PCB impacts >10mg/kg and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Shallow (0' - 2') Excavation Costs:					
Impacted Area	182,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	8,926	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	13,858	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	45	Days			Assumes average excavation/load out rate is 200 CY per day.
Pre-Excavation Investigation	1	LS	$250,000	$250,000	Pre-characterization soil boring program further define boundaries.
Mobilization/Demobilization	1	LS	$350,000	$350,000	
Site preparation	5	Acres	$4,000	$20,000	Clearing, grubbing, establishment of control zones, etc.
Excavation and loading	15,300	Tons	$25	$382,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	196	Tons	$1,000	$195,500	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	4,600	Tons	$400	$1,840,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	460	Tons	$250	$115,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	8,602	Tons	$150	$1,290,300	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	9,900	CY	$25	$247,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	18	Each	$1,200	$21,600	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	73	Each	$300	$21,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	5	Acres	$5,000	$25,000	Restoration in-kind for vegetated areas.
Pavement	12,000	SF	$13	$150,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
Erosion and Sediment Control Program	5	Acres	$10,000	$50,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	9	Weeks	$2,500	$22,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	9	Weeks	$17,500	$157,500	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	9	Weeks	$3,000	$27,000	Assumes 2 days per week for site-related verification surveying.
Shallow Excavation Subtotal:				**$5,437,000**	

Table B3. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs and subsurface soils with PCB impacts >10mg/kg and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Middle (2' - 10') Excavation Costs:					
Impacted Area	89,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	26,520	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	41,172	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	133	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	45,300	Tons	$25	$1,132,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	0	Tons	$1,000	$0	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	7,500	Tons	$400	$3,000,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	7,500	Tons	$250	$1,875,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	26,200	Tons	$150	$3,930,000	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	29,200	CY	$25	$730,000	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	54	Each	$1,200	$64,800	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	36	Each	$300	$10,800	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	0	Acres	$5,000	$0	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	3	Acres	$10,000	$30,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
H&S Program	27	Weeks	$2,500	$67,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	7	Months	$40,000	$280,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	27	Weeks	$17,500	$472,500	Subcontractors in-house project management fees.
Construction Oversight	7	Months	$50,000	$350,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	27	Weeks	$3,000	$81,000	Assumes 2 days per week for site-related verification surveying.
Middle Excavation Subtotal:				**$12,025,000**	

Table B3. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs and subsurface soils with PCB impacts >10mg/kg and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Deep (10 - 20') Excavation Costs:					
Impacted Area	68,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	25,000	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	39,000	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	125	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	42,900	Tons	$25	$1,072,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	400	Tons	$1,400	$560,000	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	130	Tons	$1,000	$130,000	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	12,000	Tons	$400	$4,800,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	19,000	Tons	$250	$4,750,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	7,070	Tons	$150	$1,060,500	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	27,500	CY	$25	$687,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	50	Each	$1,200	$60,000	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	28	Each	$300	$8,400	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	0	Acres	$5,000	$0	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	2	Acres	$10,000	$20,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	0	Weeks	$2,500	$0	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	7	Months	$40,000	$280,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	25	Weeks	$17,500	$437,500	Subcontractors in-house project management fees.
Construction Oversight	7	Months	$50,000	$350,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	0	Weeks	$3,000	$0	Assumes 2 days per week for site-related verification surveying.
Deep Excavation Subtotal:				**$14,217,000**	

Table B3. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs and subsurface soils with PCB impacts >10mg/kg and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Deepest (> 20') Excavation Costs:					
Impacted Area	32,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	11,600	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	18,009	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	58	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	19,900	Tons	$25	$497,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	0	Tons	$1,000	$0	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	250	Tons	$400	$100,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	8,300	Tons	$250	$2,075,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	9,500	Tons	$150	$1,425,000	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	12,800	CY	$25	$320,000	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	24	Each	$1,200	$28,800	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	13	Each	$300	$3,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	1	Acres	$5,000	$5,000	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	1	Acres	$10,000	$10,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	0	Weeks	$2,500	$0	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	12	Weeks	$17,500	$210,000	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	0	Weeks	$3,000	$0	Assumes 2 days per week for site-related verification surveying.
Deepest Excavation Subtotal:				**$4,946,000**	
Construction Capital Cost Subtotal:				**$36,625,000**	

Table B3. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate upper 2 ft of soils to Restricted Residential SCOs and subsurface soils with PCB impacts >10mg/kg and Environmental Easements.
- includes soil sampling program to pre-determine excavation limits,
- off-site disposal of soil; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$36,625,000	$1,465,000	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$36,625,000	$2,563,750	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$36,625,000	$3,662,500	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$7,692,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Site Management Survey	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$44,317,000	**$4,432,000**	
Capital Cost Total:				**$48,800,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Annual OM&M Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-P4:				**$48,800,000**	(rounded up to nearest $100,000)

Table B4. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P5, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate soils that Exceed Unrestricted Use SCOs
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Shallow (0' - 2') Excavation Costs:					
Impacted Area	182,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	8,926	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	13,858	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	45	Days			Assumes average excavation/load out rate is 200 CY per day.
Pre-Excavation Investigation	1	LS	$250,000	$250,000	Pre-characterization soil boring program further define boundaries.
Mobilization/Demobilization	1	LS	$350,000	$350,000	
Site preparation	5	Acres	$4,000	$20,000	Clearing, grubbing, establishment of control zones, etc.
Excavation and loading	15,300	Tons	$25	$382,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	196	Tons	$1,000	$195,500	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	4,600	Tons	$400	$1,840,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	460	Tons	$250	$115,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	8,602	Tons	$150	$1,290,300	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	9,900	CY	$25	$247,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	18	Each	$1,200	$21,600	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	73	Each	$300	$21,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	5	Acres	$5,000	$25,000	Restoration in-kind for vegetated areas.
Pavement	12,000	SF	$13	$150,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
Erosion and Sediment Control Program	5	Acres	$10,000	$50,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	9	Weeks	$2,500	$22,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	9	Weeks	$17,500	$157,500	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	9	Weeks	$3,000	$27,000	Assumes 2 days per week for site-related verification surveying.
Shallow Excavation Subtotal:				**$5,437,000**	

Table B4. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P5, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate soils that Exceed Unrestricted Use SCOs
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Middle (2' - 6'/10') Excavation Costs:					
Impacted Area	182,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	86,971	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	135,023	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	435	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	148,600	Tons	$25	$3,715,000	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	161	Tons	$1,400	$225,400	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	552	Tons	$1,000	$552,000	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	35,880	Tons	$400	$14,352,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	4,600	Tons	$250	$1,150,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	87,400	Tons	$150	$13,110,000	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	95,700	CY	$25	$2,392,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	174	Each	$1,200	$208,800	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	73	Each	$300	$21,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	0	Acres	$5,000	$0	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	5	Acres	$10,000	$50,000	Restoration in-kind for paved areas around eastern property boundary and ball field.
H&S Program	87	Weeks	$2,500	$217,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	22	Months	$40,000	$880,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	87	Weeks	$17,500	$1,522,500	Subcontractors in-house project management fees.
Construction Oversight	22	Months	$50,000	$1,100,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	87	Weeks	$3,000	$261,000	Assumes 2 days per week for site-related verification surveying.
Middle Excavation Subtotal:				**$39,759,000**	

Table B4. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P5, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate soils that Exceed Unrestricted Use SCOs
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Deep (6'/10' - 15') Excavation Costs:					
Impacted Area	182,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	39,083	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	60,677	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	196	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	66,800	Tons	$25	$1,670,000	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	546	Tons	$1,400	$764,750	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	316	Tons	$1,000	$316,250	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	15,525	Tons	$400	$6,210,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	16,100	Tons	$250	$4,025,000	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	25,300	Tons	$150	$3,795,000	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	43,000	CY	$25	$1,075,000	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	79	Each	$1,200	$94,800	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	73	Each	$300	$21,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	0	Acres	$5,000	$0	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	5	Acres	$10,000	$50,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	0	Weeks	$2,500	$0	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	10	Months	$40,000	$400,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	40	Weeks	$17,500	$700,000	Subcontractors in-house project management fees.
Construction Oversight	10	Months	$50,000	$500,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	0	Weeks	$3,000	$0	Assumes 2 days per week for site-related verification surveying.
Deep Excavation Subtotal:				**$19,623,000**	

Table B4. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P5, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate soils that Exceed Unrestricted Use SCOs
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Deepest (> 15') Excavation Costs:					
Impacted Area	182,000	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	90,417	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	140,372	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	453	Days			Assumes average excavation/load out rate is 150 CY per day.
Excavation and loading	154,500	Tons	$25	$3,862,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	0	Tons	$1,000	$0	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	2,013	Tons	$400	$805,000	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	85,819	Tons	$250	$21,454,688	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	100,194	Tons	$150	$15,029,063	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	99,500	CY	$25	$2,487,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	181	Each	$1,200	$217,200	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	73	Each	$300	$21,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	5	Acres	$5,000	$25,000	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	5	Acres	$10,000	$50,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	0	Weeks	$2,500	$0	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	23	Months	$40,000	$920,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	91	Weeks	$17,500	$1,592,500	Subcontractors in-house project management fees.
Construction Oversight	23	Months	$50,000	$1,150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	0	Weeks	$3,000	$0	Assumes 2 days per week for site-related verification surveying.
Deepest Excavation Subtotal:				**$47,616,000**	
Construction Capital Cost Subtotal:				**$112,435,000**	

Table B4. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Park Area Alternative S-P5, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavate soils that Exceed Unrestricted Use SCOs
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$112,435,000	$4,497,400	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$112,435,000	$7,870,450	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$112,435,000	$11,243,500	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$23,612,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Site Management Survey	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$136,047,000	**$13,605,000**	
Capital Cost Total:				**$149,700,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Annual OM&M Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-P4:				**$149,700,000**	(rounded up to nearest $100,000)

Table B5. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Access Road Alternative SAR-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Installation of a gravel cap over non-paved areas/ Environmental Easements
- includes a 6-inch thick gravel cap over all non-paved areas; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Gravel Cap					
Area to be Addressed	92,750	SF			Area to be affected by remedial activities requiring site restoration.
Thickness of Gravel Cap	0.5	FT			Assumed thickness of gravel cap in HHRA.
Mobilization/Demobilization	1	LS	$ 20,000	$ 20,000	
Site preparation	3	Acres	$ 10,000	$ 30,000	Clearing, grubbing, grading, general preparation for site activities.
Backfill and Compact	1,900	CY	$ 42	$ 79,654	Based on area x thickness x 10 percent loss factor.
Site Restoration	3	Acres	$ 2,500	$ 7,500	Restoration of all areas affected by the work to preconstruction condition.
Erosion and Sediment Control Program	3	Acres	$ 5,000	$ 15,000	Installation and maintenance of the Erosion & Sediment control program for the duration of the work.
H&S Program	2	Weeks	$ 2,500	$ 5,000	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	0.5	Months	$ 40,000	$ 20,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	2	Weeks	$ 17,500	$ 35,000	Subcontractors in-house project management fees.
Construction Oversight	0.5	Months	$ 50,000	$ 25,000	Full-time oversight by a qualified senior construction manager/engineer.
Construction Surveying	0.5	Weeks	$ 3,000	$ 1,500	Assumes 2 days per week for site-related verification surveying.
Gravel Cap Subtotal:				**$ 239,000**	
Engineering/Project Management:					
Engineering (5% of capital cost)	5.0%	of	$239,000	$11,950	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$239,000	$16,730	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$239,000	$23,900	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$53,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$412,000	**$42,000**	
Capital Cost Total:				**$500,000**	(rounded up to nearest $100,000)

Table B5. Detailed Costs of Remedial Alternatives: Vadose Zone Soil - Access Road Alternative SAR-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Installation of a gravel cap over non-paved areas/ Environmental Easements
- includes a 6-inch thick gravel cap over all non-paved areas; and,
- the establishment of an environmental easement.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$ 7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Annual OM&M Cost Total (Year 1):				**$6,000**	
Present Worth O&M Cost Total:				**$100,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-AR2 :				**$600,000**	(rounded up to nearest $100,000)

Table B6. Detailed Costs of Remedial Alternatives: Soil - Access Road Alternative S-AR3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavation of Access Road to Unrestricted Use Standards
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Shallow (0' - 2') Excavation Costs:					
Impacted Area	107,055	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	7,929	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	12,310	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	53	Days			Assumes average excavation/load out rate is 150 CY per day.
Pre-Excavation Investigation	1	LS	$250,000	$250,000	Pre-characterization soil boring program further define boundaries.
Mobilization/Demobilization	1	LS	$350,000	$350,000	
Site preparation	3	Acres	$4,000	$12,000	Clearing, grubbing, establishment of control zones, etc.
Excavation and loading	13,600	Tons	$25	$340,000	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	25	Tons	$1,000	$24,840	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	570	Tons	$400	$227,907	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	287	Tons	$250	$71,803	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	11,428	Tons	$150	$1,714,193	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	8,800	CY	$25	$220,000	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	16	Each	$1,200	$19,200	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	43	Each	$300	$12,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	3	Acres	$5,000	$15,000	Restoration in-kind for vegetated areas.
Pavement	38,284	SF	$13	$478,546	Restoration in-kind for paved areas around eastern property boundary and ball field.
Erosion and Sediment Control Program	3	Acres	$10,000	$30,000	Installation and maintenance of the erosion & sediment control program for duration of work.
H&S Program	11	Weeks	$2,500	$27,500	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	11	Weeks	$17,500	$192,500	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	11	Weeks	$3,000	$33,000	Assumes 2 days per week for site-related verification surveying.
Shallow Excavation Subtotal:				**$4,290,000**	

Table B6. Detailed Costs of Remedial Alternatives: Soil - Access Road Alternative S-AR3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavation of Access Road to Unrestricted Use Standards
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Middle (2' - 6'/10') Excavation Costs:					
Impacted Area	107,055	SF			Area to be affected by remedial activities requiring site restoration.
Excavation Volume	8,599	CY			Total excavation volume assumed straight wall side slopes.
Excavation Weight	13,350	Tons			Assumes bulk soil density is 115 lbs/cuft based on existing site data.
Excavation Duration	58	Days			Assumes average excavation/load out rate is 150 CY per day.
IRM Pipeline Management	1	LS	$100,000	$100,000	Pre-characterization soil boring program further define boundaries.
Excavation and loading	14,700	Tons	$25	$367,500	Unfactored excavation volume times 10 percent over excavation factor.
Transportation and Off-Site Disposal:					
1A Disposal	0	Tons	$1,400	$0	Hazardous for metals and contains PCBs >250 ppm. Hazardous or non-hazardous for VOCs.
1B Disposal	203	Tons	$1,000	$203,378	PCBs >250 ppm but non-hazardous for metals. Hazardous or non-hazardous for VOCs.
2 Disposal	380	Tons	$400	$152,145	Hazardous for metals. PCBs >50 ppm but <250 ppm. Hazardous or non-hazardous VOCs.
3 Disposal	896	Tons	$250	$223,948	Hazardous for VOCs and/or PCBs >50 ppm but <250 ppm. Non-hazardous for metals.
4 Disposal	11,870	Tons	$150	$1,780,562	Non-hazardous for VOCs, metals, and PCBs < 50 ppm.
Backfill and Compact	9,500	CY	$25	$237,500	Unfactored excavation volume time 10 percent compaction/loss factor.
Waste Characterization Sampling	18	Each	$1,200	$21,600	Characterization sampling for disposal facilities. One sample per 500 CY disposal volume.
Post Excavation Confirmation Sampling	43	Each	$300	$12,900	Post excavation endpoint sampling. One sample per 2,500 sqft of excavation area.
Revegetation Top Soil - Seeding	3	Acres	$5,000	$15,000	Restoration in-kind for vegetated areas.
Erosion and Sediment Control Program	3	Acres	$10,000	$30,000	Installation and maintenance of the erosion & sediment control program for duration of work.
H&S Program	12	Weeks	$2,500	$30,000	Implementation of the site-specific Health & Safety program for the duration of the work.
Dust/Odor Suppression	3	Months	$40,000	$120,000	Implementation of the dust/odor suppression program and CAMP for the duration of the work.
Contractors Internal PM/QC	12	Weeks	$17,500	$210,000	Subcontractors in-house project management fees.
Construction Oversight	3	Months	$50,000	$150,000	Full-time oversight by qualified senior construction manager/engineer.
Construction Surveying	12	Weeks	$3,000	$36,000	Assumes 2 days per week for site-related verification surveying.
Middle Excavation Subtotal:				**$3,691,000**	
Construction Capital Cost Subtotal:				**$7,981,000**	

Table B6. Detailed Costs of Remedial Alternatives: Soil - Access Road Alternative S-AR3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Excavation of Access Road to Unrestricted Use Standards
- includes soil sampling program to pre-determine excavation limits, and
- the off-site disposal of soil.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (5% of capital cost)	5.0%	of	$7,981,000	$399,050	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$7,981,000	$558,670	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$7,981,000	$798,100	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$1,756,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Site Management Survey	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$0	**$0**	
Capital Cost Total:				**$9,800,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Annual O&MM Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative S-AR3 :				**$9,800,000**	(rounded up to nearest $100,000)

Table B7. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using Soil Vapor Extraction, Multi-phase Extraction, and In-Situ Chemical Oxidation, respectively;
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon and potassium permanganate,
- air stripping to remove VOCs in the extracted perched water,
- discharge of treated water via recharge basins, and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
SVE/MPE Pre-Design Investigation:					
Pilot Testing	1	LS	$80,000	$80,000	Completion of two (2) SVE and two (2) MPE pilot tests.
Supplemental Soil Investigation					
Geoprobe	10	Days	$1,500	$15,000	Pre-design investigation to focus target area and establish baseline for remediation.
Analytical Analysis	50	Each	$200	$10,000	Pre-design investigation to focus target area and establish baseline for remediation.
Work plan/Summary Report/Office Prep	1	LS	$75,000	$75,000	Pre-design investigation to focus target area and establish baseline for remediation.
SVE Pre-Design Investigation Subtotal:				**$180,000**	
SVE Construction Contractor:					
Contractor Mobilization/Demobilization	1	LS	$50,000	$50,000	
Extraction Well Installation	140	LF	$90	$12,600	Assumes two (2) extraction well clusters consisting of two (2) wells per cluster.
Monitoring Well Installation	420	LF	$80	$33,600	Assumes four (4) induced vacuum monitoring clusters consisting of three (3) wells per cluster.
Conveyance Systems					
Piping (w/installation)	2,400	LF	$20	$48,000	Assumes individual four (4) inch SDR 17 HDPE below grade pipelines run to existing treatment building.
Wellhead Vaults/Modifications	16	Each	$750	$12,000	Installation of wellhead vaults for each extraction/monitoring point.
Common Trenching and Backfilling	600	LF	$60	$36,000	Trenching and backfill for below grade piping.
Major Process Equipment Items					
Extraction Blowers	0	Each	$5,000	$0	Assumes existing soil gas IRM standby blowers used. No additional capital cost.
VPGAC and KMnO4 Units	3	Each	$30,000	$90,000	Assumes two (2) 10,000 lb GAC units and one (1), 10,000 lb PPZ unit.
Site Preparation/Foundation Installation	1	LS	$25,000	$25,000	Site preparation and foundation installation for VPGAC/PPZ units.
Equipment Installation Labor	1	LS	$15,000	$15,000	Contractor fees for installation of major process components.
Building Mechanical Components					
Process Piping & Appurtenances	1	LS	$20,000	$20,000	Upgrade of existing well manifold for new wells and ductwork for air treatment units.
Electrical Components	2	LS	$0	$0	Utilizing existing electrical components. No additional cost.
Site Utility Survey	1	LS	$10,000	$10,000	Utility clearance for underground work. Assumes three (3) lines of evidence required.
Contractors Internal Management/H&S Monitoring/QC	8	Weeks	$5,000	$40,000	Subcontractors in-house project management fees.
Erosion and Sediment Controls/Maintenance	1	LS	$15,000	$15,000	Installation and maintenance of the E&S control program for the duration of the work.
Site Restoration	1	LS	$10,000	$10,000	Restoration of all disturbed areas in-kind.
System Startup / Shakedown	1	LS	$75,000	$75,000	System mechanical shakedown and startup testing.
SVE Construction Contractor Subtotal:				**$493,000**	
MPE Construction Contractor:					
Contractor Mobilization/Demobilization	0	LS	$50,000	$0	Included in SVE construction cost above.
Extraction Well Installation	5,200	LF	$90	$468,000	Assumes 92 extraction wells to a total depth of 55 feet per well plus contingency.
Monitoring Well Installation	420	LF	$80	$33,600	Assumes a total of eight (8) induced monitoring points.
Conveyance Systems					
Piping (w/installation)	57,600	LF	$5	$288,000	Assumes individual 1.5 inch SDR 17 HDPE below grade pipelines run to new storage shed/treatment unit.
Wellhead Vaults/Modifications	104	Each	$750	$78,000	Installation of wellhead vaults for each extraction/monitoring point.
Common Trenching and Backfilling	0	LF	$60	$0	Cost included as part of SVE capital above. No additional cost.
Water Supply for Liquid Ring	1	LS	$100,000	$100,000	Installation of a potable water supply for liquid-ring pump seal fluid.
Major Process Equipment Items					
Liquid Ring Pumps	2	Each	$75,000	$150,000	Two (2), 250 hp water-sealed liquid ring pump skids/packages w/moisture separator.
VPGAC and KMNO4 Units	0	Each	$30,000	$0	Cost included as part of SVE capital above. No additional cost.
Equipment Installation Labor	1	LS	$10,000	$10,000	Contractor fees for installation of major process components.
Dry Van Storage Shed	2	Each	$3,500	$7,000	Two (2) new dry van type storage containers for the MPE system extraction manifold, process components, and electrical.
Building Mechanical Components					
Process Piping & Appurtenances	1	LS	$100,000	$100,000	Influent manifold and related process piping for system.
Electrical Components					
Supply Extension	1	LS	$150,000	$150,000	Upgrade power and extend to new dry van containers.
Controls and Distribution	1	LS	$60,000	$60,000	Main control panel fabrication, power distribution, and controls distribution within dry vans.
HVAC	1	LS	$20,000	$20,000	HVAC for each dry van storage container.
Site Utility Survey	0	LS	$10,000	$0	Cost included as part of SVE capital above. No additional cost.
Site Restoration	1	LS	$25,000	$25,000	Restoration of all disturbed areas in-kind.
MPE Construction Contractor Subtotal:				**$1,510,000**	

Table B7. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using Soil Vapor Extraction, Multi-phase Extraction, and In-Situ Chemical Oxidation, respectively;
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon and potassium permanganate,
- air stripping to remove VOCs in the extracted perched water,
- discharge of treated water via recharge basins, and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
SVE/MPE Decommissioning and Closure Monitoring:					
Closure Soil Investigation					
Geoprobe	10	Days	$1,500	$15,000	Post-remediation soil investigation to document achievement of RAO.
Analytical Analysis	50	Each	$200	$10,000	Post-remediation soil investigation to document achievement of RAO.
Work plan/Summary Report/Office Prep	1	LS	$50,000	$50,000	Post-remediation soil investigation to document achievement of RAO.
System Decommissioning					
Demolition of Structures/Utilities	10%	%	$547,800	$54,800	Demolition/removal/closure/abandonment of all system components.
Well Abandonment	120	Each	$300	$36,000	Demolition/removal/closure/abandonment of all system components.
SVE/MPE Decommissioning and Closure Monitoring Total:				**$166,000**	
Total SVE/MPE Pre-Design and Installation Total:				**$2,349,000**	
ISCO Pre-Design Investigation:					
Bench Testing/Injection Test/Pilot Testing/Summary Report	1	LS	$115,000	$115,000	Bench testing for oxidant demand determination, injection/pilot testing for hydrogeologic demand determination.
Supplemental Groundwater Investigation					
Driller Mob/Demo	1	LS	$2,000	$2,000	Pre-design investigation to focus target area and establish baseline for remediation.
HSA for Hydro punch Samples	8	Days	$3,000	$24,000	Pre-design investigation to focus target area and establish baseline for remediation.
Analytical Analysis	24	Each	$150	$3,600	Pre-design investigation to focus target area and establish baseline for remediation.
Contractor's In-House Oversight	2	Weeks	$6,000	$12,000	Pre-design investigation to focus target area and establish baseline for remediation.
Work plan/Summary Report/Office Preparation	1	LS	$75,000	$75,000	Pre-design investigation to focus target area and establish baseline for remediation.
Pre-Design Investigation Subtotal:				**$232,000**	
ISCO Implementation Cost:					
Contractor Mobilization/Demobilization	1.5	LS	$25,000	$37,500	
Clearing and Erosion and Sediment Control	9,278	SF	$3	$27,834	Site preparation for site activities, establish control zones, E&S establishment/maintenance.
Other Site Preparation	1	LS	$20,000	$20,000	Additional cost for setting up secondary containment type facility for storage of hazardous materials.
Driller and Disposal Costs					
Injection Well Installation	1,240	LF	$120	$148,800	20, two (2) inch diameter injection wells to 65 feet below grade. Assumes wire-wrapped stainless steel screens.
Monitoring Well Installation	248	LF	$120	$29,760	Four (4), two (2) inch diameter monitoring wells.
Temporary Injection System Cost					
Wellhead Moods/Piping/Appurtenances Material Cost	20	Each	$2,000	$40,000	Installation of wellhead modifications including pressure relief assembly, tees, etc.
Oxidant Feed System Rental and Mob/Demo	2	Months	$20,000	$40,000	Rental of an automated oxidant hopper/mixing tank/feed system from Carus Chemical.
Materials Storage/Management	2	LS	$10,000	$20,000	Onsite hazardous materials handling and management by certified personnel.
Injection Oversight/Labor	6	Days	$4,000	$24,000	Oversight by one (1) field engineer.
System Construction/Dismantling Fee	14	Days	$3,000	$42,000	Construction/dismantling of wellhead assemblies, transfer piping, setup of skid, etc.
Material Costs					
Permanganate	23,714	Lbs	$3	$61,823	Potassium permanganate supplied by Carus Chemical. Oxidant demand based on existing bench scale data.
Performance Monitoring					
Baseline Performance Monitoring	1	Each	$10,000	$10,000	Baseline groundwater monitoring program.
Performance Monitoring	6	Days	$2,000	$12,000	Performance monitoring completed during injection to document established ROI and insitu geochemical conditions.
Post-Injection Performance Monitoring	12	Each	$8,000	$96,000	Post-injection performance monitoring program to demonstrate compliance with RAO.
Dust Suppression/Vapor Control and Monitoring	10	Days	$2,000	$20,000	Implementation of a dust suppression program.
Water Supply Coordination/Allotment (hydrant use)	2	Each	$5,000	$10,000	Coordination with local agencies for hydrant use permit and other associated water supply fees.
Contractors In-House Project Management	20	Days	$1,000	$20,000	Subcontractors in-house project management fees.
Site Utility Survey	1	LS	$10,000	$10,000	Utility clearance for underground work. Assumes three (3) lines of evidence required.
Site Restoration	9,278	SF	$3	$27,834	Restoration of all disturbed areas in-kind.
ISCO Implementation Cost Subtotal:				**$698,000**	

Table B7. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using Soil Vapor Extraction, Multi-phase Extraction, and In-Situ Chemical Oxidation, respectively;
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon and potassium permanganate,
- air stripping to remove VOCs in the extracted perched water,
- discharge of treated water via recharge basins, and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Decommissioning and Closure Monitoring:					
System Decommissioning					
Well Abandonment	24	Each	$500	$12,000	Abandonment of all wells in accordance with local code requirements.
Post-Injection Summary Report and Data Management	1	LS	$75,000	$75,000	
Decommissioning and Closure Monitoring Subtotal:				**$87,000**	
Total ISCO Cost:				**$1,017,000**	
Total Construction Cost Alternative SA-2:				**$3,366,000**	
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$3,366,000	$134,640	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$3,366,000	$235,620	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$3,366,000	$336,600	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$707,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Site Management Survey	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$4,073,000	**$408,000**	
Capital Cost Total:				**$4,500,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Field Operator	1	EA	$30,000	$30,000	Field operator costs for OM&M of treatment system. 10 hrs per month average labor time.
Laboratory Analytical	1	LS	$2,000	$2,000	Laboratory analytical for system performance and compliance water and vapor samples.
Electricity	1	ls	$75,000	$75,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$10,000	$10,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Medial Replacement	1	ls	$2,500,000	$2,500,000	Replacement of GAC and PPZ. Varies significantly following Year 1 of operation.
Project Reporting	1	ls	$45,000	$45,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$28,000	$28,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Contingency	10%	of	$2,690,000	$269,000	
Annual O&MM Cost Total (Year 1):				**$2,959,000**	
Present Worth O&M Cost Total:				**$5,100,000**	Present worth value. Assumes a discount factor of 4.5 percent. SVE/MPE system(s) operate for 3-years ONLY.
Total Cost Alternative SA-2:				**$9,600,000**	(rounded up to nearest $100,000)

Table B8. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using In-Situ Thermal Desorption
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors and the air stripper off-gas using catalytic oxidation and vapor phase gramular activated carbon; and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
ISTD Pre-Design Investigation:					
Bench Testing/Summary Report	1	LS	$100,000	$100,000	Bench scale testing to demonstrate efficacy of technology and proper application.
Supplemental Soil Investigation					
Geoprobe	10	Days	$1,500	$15,000	Pre-design investigation to focus target area and establish baseline for remediation. Vadose zone soil only.
Analytical Analysis	50	Each	$200	$10,000	Pre-design investigation to focus target area and establish baseline for remediation. Vadose zone soil only.
Work plan/Summary Report/Office Prep	1	LS	$75,000	$75,000	Pre-design investigation to focus target area and establish baseline for remediation. Vadose zone soil only.
ISTD Pre-Design Investigation Subtotal:				**$200,000**	
ISTD Construction Contractor:					
Contractor Mobilization/Demobilization	1	LS	$800,000	$800,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Well Installation	1	LS	$4,500,000	$4,500,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Electrical Construction and Power Drop	1	LS	$800,000	$800,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Vapor Cover Construction	1	LS	$200,000	$200,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Mechanical/Piping Installation	1	LS	$500,000	$500,000	Preliminary cost estimate obtained from TerraTherm, Inc.
ISTD Power Equipment Installation	1	LS	$200,000	$200,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Effluent Treatment System Installation	1	LS	$500,000	$500,000	Preliminary cost estimate obtained from TerraTherm, Inc.
System Startup / Shakedown	1	LS	$300,000	$300,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Utility Fees (Power)	1	LS	$2,800,000	$2,800,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Maintenance Hardware	1	LS	$340,000	$340,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Maintenance Operators	1	LS	$350,000	$350,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Sampling and Analysis of Air Treatment System	1	LS	$40,000	$40,000	Preliminary cost estimate obtained from TerraTherm, Inc.
Site Restoration	1	LS	$100,000	$100,000	Preliminary cost estimate obtained from TerraTherm, Inc.
ISTD Construction Contractor Subtotal:				**$11,430,000**	
ISTD Decommissioning and Closure Monitoring:					
Closure Soil Investigation					
Geoprobe	10	Days	$1,500	$15,000	Post-remediation soil investigation to document achievement of RAO.
Analytical Analysis	50	Each	$200	$10,000	Post-remediation soil investigation to document achievement of RAO.
Work plan/Summary Report/Office Prep	1	LS	$50,000	$50,000	Post-remediation soil investigation to document achievement of RAO.
ISTD Closure Monitoring Total:				**$75,000**	
Total ISTD Pre-Design and Installation Total:				**$11,705,000**	
Total Construction Cost Alternative SA-3:				**$11,705,000**	

Table B8. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using In-Situ Thermal Desorption
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors and the air stripper off-gas using catalytic oxidation and vapor phase gramular activated carbon; and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$11,705,000	$468,200	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$11,705,000	$819,350	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$11,705,000	$1,170,500	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$2,459,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Site Management Survey	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$14,164,000	**$1,417,000**	
Capital Cost Total:				**$15,600,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Annual O&MM Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative SA-3:				**$15,600,000**	(rounded up to nearest $100,000)

Table B9. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using Bentonite Clay with Zero-Valent Iron
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors using vapor phase granular activated carbon and potassium permanganate; and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
ZVI Pre-Design Investigation:					
Bench Testing/Pilot Testing/Summary Report	1	LS	$200,000	$200,000	Bench and field scale test to determine proper add mixture ratio/ZVI content and demonstrate efficacy of technology.
Supplemental Soil Investigation					
Geoprobe	10	Days	$1,500	$15,000	Pre-design investigation to focus target area and establish baseline for remediation. Includes saturated soils.
Laboratory Analytical	100	Each	$200	$20,000	Pre-design investigation to focus target area and establish baseline for remediation. Includes saturated soils.
Work plan and Summary Report	1	LS	$75,000	$75,000	Pre-design investigation to focus target area and establish baseline for remediation. Includes saturated soils.
ZVI Pre-Design Investigation Subtotal:				**$310,000**	
ZVI Construction Contractor:					
Contractor Mobilization / Demobilization	1	LS	$771,000	$771,000	Engineer's estimate based on previous work at similar site. Cost for mobilization of specialized equipment.
Clearing, Erosion, and Sediment Control	1,096	LF	$80	$87,680	Site preparation for site activities, establish control zones, E&S establishment/maintenance.
Dust Suppression, Vapor Control, and Monitoring	492	Days	$200	$98,400	Implementation of a dust suppression program and OM&M of VPGAC.
Miscellaneous Site Preparation	1	LS	$30,000	$30,000	Materials management/storage fee for duration of the project.
Drilling Costs	492	Days	$25,000	$12,300,000	Specialized deep-auger mixer. Based on actual contractor fees for similar project.
Material Costs:					
Zero-Valent Iron	969	Tons	$1,304	$1,263,092	Assumes ZVI applied at a rate of 1 percent by weight. Unit cost provided by Peerless metals.
Bentonite	1,938	Tons	$239	$463,134	Assumes bentonite applied at a rate of 2 percent by weight. Based actual application rate for similar project.
Cement	1,294	Tons	$543	$702,668	Assumes cement added at a rate of 3 percent by weight for upper 10 feet of affected area for structural stability.
Vapor Control VPGAC	1	LS	$70,000	$70,000	Cost for installation of a temporary 10,000 lb VPGAC unit to treat collected soil gas during work.
Site Utility Survey	1	LS	$20,000	$20,000	Utility clearance for underground work. Assumes three (3) lines of evidence required.
Site Restoration	75,000	SF	$5	$375,000	Restoration of all disturbed areas in-kind. Higher fee due to intrusive/disruptive nature of the work.
ZVI Construction Contractor Subtotal:				**$16,181,000**	
ZVI Post-Construction Verification:					
System Decommissioning					
Geoprobe	10	Days	$1,500	$15,000	Post-remediation soil investigation to document achievement of RAO.
Laboratory Analytical	50	Each	$200	$10,000	Post-remediation soil investigation to document achievement of RAO.
Work plan and Summary Report	1	LS	$50,000	$50,000	Post-remediation soil investigation to document achievement of RAO.
ZVI Post-Construction Verification Total:				**$75,000**	
Total ZVI Pre-Design and Installation Total:				**$16,566,000**	

Table B9. Detailed Costs of Remedial Alternatives: Source Areas - Alternative SA-4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remediate VOC Source Areas in the Vadose Zone Soils, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils using Bentonite Clay with Zero-Valent Iron
- includes a pre-design investigation,
- field and bench-scale feasibility tests,
- the vapor phase treatment of the extracted vapors using vapor phase granular activated carbon and potassium permanganate; and,
- a post-closure monitoring and system decommissioning program.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$16,566,000	$662,640	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$16,566,000	$1,159,620	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$16,566,000	$1,656,600	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$4,908,000**	
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Site Management Survey	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$21,474,000	**$2,148,000**	
Capital Cost Total:				**$23,700,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Costs are included in alternatives for Park Area Soils (S-PX).
Annual O&MM Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative SA-4:				**$23,700,000**	(rounded up to nearest $100,000)

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Table B10. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Operation of OU-3 GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer, and 50 ug/L of total VOCs below the upper 20' of the aquifer, attenuation to control onsite metals migration, and the transition to natural attenuation with monitoring to address residual COPC impacts once the GW IRM system shutdown criteria met;

- *includes groundwater extraction,*
- *treatment of the extracted groundwater through air stripping,*
- *vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite,*
- *discharge of treated water to recharge basins; and,*
- *an environmental easement to restrict certain uses for site groundwater.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$120,000	**$12,000**	
Capital Cost Total:				**$200,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Field Operator	1	EA	$50,000	$50,000	Field operator costs for OM&M of treatment system. 30 hrs per month average labor time.
Laboratory Analytical	1	LS	$30,000	$30,000	Laboratory analytical for system performance and compliance water and vapor samples.
Bag Filter/Media Replacement	1	ls	$120,000	$120,000	Replacement of filters, GAC, and PPZ.
Recharge Basin Maintenance	1	ls	$25,000	$25,000	Annual cleaning of recharge basin to restore permeability.
Electricity	1	ls	$42,000	$42,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$30,000	$30,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Waste Management Costs	1	ls	$7,500	$7,500	Cost to manage bag filters and purge water wastes.
Project Reporting	1	ls	$45,000	$45,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$28,000	$28,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Groundwater Monitoring	1	ls	$25,000	$25,000	Quarterly plume management and compliance monitoring of onsite monitoring wells.
Contingency	10%	of	$410,000	$41,000	
Annual O&MM Cost Total (Year 1):				**$451,000**	(Value is not the 30-year average annual OM&M cost)
Present Worth O&M Cost Total:				**$7,400,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative GW-2:				**$7,600,000**	(rounded up to nearest $100,000)

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Table B10a. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-2 (Assumes Source Area Remedy SA-3 implemented), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Operation of OU-3 GW IRM for 15 years to prevent the off-site migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer, and 50 ug/L of total VOCs below the upper 20' of the aquifer, attenuation to control onsite metals migration, and the transition to natural attenuation with monitoring to address residual COPC impacts once the GW IRM system shutdown criteria met;

- *includes groundwater extraction,*
- *treatment of the extracted groundwater through air stripping,*
- *vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite,*
- *discharge of treated water to recharge basins; and,*
- *an environmental easement to restrict certain uses for site groundwater.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$120,000	**$12,000**	
Capital Cost Total:				**$200,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Field Operator	1	EA	$50,000	$50,000	Field operator costs for OM&M of treatment system. 30 hrs per month average labor time.
Laboratory Analytical	1	LS	$30,000	$30,000	Laboratory analytical for system performance and compliance water and vapor samples.
Bag Filter/Media Replacement	1	ls	$120,000	$120,000	Replacement of filters, GAC, and PPZ.
Recharge Basin Maintenance	1	ls	$25,000	$25,000	Annual cleaning of recharge basin to restore permeability.
Electricity	1	ls	$42,000	$42,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$30,000	$30,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Waste Management Costs	1	ls	$7,500	$7,500	Cost to manage bag filters and purge water wastes.
Project Reporting	1	ls	$45,000	$45,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$28,000	$28,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Groundwater Monitoring	1	ls	$25,000	$25,000	Quarterly plume management and compliance monitoring of onsite monitoring wells.
Contingency	10%	of	$410,000	$41,000	
Annual O&MM Cost Total (Year 1):				**$451,000**	(Value is not the 15-year average annual OM&M cost)
Present Worth O&M Cost Total:				**$4,500,000**	15-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative GW-2:				**$4,700,000**	(rounded up to nearest $100,000)

Table B11. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Expand GW IRM to capture >5 ug/L TVOC in aquifer below 20 ft followed by Natural Attenuation with monitoring/Environmental Easements;
- includes installation of a second treatment system and extraction well infrastructure and associated groundwater extraction,
- treatment of the extracted groundwater through air stripping,
- vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite,
- discharge of treated water to recharge basins; and,
- an environmental easement to restrict certain uses for site groundwater.
- also includes operation of the existing GW IRM.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Expanded Treatment System Construction Contractor:					
Installation Fees -					
Mobilization/Demobilization	1	ls	$50,000	$50,000	
Construction Permits and Temporary Controls	1	ls	$20,000	$20,000	Filing of construction permits and related fees; setup of site controls for work.
Building Erection (including Foundation)	1200	sf	$80	$96,000	Construction of prefabricated building.
Installation of Process Equipment	1	ls	$42,960	$42,960	Including in-well components.
Installation of Process Piping	1	ls	$42,960	$42,960	Including in-well components.
HVAC	1	ls	$14,320	$14,320	Installation of heating/ventilation/air conditioning components.
Electrical Installation	1	ls	$89,500	$89,500	Including in-well components.
Installation/Development of Extraction Wells	1	ls	$303,620	$303,620	Installation of 4 additional deep extraction wells.
Installation/Development of Monitoring Wells	1	ls	$33,250	$33,250	4-inch dia., 100 foot deep monitoring well.
Wellhead Installation	4	ls	$3,500	$14,000	Install Vault and Pitless Adapter
Excavation, Stockpile, Backfilling	2000	ft	$30	$60,000	Spoils to be backfilled.
2" Conveyance Piping	3000	ft	$4	$12,000	Two (2) 2" dia. HDPE. Includes fittings.
4" Conveyance Piping	3000	ft	$6	$18,000	Two (2) 4" dia. HDPE. Includes fittings.
Power/Instrumentation/Controls Conduits	4100	ft	$25	$102,500	Includes conductors and handholds
Imported Pipe Bedding	400	ton	$20	$8,000	Includes backfill and compaction
Site Surveying	1	ls	$10,000	$10,000	Assumes 2 days per week for site-related verification surveying.
Site Restoration	1	ls	$60,000	$60,000	Restoration in-kind of all affected areas.
System Startup	1	ls	$75,000	$75,000	Startup/shakedown of the expanded/new groundwater system.
Material Costs -					
Pre-Engineered Treatment Building (30'x40')	1200	SF	$40	$48,000	Cost for pre-engineered steel building. Includes HVAC.
Piping, Valves, and Appurtenances	1	ls	$45,000	$45,000	Cost for mechanical components in building and at well vaults.
Instrumentation	1	ls	$90,000	$90,000	Flow meters, level switches, pressure gauges, etc.
Power Drop/Communications Line	1	ls	$45,000	$45,000	Long island power fees and electrician fees for power drop.
Potable Water Line	1	ls	$75,000	$75,000	Cost to extend water service from Cherry Avenue. Includes backflow preventer.
Motor Control Center	1	ls	$40,000	$40,000	Cost for motor starter cabinets, starters, and terminal bus.
Control Panel / SCADA System	1	ls	$65,000	$65,000	Cost for construction of the Main Control Panel including data acquisition and remote access components.
Sand Filter	1	ls	$167,460	$167,460	Installation of a sand filter for iron removal.
Equalization Tank	3000	gal	$1	$3,000	Influent equalization
Inlet Inline Filter System (Duplex)	2	ls	$5,000	$10,000	Bag filter assembly with bypass/backup unit.
Low Profile Air Stripper	1	ls	$40,000	$40,000	Shallow tray air stripper, skid mounted w/inlet outlet pumps.
Chemical Feed Pump	1	ls	$1,500	$1,500	For sequestering agent (if necessary).
Air Treatment System	1	ls	$75,000	$75,000	Two (2) 10,000 lb VPGAC and (1) 10,000 PPZ units.
Well Vaults	4	ls	$7,000	$28,000	H-20 rated vaults and covers for wellheads.
Submersible Well Pumps	4	ls	$7,500	$30,000	4" Grundfos pump with wire leads.
Inlet Structure for Basin	1	ls	$2,500	$2,500	New inlet structure for recharge basin.
Taxes (8.625% of EQ)	1	ls	$64,813	$64,813	
Freight (5% of EQ)	1	ls	$37,573	$37,573	
Treatment System Construction Subtotal:				**$1,919,956**	
Engineering/Project Management:					
Engineering (5% of capital cost)	5.0%	of	$1,919,956	$95,998	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$1,919,956	$134,397	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$1,919,956	$191,996	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$423,000**	

Table B11. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-3, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Expand GW IRM to capture >5 ug/L TVOC in aquifer below 20 ft followed by Natural Attenuation with monitoring/Environmental Easements;
- includes installation of a second treatment system and extraction well infrastructure and associated groundwater extraction,
- treatment of the extracted groundwater through air stripping,
- vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite,
- discharge of treated water to recharge basins; and,
- an environmental easement to restrict certain uses for site groundwater.
- also includes operation of the existing GW IRM.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$2,462,956	**$247,000**	
Capital Cost Total:				**$2,800,000**	(rounded up to nearest $100,000)
Long-Term OM&M (New and Existing Systems):					
Site Management Plan Implementation	1	LS	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Field Operator	1	EA	$75,000	$75,000	Field operator costs for OM&M of treatment system. 30 hrs per month average labor time.
Laboratory Analytical	1	LS	$50,000	$50,000	Laboratory analytical for system performance and compliance water and vapor samples.
Bag Filter/Media Replacement	1	ls	$140,000	$140,000	Replacement of filters, GAC, and PPZ.
Recharge Basin Maintenance	1	ls	$25,000	$25,000	Annual cleaning of recharge basin to restore permeability.
Electricity	1	ls	$84,000	$84,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$45,000	$45,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Waste Management Costs	1	ls	$10,000	$10,000	Cost to manage bag filters and purge water wastes.
Project Reporting	1	ls	$60,000	$60,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$35,000	$35,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Groundwater Monitoring	1	ls	$25,000	$25,000	Quarterly plume management and compliance monitoring of onsite monitoring wells.
Contingency	10%	of	$556,500	$55,650	
Annual O&MM Cost Total (Year 1):				**$612,150**	(Value is not the 30-year average annual OM&M cost)
Present Worth O&M Cost Total:				**$9,900,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative GW-3:				**$12,700,000**	(rounded up to nearest $100,000)

Table B12. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce VOC Concentrations below GA Standards using In-Situ Chemical Oxidation.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
ISCO Pre-Design Investigation:					
Bench Testing/Injection Test/Pilot Testing/Summary Report	2	LS	$115,000	$230,000	Bench testing for oxidant demand determination, injection/pilot testing for hydrogeologic demand determination.
Supplemental Groundwater Investigation					
Driller Mob/Demob	1	LS	$2,000	$2,000	Pre-design investigation to focus target area and establish baseline for remediation.
HSA for Hydropunch Samples	30	Days	$3,000	$90,000	Pre-design investigation to focus target area and establish baseline for remediation.
Analytical Analysis	100	Each	$150	$15,000	Pre-design investigation to focus target area and establish baseline for remediation.
Contractor's In-House Oversight	6	Weeks	$6,000	$36,000	Pre-design investigation to focus target area and establish baseline for remediation.
Work plan/Summary Report/Office Preparation	1	LS	$150,000	$150,000	Pre-design investigation to focus target area and establish baseline for remediation.
Pre-Design Investigation Subtotal:				**$523,000**	
ISCO Implementation Cost:					
Contractor Mobilization/Demobilization	3	LS	$25,000	$75,000	Assumes one (1) primary injection and two (2) follow up injections for rebound.
Clearing and Erosion and Sediment Control	378,083	SF	$3	$1,134,249	Site preparation for site activities, establish control zones, E&S establishment/maintenance.
Other Site Preparation	1	LS	$200,000	$200,000	Additional cost for setting up secondary containment type facility for storage of hazardous materials.
Driller and Disposal Costs					
Injection Well Installation	40,250	LF	$120	$4,830,000	430, two (2) inch diameter injection wells various target depths. Assumes wire-wrapped screens. Average depth <100 ft bls.
Monitoring Well Installation	8050	LF	$120	$966,000	Assumes one (1) monitoring point for every 10 injection points.
Temporary Injection System Cost					
Wellhead Mods/Piping/Appurtenances Material Cost	430	Each	$2,000	$860,000	Installation of wellhead modifications including pressure relief assembly, tees, etc.
Oxidant Feed System Rental and Mob/Demob	7	Months	$20,000	$130,000	Rental of an automated oxidant hopper/mixing tank/feed system from Carus Chemical.
Materials Storage/Management	3	LS	$30,000	$96,000	Onsite hazardous materials handling and management by certified personnel.
Injection Oversight/Labor	216	Days	$4,000	$865,600	Oversight by one (1) field engineer.
System Construction/Dismantling Fee	120	Days	$3,000	$360,000	Construction/dismantling of wellhead assemblies, transfer piping, setup of skid, etc.
Material Costs					
Permanganate	7,099,000	Lbs	$3	$21,591,609	Sodium permanganate supplied by Carus Chemical. Oxidant demand based on existing bench scale data.
Performance Monitoring					
Baseline Performance Monitoring	1	Each	$100,000	$100,000	Baseline groundwater monitoring program.
Performance Monitoring	157	Days	$2,000	$314,000	Performance monitoring completed during injection to document established ROI and insitu geochemical conditions.
Post-Injection Performance Monitoring	20	Each	$20,000	$400,000	Post-injection performance monitoring program to demonstrate compliance with RAO.
Dust Suppression/Vapor Control and Monitoring	195	Days	$2,000	$390,000	Implementation of a dust suppression program.
Water Supply Coordination/Allotment (hydrant use)	1	LS	$150,000	$150,000	Coordination with local agencies for hydrant use permit and other associated water supply fees.
Contractors In-House Project Management	277	Days	$1,000	$277,000	Subcontractors in-house project management fees.
Site Utility Survey	1	LS	$50,000	$50,000	Utility clearance for underground work. Assumes three (3) lines of evidence required.
Site Restoration	378,083	SF	$3	$1,134,249	Restoration of all disturbed areas in-kind.
ISCO Implementation Cost Subtotal:				**$33,924,000**	
Decommissioning and Closure Monitoring:					
System Decommissioning					
Well Abandonment	516	Each	$500	$258,000	Abandonment of all wells in accordance with local code requirements.
Post-Injection Summary Report and Data Management	1	LS	$200,000	$200,000	
Decommissioning and Closure Monitoring Subtotal:				**$458,000**	
Total ISCO Cost:				**$34,905,000**	
Engineering/Project Management:					
Engineering (4% of capital cost)	4.0%	of	$34,905,000	$1,396,200	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management (7% of capital cost)	7.0%	of	$34,905,000	$2,443,350	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management (10% of capital cost)	10.0%	of	$34,905,000	$3,490,500	All fees associated with management of construction related aspects of the project.
Engineering/Project Management Subtotal:				**$7,331,000**	

Table B12. Detailed Costs of Remedial Alternatives: Groundwater - Alternative GW-4, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce VOC Concentrations below GA Standards using In-Situ Chemical Oxidation.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Site Management Survey	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Administrative Controls Legal Fees	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Miscellaneous Project Costs Subtotal:				**$0**	
Project Capital Contingency:	10%	of	$42,236,000	**$4,224,000**	
Capital Cost Total:				**$46,500,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$0	$0	No cost. Site is restored to unrestricted use conditions.
Annual O&MM Cost Total (Year 1):				**$0**	
Present Worth O&M Cost Total:				**$0**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative GW-4:				**$46,500,000**	(rounded up to nearest $100,000)

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Table B13. Detailed Costs of Remedial Alternatives: Soil Gas - Alternative SG-2, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Operation of SG IRM / Environmental Easement requiring installation of engineering controls that address vapor intrusion issues for all future on-site structures.
- includes soil vapor extraction,
- institutional/engineering controls through the establishment of a Site Management Plan.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$120,000	**$12,000**	
Capital Cost Total:				**$200,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Field Operator	1	EA	$30,000	$30,000	Field operator costs for OM&M of treatment system. 10 hrs per month average labor time.
Laboratory Analytical	1	LS	$2,000	$2,000	Laboratory analytical for system performance and compliance water and vapor samples.
Electricity	1	ls	$50,000	$50,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$10,000	$10,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Waste Management Costs	1	ls	$7,500	$7,500	Cost to manage bag filters and purge water wastes.
Project Reporting	1	ls	$45,000	$45,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$28,000	$28,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Contingency	10%	of	$180,000	$18,000	
Annual O&MM Cost Total (Year 1):				**$198,000**	(Value is not the 30-year average annual OM&M cost)
Present Worth O&M Cost Total:				**$3,600,000**	30-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative SG-2:				**$3,800,000**	(rounded up to nearest $100,000)

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Table B13a. Detailed Costs of Remedial Alternatives: Soil Gas - Alternative SG-2 (Assumes Source Area Remedy SA-3 implemented), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Operation of SG IRM / Environmental Easement for 10 years requiring installation of engineering controls that address vapor intrusion issues for all future on-site structures.
- includes soil vapor extraction,
- institutional/engineering controls through the establishment of a Site Management Plan.

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Notes
Miscellaneous Project Costs:					
SMP Preparation	1	LS	$60,000	$60,000	Preparation of a Site Management Plan per NYSDEC guidelines.
Site Management Survey	1	LS	$30,000	$30,000	Bidding/subcontracting/preparation of an ALTA/ACSM easement survey per NYSDEC rqmts.
Administrative Controls Legal Fees	1	LS	$30,000	$30,000	Legal and consulting fees for execution of an site-specific environment easement.
Miscellaneous Project Costs Subtotal:				**$120,000**	
Project Capital Contingency:	10%	of	$120,000	**$12,000**	
Capital Cost Total:				**$200,000**	(rounded up to nearest $100,000)
Long-Term OM&M:					
Site Management Plan Implementation	1	LS	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
Field Operator	1	EA	$30,000	$30,000	Field operator costs for OM&M of treatment system. 10 hrs per month average labor time.
Laboratory Analytical	1	LS	$2,000	$2,000	Laboratory analytical for system performance and compliance water and vapor samples.
Electricity	1	ls	$50,000	$50,000	Assumes $0.17/kwh.
Major/Minor Equipment	1	ls	$10,000	$10,000	Replacement of system valves, piping, pumps, air stripper tray's, etc.
Waste Management Costs	1	ls	$7,500	$7,500	Cost to manage bag filters and purge water wastes.
Project Reporting	1	ls	$45,000	$45,000	Quarterly interim monitoring report preparation.
Project Management	1	ls	$28,000	$28,000	Includes management of field staff, budget management, system optimization reviews, office administration.
Contingency	10%	of	$180,000	$18,000	
Annual O&MM Cost Total (Year 1):				**$198,000**	(Value is not the 10-year average annual OM&M cost)
Present Worth O&M Cost Total:				**$1,700,000**	10-year present worth value. Assumes a discount factor of 4.5 percent.
Total Cost Alternative SG-2:				**$1,900,000**	(rounded up to nearest $100,000)

Table 6-2. Screening of Remedial Technologies: Source Areas, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
No Action	None	Not Applicable	No institutional or engineering controls implemented.	**Ineffective** - Does not reduce contamination in source areas. Not capable of achieving RAOs.	**Implementable** - No new measures would be implemented.	Low	Yes	Detailed evaluation of No Action alternative required in FS.
Collection/ Treatment Actions	In-Situ Chemical/ Physical Treatment	Soil Vapor Extraction (SVE)	SVE uses soil vapor extraction well(s) to remove VOCs from source areas.	**Effective** - Effective in treating VOCs in vadose zone soil source areas; conventional technology. When combined with off-gas treatment, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Proven technology used at site to remove VOCs from the soil gas. Requires off-gas treatment for air emissions.	Low to Moderate	Yes	Applicable to: - Vadose zone soil source areas
		Multi-Phase Extraction (MPE)	MPE uses a high vacuum system, applied through extraction wells, to simultaneously remove VOC-impacted perched water, LNAPL, and vapor from the subsurface.	**Effective** - Pilot test required to determine effectiveness; conventional technology. When combined with perched water and off-gas treatment, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Pilot tests required to determine effectiveness. Requires off-gas treatment for air emissions and treatment of extracted perched water.	Moderate	Yes	Applicable to: - LPZ/Perched water source area
		Enhanced Stabilization/Solidification/ Treatment (ZVI/Clay)	ZVI/Clay treatment is designed to 1) physically encapsulate contaminants within stabilized mass (solidification); 2) chemically react with contaminants to reduce their mobility (stabilization); and 3) reduce contaminant concentrations through reductive dechlorination.	**Effective** - Effective in stabilizing and treating VOCs and minimizing migration of VOCs to other media. May not be capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Short term site usage restrictions due to loss of soil structural integrity while the ZVI/Clay/Soil mixture consolidates; long term site usage restrictions can be mitigated through the inclusion of portland cement within the ZVI/Clay/Soil mixture.	High	Yes	Applicable to: - Vadose zone soil source areas - LPZ/Perched water source area - Groundwater/Saturated soil source areas
		In-Situ Chemical Oxidation (ISCO)	Chemical oxidant is injected into groundwater/saturated soils source areas resulting in breakdown of organic compounds into non-toxic compounds.	**Effective** - Effective in treating VOCs in groundwater/saturated soils source areas; conventional technology. Capable of achieving RAOs.	**Implementable** - Difficult to implement, requiring numerous wells and large volume of oxidant injection because of size and depth of groundwater/saturated soils source area. Short term restrictions to site usage while ISCO treatment activities are underway due to large quantity of wells used and need to store large quantities of hazardous materials on-site.	High	Yes	Applicable to: - Groundwater/Saturated soil source areas
	In-Situ Thermal Treatment	In-Situ Thermal Desorption (ISTD)	ISTD uses convective heating to increase the volatilization rate of VOCs. Heat is applied to the site soils via numerous vertical wells. System also incorporates a site cap and vapor extraction system to capture volatilized VOCs.	**Effective** - Effective in treating VOCs; conventional technology. When combined with off-gas treatment, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Requires off-gas treatment for air emissions. Restricts site usage in short term due to large quantity of infrastructure needed (e.g., electrical generator/power supply, site cap, large quantities of off-gas treatment media).	High	Yes	Applicable to: - Vadose zone soil source areas - LPZ/Perched water source area - Groundwater/Saturated soils source areas

Table 6-2. Screening of Remedial Technologies: Source Areas, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
Collection/ Treatment Actions	In-Situ Thermal Treatment	Electrical Resistivity Heating	Electrical resistance heating uses a series of electrodes to create an electrical current that heats soils and groundwater, thereby increasing the volatilization of VOCs. System incorporates site cap and vapor extraction system to capture volatilized VOCs.	**Effective** - Effective in treating VOCs. When combined with off-gas treatment, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Requires off-gas treatment for air emissions. Restricts site usage for a longer period than ISTD due to longer treatment times necessary and large quantity of infrastructure needed (e.g., electrical generator/power supply, site cap, large quantities of off-gas treatment media).	High	Yes	Applicable to: - Vadose zone soil source areas - LPZ/Perched water source area - Groundwater/Saturated soils source areas
Removal Actions	Excavation	Excavation	Physical removal of vadose zone soil source areas.	**Effective** - Effective in removing source areas; conventional technology. Achieves permanent contamination reduction on-site. In combination with off-site disposal and, vapor collection/treatment (if needed), capable of achieving RAOs.	**Implementable** - Readily implementable for shallow source areas (0-10 ft. bls); conventional construction (previously used at the site under Town of Oyster Bay IRM). Very difficult to implement at greater depths; would require excavation of large quantities of non-source area soils to remove VOC source areas. Short term restrictions to site usage while excavation activities are underway.	Very High	No	Applicable to: - Vadose zone source areas Not retained for further evaluation because the location, depth, and configuration of VOC source areas would require large amount of non-source area soils to be excavated and handled, making this technology extremely expensive.

DEFINITIONS:

COPCs	Contaminants of Potential Concern
FS	Feasibility Study
GAC	Granulated Activated Carbon
IRM	Interim Remedial Measure
ISCO	In-Situ Chemical Oxidation
ISTD	In-Situ Thermal Desorption
LNAPL	Light Non-Aqueous Phase Liquid
LPZ	Low Permeability
MPE	Multi-Phase
RAOs	Remedial Action Objectives
SCGs	Standard, Criteria and Guidelines
SVE	Soil Vapor Extraction
VOCs	Volatile Organic Compounds
ZVI	Zero Valent Iron

Table 6-3. Screening of Remedial Technologies: Groundwater, Site Area Feasibility Study, Northrop Grumman Systems Corporation Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
No Action	None	Not Applicable	GW IRM shut off. No institutional or engineering controls implemented.	**Ineffective** - Not capable of achieving RAOs.	**Implementable** - No new measures would be implemented; existing Groundwater IRM would be shut down.	Low	Yes	Detailed evaluation of No Action alternative required in FS.
Interim Remedial Measure (IRM)	Groundwater Extraction (Pump & Treat)	Existing Groundwater IRM consisting of: - Extraction wells - Groundwater treatment by air stripping, with off-gas treatment - Treated effluent filtration and disposal (to recharge basin) - Long-term groundwater monitoring	Present site conditions allowed to continue (Soil Gas and Groundwater IRMs continue to operate). Existing Groundwater IRM designed to prevent off-site migration of VOCs in groundwater exceeding 5 ug/L in upper 20 ft. of aquifer and 50 ug/L below upper 20 feet of aquifer.	**Effective** - Effective in controlling off-site migration of contaminated groundwater. Effectiveness of remedial action monitored through long-term monitoring. When used in conjunction with environmental easements, capable of achieving RAOs.	**Implemented** - Groundwater IRM is constructed and operational.	Low	Yes	
Environmental Easement	Institutional Controls/Engineering Controls	Fences and Signs	Fencing and posted signs used to restrict access to remedial systems.	**Effective** - Effective in limiting site access and protecting subsurface remedial system appurtenances. No contamination reduction. When used in conjunction with other remedial actions is capable of achieving RAOs.	**Implementable** - Some fencing and signs already in place. Readily implementable.	Low	Yes	
		Water Use Restriction	Legal controls used to restrict future groundwater uses and control activities involving contact with impacted groundwater.	**Effective** - Effective in limiting exposure to on-site impacted groundwater. No contamination reduction. When used in conjunction with other remedial actions is capable of achieving RAOs.	**Implementable** - Readily implementable. Will require time and coordination with property owner. Restrictions on future water use.	Low	Yes	
Additional Containment Action	Groundwater Extraction (Pump & Treat)	Enhanced Groundwater IRM including: - Construction of new extraction wells and treatment plant (air stripping) - No new construction for off-gas treatment, treated effluent filtration, or treated effluent disposal; uses existing Groundwater IRM systems - Long-term groundwater monitoring	Enhanced Groundwater IRM extraction system in deeper aquifer to prevent off-site migration of VOCs in groundwater exceeding 5 ug/L below upper 20 feet of aquifer.	**Effective** - Enhances effectiveness of current IRM in controlling off-site migration of contaminated groundwater; conventional technology. Effectiveness monitored through long-term monitoring system. When used in conjunction with environmental easements, capable of achieving RAOs.	**Implementable** - Readily implementable; conventional construction. Proven technology at site (Groundwater IRM consisting of extraction wells and treatment system is constructed and operational).	Moderate	Yes	

**Table 6-3. Screening of Remedial Technologies: Groundwater,
Site Area Feasibility Study, Northrop Grumman Systems Corporation
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.**

General Response Action	Remedial Technology Type	Process Options	Technology Description	Effectiveness	Implementability	Relative Cost	Retained for Detailed Evaluation?	Comments
Treatment Actions	Chemical	In-Situ Chemical Oxidation (ISCO)	Chemical oxidant is injected into an impacted aquifer resulting in the complete breakdown of organic compounds into non-toxic compounds.	**Effective** - Conventional technology for high-concentration source areas; not conventional for general dissolved plume treatment. Exceeds RAOs.	**Implementable** - Difficult to implement, requiring numerous wells and large volume of oxidant injection because of size and depth of plume. Would require storage of large quantities of hazardous materials.	Very High	Yes	Detailed evaluation of alternative for achieving drinking water standards required in FS.
	Natural Treatment	Natural Attenuation	Uses naturally occurring processes (e.g., dilution, dispersion, sorption, biodegradation) to achieve RAOs. Typically used following active remediation and to address low concentrations of contaminants amenable to natural attenuation processes.	**Effective** - Site-related groundwater contaminants treatable by natural attenuation processes. When used in conjunction with, or following use of active remedial actions is capable of achieving RAOs.	**Implementable** - Readily implementable; no construction required. May require additional monitoring well installation.	Low	Yes	

DEFINITIONS:

COCs	Contaminants of Concern
COPCs	Contaminants of Potential Concern
FS	Feasibility Study
GW IRM	Groundwater Interim Remedial Measure
IRM	Interim Remedial Measure
ISCO	In-Situ Oxidation
IRM	Interim Remedial Measure
RAOs	Remedial Action Objectives
SCOs	Soil Cleanup Objectives
SCGs	Standard, Criteria and Guidelines
SG IRM	Soil Gas Interim Remedial Measure
VOCs	Volatile Organic Compounds

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Table 7-1. Evaluation Criteria for Remedial Alternatives,
Site Area Feasibility Study, Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Evaluation Criteria	Criteria Definition
Overall Protectiveness of Public Health and the Environment	This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced, or controlled through removal, treatment, engineering controls, or institutional controls. The remedy's ability to achieve each of the RAOs is evaluated here.
Standards, Criteria, & Guidance (SCGs)	Under this criterion, the issue of whether an alternative meets environmental laws, regulations, standards and guidance is assessed. If one or more SCGs are not met upon the implementation of a remedial alternative, an assessment of whether a waiver is required must be provided.
Long Term Effectiveness & Permanence	The long-term effectiveness and permanence of a remedial alternative after implementation is evaluated. If wastes or residuals will remain at the site after implementation, then the following items are evaluated: (1) the magnitude and nature of the residual risks posed by the remaining wastes; (2) the adequacy of the controls intended to limit the risks; (3) the reliability of these controls; and (4) the ability of the remedy to continue to meet the RAOs in the future.
Reduction of Toxicity, Mobility, or Volume with Treatment	Under this criterion, the ability of an alternative to permanently and significantly reduce toxicity, mobility or volume of the wastes is evaluated. Preference is given to remedial alternatives where this can be achieved.
Short-Term Impacts and Effectiveness	Under this criterion, the potential short-term impacts of a remedial action upon the community, the site workers, and the environment are evaluated. The period of time required to achieve remedial objectives is also estimated and compared against the other alternatives.
Implementability	Under this criterion, the technical and administrative feasibility of implementing a remedial alternative are evaluated. For technical feasibility, the difficulties associated with the construction and operation of the alternative and the ability to monitor the effectiveness of the remedy are evaluated. For administrative feasibility, the availability of the necessary personnel and material is evaluated, along with the potential difficulties in obtaining special permits, rights-of-way, etc.
Cost Effectiveness	Capital costs and O&M costs are estimated for each remedial alternative and compared on a present worth basis. Although cost is the last criterion evaluated, where two or more alternatives have met the requirements of the other criteria, cost effectiveness should be used as the basis for final remedy selection.

DEFINITIONS:

RAOs Remedial Action Objectives
O&M Operation & Maintenance
SCGs Standard, Criteria and Guidelines

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Table 7-2. Summary of Remedial Alternatives,
Site Area Feasibility Study, Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remedial Alternative	Alternative Description
Park Soils	
S-P1	No Action. No institutional or engineering controls implemented.
S-P2	Excavate upper 2 ft of soils to Restricted Residential SCOs. Implement environmental easement.
S-P3	Option 1: Excavate upper 2 ft of soils to Restricted Residential SCOs. Excavate/solidify 98% of Blue-Green Material in upper 10 ft of soils. Excavate soils between 2 ft and 6 ft bls (10 ft around utilities) with PCBs > 50 mg/kg. Implement Environmental Easements. OR Option 2: Add 2 ft of clean-soil cover across the Park Area. Excavate/solidify 98% of Blue-Green Material in upper 10 ft of soils. Use In-situ Thermal Desorption (ISTD) to remediate soils between 2 ft and 6 ft bls (and relocate utilities) with PCB > 50 mg/kg. Implement Environmental Easements.
S-P4	Excavate upper 2 ft of soils to Restricted Residential SCOs. Excavate soils beneath 2 ft with PCBs > 10 mg/kg. Implement Environmental easement.
S-P5	Excavate soils that exceed Unrestricted Use SCOs.
Access Road Soils	
S-AR1	No Action. No institutional or engineering controls implemented.
S-AR2	Install gravel cap. Implement environmental easement.
S-AR3	Excavate Soils that Exceed Unrestricted Use SCOs.
Source Areas	
SA-1	No Action. No institutional or engineering controls implemented.
SA-2	Remediate VOC source areas in the vadose zone soils, low permeability soils/perched water, and groundwater/saturated soils using soil vapor extraction (SVE), multi-phase extraction (MPE), and In-Situ Chemical Oxidation (ISCO), respectively. Treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon (GAC) and potassium permanganate. Air stripping to remove VOCs in the extracted perched water. Discharge of treated water via recharge basins. Field and bench-scale feasibility tests.
SA-3	Remediate VOC source areas using In-situ Thermal Desorption (ITSD); includes catalytic oxidation of the VOCs in the extracted vapors, caustic scrubbing, and GAC polishing.
SA-4	Remediate VOC source areas using bentonite clay with zero valent iron (ZVI).

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Table 7-2. Summary of Remedial Alternatives,
Site Area Feasibility Study, Northrop Grumman Systems Corporation,
Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remedial Alternative	Alternative Description
Groundwater	
GW-1	No Action. Shut down the Groundwater IRM. No institutional or engineering controls implemented.
GW-2	Operation of OU-3 GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer, and 50 ug/L of total VOCs below the upper 20 feet of the aquifer. Attenuation to control onsite metals migration. Transition to natural attenuation with monitoring to address residual COPC impacts once the GW IRM system shutdown criteria are met. Includes groundwater extraction, air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins, and the implementation of an Environmental Easement to restrict use of site groundwater.
GW-3	Expand GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceed 5 ug/L Total VOCs in aquifer below 20 ft followed by natural attenuation with monitoring to address residual COPC impacts once the system shutdown criteria are met. Includes installation of a second treatment system and extraction well infrastructure, the use of air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins and the implementation of an Environmental Easement to restrict use of site groundwater.
GW-4	Reduce VOC Concentrations below GA Standards using In-Situ Chemical Oxidation.
Soil Gas	
SG-1	No Action. SG IRM shut off. No institutional or engineering controls implemented.
SG-2	Operation of SG IRM. Implement Environmental Easement requiring installation of engineering controls that address vapor intrusion issues for all future on-site structures.

DEFINITION:

S-P	Vadose Zone Soils - Park Area
S-AR	Vadose Zone Soils - Access Road
SA	Source Areas
GW	Groundwater
SG	Soil Gas
ITSD	In-situ Thermal Desorption
ISCO	In-situ Chemical Oxidation

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Table 7-3. Detailed Evaluation of Remedial Alternatives: Vadose Zone Soil - Park (S-P), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative S-P1	Alternative S-P2	*Alternative S-P3*	Alternative S-P4	Alternative S-P5
	No Action. No institutional or engineering controls implemented.	*Excavate upper 2 ft of soils to Restricted Residential SCOs. Implement environmental easement. (see Figures 4-3 thru 4-5 and 4-7) (3)*	Excavate upper 2 ft of soil to Restricted Residential SCOs or add 2 ft of clean-soil cover across the Park Area. Excavate/solidify 98% of Blue-Green Material in upper 10 ft of soils. Remediate soil between 2 ft and 6 ft bls (10 ft around utilities) with PCBs > 50 mg/kg using excavation or In-situ Thermal Desorption (ISTD). Implement environmental easements. (see Figures 4-3 thru 4-7) (3)	Excavate upper 2 ft of soils to Restricted Residential SCOs. Excavate soils beneath 2 ft with PCBs > 10 mg/kg. Implement environmental easement. (see Figures 4-3 thru 4-5 and 4-7) (3)	Excavate Soils that Exceed Unrestricted Use SCOs. (see Figures 4-3 thru 4-7)
Overall Protectiveness of the Public Health and the Environment	Does not achieve Soil RAO.	***Achieves Soil RAO. Protective of public health and the environment by eliminating the exposure of Park users to impacted surface soils. Environmental easement will limit future land uses (e.g. will be used as a Park [restricted residential] or it reverts back to Northrop Grumman) and control future activities involving potential contact of workers with impacted subsurface soils.***	Same as S-P2	Same as S-P2.	Restores Park Area Soils to pre-release conditions.
Standards, Criteria, & Guidance (SCGs)	Does not meet SCG criteria; waiver would be required if implemented.	***Achieves applicable Restricted Residential SCOs in the upper 2 ft of soil, and guidance specified in the Commissioner's Soil Clean-up Policy regarding the elimination or mitigation of all significant threats to public health and the environment in subsurface soil.***	Same as S-P2	Same as S-P2	Achieves most restrictive SCG criteria for soils.
Long Term Effectiveness & Permanence	Not effective in the long-term. Leaves residual contamination in place. No change in current risk to the public and the environment. Remedy will not achieve long-term compliance with Soil RAO.	***Leaves no long-term significant risk to the public and the environment. Future risks controlled through environmental easement. Achieves long-term compliance with Soil RAO.***	Same as S-P2	Same as S-P2	Same as S-P2, plus eliminates all future site management requirements pertaining to impacted soil; and all significant long-term threats to public health and the environment in Park soils.
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	No reduction in toxicity, mobility, or volume of contamination.	***Achieves permanent and significant reduction of toxicity, mobility, and volume of contamination in upper 2 ft. Excavated soils are transported to an off-site location for treatment and/or disposal. Approximate volume of soils to be excavated is 9,000 cubic yards.***	Same as S-P2, plus, the following additional contamination will be treated: a) soils between 2 ft to 6 ft bls (10 ft around utilities) with PCBs > 50 mg/kg (~ 4,800 cubic yards); and b) the excavation or treatment of 98% of Blue-Green Material in the upper 10 ft of soils (~450 cubic yards).	Same as S-P2, including permanent and significant reduction of toxicity, mobility, and volume of contamination associated with PCB impacts in soils. Excavated soils are transported to an off-site location for treatment and/or disposal. Approximate volume of additional soils to be excavated is 64,000 cubic yards of PCB-impacted soils (this does not include the non-impacted soils that will have to be excavated to reach/allow the PCB-impacted soils to be removed).	Achieves permanent and significant reduction in toxicity, mobility, and volume of the contamination within the Park soils. The excavated soils are transported to an off-site location for treatment and/or disposal. Approximate volume of soils to be excavated is 230,000 cubic yards, the majority of which is deeper than 6 ft bls.
Short-Term Impacts and Effectiveness	No short-term impacts to the community, site workers or the environment as a result of implementation of this alternative. Does not achieve Soil RAO in the short-term.	***Impacts to the community and site workers during implementation of this alternative can be mitigated. Comparatively low potential for short-term impact to the environment. Achieves short-term compliance with Soil RAO.***	Same as S-P2, but greater potential duration for short term construction impacts due to the deeper excavation or treatment depths in some areas.	Same as S-P2, but greater potential duration for short term construction impacts due to the deeper excavation depths in some areas.	Significant potential for short-term adverse impacts and risks to the community and site workers as a result of this alternative (e.g., fugitive dust, traffic congestion and accidents, deep excavation hazards, fuel consumption, transportation of significant quantities of contaminated media through residential neighborhoods). Comparatively longest relative estimated time to achieve Soil RAO.
Implementability	Technically and administratively feasible to implement.	***Same as S-P1, however somewhat more difficult to implement due to construction activities required.***	Same as S-P2.	Technically feasible to implement but would require special equipment/construction methods to achieve excavation over large areas at significant depths while providing protection of the public, workers and infrastructure during implementation. Would have comparatively greater administrative Implementability difficulties due to the significantly greater magnitude of the work to be performed and the large amount of materials to be managed.	Similar to S-P4, however the technical and administrative Implementability issues are greater.
Cost Effectiveness (2)	$0	**$8,000,000**	$13,400,000	$48,800,000	$149,700,000

Recommended Alternative Rationale	**Alternative S-P2 is protective of human health and the environment, as are Alternatives S-P3, S-P4, and S-P5. Alternative S-P1 will not meet the Soil RAO. Alternatives S-P3, S-P4 and S-P5 would cost substantially more than S-P2 but do not achieve greater protection of human health or the environment. Alternatives S-P3, S-P4 and S-P5 also would have significantly greater adverse short-term impacts to the community and site workers, and have more Implementability problems compared to Alternative S-P2.**

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Table 7-3. Detailed Evaluation of Remedial Alternatives: Vadose Zone Soil - Park (S-P), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Shaded/bold/italics: Identifies recommended Site Area remedial alternative.

NOTES:

(1) See Figure 3-1 for location of the Site Area property.
(2) Detailed cost estimate spreadsheet provided in Appendix B.
(3) Long-term groundwater monitoring program costs are included in the alternatives for groundwater (Table 7-6).

DEFINITIONS:

NYCRR New York Code of Rules and Regulations
PCBs Polychlorinated Biphenyls
RAOs Remedial Action Objectives
SCGs Standard, Criteria and Guidelines
SCOs Soil Cleanup Objectives
TSCA Toxic Substance Control Act of 1976
bls Below Land Surface

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Table 7-4. Detailed Evaluation of Remedial Alternatives: Vadose Zone Soil - Access Road (S-AR), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative S-AR1 No Action. No institutional or engineering controls implemented.	*Alternative S-AR2* *Install gravel cap. Implement environmental easement. (See Figures 4-3, 4-5, 4-8, and 4-9) (2)*	Alternative S-AR3 Excavate Soils that Exceed Unrestricted Use SCOs.
Overall Protectiveness of the Public Health and the Environment	Does not achieve Soil RAO.	***Protective of public health by eliminating the ingestion, inhalation, and direct contact exposure pathways associated with the impacted surface soils. Existing fencing further reduces access/exposures. An environmental easement would limit future land uses and control future activities involving potential contact of workers with impacted soils. Achieves the Soil RAO.***	Restores Access Road Vadose Zone Soils to pre-release conditions.
Standards, Criteria, & Guidance (SCGs)	Does not meet SCG criteria; waiver would be required if implemented.	***Achieves the guidance requirements specified in the Commissioner's Soil Clean-up Policy regarding the elimination or mitigation of significant threats to public health and the environment in surface and subsurface soil.***	Achieves most restrictive SCG criteria for soils.
Long Term Effectiveness & Permanence	Not effective in the long-term. Leaves residual contamination in place. No change in current risk to the public and the environment. Remedy will not achieve long-term compliance with Soil RAO.	***Leaves no long-term significant risk to the public and the environment. Future risk controlled through the environmental easement. Achieves long-term compliance with Soil RAO for Access Road soils.***	Same as S-AR2, plus eliminates future site management requirements pertaining to impacted soil.
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	No reduction in toxicity, mobility, or volume of contamination.	***No reduction in toxicity or volume of contamination. Application of a gravel cap would eliminate fugitive impacted dust emissions.***	Achieves permanent and significant reduction in toxicity, mobility, and volume of the contamination within the Access Road property. The excavated soils are transported to an off-site location for treatment and/or disposal. Approximate volume of soils to be excavated is 17,000 cubic yards.
Short-Term Impacts and Effectiveness	No short-term impacts to the community, site workers or the environment as a result of implementation of this alternative. Does not achieve Soil RAO in the short-term.	***Very low potential for short-term impacts to the community, site workers, and the environment during the short term construction of the gravel cap. Achieves short-term compliance with Soil RAO for Access Road soils.***	Higher potential than S-AR2 for short-term adverse impacts and risks to the community, site workers, and the environment as a result of this alternative (e.g., fugitive dust, traffic congestion and accidents, excavation/open pit hazards, fuel consumption, transportation of significant quantities of impacted media through residential neighborhoods).
Implementability	Technically and administratively feasible to implement.	***Same as S-AR1, however somewhat more difficult to implement due to construction activities required.***	Similar to S-AR2, but more difficult to implement due to additional construction activities required and larger volume of materials to be managed. Also requires significant management of existing subsurface utilities (i.e., soil gas IRM and GW IRM piping).
Cost Effectiveness (3)	$0	***$600,000***	$9,800,000

Northrop Grumman Recommended Alternative Rationale	Alternative S-AR2 provides the same level of protection to human health and the environment as Alternative S-AR3 and achieves the Soil RAO. Alternative S-AR3 is not any more protective of human health and the environment when compared to Alternative S-AR2 but costs approximately $9M more and is therefore not cost effective. In addition, Alternative S-AR3 has a significant potential for short-term impacts to the community and site workers when compared to Alternative S-AR2. Finally, remediation to the Unrestricted Use SCO (Alternative S-AR3) is not consistent with the intended future use of the Access Road. Alternative S-AR1 will not achieve Soil RAO.

Table 7-4. Detailed Evaluation of Remedial Alternatives: Vadose Zone Soil - Access Road (S-AR), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Shaded/bold/italics: Identifies Northrop Grumman recommended remedial alternative.

NOTES:

(1) See Figure 3-1 for location of the Access Road property.
(2) Long-term groundwater monitoring program costs are included in the alternatives for groundwater (Table 7-6).
(3) Detailed cost estimate spreadsheet provided in Appendix B.

DEFINITIONS:

RAO Remedial Action Objectives
SCGs Standard, Criteria and Guidelines
SCOs Soil Cleanup Objectives

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Table 7-5. Detailed Evaluation of Remedial Alternatives: Source Areas (SA), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative SA-1	Alternative SA-2 (2)	*Alternative SA-3 (2)*	Alternative SA-4 (2)
	No Action. No institutional or engineering controls implemented.	Remediate VOC source areas in the vadose zone soils, low permeability soils/perched water, and groundwater/saturated soils using soil vapor extraction (SVE), multi-phase extraction (MPE), and In-Situ Chemical Oxidation (ISCO), respectively. Treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon (GAC) and potassium permanganate. Air stripping to remove VOCs in the extracted perched water. Discharge of treated water via recharge basins. Field and bench-scale feasibility tests. (see Figure 4-1)	*Remediate VOC Source Areas using In-situ Thermal Desorption; includes catalytic oxidation of the VOCs in the extracted vapors, caustic scrubbing, and vapor phase granular activated carbon polishing. (see Figure 4-1)*	Remediate VOC Source Areas using Bentonite Clay with Zero Valent Iron. (see Figure 4-1)
Overall Protectiveness of the Public Health and the Environment	Does not achieve the RAOs.	Protective of public health and the environment. Achieves RAOs however, additional site-specific testing needed to confirm effectiveness of technologies.	***Protective of public health and the environment. Achieves RAOs.***	Protective of public health and the environment through the elimination of exposure pathways and immobilization of VOCs. Will achieve RAO for source area groundwater; however does not achieve RAO for source area soils.
Standards, Criteria, & Guidance (SCGs)	Does not meet SCG Criteria; waiver would be required if implemented.	Designed to reduce contaminant concentrations in source areas. Achieves SCOs for Restricted Residential soils but does not meet SCG Criteria for groundwater; an assessment of whether a groundwater waiver is required would be provided. Meets SCG criteria for air emissions.	***Same as SA-2.***	Achieves the guidance requirements specified in the Commissioner's Soil Clean-up Policy regarding the elimination or mitigation of significant threats to public health and the environment in surface and subsurface soil. Does not meet SCG criteria for groundwater; an assessment of whether a groundwater waiver is required would be provided.
Long Term Effectiveness & Permanence	Not effective in the long-term. Leaves residual impacted soil in place. No change in current risk to the public and the environment. Remedy will not achieve long-term compliance with RAOs.	May be effective in the long-term; however, effectiveness would have to be evaluated through additional testing. Leaves no significant risk to the public and the environment when coupled with operation of the existing IRMs. May not be capable of achieving long-term compliance with the RAOs for source area soils due to site specific geology; however magnitude of residual risk would be low during operation of the existing IRMs. May require additional engineering and/or institutional controls to mitigate residual risk.	***Effective in the long-term. Leaves no significant risk to the public and the environment. Achieves long-term compliance with RAOs for source area soils.***	Effective in the long-term. Leaves no significant risk to the public and the environment. Achieves long-term compliance with RAO for source area groundwater. Does not achieve long-term compliance with RAOs for source area soils. However, magnitude of residual risk would be low when coupled with institutional controls.
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	No reduction in toxicity, mobility, or volume of contamination.	Achieves moderate reduction of mobility, volume, and toxicity of VOCs within source area vadose zone soils. Magnitude of volume, mobility, and toxicity reduction in vadose zone soils will be limited by site-specific geology. Achieves moderate reduction of toxicity, mobility, and volume of VOCs in source area saturated zone soils and groundwater. Magnitude of reduction in saturated zone soils and groundwater will be limited by site specific geology. Approximate volume of vadose zone and saturated zone soil source areas to be remediated is 52,000 cubic yards.	***Achieves permanent and significant reduction of toxicity, mobility, and volume of VOCs within source areas. Achieves greatest overall reduction when compared to Alternatives SA-1, SA-2, and SA-4. Approximate volume of vadose zone and saturated zone soil source areas to be remediated is 52,000 cubic yards.***	Achieves permanent and significant reduction of mobility of VOCs within source area vadose zone and saturated zone soils. Achieves moderate reduction in volume and toxicity of VOCs within source areas. Eliminates dissolved phase groundwater contamination pathway through stabilization and treatment of VOCs within source area soils. Approximate volume of vadose zone and saturated zone soil source areas to be remediated is 52,000 cubic yards.

Table 7-5. Detailed Evaluation of Remedial Alternatives: Source Areas (SA), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative SA-1	Alternative SA-2 (2)	*Alternative SA-3 (2)*	Alternative SA-4 (2)
	No Action. No institutional or engineering controls implemented.	**Remediate VOC source areas in the vadose zone soils, low permeability soils/perched water, and groundwater/saturated soils using soil vapor extraction (SVE), multi-phase extraction (MPE), and In-Situ Chemical Oxidation (ISCO), respectively. Treatment of the extracted vapors and the air stripper off-gas using vapor phase granular activated carbon (GAC) and potassium permanganate. Air stripping to remove VOCs in the extracted perched water. Discharge of treated water via recharge basins. Field and bench-scale feasibility tests. (see Figure 4-1)**	***Remediate VOC Source Areas using In-situ Thermal Desorption; includes catalytic oxidation of the VOCs in the extracted vapors, caustic scrubbing, and vapor phase granular activated carbon polishing. (see Figure 4-1)***	**Remediate VOC Source Areas using Bentonite Clay with Zero Valent Iron. (see Figure 4-1)**
Short-Term Impacts and Effectiveness	No short-term impacts to the community, site workers or the environment as a result of implementation of this alternative Does not achieve RAOs in the short-term.	Short term impacts to the community and site workers during construction of this alternative can be mitigated. Low potential for impact to the environment (due to uncontrolled release of vapor emissions), which can be mitigated through proper remedial system operation. Longer relative estimated time to achieve the site RAOs when compared to Alternative SA-3. Shorter relative estimated time to achieve the site RAOs when compared to Alternative SA-4. However, as referenced above, ability to achieve RAOs would need to be demonstrated through additional testing.	***Same as SA-1. However, shortest relative time to achieve the site RAOs when compared to Alternatives SA-1, SA-2, and SA-4.***	Lowest potential for impacts to the community, site workers and environment in the short-term. Shortest relative estimated time to implement when compared to Alternatives SA-2 and SA-3. However, will not achieve RAOs for source areas in the short-term.
Implementability	Technically and administratively feasible to implement.	Technically and administratively feasible to implement.	***Technically and administratively feasible to implement. However relatively more difficult to implement then Alternatives SA-1, SA-2, and SA-4 due to complex infrastructure and above grade treatment requirements. Limited availability of contractors qualified to implement the work.***	Technically and administratively feasible to implement. However relatively more difficult to implement then Alternatives SA-1 and SA-2. Limited availability of contractors qualified to implement the work.
Cost Effectiveness (3)	$0	$9,600,000	***$15,600,000***	$23,700,000

Northrop Grumman Recommended Alternative Rationale	Alternative SA-3 was selected because it is capable of achieving significant and permanent reduction in the mobility, toxicity, and volume of mass and therefore achievement of the RAOs for source areas. Alternative SA-3 is capable of overcoming geologic constraints that may render Alternative SA-2 ineffective. Alternative SA-1 will not achieve RAOs. Alternative SA-2 was not selected due to the potential limitations caused by geologic constraints and therefore potential inability to achieve RAOs for source areas. Alternative SA-4 is protective of human health and the environment but will not achieve the RAO for source area soils. In addition, Alternative SA-4 has the highest cost when compared to Alternatives SA-1, SA-2, and SA-3.

Table 7-5. Detailed Evaluation of Remedial Alternatives: Source Areas (SA), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Shaded/bold/italics: Identifies Northrop Grumman recommended remedial alternative.

NOTES:

(1) VOC Source Areas (>10 ppm TVOCs) are located in the Vadose Zone, Low Permeability Soils/Perched Water, and Groundwater/Saturated Soils (See Figure 4-1).

(2) 6NYCRR Part 375-1.8 requires evaluation of removal and/or treatment of sources to the greatest extent possible.

(3) Detailed cost estimate spreadsheet provided in Appendix B.

DEFINITIONS:

IRM Interim Remedial Measures
LPZ Low Permeability Zone
RAO Remedial Action Objectives
SCGs Standard, Criteria and Guidelines
SCOs Soil Cleanup Objectives
NYCRR New York Code of Rules and Regulations
VOCs Volatile Organic Compounds

Table 7-6. Detailed Evaluation of Remedial Alternatives: Groundwater (GW), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative GW-1	*Alternative GW-2*	Alternative GW-3	Alternative GW-4 (2)
	No Action. Groundwater IRM shut down. No institutional or engineering controls implemented.	*Operation of OU-3 GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer, and 50 ug/L of total VOCs below the upper 20 feet of the aquifer. Attenuation to control onsite metals migration. Transition to natural attenuation with monitoring to address residual COPC impacts once the GW IRM system shutdown criteria are met. Includes groundwater extraction, air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins, and the implementation of an Environmental Easement to restrict use of site groundwater. (see Figures 4-14 and 4-15)*	Expand GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceed 5 ug/L Total VOCs in aquifer below 20 ft followed by natural attenuation with monitoring to address residual COPC impacts once the system shutdown criteria are met. Includes installation of a second treatment system and extraction well infrastructure, the use of air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins and the implementation of an Environmental Easement to restrict use of site groundwater. (see Figures 4-14 and 4-15)	Reduce VOC Concentrations below GA Standards using In-Situ Chemical Oxidation. (see Figures 4-14 and 4-15)
Overall Protectiveness of the Public Health and the Environment	Does not achieve the RAOs for site area groundwater.	***Protective of public health and the environment. Achieves RAOs for site area groundwater by controlling off-site migration of impacted groundwater. A use restriction for site groundwater will control potential on-site exposures.***	Same as GW-2 but also prevents off-site migration of groundwater with TVOC concentration > 5 ug/L below 20 ft in aquifer.	Protective of public health and the environment. Achieves RAOs. Restores site to pre-release conditions.
Standards, Criteria, & Guidance (SCGs)	Does not meet SCG criterion; waiver would be required if implemented.	***Achieves SCGs associated with the ex-situ treatment and discharge of the extracted groundwater.***	Same as GW-2 but also meets SCG criterion for groundwater.	Meets most restrictive SCG criterion for groundwater.
Long Term Effectiveness & Permanence	Not effective in the long-term. Leaves residual impacted groundwater in place. No change in current risk to the public and the environment. Remedy will not achieve long-term compliance with RAOs.	***Leaves no significant risk to the public and the environment. Achieves long-term compliance with the RAOs.***	Same as GW-2.	Same as GW-2, plus eliminates all future site management requirements pertaining to impacted groundwater.
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	No reduction in toxicity, mobility, or volume of contamination.	***Provides reduction in mobility and volume of VOCs in site groundwater. Removes approximately 3.5 billion gallons of groundwater (~7,800 lbs of VOC mass) in 30 years (see Appendix A). Natural attenuation will eliminate the mobility of metals.***	Same as GW-2 but results of modeling performed (see Appendix A) indicate that the expanded IRM would result in a 10 percent increase in contaminant mass removed from the aquifer after 30 years of operation. However, without the expanded IRM, most of the additional 10 percent mass would be recovered by the existing groundwater IRM but over a longer period. Additionally, as shown in the "cost" section of this table, the cost of the infrastructure and OMM required for the Expanded IRM are almost double that of the groundwater IRM.	Achieves permanent and significant reduction in toxicity, mobility, and volume of the contamination. Volume treated is approximately 31,000,000 gallons.
Short-Term Impacts and Effectiveness	No short-term impacts to the community, site workers or the environment as a result of implementation of this alternative Does not achieve RAOs in the short-term.	***Effective in preventing the majority of the site related COPCs in the groundwater from migrating off-site in the short-term. Low potential for impact to the environment due to uncontrolled release of untreated groundwater or vapor emissions if not properly operated; however, potential for impact can be mitigated through proper operation. Time to meet groundwater RAO is immediate because remedy was installed as an IRM and is already operational.***	Same as GW-2; slight potential for short-term impacts to the community and site workers during construction activities; however, impacts easily mitigated. In addition, slightly higher potential for impacts to the environment due to the potential for additional uncontrolled release caused by operation of a second treatment system.	Significant potential for short-term adverse impacts and risks to the community, site workers, and the environment as a result of this alternative (e.g., exposure to the large quantity of hazardous material [permanganate] that would have to be transported, stored, and handled at the site). Potential for release of metals currently insoluble, stable, and bound to the aquifer matrix.

Table 7-6. Detailed Evaluation of Remedial Alternatives: Groundwater (GW), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative GW-1	*Alternative GW-2*	Alternative GW-3	Alternative GW-4 (2)
	No Action. Groundwater IRM shut down. No institutional or engineering controls implemented.	***Operation of OU-3 GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer, and 50 ug/L of total VOCs below the upper 20 feet of the aquifer. Attenuation to control onsite metals migration. Transition to natural attenuation with monitoring to address residual COPC impacts once the GW IRM system shutdown criteria are met. Includes groundwater extraction, air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins, and the implementation of an Environmental Easement to restrict use of site groundwater. (see Figures 4-14 and 4-15)***	Expand GW IRM to prevent the off-site migration of site-related VOCs in groundwater that exceed 5 ug/L Total VOCs in aquifer below 20 ft followed by natural attenuation with monitoring to address residual COPC impacts once the system shutdown criteria are met. Includes installation of a second treatment system and extraction well infrastructure, the use of air stripping, vapor phase treatment of the air stripper off-gas using granular activated carbon and potassium permanganate impregnated zeolite, discharge of treated water to recharge basins and the implementation of an Environmental Easement to restrict use of site groundwater. (see Figures 4-14 and 4-15)	Reduce VOC Concentrations below GA Standards using In-Situ Chemical Oxidation. (see Figures 4-14 and 4-15)
Implementability	Technically and administratively feasible to implement.	***Technically implementable; active portion of the remedy is already installed. Administratively implementable; will require establishment of a groundwater use restriction for on-site groundwater through an environmental easement.***	Technically implementable; existing groundwater IRM of equivalent scope recently installed at the site. Administratively implementable; will require establishment of a groundwater use restriction through an environmental easement.	Technically difficult to implement and will require significant infrastructure to deliver reagents effectively and significant controls for protection of the public and workers during implementation. Will require additional administrative efforts to address the potential risks to the public during the work. Finally, site geology could limit reagent delivery and the effectiveness of the remedy.
Cost Effectiveness (3)(4)	$0	***$7,600,000***	$12,700,000	$46,500,000

Northrop Grumman Recommended Alternative Rationale	Alternative GW-2 was selected because it is capable of achieving the RAOs for site groundwater, is comparatively cost effective, and is effective in the short-term and long-term. The active portion of this alternative was implemented as an IRM and is already installed and operational and meeting its design objectives. Alternative GW-1 was not selected because it does not achieve RAOs for groundwater. Alternative GW-3 was not selected due to the limited additional remedial benefit (i.e., 10 percent increase in mass recovered with nearly double the volume of groundwater recovered) and significant cost increase when compared to Alternatives GW-1 and GW-2. Alternative GW-4 has a significant risk for adverse impacts to the public, site workers, and the environment during implementation. In addition, the effectiveness of the remedy could be limited by geologic constraints, and there is a significant increase in cost when compared to Alternatives GW-1, GW-2, and GW-3.

Shaded/bold/italics: Identifies Northrop Grumman recommended remedial alternative.

NOTES:

(1) GW IRM site plan shown on Figure 4-16.
(2) 6NYCRR Part 375-1.8 requires evaluation to determine measures required to restore groundwater quality to applicable standards and guidance.
(3) Costs for Alternatives GW-2 and GW-3 do not reflect additional significant cost savings that would be achieved through implementation of source area Alternatives SA-2 through SA-4. Those savings are reflected, however, in Table 8-1.
(4) Detailed cost estimate spreadsheet provided in Appendix B.

DEFINITIONS:

COPCs Contaminant of Potential Concern
GW IRM Ground Water Interim Remedial Measures
RAOs Remedial Action Objectives
SCGs Standard, Criteria and Guidelines
TVOCs Total Volatile Organic Compounds
NYCRR New York Code of Rules and Regulations
VOCs Volatile Organic Compounds

ARCADIS

Table 7-7. Detailed Evaluation of Remedial Alternatives: Soil Gas (SG), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Criteria / Alternatives	Alternative SG-1 No Action. SG IRM shut off. No institutional or engineering controls implemented.	*Alternative SG-2* *Operation of SG IRM. Implement Environmental Easement requiring installation of engineering controls that address vapor intrusion issues for all future on-site structures. (see Figures 4-10 thru 4-13)*
Overall Protectiveness of the Public Health and the Environment	Does not achieve the RAOs.	***Protective of public health and the environment by preventing the off-site migration of VOCs in soil gas and thereby preventing off-site exposure to VOCs in sol gas. Achieves RAOs. Environmental easement will require engineering controls on all future structures constructed onsite to prevent vapor intrusion/exposures.***
Standards, Criteria, & Guidance (SCGs)	Does not meet SCG criterion; waiver would be required if implemented.	***Achieves SCGs associated with discharge of extracted soil gas.***
Long Term Effectiveness & Permanence	Not effective in the long-term. Does not prevent the off-site migration of site-related VOCs along the southern and western property boundaries. No change in current risk to the public and the environment. Remedy will not achieve long-term compliance with RAOs.	***Operation of the existing soil gas IRM will prevent long-term migration of onsite soil gas to offsite receptors. Environmental easement will ensure protection of human health on site through engineering controls.***
Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment	No reduction in toxicity, mobility, or volume of contamination.	***Will reduce the volume of impacted soil gas and will continue to reduce the off-site migration of site-related VOCs along the southern and western property boundaries. Will remove approximately 9.5 billion cubic feet of soil gas in 30 years.***
Short-Term Impacts and Effectiveness	No short-term impacts to the community, site workers or the environment as a result of implementation of this alternative Does not achieve RAOs in the short-term.	***Will be effective in the short-term with minimal impact to the public, workers, and the environment. The existing IRM is currently meeting RAOs.***
Implementability	Technically and administratively feasible to implement.	***Technically implementable; remedy is already installed and operational. Administratively implementable; will require establishment of an environmental easement and engineering controls on new structures constructed onsite.***
Cost Effectiveness (2)	$0	***$3,800,000***

Northrop Grumman Recommended Alternative Rationale	Alternative SG-2 is capable of achieving the RAO for soil gas and is effective in the short-term and the long-term. The active portion of this alternative has been implemented as an IRM and is already installed and operational and meeting its design objectives. Alternative SG-1 will not achieve RAOs.

Table 7-7. Detailed Evaluation of Remedial Alternatives: Soil Gas (SG), Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. (1)

Shaded/bold/italics: Identifies Northrop Grumman recommended remedial alternative.

NOTES:

(1) SG IRM site plan shown on Figure 4-16.

(2) Cost for Alternative SG-2 does not reflect additional significant cost savings that would be achieved through implementation of source area Alternatives SA-2 through SA-4. Those savings are reflected, however, in Table 8-1.

(3) Detailed cost estimate spreadsheet provided in Appendix B.

DEFINITIONS:

SCGs Standard, Criteria and Guidelines
SG IRM Soil Gas Interim Remedial Measure
RAO Remedial Action Objective
VOCs Volatile Organic Compounds

ARCADIS

Table 8-1. Summary of Northrop Grumman Recommended Remedy, Site Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Media/Area	Recommended Alternative	Cost ($MM) (1)
Soils		
Park	S-P2: Excavate upper 2 ft of soils to Restricted Residential SCOs. Implement environmental easement.	8.0
Access Road	S-AR2: Install gravel cap over areas where soil exceeds Restricted Residential SCOs. Includes a land-use restriction in the form of an environmental easement to limit site use where residual COPC impacts exist above Unrestricted Use SCOs.	0.6
Groundwater	GW-2: Continue to operate, maintain, and monitor existing groundwater IRM system to prevent offsite migration of site-related VOCs in groundwater that exceeds 5 ug/L total VOCs in the upper 20 feet of the aquifer and 50 ug/L below the upper 20 feet of the aquifer. Includes establishment of a groundwater use restriction through an environmental easement to prevent the use of onsite groundwater. The final phase of the remedy will include shutdown of the groundwater IRM when termination criteria (to be developed and included in the Operation, Maintenance, and Monitoring (OM&M) Manual) are achieved, followed by natural attenuation with monitoring of the residual COPCs.	4.7(2)
Source Areas	SA-3: Remediate VOC source areas using in-situ thermal desorption (ISTD), which consists of installation of a temporary electrical sub-station, heater wells, and a soil vapor extraction/treatment system to remove VOCs (desorbed from the soils during the heating process) from the soil gas.	15.6
Soil Gas	SG-2: Continue to operate, maintain, and monitor the existing soil gas IRM system to prevent offsite migration of onsite soil gas until termination criteria (to be developed and included in the OM&M Manual) are achieved. Establish an environmental easement that will require installation of engineering controls to control vapor intrusion for any new structures constructed onsite. Environmental easement will be maintained until onsite soil gas meets applicable RAOs.	1.9(2)
TOTAL		30.8

Notes:

1. Detailed cost analysis presented in Appendix B.
2. The operational periods of the Groundwater and Soil Gas IRMs are assumed to be significantly reduced if VOCs source areas are remediated via Alternatative SA-3. Accordingly, the costs in this table are less than those provided in Tables 7-6 and 7-7 and reflect reduced IRM operational timeframes and a significant reduction in VOC mass treated by the IRMs. The Soil Gas IRM is assumed to operate for 10 years and the Groundwater IRM is assumed to operate for 15 years. Cost analyses to reflect these reduced timeframes are presented in Appendix B.