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July 15, 2013

Via Email (efmctier@gw.dec.state.ny.us) and Overnight Mail

Edward F. McTiernan, Esq.
General Counsel and Deputy Commissioner
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-1500

Re: Northrop Grumman Systems Corporation – Bethpage Park-Former Grumman Settling Ponds and Adjacent Areas of the Northrop Grumman – Bethpage Facility; Operable Unit Number: 03 – Site No. 130003A

Dear Mr. McTiernan:

We are counsel to the Northrop Grumman Systems Corporation ("Northrop Grumman") with respect to the above captioned property (the "Site"), which has been designated by the Department as an Operable Unit of the above-noted Inactive Hazardous Waste Disposal Site, and for which the agency issued a Record of Decision ("ROD") dated March 29, 2013. The goal of this letter is to begin the process to reach an agreement to effectuate an efficient and protective remedy for the Site in an expeditious manner.

Application to Reopen and Modify the ROD

Northrop Grumman requests that the ROD be reopened. Northrop Grumman further requests that upon reopening, the Department consider the comments set forth below and in the enclosed Technical Synopsis by Environmental Management & Global Innovation, Inc. and, upon such consideration, to modify the ROD to eliminate the provision for in situ thermal desorption and soil vapor extraction (collectively "ISDT/SVE") of the volatile organic compounds ("VOCs") source area; to revise the excavation of Park soil containing polychlorinated biphenyls ("PCBs") to excavation of soil containing PCBs in excess of restricted residential standards to two feet below ground surface ("bgs") and excavation of soil containing PCBs in excess of 50 parts per million ("ppm") to ten feet bgs in the vicinity of utilities and to six feet bgs elsewhere on the Site, with a two-foot clean soil cover; to provide for a gravel cap without excavation on the Access Road; and to provide for further sampling of soil in neighboring residential yards to develop an appropriate characterization.

Northrop Grumman submits this Application based, inter alia, on the following:

- A need to significantly alter the response action set forth in the ROD, within the meaning of 40 C.F.R. § 300.825(c) and DER-2, which is supported by the attached Technical Synopsis;
- The ROD imposes an in situ remedy for a VOC source area that is not necessary to protect the Site or downgradient groundwater, as reflected in the historical monitoring data and the more recent monitoring data that are post-ROD, are not contained in the Administrative Record and could not have been submitted during the comment period on the Proposed Remedial Action Plan ("PRAP"); and
- An alternative PCB remedy, not considered in the ROD, would be fully protective of public health and environment, consistent with Department policy and practice, avoid impacts to the community, and be significantly more cost effective than the selected ROD remedy.

Modification of the ROD consistent with this Application will produce a remedy that is fully protective of public health and the environment, cost-effective and consistent with Department practice and policy, and will allow the Park to be returned to productive use years sooner than now allowed by the adopted ROD.

## The Record of Decision

The ROD has a multi-faceted remedy, which includes: the continuation and possible expansion of the current Groundwater Interim Remedial Measure ("IRM"), consisting of a pump and treat system along the southern boundary of the Site; the continuation of the Soil Gas IRM, consisting of a soil vacuum system along the southern and western boundaries of the Site; the installation of one or more groundwater extraction well(s) to capture and treat the so-called "hot spot" area of the plume downgradient of the Site; the installation of additional groundwater monitoring wells to facilitate a more refined delineation of the downgradient groundwater plume; ISDT/SVE treatment of the VOC source area; and the excavation of soil on the Site containing PCBs in excess of 1 ppm to two feet bgs, soil containing PCBs in excess of 10 ppm to ten feet bgs, and soil containing PCBs in excess of 50 ppm to any depth (estimated to be 35 feet bgs).

NYSDEC's estimated net worth cost to implement the ROD is $81 million, although itemized costs were not provided in the ROD. Northrop Grumman has estimated the net worth cost of implementing the different elements of the ROD, including:

- The estimated net worth cost for ISDT/SVE, based on the May 2010 Feasibility Study, revised March 2011 ("FS"), is $15.6 million; this cost has increased to approximately $18.9 million since the FS.
- The estimated net worth cost of implementing the excavation of soil containing PCBs, as required by the ROD, is $35.1 million.

As summarized below and described in the Technical Synopsis, in situ treatment of the VOC source area is not necessary, as reflected by the recent and historical monitoring data from the pump and treat system; the excavation of soil in the Park containing over 10 ppm to ten feet bgs, plus the unlimited excavation of soil containing PCBs over 50 ppm, is excessive and unnecessary to protect public health and the environment; and the excavation of soils in the Access Road containing PCBs over 1 ppm to two feet bgs plus the unlimited excavation of soils containing PCBs over 10 ppm is excessive and unnecessary to protect public health and the environment. Thus, Northrop Grumman submits that a fully protective and appropriate remedy can be implemented in a far more cost-effective manner, achieving the same fundamental results while reducing the costs by approximately $35 million.

The Unnecessary Remedy for Treating the VOC Source Area

The ROD requires ISDT/SVE to treat the specified VOC source area to levels that will protect groundwater. However, as described in the accompanying Technical Synopsis, the IRM pump and treatment system in the wells along the southern boundary of the Site is effectively removing the VOCs from the groundwater. The data collected over the past year, which was not available during the comment period on the PRAP, confirm earlier results that the IRM is capturing and treating the groundwater, thereby preventing off-site migration of Site-related VOCs greater than 5 ppb. To the extent VOCs from the source area might migrate to the groundwater under the Site, they are being and will continue to be removed by the pump and treat system. Consequently, there is no need to undertake ISDT/SVE, at an estimated cost of $18.9 million, to achieve a remediation that is already being successfully implemented.[1]

This conclusion is supported by the Comparative Analysis of the pump and treat system versus ISDT/SVE treatment of VOCs in the Technical Synopsis. The pump and treat system ranks equal to or higher than ISDT/SVE/SVE in all but one evaluative factor under 6 NYCRR 375-1.8(f). For example, both methods are protective of public health and the environment, while the pump and treat system is much more consistent with the Department's sustainability and energy-efficiency objectives. The primary factor that favors in situ treatment is that it would reduce the mass of VOCs in the source area faster than the pump and treat system – though at a much higher cost. This advantage is at a price to the public, as the remedy could increase the risk of exposure to workers and residents, and would delay putting the Park back to productive use. In short, as reflected in the Technical Synopsis, there are substantial public benefits to modifying the ROD to eliminate the unnecessary treatment of the VOC source area, while continuing the very successful pump and treat program at the Park's southern boundary.

The Unnecessary Extent of the Remedy for Soil Containing PCBs

The ROD requires the excavation of soil in the Park containing PCBs in excess of 10 ppm to 10 feet bgs and below that depth, to 50 ppm (estimated at 35 feet bgs), in addition to the excavation of the top two feet of soil and the imposition of a cover system and engineering and institutional controls. PCBs are not mobile in Site soil and are not a source of contamination to Site groundwater.[2] In addition, PCBs at depth pose no unacceptable health risks by direct contact; potential exposure from any occasional excavation for utilities or other construction activities in areas with residual PCB contamination would be addressed by an appropriate Construction Health and Safety Plan that would be effectuated through institutional and

[1] This savings would be reduced somewhat because eliminating ISTD/SVE would lengthen the operating costs of the pump and treat system, so the long-term differential would be approximately $14.1 million.
[2] Indeed, the ROD acknowledges that PCBs are generally immobile and do not appear to be migrating into groundwater at the Site.

engineering controls (as would be required by the ROD for excavation below the two-foot clean soil cover).

The Human Health Risk Assessment ("HHRA") that was provided by Northrop Grumman to the Department in April 2009 (and is again provided herewith) demonstrates that there would be no unacceptable risks to public health with the removal of the top two feet of soil in the Park and a two-foot cover of clean soil. It is evident that excavating soil with PCBs over 50 ppm to the depths proposed herein offers a greater level of protection of human health and the environment than the two-foot excavation and soil cover scenario presented in the HHRA.[3]

The foregoing conclusion regarding protection of human health and the environment is supported by the Comparative Analysis presented in the Technical Synopsis of:

- A TSCA cap with no excavation of soil containing PCBs;
- Excavation of soil containing PCBs with a concentration greater than 1 ppm to a depth of two feet and over 50 ppm to a depth of six feet (or ten feet where utilities are present); and
- Excavation of soil containing PCBs with a concentration greater than 1 ppm to a depth of two feet, over 10 ppm to a depth of ten feet, and over 50 ppm to all depths according to the ROD.

Due to the longer duration of excavation and greater volume of contaminated materials excavated under the soil remedy selected in the ROD, there would be a greater potential exposure of residents and Park users to dust generated during soil excavation (which would occur to some degree regardless of proper management techniques) and to the dangers of truck traffic past the nearby residential neighborhoods and schools. Finally, a shallower excavation would allow the Park to be put back into productive use sooner.

The Proposed Soil Remedy

Northrop Grumman respectfully suggests, based on the foregoing, that the excavation of soil with PCBs exceeding 10 ppm to ten feet bgs or 50 ppm to greater depths is not necessary to protect public health or the environment. Nevertheless, Northrop Grumman is cognizant that the Department does not believe that a two-foot excavation and soil cover (or a TSCA cap) is sufficient. While Northrop Grumman disagrees, it also would prefer to move forward and implement an appropriate remedy. Thus, Northrop Grumman requests that the ROD be modified to provide for:

1. Excavation of the top two feet of soil in the Park with any exceedance of the restricted residential soil cleanup objectives ("SCOs") (i.e., PCBs, metals and semi-volatile organic compounds) of 6 NYCRR 375-6.8, with a two-foot clean fill or concrete/asphalt cover;
2. Excavation of soil in the Park containing PCBs with concentrations exceeding 50 ppm from two feet bgs to ten feet bgs in the vicinity of utilities and from two feet bgs

[3] Under the Toxic Substances Control Act ("TSCA"), the U.S. Environmental Protection Agency may allow use of an impermeable cap without substantial removal of PCB-contaminated soil under certain conditions.

to six feet bgs in other areas (which would include the Blue-Green Material encountered during such excavation); and

3. Installation of a gravel cap on the Access Road, without soil excavation.[4]

This proposed approach would fully protect public health and the environment, while lessening exposure and the length and extent of disruption to the community. The ROD underestimated the time needed for the excavation of all soil with PCBs over 50 ppm, and thus the duration of this component of the remediation would be longer than the predicted 24 months. Indeed, combined with the elimination of ISDT/SVE, the proposed modified soil remedy would allow the Park to be placed back into productive use years sooner than the remedy required by the ROD.

This proposal also addresses the Department's (unfounded) assertion in the ROD that allowing soil containing PCBs over 50 ppm below a cap "would restrict allowable uses of this area for an indefinite period of time, require additional long-term maintenance and, in essence, create a hazardous waste landfill in the middle of a residential area." (ROD at A-7). To the contrary, Park use would not be restricted by the proposed excavation with a two-foot soil cover; rather, public use would be accelerated by the shorter duration of excavation. No long-term maintenance would be involved that would be greater than that already entailed in the ROD (compliance with institutional and engineering controls). And no "landfill" would be created; if a landfill were assumed, arguendo, to be created, the ROD contains no explication of why a "landfill" containing PCBs of up to 49 ppm is any different in terms of protection of public health or the environment than a "landfill" with PCBs over 50 ppm.

The ROD is Inconsistent with the NCP and DEC Regulations, Practice and Policy

The HHRA demonstrates that excavation of PCBs in the top two feet, with clean backfill, is protective of the public health. The Department's position that the HHRA could only be utilized to modify the SCOs, and not to justify a lesser excavation, essentially means that the Department ignored the HHRA. The HHRA was and is relevant to the acceptable levels of contaminants at depth as reflected by past Departmental practice and policy, as well as by CP-51, the very guidance relied on by the agency in formulating the ROD. Stated somewhat differently, the Department, as a matter of practice and policy, has allowed contaminants that exceed the applicable SCOs, including PCBs, to remain in place and has not required excavation to depth to achieve compliance with the SCOs. That is reflected by the ROD itself, which allows backfilling below ten feet bgs with soil containing PCBs less than 50 ppm; soil containing PCBs containing between 10 and 50 ppm exceed the applicable SCO.

The proposed remedy would be far more cost-effective than the massive soil excavation imposed by the ROD. In contrast to the estimated present worth cost of \$35.1 million for the excavation required under the ROD, the present worth cost of implementing the PCB component of the remedy proposed by Northrop Grumman, as explained in the Technical Synopsis, would

[4] Given the paucity and age of the sampling conducted to date, further investigation of the soil in residential yards is necessary before any remedy would be warranted. Thus, Northrop Grumman also requests that the ROD be modified to provide for such an investigation prior to a determination of the need for and scope of any remediation. We note that there is no linkage of any contamination in the yards to Northrop Grumman operations.

be $14.0 million. Thus, the revised soil remedy would save, under present worth costs, $21.1 million – while not sacrificing public health or the environment.

Cost-Effectiveness is a Critical Criterion in Selecting a Remedy

The Department's selection of the deep excavation of PCBs violates a basic rule governing remedy selection found in both the National Contingency Plan ("NCP")[5] and 6 NYCRR Part 375. The NCP provides a systematic approach that has certain threshold factors. First, the selected remedy must be protective of human health and the environment and comply with applicable or relevant and appropriate requirements (known as "ARARs"). 40 CFR § 300.40(f)(1)(ii)(A)-(B). Second, each remedy selected must be cost-effective (i.e., "costs are proportional to its overall effectiveness"). 40 CFR § 300.430(f)(1)(ii)(D). The Federal Register explanation to the NCP states that "it is clear that if all the remedies examined are equally feasible, reliable, and provide the same level of protection, the lead agency will select the least expensive remedy." 55 Fed. Reg. at 8727 (Mar. 8 1990) (citing 50 Fed. Reg. at 47921 (Nov. 20, 1985)). This emphasis on cost-effectiveness in the selected remedy in the NCP is reflected in the Department's regulations for remedy selection at 6 NYCRR 375-1.8(f). Here, the Department states in the Bethpage Site PRAP, "Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision." (PRAP at 10). Despite the regulatorily established importance of cost-effectiveness, DEC failed to provide appropriate consideration to this factor.

The ROD Incorrectly Calculates the Cost-effectiveness of Each Alternative

The ROD credits the soil cover for the Park and installation of a gravel cap for Access Road soils, included in Alternative 4, as being only slightly less protective of public health and the environment as the selected remedy, Alternative 5. However, the Department's analysis mistakenly states that Alternative 5 is the most cost-effective approach, listing in its reasoning the ability to allow for future construction, the prevention of further off-site migration of contaminated groundwater, and prevention of exposure to public health at the public water supplies.

The Department's reliance on the possibility of future construction on the Site is unwarranted because that is not a proper consideration when evaluating the cost-effectiveness of a particular remedy under the NCP, Part 375 or Guidance Document DER-10. See 40 CFR § 300.430(e)(9)(iii)(G); DER-10 § 4.2(h). Even if future construction were a legitimate consideration, construction is unlikely as the area will remain a public park (ROD at 16).[6] Moreover, the HHRA demonstrates that construction and utility workers would not be subject to unacceptable risks.

Because Alternative 4 and Alternative 5 in the ROD have essentially the same overall effectiveness, the critical factor here is the direct capital cost. The ROD explains accurately that the capital cost of Alternative 5 is far greater than that of Alternative 4. Comparing the capital costs listed in Exhibit C of the ROD reveals the difference to amount to $21,250,000. The ROD goes on to state, without explanation or any basis, that the long-term maintenance cost of the

[5] The NCP, 40 CFR §§ 300 et seq., is incorporated into Part 375 by reference. 6 NYCRR 375-1.1(g)(2).
[6] A non-Park use would require parkland alienation, a difficult and time-consuming process in New York.

covered area with Alternative 4 would be higher than the long-term maintenance under Alternative 5. There is no apparent difference between the cost of maintaining the cover required under the ROD and the same cover associated with Alternative 4; under either alternative an excavation below the two-foot soil cover system would trigger the same repair of the cover. Incursions below the two-foot cover in both instances would trigger the application of institutional and/or engineering controls; even under Alternative 5, those controls would be triggered in the unlikely event of excavation below ten feet bgs because the soil would contain PCBs between 10 and 50 ppm.[7] Moreover, it is difficult to fathom how maintenance of a cover system over a 30-year period (the period of performance used in evaluating costs) could make up the difference in capital costs of $21,250,000. Yet the ROD comes to the conclusion that Alternative 5 is a more cost-effective solution than Alternative 4, despite the fact that the extra soil excavation provides no measurable additional protection to public health or the environment.[8]

The ROD's evaluation of cost-effectiveness was criticized in comments Northrop Grumman submitted during the PRAP comment period. The Department never responded to this criticism directly. Furthermore, in response to comments submitted by Massapequa Water District stating that the PRAP provides an "erroneous rational for the selection of Alternative 5," the Department responded not by explaining why its rationale was correct, but simply by stating that the selected remedy was based on the evaluation of all the remedy selection criteria.

The limited excavation alternative (two foot excavation with clean backfill) provided in the FS and evaluated in the HHRA clearly indicates that it is protective of public health and the environment. Moreover, the Department has long recognized that an appropriate remedy may allow contamination above the SCOs to remain at depth so long as public health and the environment are protected. This policy and practice is reflected in Department guidance set forth in CP-51. Accordingly, the Department has selected a remedy that not only confounds its established policy and practice but also violates the balancing requirement.[9]

<u>A Tolling Agreement Is Reasonable and Sensible</u>

Northrop Grumman would prefer to avoid litigation. For a variety of reasons, however, Northrop Grumman believes that the ROD would not survive legal challenge. In addition to substantive deficiencies, the Department created OU3 out of whole cloth because the record demonstrates that the Operable Unit was created without compliance with important procedural requirements of Section 375-2.7.

Northrop Grumman has made this request to reopen and modify the ROD because it would prefer to resolve its differences with the Department without resort to litigation and to move forward with an appropriate, but not overreaching and unnecessary remedy. Based on this

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[7] Under the Northrop Grumman proposal, the excavation to six or ten feet bgs would be backfilled with clean fill, rather than fill containing PCBs up to 10 ppm as provided for by the ROD, and thus would provide more protection to workers than the selected remedy.

[8] Furthermore, according to the ROD, the long-term annual maintenance costs (compliance with institutional and engineering controls) for Alternative 5 are actually higher than those for Alternative 4.

[9] As explained in the Technical Synopsis, the ROD's requirement to excavate a portion of the Access Road is also unnecessary to protect public health and the environment, and the ROD should be modified accordingly.

objective, Northrop Grumman respectfully suggests a tolling agreement that would extend by three months the time for Northrop Grumman to challenge the ROD. This time frame would give the Department and Northrop Grumman a reasonable, but not unduly lengthy, time period in which to seek to resolve this dispute and move forward expeditiously with appropriate remediation of the Site.

Accordingly, we have enclosed a draft stipulation extending Northrop Grumman's time to commence an Article 78 proceeding to October 29, 2013.

We would like to meet with the Department at its earliest convenient time.

Very truly yours,

Daniel Riesel
Mark A. Chertok

Cc: Rosalie Rusinko, Esq. (rkrusink@gw.dec.state.ny.us)
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(All via Electronic mail only)

3283/Ltr to DEC 7-15-13 final

## Attachment 1

**Technical Synopsis in Support of an Application to Reopen and Modify the March 2013 Record of Decision for Operable Unit 3 of the Former Grumman Facility in Bethpage, New York NYSDEC Site # 130003A July 12, 2013**

Environmental Management & Global Innovations, Inc. (EMAGIN) has prepared this technical synopsis to support an application to reopen and modify the March 2013 Record of Decision (ROD) for Operable Unit 3 (OU3; NYSDEC 2013). The technical synopsis provides the following:

- An analysis of the groundwater pump-and-treat system at the Bethpage Community Park (Park), including data post-dating the Proposed Remedial Action Plan (PRAP; NYSDEC 2012) and associated public comment period; and
- An analysis of PCB remediation options for soils at the Park and adjacent Access Road.

Alternative technical approaches to the following three remedial requirements in the OU3 ROD are evaluated:

- In-situ thermal desorption and soil vapor extraction (ISTD/SVE) to remediate the volatile organic compound (VOC) source area at the Park.
- Excavation of polychlorinated biphenyls (PCBs) over 10 parts per million (ppm) in Park soil to a depth of 10 feet and over 50 ppm to all depths.
- Excavation of PCBs over 1 ppm in Access Road soil to a depth of 2 feet and over 10 ppm below 2 feet.

### In-situ Thermal Treatment to Remediate the VOC Source Area

The OU3 ROD requires use of ISTD/SVE or an alternate in-situ treatment technology to treat the VOC source area to seek to attain the protection-of-groundwater soil cleanup objectives (SCOs) for VOCs. The ROD does not acknowledge that operation of the groundwater pump-and-treat system since 2009 at the Park, consisting of 4 recovery wells and associated water treatment, is functioning to reduce the mass of the VOCs in the source area and to recover and treat VOCs that are mobilized from the source area to groundwater. EMAGIN has evaluated over three years of data on the effectiveness of the pump-and-treat remediation system, including data post-dating the ROD, and has concluded that the system is effectively controlling VOC impacts from migrating off site from the source area at the Park. This control of source area impacts is expected to continue in the future, with or without ISTD/SVE.

Groundwater pump-and-treat and ISTD/SVE are treatment technologies that have been commonly used to remediate VOC source areas. ISTD/SVE has an advantage over pump-and-treat in terms of short-term effectiveness; the technology can initially reduce concentrations of chemicals of concern in source areas faster than pump-and-treat. However, the technology does not address contaminants that have migrated outside of the source area in groundwater and soil gas nor does it generally achieve final cleanup standards. Therefore, ISTD/SVE must be supplemented by other technologies such as pump-and-treat and soil gas remediation to be fully protective and to ensure adequate remediation. On the other hand, groundwater pump-and-treat can act as a “stand alone” technology for source area remediation because it not only reduces the mass of contaminants (albeit over a longer timeframe), but it also addresses impacted groundwater downgradient of the source area. [1]

2009-2013 Data Evaluation. Routine monitoring of the influent and effluent of the treatment system and sampling of groundwater concentrations in monitoring wells downgradient of the source area have shown that the pump-and-treat system captures and treats VOCs downgradient of the source area, thereby reducing source area mass (ARCADIS 2013). Two of the recovery wells, RW-2 and RW-3, are located at a distance of only about 200 feet downgradient of the source area (see Figure 1). Of the total VOCs captured by the recovery well system through 2012 (823 pounds of site-related VOCs), wells RW-2 and RW-3 are responsible for over 99 percent of that total (818 pounds). VOC concentrations in Well RW-2 (the recovery well with the highest site-related VOCs) declined from 3,900 ppb in July 2009 to less than 400 ppb in January 2013. This rapid reduction in groundwater concentrations indicates that the VOCs associated with the source area are not highly mobile because, if they were, they would persist at higher concentrations (see Figure 2).

Water quality and water level data from the 2012 annual monitoring of the pump-and-treat system (ARCADIS 2013; data post-date the ROD) indicate that the system is preventing off-site migration of site-related VOCs greater than 5 ppb. This is illustrated in Figure 3, which shows that groundwater flow lines originating outside the 5 ppb VOC contour line converge on the four recovery wells, thereby indicating that the pump-and-treat system is capturing and treating the groundwater downgradient of the VOC source area with site-related VOCs above 5 ppb. The ROD provides for an additional evaluation of the pump-and-treat system's effectiveness to be completed, and if necessary, for additional recovery wells and treatment capacity to be constructed.

Comparative Analysis. Using three years of operating data and the last year's confirmation of the earlier trend, the pump-and-treat system was compared to ISTD/SVE, the remedy selected in the ROD for source area treatment. EMAGIN evaluated both technologies against the threshold and balancing criteria in 6 NYCRR Subpart 375-1.8(f), as shown in the attached Table 1 and summarized below. Remedy sustainability was added to the evaluation, consistent with NYSDEC's preference for sustainable remedies, as described in its guidance document "DER-31/Green Remediation."

- The pump-and-treat system has demonstrated short-term effectiveness; VOC mass has been removed, and the system has achieved control of off-site migration of VOCs in groundwater.
- ISTD/SVE source area treatment would permanently remove VOC mass faster, but needs to be accompanied by pump-and-treat to address VOC migration in groundwater, a significant exposure pathway.
- The pump-and-treat system would present minimal short-term impacts to community, workers, and the environment because the remedy is already in place.
- The pump-and-treat system is easily implemented because it is already in place and operating. ISTD/SVE is more difficult to implement due to complex infrastructure and above-ground treatment requirements.
- The pump-and-treat system is more cost effective than ISTD/SVE, resulting in equivalent long-term protection at a cost of $14.1 million less than ISTD/SVE.

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[1] In addition, operation of the soil gas remediation system since 2008 at the Park is preventing the off-site migration of VOCs mobilized from the source area into soil gas. A Site Management Plan would include provisions for evaluating the potential for soil vapor intrusion at any buildings developed on the site and implementing appropriate mitigation.

- The pump-and-treat system would not require restrictions on land use, whereas construction and operation of ISTD/SVE would not allow use of the treatment area for several years.
- The pump-and-treat system would consume significantly less energy, have lower carbon dioxide emissions, and use fewer raw materials than ISTD/SVE.

Pump-and-treat and ISTD/SVE (in conjunction with pump-and-treat) are protective of public health and the environment and achieve the State's standards, criteria, and guidance (SCGs) and, thus, meet the threshold criteria. ISTD/SVE is preferable to pump-and-treat in terms of reduction of toxicity, mobility and volume. Pump-and-treat is preferable to ISTD/SVE in terms of implementability, cost effectiveness, sustainability, and land use. The two technologies are essentially equivalent in terms of short-term impacts and effectiveness and long-term effectiveness and permanence. Thus, on balance, pump-and-treat is supported by the Department's evaluation criteria as an equivalent remedy to ISTD/SVE for controlling VOC impacts from the source area at the Park.

**Excavation of PCBs over 10 ppm in Park Soil to a Depth of 10 feet and Over 50 ppm to All Depths**

Risk Assessment. Excavation of PCBs in the Park to the extent required in the ROD is not necessary to protect human health and the environment. A human health risk assessment (HHRA; ARCADIS 2009) was performed as part of the Site Area remedial investigation to quantify risks associated with actual and potential exposure to Park soil. An assumption made in the HHRA was that the upper two feet of impacted soil was removed and backfilled with clean fill. Potentially complete exposure pathways included future exposure of utility workers and construction workers to surface and subsurface soil via ingestion, dermal contact, and inhalation. Results of the HHRA indicated that cancer risk for utility workers and construction workers was on the low end of U.S. EPA's acceptable risk management range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$. The HHRA results also indicated that non-cancer risk for utility workers and construction workers was less than 1, the EPA threshold for non-carcinogenic health concerns. In summary, the HHRA determined there were no unacceptable risks associated Park soil where the upper two feet were excavated and replaced with clean fill.

A less extensive (focused) excavation alternative for PCBs in Park soil was evaluated in the Site Area Focused Feasibility Study (ARCADIS 2010), as compared to the unlimited excavation of PCBs in Park soil, the remedy selected in the ROD. The focused PCB excavation alternative includes:

- Excavation of the upper 2 feet of Park soil to restricted-residential soil cleanup objectives (SCOs); and
- Excavation of soil with PCBs over 50 parts per million (ppm) to a depth of 6 feet (or 10 feet near utilities).

The unlimited PCB excavation alternative selected in the ROD includes:

- Excavation of the upper 2 feet of Park soil to restricted-residential SCOs;
- Excavation of soil with PCBs over 10 ppm to a depth of 10 feet;
- Excavation of soil with PCBs over 50 ppm to all depths (estimated at 35 feet), including backfilling of the excavation below a depth of 10 feet with soil containing less than 50 ppm PCBs.

In terms of risk, the focused excavation alternative would be protective. The HHRA has demonstrated that no unacceptable risks would be associated with site soil where only the upper two feet are excavated. The focused excavation alternative (6 feet, or 10 feet near utilities) replaces additional impacted soil with clean fill and therefore would reduce the potential exposure to chemicals by workers, compared to the two-foot excavation. Furthermore, the only likely potential future exposure to Park soil would be to a utility or construction worker who would not be expected to contact soil deeper than the 6 or 10 feet that had been excavated (and backfilled with clean fill) as part of the focused excavation. In the unlikely event that work deeper than 6 or 10 feet was required, workers would be protected by following a construction health and safety plan that would be required as part of the Site Management Plan.

Comparative Analysis. EMAGIN compared the following alternatives for remediation of PCBs in Park soil in terms of the threshold and balancing criteria in 6 NYCRR Subpart 375-1.8(f):

- The focused excavation alternative described in the 2010 Focused Feasibility Study;
- The unlimited excavation alternative described in the OU3 ROD; and
- The TSCA cap alternative described in Northrop Grumman's March 21, 2013 letter to NYSDEC "Further Analysis of the Proposed Soil Remedy."

Remedy sustainability was added to the evaluation, consistent with NYSDEC's preference for sustainable remedies, as described in its guidance document "DER-31/Green Remediation." A key finding of the evaluation is that capping is not only protective but is better than excavation in terms of short-term impacts, implementability, cost effectiveness, and sustainability (Table 2). Conclusions relating to the comparison of the two excavation alternatives follow:

- Focused excavation would have lower short-term impacts on workers and the community during construction and would be implemented in less time than unlimited excavation.
- Focused excavation would be a permanent, long term remedy when combined with appropriate land use controls but unlimited excavation would be more permanent and reliable because a greater volume of impacted soil would be removed.
- Focused excavation would be easier to implement because of shallower excavation and have fewer safety hazards, compared to unlimited excavation.
- Focused excavation is more cost effective than unlimited excavation, resulting in equivalent long-term protection at a cost of $21 million less than unlimited excavation.
- Focused excavation would return the Park property to productive use faster than unlimited excavation would allow.
- Focused excavation would consume significantly less energy, have lower carbon dioxide emissions, use fewer raw materials, and generate less waste than unlimited excavation.

The focused and unlimited excavation alternatives are both protective of public health and the environment and achieve the State's SCGs and, thus, meet the threshold criteria. Focused excavation is preferable to unlimited excavation in terms of short-term impacts, implementability, cost effectiveness, and sustainability. Unlimited excavation is preferable to focused excavation in terms of long-term effectiveness and permanence. The two alternatives are essentially equivalent in terms of the balancing criteria for reduction of toxicity, mobility or volume; and land use. Thus, on balance, focused excavation is supported by the Department's evaluation criteria as an equivalent remedy to full excavation for Park soil.

**Excavation of PCBs over 1 ppm in Access Road Soil to a Depth of 2 feet and Over 10 ppm Below 2 feet**

Risk Assessment. Excavation of PCBs in the Access Road to the extent required in the ROD is not necessary to protect human health and the environment. The above-referenced HHRA quantified risks associated with actual and potential exposure to Access Road soils. Potentially complete exposure pathways for the Access Road included exposure of utility workers to surface and subsurface soils via ingestion, dermal contact, and inhalation. Results of the HHRA indicated that the cancer risk for utility workers was on the low end of U.S. EPA's acceptable risk management range of 1 x $10^{-4}$ to 1 x $10^{-6}$. The HHRA results also indicated the non-cancer risk for utility workers was less than 1, the EPA threshold for non-carcinogenic health concerns. In summary, the HHRA determined there were no unacceptable risks associated Access Road soil.

A capping alternative for PCBs in Access Road soil was evaluated in the Site Area Focused Feasibility Study (ARCADIS 2010), as compared to excavation of PCBs in Access Road soil, the remedy selected in the ROD. The capping alternative includes:

- Installation of a gravel cap over impacted soil; and
- Use of engineering (fencing) and institutional (environmental easement) controls to limit land use and control future activities.

The PCB excavation alternative selected in the ROD for Access Road soil includes:

- Excavation of soil with PCBs over 1 ppm in the upper 2 feet; and
- Excavation of soil with PCBs over 10 ppm below 2 feet.

The capping alternative would be protective of human health. The HHRA has demonstrated that no unacceptable risks are associated with Access Road soil, even with no excavation. Furthermore, the only likely potential future exposure to Access Road soil would be to a utility worker who would be protected by following a construction health and safety plan that would be required as part of the Site Management Plan.

Comparative Analysis. The 2010 Focused Feasibility Study compared capping and excavation alternatives for the Access Road against the threshold and balancing criteria in 6 NYCRR Subpart 375-1.8(f) as summarized below:

- Capping would have lower short-term impacts on workers and the community during construction and would be implemented in less time than excavation.
- Capping would be a permanent, long term remedy when combined with appropriate land use controls but excavation would be more permanent and reliable because impacted soil is removed.
- Capping would prevent exposure to impacted soil but excavation would achieve more permanent and significant reductions.
- Capping would be easier to implement because of less construction, fewer safety hazards, and less material management compared to excavation.
- Capping is more cost effective than excavation, resulting in equivalent long-term protection at a cost of several million dollars less than excavation.

Capping and excavation alternatives are both protective of public health and the environment and achieve the State's SCGs and, thus, meet the threshold criteria. Capping is preferable to excavation in terms of short-term impacts, implementability, and cost effectiveness. Excavation is preferable to capping in terms of long-term effectiveness and permanence; and reduction of toxicity, mobility or volume.  Thus, on balance, capping is supported by the Department's evaluation criteria as an equivalent remedy to excavation for Access Road soil.

**References**

ARCADIS. 2009. Human Health Risk Assessment, Former Grumman Settling Ponds (Operable Unit 3), Bethpage, New York. April 2009.

ARCADIS. 2010. Site Area Focused Feasibility Study, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. May 2010.

ARCADIS. 2013. Operation, Maintenance, and Monitoring Report for the Groundwater Interim Remedial Measure, 2012 Annual Summary, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. May 2013.

NYSDEC. 2012. Proposed Remedial Action Plan, Northrop Grumman – Bethpage Facility, Operable Unit Number: 03, Bethpage, Nassau County. May 2012.

NYSDEC. 2013. Record of Decision, Northrop Grumman – Bethpage Facility, Operable Unit Number: 03, Bethpage, Nassau County. March 2013.

Northrop Grumman. 2013. Letter to NYSDEC "Further Analysis of the Proposed Soil Remedy." March 2013.

**TABLE 1. COMPARATIVE ANALYSIS OF PUMP AND TREAT VS. IN-SITU THERMAL DESORPTION AND SOIL VAPOR EXTRACTION FOR TREATMENT OF SITE AREA GROUNDWATER, INCLUDING THE VOC SOURCE AREA**
**Former Grumman Facility in Bethpage, New York**
**July 12, 2013**

| Evaluation Criteria | Pump and Treat (Park Groundwater Remediation System) [1] | In-situ Thermal Desorption and Soil Vapor Extraction (ISTD/SVE) [1] |
|---|---|---|
| **Protection of Public Health and the Environment** | • Protective of public health and the environment.<br>• Controls off-site migration of impacted groundwater. Use restriction for site groundwater will control potential on-site exposure (ARCADIS 2011). | • Protective of public health and the environment when implemented in combination with Park P&T.<br>• Use restriction for site groundwater will control potential on-site exposure. |
| **Ranking** | | |
| **Compliance with NY SCGs** | • Park pump-and-treat (P&T) system will achieve groundwater standards, criteria, and guidance values (SCGs).<br>• Currently achieves SCGs associated with ex-situ treatment and discharge of recovered groundwater. | • ISTD/SVE must be used in combination with Park P&T to achieve groundwater SCGs. |
| **Ranking** | | |
| **Short-term Impacts and Effectiveness** | • Minimal short-term impacts to community, workers, and the environment because remedy is already in place.<br>• Park P&T is already achieving control of off-site volatile organic compound (VOC) migration in groundwater.<br>• Currently meets the groundwater remediation objectives (e.g., preventing exposure and off-site migration). Would take longer than ISTD/SVE to meet source area remediation objectives (e.g., mass removal). | • Construction of ISTD/SVE and handling of contaminated media may present impacts to workers and surrounding community.<br>• Potential impacts related to heating of soils (e.g., damage to utilities).<br>• Would meet source area remediation objective faster than Park P&T. |
| **Ranking** | | |
| **Long-term Effectiveness and Permanence** | • Park P&T with appropriate land use controls would be an effective and permanent remedy to control risks.<br>• Would require long-term maintenance to achieve SCGs.<br>• Per the OU3 Record of Decision (ROD), an evaluation of the Park P&T's effectiveness will be required to confirm complete plume capture. If the Park P&T is not shown to completely capture the plume, additional recovery wells and treatment capacity may be needed (estimated cost: $5.1M, assuming 4 additional recovery wells) (ARCADIS 2011).<br>• No significant residual risk to the public and environment when P&T is complete. | • ISTD/SVE would permanently reduce the highest VOC concentrations in the source area.<br>• ISTD/SVE must be used in combination with Park P&T and appropriate land use controls to achieve groundwater SCGs.<br>• No significant residual risk to the public and the environment when ISTD/SVE and Park P&T are complete. |
| **Ranking** | | |
| **Reduction of Toxicity, Mobility or Volume** | • Provides permanent reductions in toxicity, mobility, and volume of contaminants originating in source area through capture of groundwater in Park P&T wells lying within about 200 feet of identified source area boundary.<br>• Reduction in volume of source area VOCs occurs over longer period of time than with ISTD/SVE. | • Provides permanent reductions in toxicity, mobility, and volume of contaminants originating in source area through direct treatment.<br>• Reduction in volume of source area contaminants occurs over shorter period of time than with Park P&T alone. |
| **Ranking** | | |
| **Implementability** | • Park P&T is easily implemented because it is already in place and operating.<br>• Requires an environmental easement to restrict site groundwater use. | • Treatability study required to confirm ISTD/SVE effectiveness and design treatment system.<br>• More difficult to implement than Park P&T due to complex infrastructure and above-ground treatment requirements.<br>• Limited availability of technology vendors.<br>• Requires an environmental easement to restrict site groundwater use. |
| **Ranking** | | |
| **Cost Effectiveness** | • Park P&T is more cost effective than ISTD/SVE, resulting in equivalent long-term protection at a cost of $14.1 million less than ISTD/SVE. [2] | • Cost of Park P&T would still be incurred to remediate groundwater surrounding source area, although ISTD/SVE will shorten operating time of Park P&T.<br>• Cost of ISTD/SVE plus Park P&T would result in a cost of $14.1 million more than Park P&T alone for 30 years. [2] |
| **Ranking** | | |
| **Land Use** | • Park P&T would not pose additional restriction to land use.<br>• Workers and the public would be protected through land use restrictions if future intrusive activities are required. | • Will not allow use of treatment area for several years during treatment and cool-down period.<br>• Workers and the public would be protected through land use restrictions if future intrusive activities are required. |
| **Ranking** | | |

**TABLE 1. COMPARATIVE ANALYSIS OF PUMP AND TREAT VS. IN-SITU THERMAL DESORPTION AND SOIL VAPOR EXTRACTION FOR TREATMENT OF SITE AREA GROUNDWATER, INCLUDING THE VOC SOURCE AREA**
**Former Grumman Facility in Bethpage, New York**
**July 12, 2013**

| Evaluation Criteria | Pump and Treat (Park Groundwater Remediation System) [1] | In-situ Thermal Desorption and Soil Vapor Extraction (ISTD/SVE) [1] |
|---|---|---|
| Sustainability | • Park P&T would consume less energy, have lower carbon dioxide ($CO_2$) emissions, and use fewer raw materials than ISTD/SVE. | • ISTD/SVE would consume more fuel, have higher $CO_2$ emissions, and use more raw materials than Park P&T alone. |
| Ranking | Medium | Low |
| Overall Ranking | High | Medium |

Ranking: Low (red) | Medium (yellow) | High (green)

Notes:
1) Selected in Record of Decision, Operable Unit 3, March 2013.
2) Source: ARCADIS 2012/2013 cost estimates.

References:
ARCADIS 2011 - Site Area Feasibility Study, Operable Unit 3, dated March 4, 2011.

**Table 2. COMPARATIVE ANALYSIS OF CAPPING AND TWO SOIL EXCAVATION ALTERNATIVES**
**Former Grumman Facility in Bethpage, New York**
**July 12, 2013**

| Evaluation Criteria | TSCA Cap/Parking Lot: [1]<br>• Install TSCA cap/parking lot over Park soil<br>• Excavate upper 2 feet of satellite park soils > restricted residential SCOs | Focused Park Soil Excavation: [2]<br>• Excavate upper 2 feet of Park soil to restricted-residential soil cleanup objectives (SCOs)<br>• Excavate/solidify 98% of blue-green material in upper 10 feet of Park soil<br>• Excavate Park soil from 2 - 6 feet (10 feet around utilities) with polychlorinated biphenyls (PCBs) > 50 ppm | Unlimited Park Soil Excavation: [3]<br>• Excavate upper 2 feet of Park soil to restricted-residential SCOs<br>• Excavate Park soil from 2 – 10 feet with PCBs > 10 ppm<br>• Excavate Park soil from 10 feet to all depths (estimated at 35 feet) with PCBs > 50 ppm and backfill with soil containing PCBs < 50 ppm |
|---|---|---|---|
| Protection of Public Health and the Environment | • Protective of public health and the environment by eliminating exposure of Park users to impacted surface soils.<br>• Cap would be impervious and would provide a high level of protection from direct exposure to soils and from infiltration through the cap.<br>• Environmental easement prevents change in land use and controls future activities of workers involving potential contact with impacted subsurface soils. | • Protective of public health and the environment by eliminating exposure of Park users to impacted surface soils (ARCADIS 2009 and ARCADIS 2010).<br>• Environmental easement prevents change in land use and controls future activities of workers involving potential contact with impacted subsurface soils. (ARCADIS 2010). | • Protective of public health and the environment by eliminating exposure of Park users to impacted surface soils.<br>• Environmental easement prevents change in land use and controls future activities of workers involving potential contact with impacted subsurface soils. |
| Ranking | | | |
| Compliance with NY SCGs | • Complies with standards, criteria, and guidance values (SCGs).<br>• Would require permanent restrictions. | • Complies with SCGs.<br>• Would require permanent restrictions. | • Complies with SCGs.<br>• Would require permanent restrictions. |
| Ranking | | | |
| Short-term Impacts and Effectiveness | • Least impacts on the community during implementation.<br>• Would take least time to implement and to achieve soil remediation objective (e.g., prevent exposure, mitigate threats). | • Would have lower short-term impacts on the community (e.g., dust generation and soil transport past residential neighborhoods) during implementation than unlimited excavation because less excavation and shorter duration of on-site activities involved.<br>• Would take longer to implement than capping, but would achieve the soil remediation objective sooner than unlimited excavation. | • Would have the highest negative short-term impacts during implementation due to extensive excavation, backfilling, and off-site disposal activities (e.g., dust generation and soil transport by hundreds of trucks past residential neighborhoods and transport over thousands of miles).<br>• Would take substantially longer to implement than capping and focused excavation and would take the longest time to achieve the soil remediation objective. |
| Ranking | | | |
| Long-term Effectiveness and Permanence | • Combined with appropriate land use controls, would be an effective long-term and permanent remedy to control residual risks. The land use control that has been in place since 1962 at the Park has ensured that the land remained a park for over 50 years.<br>• Routine inspection and maintenance of the cap and land use controls would provide continued protection from exposure to impacted site soils. | • Combined with appropriate land use controls, would be an effective long-term and permanent remedy to control residual risks (ARCADIS 2010).<br>• Routine inspection and maintenance of soil cover would provide continued protection from exposure to impacted site soils. | • Most permanent and reliable remedy because impacted soils with PCBs > 50 ppm removed from the site and fewer uncertainties could be associated with long-term maintenance. |
| Ranking | | | |
| Reduction of Toxicity, Mobility or Volume | • Toxicity and volume of impacted soil would not be reduced under this alternative, but exposure on-site is mitigated using a TSCA cap and limited soil removal.<br>• PCBs and metals in soils at the Park are not mobile and, therefore, are not sources of contamination to groundwater or other media. Additionally, the TSCA cap would limit infiltration of water through the cap, further limiting mobility. | • Toxicity and volume of impacted soil would not be reduced under this alternative, but potential for on-site exposure would be mitigated by moving soil to an off-site landfill.<br>• PCBs and metals in soils at the Park are not mobile and, therefore, are not sources of contamination to groundwater or other media.<br>• Excavation, handling, and transportation of a smaller volume of contaminated soil would present a lesser threat of exposure and associated risks to workers and the surrounding community than unlimited excavation. | • Toxicity and volume of impacted soil would not be reduced under this alternative, but potential for on-site exposure would be mitigated by moving the soil to an off-site landfill.<br>• PCBs and metals in soils at the Park are not mobile and, therefore, are not sources of contamination to groundwater or other media.<br>• Excavation, handling and transportation of a larger volume of contaminated soil would present greater threat of exposure and associated risk to workers and the surrounding community than capping and focused excavation. |
| Ranking | | | |

**Table 2. COMPARATIVE ANALYSIS OF CAPPING AND TWO SOIL EXCAVATION ALTERNATIVES**
**Former Grumman Facility in Bethpage, New York**
**July 12, 2013**

Emagin

| Evaluation Criteria | <u>TSCA Cap/Parking Lot</u>: [1]<br>• Install TSCA cap/parking lot over Park soil<br>• Excavate upper 2 feet of satellite park soils > restricted residential SCOs | <u>Focused Park Soil Excavation</u>: [2]<br>• Excavate upper 2 feet of Park soil to restricted-residential soil cleanup objectives (SCOs)<br>• Excavate/solidify 98% of blue-green material in upper 10 feet of Park soil<br>• Excavate Park soil from 2 - 6 feet (10 feet around utilities) with polychlorinated biphenyls (PCBs) > 50 ppm | <u>Unlimited Park Soil Excavation</u>: [3]<br>• Excavate upper 2 feet of Park soil to restricted-residential SCOs<br>• Excavate Park soil from 2 – 10 feet with PCBs > 10 ppm<br>• Excavate Park soil from 10 feet to all depths (estimated at 35 feet) with PCBs > 50 ppm and backfill with soil containing PCBs < 50 ppm |
|---|---|---|---|
| Implementability | • Most easily implemented because of limited remedial construction. | • More easily implemented than unlimited excavation because of shallower excavation, fewer safety hazards, and management of less excavated material. | • Most difficult to implement because of extensive construction and associated technical and administrative challenges and monitoring requirements (e.g., difficulties associated with excavating the majority of the site and lack of space to stage excavated soil prior to disposal).<br>• Use of sheet piling and other special safety precautions to protect construction workers and reduce impacts to roads, utilities, and other structures would subject local residents to noise and vibration. |
| Ranking | High | Medium | Low |
| Cost Effectiveness | More cost effective than excavation, resulting in equivalent long-term protection at a cost of over $25 million less than unlimited excavation[4]. | More cost effective than unlimited excavation, resulting in equivalent long-term protection at a cost of $21 million less [2,4] | Would result in a cost of $25 million more than capping and $21 million more than focused excavation, with no increase in level of protection[4]. |
| Ranking | High | Medium | Low |
| Land Use | • After construction, capping would allow for land use consistent with current restrictions that have been in place since 1962.<br>• Workers and the public would be protected through land use restrictions if future intrusive activities are required.<br>• Least construction time would be required than for unlimited excavation, allowing fastest return of the Park property for use. | • After construction, would allow for land use with current restrictions that have been in place since 1962.<br>• Workers and the public would be protected through land use restrictions if future intrusive activities are required (ARCADIS 2010).<br>• Less construction time would be required than for unlimited excavation, allowing faster return of the Park property for use. | • After construction, would allow for land use consistent with current restrictions that have been in place since 1962.<br>• Workers and the public would be protected through land use restrictions if future intrusive activities are required.<br>• More construction time would be required than capping and focused excavation, resulting in slower return of the Park property for use. |
| Ranking | High | High | High |
| Sustainability | • Consumes 84% less fuel than unlimited excavation.<br>• Generates 75% less carbon dioxide ($CO_2$) emissions than unlimited excavation.<br>• Requires off-site landfill disposal of 98% less material than unlimited excavation; this translates into saving 4 million cubic feet of landfill space.<br>• Requires 86% less raw materials (e.g., clean backfill, asphalt) than unlimited excavation. | • Consumes 70% less fuel than unlimited excavation.<br>• Generates 60% less $CO_2$ emissions than unlimited excavation.<br>• Requires off-site landfill disposal of 80% less material than unlimited excavation.<br>• Requires 70% less raw materials (e.g., clean backfill, asphalt) than unlimited excavation. | • Consumes 200% more fuel than focused excavation and 500% more than capping.<br>• Generates 170% more $CO_2$ emissions than focused excavation and 300% more than capping.<br>• Requires off-site landfill disposal of 370% more material than focused excavation and 6,100% more than capping.<br>• Consumes 220% more raw material than focused excavation and 600% more than capping. |
| Ranking | High | Medium | Low |
| Overall Ranking | High | Medium | Medium |

Ranking: Low (red) | Medium (yellow) | High (green)

Notes:
1) Source: Northrop Grumman comment letter "Further Analysis of the Proposed Soil Remedy", dated March 21, 2013. TSCA = Toxic Substances Control Act.
2) Source: Site Area Focused Feasibility Study, Operable Unit 3, dated May 12, 2010.
3) Source: Record of Decision, Operable Unit 3, March 2013.
4) Source: ARCADIS 2012/2013 cost estimates.

<u>References:</u>

ARCADIS 2009 (HHRA) - Human Health Risk Assessment Former Grumman Settling Ponds (Operable Unit 3) Bethpage, New York, April 2009. ARCADIS
ARCADIS 2010 (FS) - Site Area Focused Feasibility Study Operable Unit 3 (Former Grumman Settling Ponds) Bethpage, New York, May 12, 2010. ARCADIS

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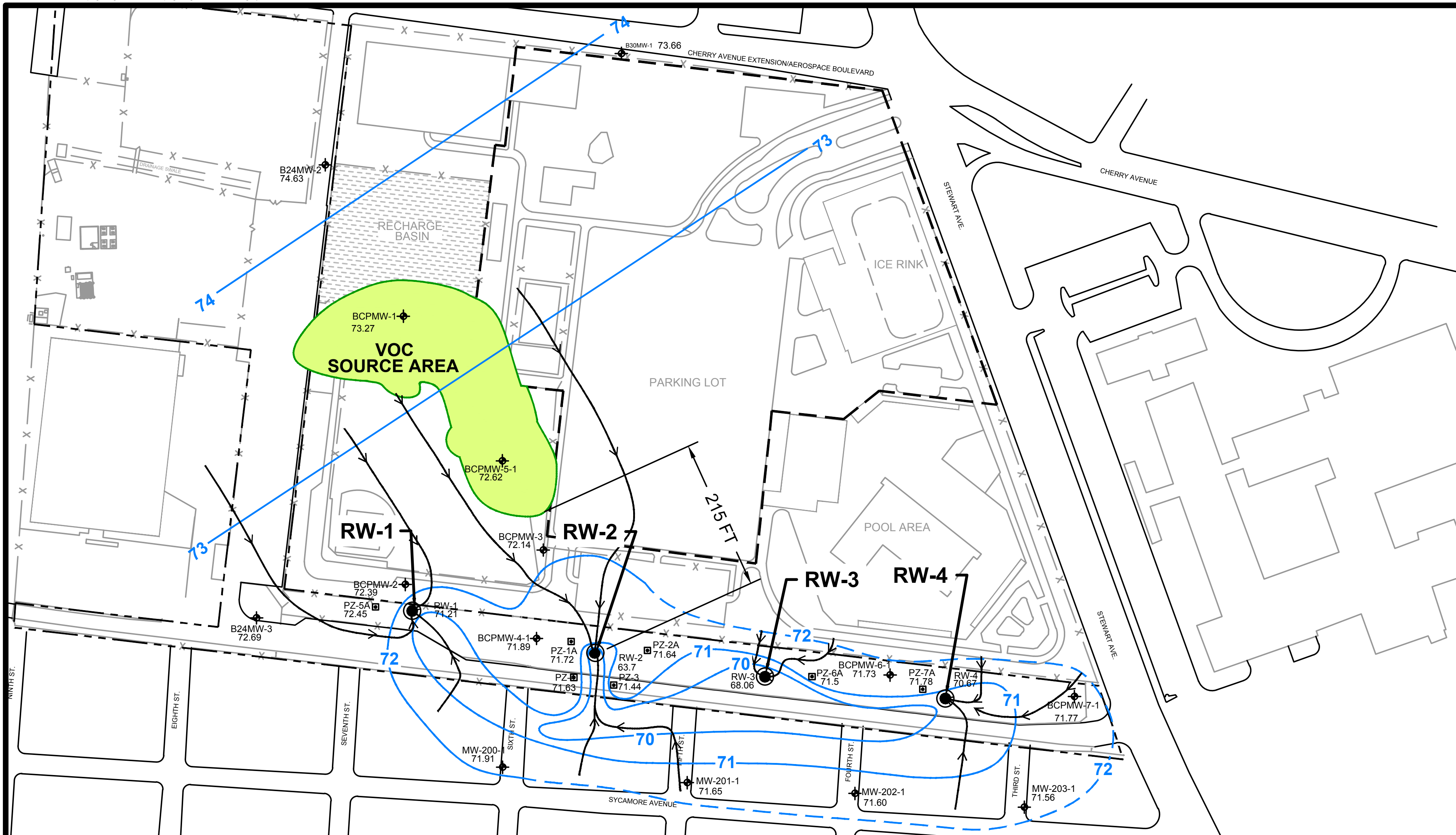


## EXPLANATION:

MW-200-1 — MONITORING WELL

RW-2 — RECOVERY WELL

PZ-2C — PIEZOMETER

71.78 — WATER-LEVEL ELEVATION (FEET MEAN SEA LEVEL)

70 — GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)

HORIZONTAL COMPONENT OF GROUNDWATER FLOW

ADAPTED FROM FIGURE 4 OF MAY 2013 ANNUAL REPORT FOR GROUNDWATER IRM (ARCADIS 2013)

VOLATILE ORGANIC COMPOUND (VOC) SOURCE AREA ADAPTED FROM FROM FIGURE 4-1 OF MARCH 4, 2011 SITE AREA FEASIBILITY STUDY (ARCADIS 2011)

N W E S

0 200'

1" = 200'

NORTHROP GRUMMAN
BETHPAGE, NY

FIGURE 1
GROUNDWATER FLOW AND VOC SOURCE AREA
OCTOBER 2012

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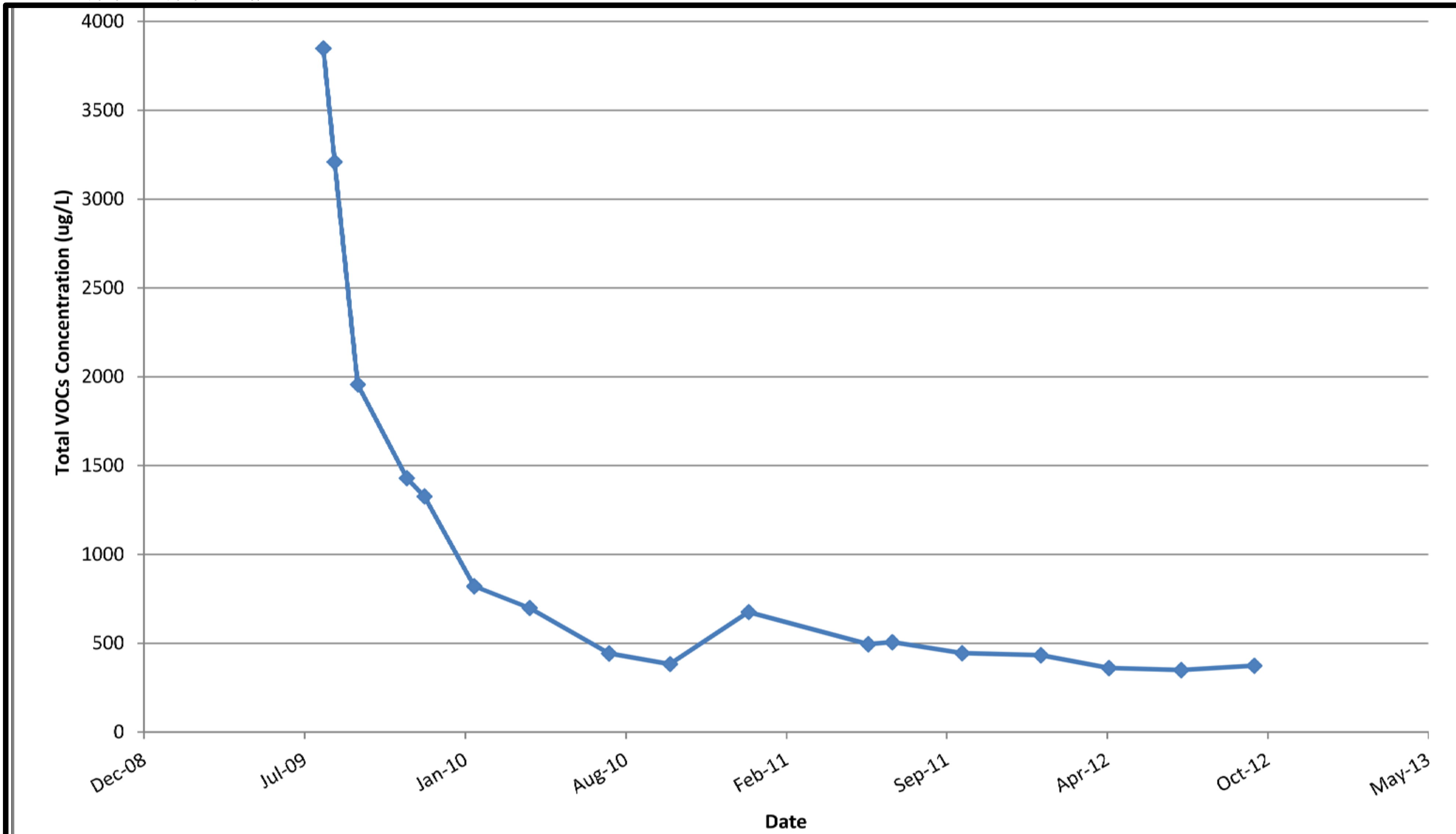


EXPLANATION:

◆ TOTAL VOLATILE ORGANIC COMPOUND (TVOC) CONCENTRATION (ug/L)

NORTHROP GRUMMAN
BETHPAGE, NY

FIGURE 2
TOTAL VOC CONCENTRATION
vs. TIME IN RW-2

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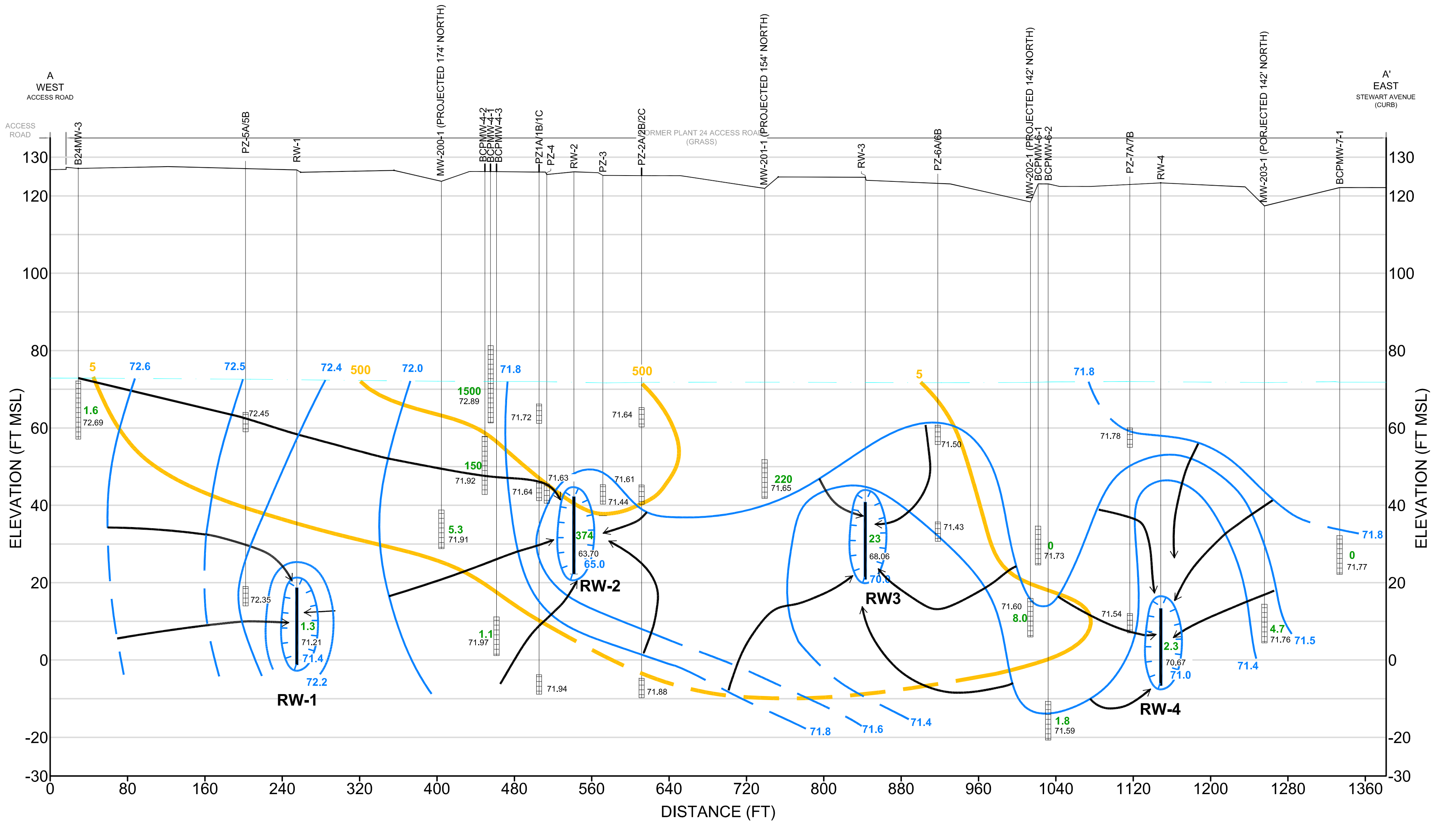


EXPLANATION:

MSL - MEAN SEA LEVEL

ug/L - MICROGRAMS PER LITER

TVOCs - TOTAL VOLATILE ORGANIC COMPOUNDS

5 — LINE OF EQUAL TVOC CONCENTRATION (DASHED WHERE INFERRED)

4.7 — TVOC CONCENTRATION (ug/L)

71.91 — WATER ELEVATION (FT MSL) ON OCTOBER 5, 2012

72.6 — LINE OF EQUAL WATER LEVEL ELEVATION IN FT MSL (DASHED WHERE INFERRED)

→ DIRECTION OF GROUNDWATER FLOW

FIGURE ADAPTED FROM FIGURE 9 OF MAY 2013 ANNUAL REPORT FOR GROUNDWATER IRM (ARCADIS 2013)

NORTHROP GRUMMAN
BETHPAGE, NY

FIGURE 3
CROSS SECTION ALONG THE ACCESS RD SHOWING GROUNDWATER FLOW AND TOTAL VOC CONCENTRATIONS

06/27/13 Emagin 7AS301101

Attachment 2

TOLLING AND STANDSTILL AGREEMENT

This is a Tolling and Standstill Agreement ("Agreement"), effective July __, 2013, by and between Northrop Grumman Systems Corporation ("NGS") and the New York State Department of Environmental Protection ("NYSDEC").

WHEREAS, NYSDEC has issued a Record of Decision relating to the Northrop Grumman—Bethpage Facility Operable Unit Number 03, Site No. 130003A (the "Site") on or after March 31, 2013 which sets forth certain remedial actions that NYSDEC has selected for the Site, and on May 15, 2013, NYSDEC directed the Town of Oyster Bay, the United States Department of the Navy and NGS to implement the ROD, and

WHEREAS, NGS has objected to the selection of certain of remedial actions selected and the procedures that led to the promulgation of the ROD, and has informed NYSDEC that it intends to challenge those actions in an appropriate court of law, and

WHEREAS, NGS and NYSDEC have entered into discussion to resolve the dispute and to reach a result which will be in the public interest and consistent with applicable regulation, and

WHEREAS, the NGS and NYSDEC desire to resolve their dispute in the hope of reaching an amicable resolution; and

NOW, THEREFORE, it is hereby agreed by and between the parties to this Agreement as follows:

1. Tolling: During the pendency of this Agreement, the parties hereby toll and extend all statutes of limitation, statutes of repose, contractual time bars, and any other time-bar limitations or defenses of any jurisdiction with respect to all issues arising from or relating to OU-3 and the Record of Decision related thereto, to and including October 31, 2013.

2. Non-Prejudice. Neither this Agreement nor the performance by a party under and according to its terms shall be construed as an admission of wrongdoing or liability of any kind to other party hereto or to any person or entity.

3. Terms of Agreement. This Agreement shall continue in effect for a period concluding on October 31, 2013 and is subject to renewal thereafter by written agreement of the parties unless terminated pursuant to paragraph [insert].

4. Notice. Any notice to be given hereunder to the other party, shall be in writing and shall be sent by overnight mail, express courier or by hand delivery, to the

persons indicated below or to such other persons as any party may designate by written notice to the other parties:

As to Northrop Grumman Systems Corporation:
Mark Chertok
Sive, Paget & Riesel, P.C.
460 Park Avenue, 10th Floor
New York, NY 10021-1182

As to New York State Department of
Environmental Conservation:

____________________
New York State Department of
Environmental Conservation
625 Broadway
Albany, NY 12233-7250

5. Inadmissibility. This Agreement shall be admissible in any proceeding involving the parties hereto only to prove the terms hereof, and shall be inadmissible for any other purpose.

6. Entire Agreement. This Agreement contains the entire agreement of the parties with respect to the subject matters relating thereto, and there are no other agreement as to these subjects continued in or described by this Agreement.

7. No Third-Party Rights. No person or entity other than NGS or NYSDEC shall have any rights under this Agreement.

8. Modification. Any change, modification, deletion or addition to this Agreement must be in writing and executed with the same formality as this Agreement.

9. Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument. It shall be necessary to account for only one fully executed counterpart in providing this Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement on the dates indicated by their respective signatures.

| | |
|---|---|
| NORTHROP GRUMMAN SYSTEMS CORPORATION | NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION |
| Date: ____________________________ | Date: ______________________________ |

By: ______________________________ By: ______________________________

Infrastructure, environment, buildings

Imagine the result

# Human Health Risk Assessment

Former Grumman Settling Ponds (Operable Unit 3)

Bethpage, New York

April 2009

**Tables**

**Figures**

## Appendices

**Acronyms**

| | |
|---|---|
| AF | absorption fraction |
| ALM | Adult Lead Model |
| AOC | Administrative Order on Consent |
| AT | averaging time |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BaP | benzo(a)pyrene |
| bgs | below ground surface |
| BKSF | biokinetic slope factor |
| BWD | Bethpage Water District |
| CalEPA | California Environmental Protection Agency |
| CDC | Center for Disease Control |
| $cm^2$ | square centimeters |
| COPC | constituent of potential concern |
| ED | exposure duration |
| EF | exposure frequency |
| EPC | exposure point concentration |
| FS | feasibility study |
| GSD | geometric standard deviation |
| HEAST | Health Effects Assessment Summary Tables |
| HHRA | human health risk assessment |
| HI | hazard index |
| HQ | hazard quotient |
| IR | ingestion rate |
| IRIS | Integrated Risk Information System |
| IRM | interim remedial measures |

| | |
|---|---|
| kg | kilogram |
| KM | Kaplan-Meier |
| MADEP | Massachusetts Department of Environmental Protection |
| µg | microgram |
| µg/dL | micrograms per deciliter |
| $mg/cm^2$ | milligrams per square centimeters |
| mg/day | milligrams per day |
| mg/kg | milligrams per kilogram |
| $mg/m^3$ | milligrams per cubic meter |
| mg/kg-day | milligrams per kilogram of body weight per day |
| MRL | minimum risk level |
| NAS | National Academy of Science |
| NCEA | National Center for Environmental Assessment |
| NWIRP | Naval Weapons Industrial Reserve Plant |
| NYSDEC | New York State Department of Environmental Conservation |
| NYSDOH | New York State Department of Health |
| OU3 | Operable Unit 3 |
| PAH | polycyclic aromatic hydrocarbon |
| Pb | lead |
| Pb/dL | lead per deciliter |
| PbB | blood lead level |
| PCB | polychlorinated biphenyl |
| PPRTV | provisional peer-reviewed toxicity value |
| Q-Q | Quantile-Quantile |
| RBA | relative bioavailability |
| RfC | reference concentration |

| | |
|---|---|
| RfD | reference dose |
| RI | remedial investigation |
| RPD | relative percent difference |
| RPF | relative potency factor |
| RSL | regional screening level |
| SCO | soil cleanup objective |
| SF | slope factor |
| SVOC | semivolatile organic compound |
| UCL | upper confidence level |
| URF | unit risk factor |
| USEPA | U.S. Environmental Protection Agency |
| VOC | volatile organic compound |
| WHO | World Health Organization |

## 1. Introduction

ARCADIS U.S., Inc. (ARCADIS) has prepared this Human Health Risk Assessment (HHRA) on behalf of Northrop Grumman Systems Corporation (Northrop Grumman) for the Former Grumman Settling Ponds, Operable Unit 3 (OU3) Site in Bethpage, New York (hereinafter referred to as Site Area). This HHRA is submitted pursuant to Section II of the July 4, 2005 Administrative Order on Consent (AOC) issued by the New York State Department of Environmental Conservation (NYSDEC) (2005) that required a Remedial Investigation (RI) and Feasibility Study (FS) be conducted for OU3.

For the purposes of this HHRA, the Site Area is divided into the following three sub-areas (Figure 1):

- the southern portion of the Bethpage Community Park (hereinafter referred to as Bethpage Park), which was not subject to soil removal during the Park redevelopment, including the ball field to the southwest, the playground in the south central area, and the pool area to the southeast (see Figure 2)

- the Former Grumman Plant 24 Access Road property (hereinafter referred to as the Access Road), which is located along the southern and western perimeters of the Park

- the residential area along the north side of Sycamore Avenue (hereinafter referred to as the Sycamore Avenue residences), which is bounded to the north by the Former Grumman Plant 24 Access Road Property, to the south by Sycamore Avenue, to the east by Stewart Avenue, and to the west by 11$^{th}$ Street

A baseline risk assessment, which evaluates human health risks in the absence of any remediation, is a normal component of the RI. This HHRA differs slightly from a standard baseline risk assessment in that certain soil remediation scenarios are assumed and those scenarios are factored into the calculation of human health risks. Specifically, the goals of this HHRA are to evaluate potential post-remediation human health risks posed by site-related constituents in soil in the Site Area and to support any remedial action decisions needed to address those risks. Further, the HHRA was completed to provide a site-specific assessment of risk associated with certain portions of the Site Area (i.e. the Bethpage Community Park and the Former Grumman Plant 24 Access Road property as discussed above) because the NYSDEC (2006) SCOs were developed using standard exposure assumptions that differ from site-specific exposures and conditions in those areas.

Risk assessment, as defined by the National Academy of Sciences (NAS 1983), is the characterization of the probability of potentially adverse health effects resulting from human exposures to environmental hazards. In essence, it is the systematic evaluation of the possible health effects posed by a particular substance or mixture of substances present in one or more environmental media. The framework to quantify such adverse health effects was established by the NAS in 1983 and subsequently adopted by the U.S. Environmental Protection Agency (USEPA).

The four basic components of human health risk assessment, as defined by the NAS (1983), will be conducted to assess whether residual levels of constituents of potential concern (COPCs) in Site Area soils could present a significant potential risk to public health. The four components of risk assessment are:

- Hazard identification – the evaluation of the nature and the extent of potential health hazards associated with exposure to COPCs at the Site Area. The objective of hazard identification is to identify the COPCs and to understand the occurrence and distribution of each in soils.

- Exposure assessment – the identification and evaluation of actual or potential routes of exposures, characterization of exposed populations, and determination, quantification, and evaluation of the extent of exposure to COPCs. The objectives of exposure assessment are to identify potentially exposed populations, to develop exposure scenarios, and to estimate levels of intake of COPCs.

- Dose response assessment – the analysis and interpretation of the relationship between the intake of a COPC and the anticipated incidence of adverse health effects in the exposed population. The objective of dose-response is to identify health-based criteria for noncarcinogenic and carcinogenic effects.

- Risk characterization – the analysis, interpretation and evaluation of the potential incidence of adverse health effects under the various conditions of exposure. The objectives of risk characterization are to estimate potential noncarcinogenic hazards and carcinogenic risks and to identify uncertainties associated with the analysis.

In developing the approach for this HHRA, ARCADIS considered relevant state and federal guidance documents, including, but not limited to, the following:

- *Draft DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC 2002)
- *Draft DER-22 Soil Cleanup Guidance* (NYSDEC 2008) (replaces NYSDEC [1994] *Technical and Administrative Guidance Memorandum #4046*)
- *New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document* (NYSDEC 2006)
- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA 1989a)
- *Guidelines for Exposure Assessment* (USEPA 1992a)
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002a)
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final.* (USEPA 2004)
- *Guidelines for Carcinogen Risk Assessment*; *Final* (USEPA 2005)
- *Exposure Factors Handbook* (USEPA 1997a)

This HHRA is generally presented in the format outlined in the USEPA guidance entitled *Risk Assessment Guidance for Superfund Volume I – Human Health Evaluation Manual, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments* (USEPA 2001). In addition to the four main HHRA components, Section 2 of this HHRA presents the site characterization, which describes the environmental setting. The hazard identification, including identification of COPCs and media of concern is presented in Section 3, and Section 4 presents the dose response assessment for each of the COPCs. Section 5 provides the exposure assessment including the identification of complete exposure pathways and a description of the specific assumptions and parameters used to quantify exposure. Section 6 presents the quantitative risk and hazard estimates and Section 7 discusses the sources and degree of the uncertainty associated with those estimates. The results of this quantitative HHRA will be used to help evaluate the residual risks associated with the proposed remedial actions for the Site. Summary and conclusions are presented in Section 7, and Section 8 presents the references cited in this report.

## 2. Site Characterization

Site characterization presents the site description, site development history, and potential soil remediation scenarios considered in the HHRA.

### 2.1 Site Description

The Site Area is located adjacent to the former Naval Weapons Industrial Reserve Plant (NWIRP) Facility (NYSDEC Site ID# 1-30-003B) and is bordered by Cherry Avenue Extension/Aerospace Boulevard (which is owned by Northrop Grumman) and commercial properties to the north, Stewart Avenue and Bethpage High School to the east, residential areas to the south, and 901 Stewart Avenue (former Northrop Grumman Plant 24, which is currently unoccupied) to the west. Other unoccupied properties owned by Northrop Grumman, including the McKay Field property, ball fields, and former nursery areas, are also located to the west. Further to the west are the north campus of the Northrop Grumman Facility and the former Occidental Chemical Corporation Polymer Site (Figure 1).

In 1962, the Bethpage Park property was donated by Grumman to the Town of Oyster Bay for exclusive use as parkland. Shortly after Grumman donated the land to the Town, the Town commenced construction and other work on the Park property. The park structures, as they were prior to the town's recent redevelopment, were built by the Town without any Grumman involvement. They included an ice rink, a parking lot, picnic and playground areas, a basketball court, paddleball courts, shuffleboard courts, horseshoe pits, and bicycle rack areas. Prior to the town's redevelopment of the Park for construction of a new ice rink, which commenced in 2005, the Park was open year-round.

Adjoining the Park property to the south and west is the Former Grumman Plant 24 Access Road Property, which is owned by Northrop Grumman. It runs east-to-west along the southern boundary of the Park and north-to-south along the western boundary 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 gated and, as a result, are not publicly accessible. Sycamore Avenue is a Town-owned roadway that is south of the Access Road.

As described above, most of the Site Area has been fully developed and is either parkland (i.e., Bethpage Park) industrial property (i.e., Former Grumman Access Road) or residential properties (i.e., the Sycamore Avenue residences), with paved areas and unpaved areas covered by grass or ornamental landscaping. The recharge basin and portions of the Park perimeter are overgrown.

### 2.2 Site Activities

In 2005, the Town of Oyster Bay initiated redevelopment of approximately 11 acres of the Bethpage Park.  As part of the redevelopment, the Town executed an AOC with the NYSDEC in 2005 for the implementation of an interim remedial measure (IRM) for soils in the construction area. The Town performed an investigation of soil, soil gas, and groundwater in the construction area in 2005 and submitted work plans to NYSDEC recommending excavation and off-site disposal of soil within the construction areas. A number of former features of the Park were demolished and removed in 2006. The Town's IRM soil excavation/disposal was performed from October 2006 to May 2007 and redevelopment was completed in early 2008. The approximate limits of the Town's IRM program are shown in Figure 2. As part of this program, the Town excavated and removed soil from the central, northern, and northeastern portions of the Park to depths between 2 and 20 feet below ground surface (bgs). In these areas, soils that were removed were replaced with clean fill and portions of the area were covered with impermeable materials, such as asphalt. NYSDEC approved the Town IRM on September 17, 2008.

With the redevelopment of the Park, most of the previous features were removed by the Town. Presently, the redeveloped Park contains two swimming pools, offices, and an ice rink on the eastern side, a parking lot in the center, tennis courts 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 areas of the park are fenced and gated, allowing no public access. These areas include the recharge basin and the baseball diamond. Other portions of the Park are publicly accessible. These include the area around the swimming pools, offices, ice rink, parking lot, tennis courts, basketball courts, and the small playground on the south side.

In 2007, a soil gas IRM was proposed for the Site Area. The Soil Gas Interim Remedial Measure 95 Percent Design Report and Design Drawings (ARCADIS 2007) were approved by the NYSDEC on September 19, 2007 (NYSDEC 2007). ARCADIS completed the soil gas IRM for the Site Area in February 2008. The soil gas IRM was installed along the southern and western boundaries of the Park with the goal of preventing off-site migration of constituents in soil gas. A detailed description of the soil gas IRM is provided in the OM&M Manual (ARCADIS 2009). A history of all soil investigations conducted at the Site Area is provided in the Remedial Investigation for the Site (ARCADIS 2008).

### 2.3 Soil Remediation Scenarios

For purposes of this HHRA, certain soil remediation activities are assumed for each of the three sub-areas included in the Site Area. Each of these is described below.

Bethpage Park

For the purposes of this HHRA, the upper 2 feet of surface soils in Bethpage Park are assumed to be removed from the areas indicated in Figure 3 and replaced with fill that falls below the NYSDEC restricted residential SCOs. Accordingly, potential risks for receptors exposed to soils in Bethpage Park were evaluated assuming removal of soils from the 0-2 foot depth interval in those areas and no removal of soils deeper than 2 feet.

Access Road

For the purposes of this HHRA, placement of a gravel cover is assumed for the unpaved portions of the Access Road property. This gravel cover would prevent direct contact or indirect contact (i.e., wind-blown dusts) with surface soils during non-invasive activities (e.g., walking).

Sycamore Avenue Residences

For the purposes of this HHRA, soil removal is assumed for any soils in the Sycamore Avenue residential neighborhood that exceed NYSDEC residential SCOs for polychlorinated biphenyls (PCBs). PCBs are the only COPC in soil. Because the State's default residential SCOs are used, it is unnecessary to quantitatively evaluate human health risks in this HHRA for the residential properties.

## 3. Hazard Identification

The objective of the hazard identification is to identify the media of concern and the COPCs present in those media to understand the nature and extent of each COPC at the Site Area. This information is then used to help develop the potential exposure scenarios to be evaluated and to guide the selection of toxicity criteria for use in this HHRA.

### 3.1 Media of Concern

The media of potential interest considered in this HHRA were soil, groundwater (including perched water), and soil gas (i.e., indoor air). Exposure to groundwater was determined to not represent a complete pathway because 1) depth to groundwater precludes direct contact and 2) Site Area groundwater is not used as a drinking source or for irrigation. Specifically, groundwater supply wells do not exist in the Site Area. Water for potable use within the Site Area is provided by the Bethpage Water District (BWD). Water from these wells is monitored and treated prior to distribution. Under these conditions, there could be not current or future exposure to Site Area groundwater.

Exposure to COPCs in indoor air via migration from groundwater and/or subsurface soils was recently evaluated in the Sycamore Avenue residential neighborhood by the NYSDEC and the New York State Department of Health (NYSDOH). It was concluded that indoor air did not present a complete exposure pathway for residents (ARCADIS 2005; EA Engineering 2007). As discussed in Section 2.2, an IRM to prevent the migration of soil vapor off-site was completed in early 2008. Likewise, as part of an environmental easement for Bethpage Park, any new building construction will include vapor barriers to mitigate the migration of COPCs from the subsurface environment to indoor air.

Consistent with the above discussions of groundwater and indoor air exposures, the media of concern in the Site Area for this HHRA is limited to soils. As noted above, soils from the Sycamore Avenue residential properties with PCB concentrations greater than SCOs will be removed. Therefore, these soils are not discussed further in this HHRA.

In areas where soil removal activities are assumed, post-removal conditions are evaluated to estimate potential residual risks. In areas where soil removal is not assumed, the HHRA uses existing data to evaluate potential risks. As noted above, although no soil removal is assumed for the Access Road, the HHRA assumes that a gravel cover will be placed on the unpaved portions of the property to prevent any exposures to individuals engaged in noninvasive activities.

It is assumed that soil remediation for the Bethpage Park will include removal of the upper two feet of exposed (unpaved and uncovered) soils where constituents are present at levels exceeding restricted residential SCOs. It is also assumed that, following removal, excavated areas would be restored to pre-removal grades with soils that do not contain constituent concentrations greater than NYSDEC's restricted residential SCOs.

Because removal of only the upper two feet of soil is assumed , current concentrations of COPCs will remain in subsurface soils (>2 feet) within Bethpage Park. Activities that may involve contact with those deeper soils, such as construction or utility maintenance, installation or repair may present a potential for exposure to those COPCs

### 3.2 Analytical Data

To ensure the accuracy and validity of the HHRA, it is imperative that the analytical data upon which the HHRA is based are of known and sufficient quality. Therefore, in accordance with USEPA (1989a) guidance, all available data are evaluated with respect to a) analytical methods; b) quantitation limits; c) qualifiers and codes; d) blank sample analytical results; e) background concentrations; f) frequency of detection; and g) essential nutrient qualities.

The analytical data evaluated in this HHRA for Bethpage Park and the Access Road include samples collected by ARCADIS and Dvirka and Bartilucci from 1999 to 2007 (ARCADIS 2008), excluding those areas that were excavated by the Town of Bethpage. Additionally, data from Samples F-7 and F-8 were not included in the Bethpage Park dataset because these samples were collected from the bottom of the recharge basin.

The data used in the HHRA were validated. Results without data qualifiers, plus those values with J and B qualifiers, were treated as detected concentrations at the reported/estimated concentrations. Values qualified with U and UJ were treated as non-detects. Values with R qualifiers, indicating the result was rejected during data validation, were not used in the HHRA. Generally, the soils data evaluated in this HHRA for Bethpage Park included the data from the 2-6 foot depth interval as this is the depth interval in which most of the Park utilities are located. There are some areas of the Park, however, in which utilities are known to be present in deeper soils (i.e., down to 10 feet). In those areas, soils data from the 2-10 foot depth interval were evaluated. Because a BWD water pipe is present within the Access Road down to an approximate depth of 9.1 feet, soils data from the 0-10 foot depth interval were evaluated in the HHRA.

### 3.3 Potential Constituents of Concern

All chemicals detected in environmental media of concern (Section 2.1) are defined as COPCs, unless there is a justifiable rationale for their exclusion. Chemicals that meet one or more of the screening criteria are excluded from the list of COPCs and are not evaluated further in this HHRA. As part of the screening, data from Bethpage Park and the Access Road were evaluated separately to identify COPCs.

For the Bethpage Park and Access Road, COPCs are identified by comparing the maximum concentrations of detected constituents from Bethpage Park and the Access Road to the restricted residential SCOs established by NYSDEC (2006). The Restricted Residential SCOs are based on potential exposure of adults and children to soils via ingestion, inhalation of volatiles and particulates, and dermal contact (NYSDEC 2006). SCOs for individual chemicals reflect risk levels that do not exceed a cancer risk of $1 \times 10^{-6}$ and a hazard index of 1 for non-cancer endpoints (NYSDEC 2006). These SCOs are developed using standard exposure parameters and toxicity values (NYSDEC 2006). Since it is assumed that the 0-2 foot soils in Bethpage Park that exceed the restricted residential SCOs will be removed and replaced with clean fill, the COPC screening for this area of the Site only focuses on data for subsurface soils (>2 feet).

In the event that a constituent did not have an available SCO, the USEPA (2008a) Regional Screening Levels (RSLs) for residential soil were used as a secondary screening source for all areas of the Site. Additionally, if neither a SCO nor a RSL was available, the maximum SCOs for organics (100 mg/kg) and inorganics (10,000 mg/kg) were used to screen the analytical data (NYSDEC 2006).

Appendix A provides a summary of the soils data that were included in the screening evaluation for the Park. Table 2-1 presents the COPC screening for the Park. Table 2-2 presents the COPC screening for the Access Road. Appendix B provides a summary of the soils data that were included in the screening evaluation for the Access Road.

Appendix C provides a summary of the surface soils data (0-2 feet bgs) for Bethpage Park.

The results of the screening analyses for soils are provided in Tables 2-1 and 2-2. The comparison of chemical concentrations to screening criteria is only conducted for detected constituents. A total of 29 constituents, including several volatile organic constituents (VOCs), semi-volatile constituents (SVOCs) (primarily polycyclic aromatic hydrocarbons [PAHs]), PCBs, and metals, are identified as COPCs for Bethpage Park. PCBs, arsenic, cadmium, chromium, and cyanide are identified as COPCs for the Access Road. Potential cancer risks and non-cancer hazards are quantitatively evaluated for these COPCs in Section 5 of this HHRA.

## 4. Exposure Assessment

Exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to chemicals present in the environment. The exposure assessment includes the identification of potentially exposed populations, development of exposure scenarios, analysis of exposure pathways, definition of exposure points, and estimation of exposure point concentrations (EPCs). This information is used to estimate potential dose rates under current and reasonably foreseeable uses of the Site. The dose rate estimates are then combined with the toxicity values identified in the dose-response assessment (Section 5) to estimate the risks associated with current and reasonably foreseeable future exposures as part of the risk characterization (Section 6).

The exposure assessment is a critical component of the site assessment process, as it qualitatively and quantitatively describes the potential contact between people and COPCs in environmental media at the Site. There are two important results of the exposure assessment: exposure profiles and quantitative estimates of exposure. An exposure profile is a narrative description of the exposures that may occur at the Site. The quantification of exposure translates the narrative exposure profile into a series of exposure equations resulting in numerical estimates of dose rates. These numerical estimates are subsequently used in the risk calculations.

Risk assessors most often apply point estimates of key exposure characteristics in calculating dose rate. This practice requires that variability within the population under study be reduced to a single value for each exposure parameter. If conservative upper-bound estimates are utilized for these single point values, multiplying these values together in the risk assessment often results in overestimation of dose rate and risk

(USEPA 1992a). The magnitude of the overestimation in dose rate or risk increases with each additional input parameter that has been overestimated.

The initial step in evaluating potential human exposure is the identification of potentially complete exposure pathways, which per regulatory guidance (NYSDEC 2002), must contain the following five elements: 1) constituent source, 2) constituent release and transport mechanisms, 3) point of exposure, 4) route of exposure and 5) receptor population. Exposure pathways without even one of these elements are considered incomplete and do not require further evaluation (NYSDEC 2002). Potential receptors and associated exposure pathways are summarized in Table 1-1 of this HHRA and discussed below for Bethpage Park and the Access Road.

## 4.1 Exposure Scenarios

The exposure scenarios that are evaluated in this HHRA differ among the different locations within the Site Area and are based on current and potential future uses of each location. The scenarios for each location are discussed below.

### 4.1.1 Bethpage Park

As discussed previously, the current and future uses of Bethpage Park are primarily recreational. Bethpage Park is used by residents of the surrounding areas for a variety of purposes, including playgrounds, basketball courts, tennis courts, swimming pools and an ice rink. In addition, there are expected to be some full-time office workers at some of the park facilities (e.g., ice rink).

Recreational users and office workers at Bethpage Park could come into contact with surface soils in the park during their activities. It is expected that recreational users, who would include both children and adults, would have the higher potential for exposure to those soils than would office workers, due to the fact that they could be regularly engaged in a number of outdoor activities there. However, as discussed in Section 1.1 of this HHRA, it is assumed that the upper two feet of soils in Bethpage Park that exceed the restricted residential SCOs are removed. Because it is assumed that there will be no COPCs in the 0-2 foot soils in Bethpage Park after that removal is complete, potential exposure to surface soils for recreational users is incomplete and is not evaluated further in this HHRA.

Underground utilities are present in portions of Bethpage Park. Utility workers may be involved in the replacement, repair or maintenance of those utilities and may be exposed to both surface and subsurface soils during such activities. In most areas of the park, utilities are present in the 0-6 foot depth interval. In some specific areas, utilities were historically placed in deeper soils at a depth of 8 or 9 feet bgs. Thus, potential exposure to adult utility workers is evaluated using data from the 0-6 foot soil depth for most of the park, and using soil data from the 0-10 foot depth interval in those areas of the park where it is known that utility depths are below 6 feet.

Construction workers may be involved in the repair and/or alteration of existing buildings or the construction of new buildings or features in the park. Future construction is expected to be slab-on-grade construction and therefore, would not be expected to extend beyond a depth of 6 feet. Thus, potential exposures of adult construction workers to surface and subsurface soils are evaluated in this HHRA.

#### 4.1.2 Access Road

Much of the Access Road area is fenced to prohibit public access. While paved areas are publicly accessible, the presence of pavement prevents direct contact with soils in this area. Based on current knowledge, the paved portion of the Access Road is sometimes used for walking. The remaining grassy areas of the Access Road property are not accessible to the public and the placement of a gravel cover over areas of exposed soil is expected to effectively control potential exposures. Thus, recreational exposures to soils in the Access Road area are not evaluated in this HHRA.

The BWD water pipe crosses the Access Road area and as such, it is possible that utility work could take place in this area in the future. The BWD water pipe extends down to a depth of 9.1 feet. Therefore, soils data from 0-10 feet bgs are used in the HHRA to evaluate potential exposures of adult utility workers to surface and subsurface soils in this area. Because this area is relatively small, future construction in this area of the Site is unlikely.

### 4.2 Exposure Point Concentrations

Discrete EPCs were developed for each portion of the Site Area. For Bethpage Park, EPCs for the utility worker and construction worker scenarios were developed by combining the existing data for subsurface soils (>2 feet) with the assumed post-removal data for the 0-2 foot depth interval. Subsurface soils data for the utility worker included data for the 2 to 6 foot depth interval as well as data from several sampling locations where utility easements were identified up to 10 feet in depth (i.e., samples B-60, TP-1, G-5-SB, P-3 through P-16, and B-28). Subsurface soils data for the construction worker included data for the 2-6 foot depth interval only. Bethpage Park soils exceeding the NYSDEC Restricted Residential SCOs are assumed to be removed and the exact post-removal concentrations of individual constituents in the 0-2 foot depth interval cannot be predicted, therefore, the concentration of each COPC was conservatively assumed to be equivalent to the residential SCO for that constituent for the 0-2 foot depth interval.

All soils data (0-10 feet bgs) were used for the utility worker scenario for the Access Road. Because the BWD water pipe is located at approximately 9 feet bgs and because any new utilities in the Access Road would likely be placed within the 0-6 foot depth interval, the EPCs included data for the 0-10 foot depth interval.

Prior to EPC calculations, duplicate field samples were paired with their parent samples using the following methodology (USEPA 1992b; 2002c):

- If both the parent and duplicate values were non-detect, the maximum reporting limit was used as a single representative result.
- If both the parent and duplicate values were detects and neither value was greater than five times the reporting limit, the maximum value of the pair was used as a single representative result.
- If both the parent and duplicate values were detects and one or both of the values was greater than five times the reporting limit, the relative percent difference (RPD) was evaluated. If the RPD was greater than 100 percent, the maximum value was used as a single representative result. If the RPD was less than 100 percent, the arithmetic mean of the two values was used as a single representative result.

EPCs (e.g., 95 percent Upper Confidence Levels [UCLs]) were derived from existing data using the USEPA (2007a) ProUCL Software (Version 4.0). ProUCL statistical software was used to calculate the UCL of the unknown population arithmetic mean (USEPA 2007a). The rationale for calculating the UCL term followed the procedures outlined in the ProUCL's User's Guide. Each data set was tested for normality using the Shapiro-Wilk W Test statistic with accompanying Quantile-Quantile (Q-Q) plots. Each data set was also tested for the gamma distribution using the Anderson-Darling and Kolmogorov-Smirnov Empirical Distribution Functions test statistics with accompanying Q-Q plots.

Based on the distribution of the data set, a recommended UCL calculation procedure was followed. In instances where the recommended UCL exceeded the maximum detected concentration, the maximum concentration was used as the EPC consistent with USEPA (2007a) guidance.

For data sets with non-detect observations occurring at multiple detection limits, the Kaplan-Meier (KM) estimate method was used. The KM estimate method adjusts for censoring by calculating an estimate of standard error of the mean, which then can be used to calculate a UCL for various methods (e.g., normal approximations, percentile bootstrap, Chebyshev inequality) (USEPA 2007a).

EPCs are presented in Tables 3-1 through 3-3. Analytical data that were used to calculate EPCs are provided in Appendices A and B.

## 4.3 Exposure Pathways

Potential receptors considered in this HHRA included utility workers and construction workers. Potential routes of exposure associated with site-related soils are discussed below for each receptor group.

### 4.3.1 Utility Worker

Utility workers are defined as adult workers engaged in short-term intrusive activities to maintain, repair, or replace utility pipes. Utility workers are assumed to have future exposures to surface and subsurface soils at Bethpage Park and the Access Road through direct contact (ingestion and dermal contact) and through inhalation of dusts and vapors.

### 4.3.2 Construction Workers

Construction workers are defined as adult workers engaged in short-term intrusive activities associated with building construction. Construction workers are assumed to have exposures to surface and subsurface soils at Bethpage Park through direct contact (ingestion and dermal contact) and through inhalation of dusts and vapors.

## 4.4 Exposure Factors

This HHRA used exposure factors that reflect conditions at the Site Area consistent with current scientific and regulatory policy. While some exposure factors are USEPA default values, others are site-specific values that more accurately reflect exposures at the Site Area. The goal of this HHRA is to evaluate potential scenarios that represent reasonable maximum exposures that may be experienced by the identified receptor groups. The specific exposure factors used to quantify potential risks and hazards for the receptors/pathways identified previously are presented in Table 4-1.

#### 4.4.1 Intake Equations

Intakes (i.e., average daily doses) for the ingestion and dermal contact exposure pathways for all constituents are expressed in milligrams per kilogram of body weight per day (mg/kg-day) and were calculated using the EPC and applying the exposure factors that account for ingestion rates, dermal surface areas, dermal adherence factors, absorption rates, exposure frequencies, exposure durations, body weights, and averaging time.

Intakes for the inhalation exposure pathways are expressed in milligrams per cubic meter ($mg/m^3$) and were calculated using the EPC and applying the exposure factors that account for exposure time, exposure frequency, exposure duration, and averaging time. The intake equations used in this HHRA for ingestion, dermal contact, and inhalation for the utility and construction workers are presented in Table 4-1.

The exposure factors used in this HHRA are discussed below and summarized in Table 4-1.

#### 4.4.2 Soil Ingestion Rates

Upper-bound estimates of soil ingestion rates were used for the utility worker and construction worker.

For the utility and construction worker scenarios, it is reasonable to assume that because of the intensity of intrusive activities and the dust generated by them, soil ingestion may be higher for these individuals than expected for other adult activities. USEPA (2002a) recommends the use of an upper-bound soil ingestion rate of 330 mg/day based on the results of the study by Stanek, Calabrese et al. (1997). However, as discussed below, that soil ingestion rate is not likely to be representative of actual, daily adult soil ingestion.

As discussed in USEPA's *Exposure Factors Handbook* (1997a), adults are not expected to have the same intentional mouthing behaviors as young children. As a result, soil ingestion for adults generally results from soil or dust that adheres to the skin surface of the hands and is incidentally ingested if individuals place their unwashed hands or materials contacted by their hands (such as food or cigarettes) into their mouths during the day. Thus, soil ingestion by adults is likely to be a function of the amount of soil that adheres to their hands during the day.

The Massachusetts Department of Environmental Protection (MADEP 2002) recognized this fact and re-evaluated available soil ingestion data to determine an appropriate “enhanced” soil ingestion rate to be used for the evaluation of intensive soil activities for adults, such as utility and construction work. Their analysis was based on updated information about rates of soil adherence to the hands of individuals engaged in more intensive soil contact activities. Based on its review of the literature, MADEP (2002) concluded that an upper bound soil ingestion rate of 100 mg/day was appropriate for these types of activities. This analysis, combined with the conclusions reported by the authors of the soil ingestion study upon which USEPA’s recommended value is based (Stanek, Calabrese et al. 1997; Calabrese 2003), indicates that the default value recommended by USEPA (2002a) is not representative. For that reason, an upper-bound soil ingestion rate of 100 mg/day is used to evaluate exposure through soil ingestion for both the construction and utility worker scenarios.

#### 4.4.3 Fraction Soil Ingested

For all scenarios, it was assumed that Site media account for 100 percent of potential exposures. This is a conservative approach for the utility and construction worker scenarios since this does not account for exposures outside of the Site during non-working hours that may dilute daily intakes.

#### 4.4.4 Exposed Dermal Surface Areas and Adherence Factors

To evaluate potential dermal exposures for utility and construction workers at Bethpage Park and the Access Road, the USEPA (2004) default surface area (3,300 $cm^2$) was used for both receptors. The USEPA (2004) recommended adherence factor for a commercial/industrial worker (0.2 $mg/cm^2$) is based on the $50^{th}$ percentile for utility workers. Therefore, the dermal adherence factors for the utility worker (0.2 $mg/cm^2$) and the construction worker (0.10 $mg/cm^2$) used in this HHRA represent the geometric means for these receptors from USEPA (2004).

#### 4.4.5 Dermal Absorption Factors

The dermal absorption factors used in this HHRA are chemical-specific and were taken from USEPA (2004). Consistent with USEPA (2004) guidance, a default dermal absorption factor of 10 percent was used for SVOCs lacking chemical-specific factors. However, no default dermal absorption factors are available for VOCs or inorganics. Therefore, consistent with USEPA (2004) guidance, COPCs lacking a chemical-specific dermal absorption factor were not quantitatively evaluated for the dermal pathway.

#### 4.4.6 Exposure Frequencies

For the utility worker, it was assumed that utility work would be of limited frequency (3 days per year for Bethpage Park and 3 days per year for the Access Road) based on the relative size of the Site and the number of utilities present. For the construction worker, an exposure frequency of 60 days per year was assumed based on the current understanding regarding future development plans for Bethpage Park.

#### 4.4.7 Exposure Durations

The exposure duration for the utility worker (25 years) represents the USEPA (2002a; 2004) default. For the construction worker, an  exposure duration of 1 year was assumed since construction projects at Bethpage Park are expected to last no longer than 1 year.

#### 4.4.8 Exposure Time

For the inhalation pathway, the exposure time represents the length of time the receptor may be exposed, i.e., the length of time spent participating in an activity that could lead to exposure. For both the utility and construction workers, it was assumed that the exposure time consists of a standard 8-hour workday.

#### 4.4.9 Body Weights

The body weight used for the utility worker and construction worker (70 kg) represents the USEPA (1989a; 2002a; 2004) default.

#### 4.4.10 Volatilization Factors

Table 4-2 presents the chemical-specific factors used to calculate the volatilization factors for VOCs identified as COPCs. The volatilization factor and particulate emission factor were used to calculate intakes for the inhalation pathway as shown in Table 4-1.

### 4.5 Evaluation of Lead

Lead was identified as a COPC for Bethpage Park. NYSDEC (2006) provides a cancer toxicity value for lead for both the oral and inhalation exposure routes, (i.e., a SF and URF), but does not provide non-cancer toxicity values for lead. Therefore, potential cancer risks due to lead for utility and construction workers were quantitatively evaluated using the standard intake equations and applying the NYSDEC-recommended toxicity values. In addition, potential Site risks due to lead were evaluated with the USEPA (2003b) Adult Lead Model (ALM), which allows a quantification of lead risks based on biokinetics. This method allows the use of region-specific parameters (Northeast baseline blood levels) to quantify Site risks. Specifically, the ALM is used to evaluate lead risks for non-residential scenarios where the receptor of concern is the fetus of an adult worker. In this HHRA, the ALM was used to quantify potential lead risks for the construction worker exposed to soils at Bethpage Park. Because USEPA (2007b) does not recommend the use of the ALM for exposures less than 90 days because blood lead levels don't reach quasi steady state until that time, the utility worker was not evaluated with the ALM. Rather, the utility worker will have less exposure than the construction worker so the construction worker also serves as a surrogate in the ALM for evaluating lead risks for the utility worker.

Because lead is ubiquitous in the environment, predicted blood lead levels (PbB) associated with exposure to site-related sources of lead are added to an assumed age-specific baseline PbB that also reflects exposure to non-site-related lead sources. Potential health risks associated with lead exposure are evaluated by comparing the estimated PbB to the target PbB of 10 µg/dL (Centers for Disease Control [CDC], 1991). The target PbB is based on potentially adverse neurological effects in children (CDC 1991). Therefore, lead risk is evaluated based on the probability that PbB among a receptor population will exceed 10 •g/dL. This is sometimes referred to as the "P10 statistic." Consistent with USEPA guidance (USEPA 2003b), this lead evaluation focuses on determining if P10 equals or exceeds 5 percent, which is equivalent to calculating the $95^{th}$ percentile of the probability distribution of PbB among a receptor population.

The following equation is used in the ALM to estimate quasi-steady state PbBs:

$$PbB_{GM} = PbB_0 + \frac{PbSxBKSFxIRxAFxEF}{AT}$$

where:

$PbB_{GM}$ = geometric mean (50th percentile) of the lognormal distribution of PbBs in adult workers

$PbB_0$ = baseline PbB due to exposure to non-site-related sources of lead (µg/dL)

PbS = soil lead concentration (mg/kg)

BKSF = biokinetic slope factor (µg/dL per µg/day)

IR = soil ingestion rate (g/day)

AF = gastrointestinal absorption fraction for lead in soil (unitless)

EF = exposure frequency (days/year)

AT = averaging time (years)

USEPA assumes a linear relationship between PbB in the adult woman and the fetus. Therefore, the geometric mean PbB in the fetus is equal to $PbB_{GM}$ multiplied by a constant, R (0.9).

Table 4-3 presents the exposure variables used in the ALM to evaluate lead risks for the construction worker at Bethpage Park. The exposure variables are briefly discussed below.

Baseline Blood Lead Concentration ($PbB_0$)

The baseline PbB is intended to represent the best estimate of a reasonable central value of PbB in women of child-bearing age who are not exposed to lead-contaminated non-residential soil or dust from the Site. USEPA (2003b) recommends a range of baseline concentrations (1.7 to 2.2 µg/dL) based on national survey data for women from different demographic groups defined by geographic region, ethnicity, and race. A baseline value of 1.9 µg/dL was used in the ALM, which represents non-Hispanic white populations from the Northeast Region (USEPA 2002b).

Geometric Standard Deviation (GSD)

USEPA recommends a range of GSDs that may be used in the ALM model, depending on site-specific demographics and the characteristics of the receptor population (USEPA 2003b). Higher GSD values imply greater variability in PbBs and will result in a higher probability of exceeding the target PbB of 10 µg/dL. A GSD of 2.01 was used in this lead evaluation to reflect a non-Hispanic white population from the Northeast (USEPA 2002b).

Biokinetic Slope Factor (BKSF)

The BKSF represents the increase in typical adult PbB due to average daily lead uptake. USEPA (2003b) recommends a default value of 0.4 µg Pb/dL blood per µg Pb absorbed/day for the BKSF. This value is based on empirical data on the relationship between tap water lead concentrations and PbBs for a sample group of adult males. This default value is used for in the ALM.

Soil Ingestion Rate ($IR_S$)

Consistent with USEPA (2007b) guidance, a soil ingestion rate of 100 mg/day is used to evaluate potential risks for the construction worker. This value represents the central tendency ingestion rate for soil contact-intensive adult scenarios (USEPA 2007b). This value is also consistent with the soil ingestion rate used in the standard intake equations in the HHRA for the construction worker.

Exposure Frequency (EF) and Averaging Time (AT)

The exposure frequency used for the construction worker in the ALM reflects 12 weeks (3 months) of exposure and assumes 5 days per week of exposure (i.e., 5 days/week x 12 weeks = 60 days/year). So as not to dilute the exposures over the entire year, the averaging time is based on the exposure frequency (i.e., 7 days/week x 12 weeks/year = 84 days/year).

Lead Absorption Fraction (AF)

The default value for lead absorption (0.12) is used in the ALM. This value is based on experimental studies of the bioavailability of ingested lead in adults with considerations for the following three major sources of variability:  1) effect of food on lead bioavailability; 2) nonlinearity in PbB; and 3) effect of lead form and particle size on bioavailability. The value assumes the a relative bioavailability (RBA) of 0.6 for lead in site-related media as compared to soluble lead, and also assumes an absorption fraction of 0.2 for soluble lead. Thus the final AF is 0.12 (i.e. AF = 0.6 x 0.2 = 0.12).

Fetal/Maternal Blood Lead Concentration ($R_{fetal/maternal}$)

A fetal/maternal blood lead ratio of 0.9 is used for adult receptors, which is the default value recommended by USEPA (2003b) based on studies that have explored the relationship between umbilical cord and maternal PbBs.

Exposure Point Concentration

As recommended by USEPA (2003b; 2007b), the EPC used in the ALM represents the arithmetic mean of Site Area data for surface and subsurface soils. Consistent with the EPC methodology described in Section 3.2, surface soil lead concentrations for Bethpage Park were replaced with the NYSDEC Restricted Residential SCO prior to calculation of the EPC assuming that soils with concentrations greater than the SCOs will be removed.

Results of the lead evaluation are discussed below in the risk characterization.

## 5. Dose Response Assessment

The dose response assessment identifies the potential effects that are associated with exposure to a given chemical. The USEPA's guidance evaluates two types of toxic effects: carcinogenic effects and non-carcinogenic effects. To quantify carcinogenic effects, the USEPA has derived slope factors (SFs) for those chemicals found to cause a dose-related, statistically significant increase in tumor incidence in an exposed population relative to the incidence of tumors observed in an unexposed population. These dose-related incidence rates are usually determined in a laboratory study. SFs are typically developed based on oral toxicity studies and are reported as risk per dose in units of $(mg/kg\text{-}day)^{-1}$. The SFs are used to quantify the potential risk of cancer associated with a given exposure. Unit risk factors (URFs) are based on inhalation studies and are reported in units of $(mg/m^3)^{-1}$. The oral/dermal SFs, including weight-of-evidence classifications, for carcinogenic COPCs are presented in Table 6-1. Table 6-2 presents the URFs for carcinogenic COPCs.

To quantify non-carcinogenic effects, the USEPA has derived oral reference doses (RfDs) in units of mg/kg-day that represent a threshold of toxicity. RfDs are intended to represent "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA 1989a). Reference concentrations (RfCs) were derived for the inhalation pathway and are presented in units of $mg/m^3$. Table 5-1 presents oral/dermal RfDs for noncarcinogenic COPCs. Table 5-2 presents the RfCs for noncarcinogenic COPCs.

The oral SFs and RfDs described above were used to evaluate both ingestion and dermal contact exposure routes. Because most oral toxicity values are based on an administered dose, these toxicity values were sometimes adjusted (expressed as an absorbed dose) when evaluating dermal exposure scenarios. The USEPA requires this adjustment only when the gastrointestinal absorption of a compound is less than 50 percent (USEPA 2004).

Toxicity data presented were preferentially selected from the USEPA Integrated Risk Information System (IRIS) on-line database (USEPA 2008b). The toxicity data from NYSDEC (2006) were used as a secondary source if no toxicity data were available in IRIS. The NYSDEC (2006) selected their toxicity data from various sources, including the USEPA, Agency for Toxic Substances and Disease Registry (ATSDR), World Health Organization (WHO), Health Canada, NYSDOH, and California EPA (CalEPA). If toxicity data were not available from IRIS or NYSDEC (2006), values were selected according to the USEPA (2003a) toxicity hierarchy, which includes the Provisional Peer-Reviewed Toxicity Values (PPRTVs) provided by the USEPA National Center for Environmental Assessment (NCEA), ATSDR minimum risk levels (MRLs), CalEPA values, and the USEPA (1997b) Health Effects Assessment Summary Tables (HEAST).

For the carcinogenic PAHs, for which no specific toxicity information is provided, relative potency factors (RPFs) recommended by USEPA (1993) were used. The compound-specific RPF is multiplied by the SF for benzo(a)pyrene (BaP) to derive a toxicity factor for those constituents, based on their assumed potency relative to BaP.

Surrogate toxicity data were used when chemical-specific values were unavailable. Specifically, for RfDs, the value for mercuric sulfide was used for mercury, Aroclor 1254 was used for total PCBs, and thallium sulfate was used for thallium. For RfCs, the value for elemental mercury was used for mercury and thallium sulfate was used for thallium. The SF and URF for PCBs represent the values for high risk PCBs.

When available, subchronic toxicity data were used to evaluate potential non-cancer hazards for the construction worker. When only one toxicity value was available (i.e., chronic or subchronic), the same value was used to evaluate both chronic and subchronic exposures.

# 6. Risk Characterization

The risk characterization integrates the results of the data evaluation, toxicity assessment, and exposure assessment to evaluate potential risks associated with exposure to site-related constituents in Site Area soils. Consistent with the USEPA (1989a) guidance, the potential for carcinogenic risks and non-carcinogenic health hazards are evaluated separately.

Tables 7-1 through 7-3 and Tables 9-1 through 9-3 present the cancer and non-cancer intakes, as well as the cancer risks and non-cancer hazards, respectively. The RAGS Part D Table 8 series are not presented as part of this HHRA because radiation risks are not of concern for the Site.

## 6.1 Non-Carcinogenic Health Hazards

Quantitative estimates for noncancer effects are called hazard quotients (HQs). The HQ is the ratio of the estimated average daily dose or exposure intake and the appropriate noncancer toxicity value (RfD), as presented below for oral and inhalation exposures.

$$HQ = \frac{E_{oral}}{RfD}$$

where:

E = exposure intake (mg/kg-day)

RfD = reference dose (mg/kg-day)

$$HQ = \frac{E_{inhalation}}{RfC}$$

where:

E = Exposure intake (mg/m$^3$)

RfC = Reference Concentration (mg/m$^3$)

The Hazard Index (HI) is used to characterize potential non-carcinogenic health hazards associated with exposure to multiple chemicals. This approach assumes that sub-threshold chronic exposures to multiple chemicals are additive. However, HQs should only be summed for constituents with the same target organ. The USEPA target HI is 1; therefore, exposures with a cumulative HI or target-organ HI of less than 1 are presumed not to pose unacceptable health hazards. An HQ/HI value greater than 1 indicates that a calculated exposure is greater than the RfD for a given constituent; however, it does not reflect the probability of an adverse effect, nor does it necessarily imply that adverse health effects will occur (USEPA 1989a). Although cumulative HIs are presented in the risk characterization, the target-organ HIs are the true indicators of whether a group of chemicals presents an unacceptable health hazard. Tables 7-1 through 7-3 present cumulative HIs, while Tables 9-1 through 9-3 present target organ-specific HIs.

The HI for the oral and dermal exposure pathways is calculated as follows:

$$HI = \frac{E1}{RfD1} + \frac{E2}{RfD2} + \ldots + \frac{Ei}{RfDi}$$

where:

HI = Hazard Index

$$\frac{E}{RfD} = HQ$$

where:

Ei = Exposure intake for the ith chemical (mg/kg-day)

RfDi = RfD for the ith chemical (mg/kg-day)

The HI for the inhalation exposure pathway is calculated as follows:

$$HI = \frac{E1}{RfC1} + \frac{E2}{RfC2} + \ldots + \frac{Ei}{RfCi}$$

where:

HI = Hazard Index

$$\frac{E}{RfC} = HQ$$

where:

Ei = exposure intake for the ith chemical (mg/m$^3$)

RfCi = RfC for the ith chemical

Non-carcinogenic health hazards for each area of the Site are discussed separately below.

#### 6.1.1 Bethpage Park

Potentially complete exposure pathways for Bethpage Park included exposure of utility workers and construction workers to surface and subsurface soils via ingestion, dermal contact, and inhalation. The target organ-specific HIs for the utility worker and construction worker at the Bethpage Park were below the USEPA target of 1. Tables 7-1 and 9-1 present the HIs for the utility worker. Tables 7-3 and 9-3 present the HIs for the construction worker.

Lead was identified as a COPC for Bethpage Park. The USEPA (2003b) ALM was used to evaluate potential lead risks for receptors exposed to soils at Bethpage Park in the absence of noncancer toxicity values. Because blood lead levels do not reach quasi-steady state until 90 days, use of the ALM was not appropriate to evaluate potential lead risks for the utility worker. Therefore, the ALM was only used to evaluate potential lead risks for the construction worker.

Table 7-4 presents the ALM modeling results for the construction worker exposed to surface and subsurface soils at Bethpage Park. The ALM predicts that exposure of construction workers to surface and subsurface soils at Bethpage Park will result in a P10 less than 5 percent (i.e., less than 5 percent of fetal PbBs will be greater than the target of 10 µg/dL). Since the utility worker is expected to have less exposure than the construction worker, it can be assumed that the P10 for the utility worker would also be less than 5 percent.

#### 6.1.2 Access Road

Potentially complete exposure pathways for the Access Road included exposure of utility workers to surface and subsurface soils via ingestion, dermal contact, and inhalation. The target organ-specific HIs for the utility worker were below the USEPA target of 1. Tables 7-2 and 9-2 present the HIs for the utility worker.

### 6.2 Carcinogenic Risk

Carcinogenic risk is expressed as a probability of developing cancer over the course of a lifetime as a result of a given level of exposure (USEPA 1989a) (also referred to as "excess cancer risk"). Tables 7-1 through 7-3 and Tables 9-1 through 9-3 present cancer risks for individual COPCs for each exposure pathway and receptor. As stated previously, the RAGS Part D Table 8 series is not presented as part of this HHRA because radiation risks are not of concern for the Site.

Quantitative estimates for carcinogenic effects are obtained by calculating the excess lifetime cancer risk. Cancer risk, which is equal to the product of the estimated dose and the cancer toxicity value, is estimated for each known, probable or possible carcinogenic COPC in each medium. For a given chemical, carcinogenic risk for the oral and dermal exposure routes is calculated as follows:

$$Risk = ExSF$$

where:

E = exposure intake (mg/kg-day)

SF = slope factor $(\text{mg/kg-day})^{-1}$

For a given chemical, carcinogenic risk for the inhalation exposure route is calculated as follows:

$$Risk = ExURF$$

where:

E = exposure intake $(\text{mg/m}^3)$

URF = unit risk factor $(\text{mg/m}^3)^{-1}$

Cancer risks reflect the increased risk, above that experienced by the general population, which may result from the selected exposure scenarios. The risk estimates are considered upper bound estimates of risk. It is very likely that the true risks are less than those predicted and may, in fact, be essentially zero. Current regulatory methodology conservatively assumes that cancer risks can be summed across routes of exposure, media, and COPCs to derive the cumulative cancer risk (USEPA 1989a).

When evaluating potential individual cancer risks, USEPA has established an acceptable risk range of 1 in 1,000,000 ($1 \times 10^{-6}$) to 1 in 10,000 ($1 \times 10^{-4}$) (USEPA 1990). In establishing this range, USEPA accepted the policy that a risk range, rather than a single risk value, adequately protects public health (55 Federal Register 8716). The National Contingency Plan states that "for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between $1 \times 10^{-4}$ to $1 \times 10^{-6}$" (USEPA 2003c).

Carcinogenic risks for each area of the Site are discussed separately below.

#### 6.2.1 Bethpage Park

Potentially complete exposure pathways for Bethpage Park included exposure of utility workers and construction workers to surface and subsurface soils via ingestion, dermal contact, and inhalation. The total cancer risk for the utility worker is $2 \times 10^{-6}$ which is on the low end of USEPA's target risk management range. The total cancer risk for the construction worker is $1 \times 10^{-6}$. Tables 7-1 and 9-1 present the cancer risks for the utility worker. Tables 7-3 and 9-3 present the cancer risks for the construction worker.

NYSDEC (2006) recommends a cancer slope factor and unit risk factor for lead. These toxicity values were developed by CalEPA and adopted by the NYSDEC. These toxicity values were used to quantify potential cancer risks for workers exposed to lead in soils at Bethpage Park. Lead risks for the utility worker are $1 \times 10^{-8}$, and lead risks for the construction worker are $7 \times 10^{-9}$, both of which are well below $1 \times 10^{-6}$.

#### 6.2.2 Access Road

Potentially complete exposure pathways for the Access Road included exposure of utility workers to surface and subsurface soils via ingestion, dermal contact, and inhalation. The total cancer risk for the utility worker is $2 \times 10^{-6}$, which is on the low end of USEPA's target risk management range. Tables 7-2 and 9-2 present the cancer risks for the utility worker.

### 6.3 Summary

The following table presents a summary of total risks and hazards for each receptor (also shown in Table 9-4):

| Receptor | Exposure Point | Total Cancer Risk | Hazard Index |
|---|---|---|---|
| Utility Worker | Bethpage Park | $2 \times 10^{-6}$ | 0.1 |
| Utility Worker | Access Road | $2 \times 10^{-6}$ | 0.07 |
| Construction Worker | Bethpage Park | $1 \times 10^{-6}$ | <1.0* |

* All organ-specific HI's were found to be less than the target HI of 1.0.

Given the soil remedial actions described in this HHRA:

- The organ-specific HIs for all receptors and exposure points are below the USEPA target HI of 1

- Total cancer risks for all receptors and exposure points are on the low end of the acceptable risk range.

## 7. Uncertainty Analysis

There are various sources of uncertainty inherent in the risk assessment process. These include uncertainties associated with exposure parameters and toxicity factors for which conservative assumptions are typically used so as not to underestimate risk. The objective of an uncertainty analysis is to present key information regarding assumptions and uncertainties in the risk assessment process in order to place the quantitative risk estimates in proper perspective (USEPA 1989a).

### 7.1 Exposure Factors

Sources of uncertainty in this HHRA include exposure factors, such as area use factors, exposure durations, and exposure frequencies. The following provides a discussion of the individual exposure factors that may lend uncertainty to this HHRA.

Site soils were assumed to represent 100 percent of potential exposure (i.e., FI = 1) for the utility worker and construction worker, which is conservative given that this does not account for exposures outside of the Site during non-working hours. It is likely that these receptors may be exposed to off-site soils that would have lower COPC concentrations, which would essentially dilute the exposure point concentration and subsequent intakes. Using an area use factor of 1 to estimate potential risks is a conservative approach, indicating risks are unlikely to be higher and may actually be much lower than the risk estimates presented in this HHRA.

The exposure duration for the utility worker (i.e., 25 years) represents that for an outdoor worker. USEPA (2002a) defines an outdoor worker as a long-term receptor exposed during the work day who is a full-time employee of the company operating on-site and who spends most of the workday conducting maintenance activities outdoors. The utility worker evaluated in this HHRA represents an individual who would be involved in intermittent utility maintenance, repair, and/or placement, and not necessarily someone who is employed at the Park or Access Road on a full-time basis. Therefore, assuming that the same individual would be working on utilities at the Site over a 25-year period is highly conservative.

### 7.2 Toxicity Values

As discussed in Section 3, the toxicity values used to quantify potential risks and hazards were primarily taken from the USEPA IRIS on-line database. However, IRIS did not contain toxicity values for several of the COPCs. In this instance, the NYSDEC-recommended toxicity values were used in the HHRA. If neither IRIS nor NYSDEC (2006) contained toxicity values for a particular COPC, alternate resources were used (e.g., PPRTVs, HEAST, CalEPA).

Many of the toxicity values used in this HHRA are based on older animal studies. As with the case of non-cancer toxicity values, the application of uncertainty and modifying factors (sometimes also referred to as safety factors) in the development of these toxicity values indicates there is a certain amount of uncertainty associated with these values, usually due to the fact that these values are based on animal studies rather than epidemiological studies. Further, some toxicity values that are based on epidemiological studies rely on route-to-route extrapolation. Both cancer and non-cancer toxicity values build in a “margin of safety” (USEPA 2008c). Therefore, the toxicity values themselves may be overly conservative. The use of conservative toxicity values along with conservative exposure factors results in conservative estimates of potential risks. Therefore, it is unlikely that the estimated risks in this HHRA are reflective of actual risks.

#### 7.3 Dermal Absorption Factor for PCBs

A dermal absorption factor of 14 percent for uptake of PCBs from soil was used in this HHRA. The dermal absorption factor is presented in the USEPA (2004) *Dermal Risk Assessment Guidance* and is based on a study by Wester, Maibach et al. (1993) of rhesus monkeys dermally exposed to PCB-contaminated soil (Aroclors 1242 and 1254). In this study, the PCB-contaminated soil was applied to the skin of rhesus monkeys for a 24-hour period. Absorption of PCBs was determined by urinary and fecal excretion over a 5-week period. The amount of PCBs excreted following dermal exposure was compared to the amount excreted following an intravenous administration (assumed to represent 100 percent absorption). Although the study provided interesting information on the kinetics of dermal absorption of PCBs in rhesus monkeys, there is a significant level of uncertainty associated with extrapolating these results to the general population. Wester, Maibach et al. (1993) allowed the PCB-containing soil to remain in contact with the skin of the rhesus monkeys for 24 hours, a period much greater than would be expected to occur as a result of occupational, residential, or recreational exposure. Lastly, the soil/PCB matrix used by Wester, Maibach et al. (1993) was unweathered and contained relatively little organic carbon – a mixture that is not typically representative of environmental conditions. Given that the presence of organic carbon reduces the bioavailability of lipophilic compounds such as PCBs (Umbriet, Hesse et al. 1986; Shu, Teitelbaum et al. 1988; USEPA 1989b) and weathered organic constituents frequently exhibit reduced bioavailability (Loehr and Webster 1996), the 14 percent dermal absorption factor observed in the Wester, Maibach et al. (1993) study likely overestimates the availability of environmental PCBs.

Empirical evidence of the uncertainty (and overestimation) associated with using the 14 percent absorption factor can be found in the analysis of the dermal absorption of Aroclor 1260 in the rhesus monkey (Mayes, Brown et al. 2001). The results of this analysis demonstrated that 4 percent of the dermally applied dose was absorbed following either a 12-hour or 24-hour exposure period. Based on this information, it is likely that the dermal absorption factor for humans would be lower than 14 percent. By using 14 percent as the dermal absorption factor to quantify potential dermal exposures, risks and hazards associated with dermal contact with PCBs in soils are likely to be overestimated.

## 8. Summary and Conclusions

Several VOCs, SVOCs (primarily PAHs), PCBs, and metals were identified as COPCs and quantitatively evaluated for Bethpage Park. PCBs, arsenic, cadmium, and chromium were identified as COPCs that were quantitatively evaluated for the Access Road. Potentially complete exposure pathways that were quantitatively evaluated as part of this HHRA included exposure of utility workers and construction workers to soils at Bethpage 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.

Results of this HHRA indicate that cancer risks for utility workers and construction workers are on the low end of USEPA's risk management range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$. The results of this HHRA indicate the non-cancer risks for utility workers and construction workers are less than 1.

As discussed previously, as with any risk assessment, there are uncertainties associated with the risk and hazard estimates presented in this HHRA. Some of the exposure factors used in this HHRA are site-specific, but still conservative, and as such, potential risks and hazards may be overestimated.

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Table 1-1. Summary of Exposure Pathways
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Scenario Timeframe | Medium | Exposure Medium | Exposure Point | Location | Receptor Population | Receptor Age | Exposure Route | Pathway Complete? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Current/Future | Soil | Surface Soil | Surface Soil | Bethpage Park | Trespasser | Adolescent | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with concentrations greater than restricted residential SCOs will be removed. |
| | | | | | Recreator | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with concentrations greater than restricted residential SCOs will be removed. |
| | | | | | | Child | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with concentrations greater than restricted residential SCOs will be removed. |
| | | | | | Site Worker | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with concentrations greater than restricted residential SCOs will be removed. |
| | | | | Plant 24 Access Road | Trespasser | Adolescent | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with capped with a gravel cover, which will preclude direct contact exposures. |
| | | | | | Recreator (a) | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Surface soils with capped with a gravel cover, which will preclude direct contact exposures. |
| | Groundwater | Groundwater | Groundwater | Bethpage Park | Recreator | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | | | | | | Child | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | | | | | Construction Worker | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | | | | Plant 24 Access Road | Trespasser | Adolescent | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | | | | | Utility Worker | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | | | | | Recreator (a) | Adult | Dermal<br>Ingestion<br>Inhalation | No<br>No<br>No | Depth to groundwater precludes direct contact. Site groundwater is not used as a drinking source. |
| | Soil/Groundwater | Indoor Air | Indoor Air | Bethpage Park | Recreator | Adult | Inhalation | No | An IRM is in place to address soil gas. Current buildings have vapor barriers. Future buildings will be constructed with vapor barriers. |
| | | | | | | Child | Inhalation | No | An IRM is in place to address soil gas. Current buildings have vapor barriers. Future buildings will be constructed with vapor barriers. |
| | | | | | Site Worker | Adult | Inhalation | No | An IRM is in place to address soil gas. Current buildings have vapor barriers. Future buildings will be constructed with vapor barriers. |

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Table 1-1. Summary of Exposure Pathways

Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Future | Soil | Surface and Subsurface Soil | Surface and Subsurface Soil | Bethpage Park | Utility Worker | Adult | Dermal<br>Ingestion<br>Inhalation | Yes<br>Yes<br>Yes | Utility workers may be exposed to surface and subsurface soils (0-6 feet bgs) during maintenance activities. Surface soils (0-2 feet bgs) with concentrations greater than SCOs will be removed. |
| | | | | | Construction Worker | Adult | Dermal<br>Ingestion<br>Inhalation | Yes<br>Yes<br>Yes | Construction workers may be exposed to surface and subsurface soils (0-6 feet bgs) during intrusive activities. Surface soils (0-2 feet bgs) with concentrations greater than SCOs will be removed. |
| | | | | Plant 24 Access Road | Utility Worker | Adult | Dermal<br>Ingestion<br>Inhalation | Yes<br>Yes<br>Yes | Utility workers may be exposed to subsurface soils (0-10 feet bgs) during maintenance activities. |

Notes:

This table identifies exposure pathways that are considered in the human health risk assessment.

Surface soils are defined as 0-2 feet bgs.

Subsurface soils are defined as 0-10 feet bgs in the Access Road and 0-6 feet bgs for Bethpage Park, with the exception of select utility locations within the Park that extend down to 10 feet bgs.

(a) Recreator includes walkers and joggers.

bgs – below ground surface

Child – Individual aged 0-6 years

Construction Worker – Individual who may be involved in intrusive construction activities.

Current – Exposure scenarios that may exist based on current site conditions

Future – Exposure scenarios that may exist in the future based on site redevelopment, etc.

IRM – Interim remedial measure

SCO – Soil cleanup objective

Utility Worker – Individual who may be involved in utility maintenance work

Table 2-1. Occurrence, Distribution and Selection of COPCs – Bethpage Park Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 2-6 feet [1]
Exposure Point: Bethpage Park

| Chemical Name | Minimum Detected Value (mg/kg) | Maximum Detected Value (a) (mg/kg) | Location of Maximum Detected Value | Frequency of Detection | Range of SQLs (mg/kg) | Screening Level (mg/kg) | Screening Level Reference | COPC? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Volatile Organic Compounds | | | | | | | | | |
| 1,1,1-Trichloroethane | 0.003 | 0.013 | TP-08 | 4 / 64 | 0.00037 - 0.056 | 100 | SCO | no | BSV |
| 1,1,2-Trichloroethane | 0.012 | 4 | TP-02A | 2 / 64 | 0.0007 - 0.056 | 1 | RSL | YES | ASV |
| 1,1-Dichloroethane | 0.0014 | 0.24 | TP-08 | 16 / 64 | 0.00032 - 0.056 | 26 | SCO | no | BSV |
| 1,1-Dichloroethene | 0.0062 | 0.8 | TP-02A | 2 / 64 | 0.0015 - 0.056 | 100 | SCO | no | BSV |
| 1,2,4-Trimethylbenzene | 0.0071 | 0.035 | B-42 | 2 / 6 | 0.00035 - 0.00036 | 52 | SCO | no | BSV |
| 1,2-Dichlorobenzene | 0.005 | 16 | TP-02A | 11 / 78 | 0.0004 - 71 | 2000 | RSL | no | BSV |
| 1,2-Dichloroethane | 0.0031 | 0.067 | TP-08 | 3 / 64 | 0.0004 - 0.056 | 3 | SCO | no | BSV |
| 1,2-Dichloroethene | 0.006 | 0.006 | B-67 | 1 / 24 | 0.00072 - 0.056 | 100 | SCO | no | BSV |
| 1,2-Dichloropropane | 0.057 | 0.057 | TP-08 | 2 / 64 | 0.00062 - 0.056 | 1 | RSL | no | BSV |
| 1,3,5-Trimethylbenzene | 0.0032 | 0.039 | B-42 | 2 / 4 | 0.00028 - 0.00029 | 52 | SCO | no | BSV |
| 1,4-Dichlorobenzene | 0.012 | 2.4 | TP-02A | 7 / 78 | 0.00037 - 0.74 | 13 | SCO | no | BSV |
| 2-Butanone | 0.005 | 0.065 | B-56 | 16 / 64 | 0.0015 - 0.27 | 100 | SCO | no | BSV |
| Acetone | 0.005 | 0.99 | TP-01 | 41 / 64 | 0.0018 - 0.054 | 100 | SCO | no | BSV |
| Benzene | 0.008 | 1.1 | TP-02A | 4 / 64 | 0.00035 - 0.056 | 5 | SCO | no | BSV |
| Benzene, 1-methylethyl- | 0.001 | 0.13 | B-60 | 7 / 22 | 0.00033 - 0.011 | 100 | SCO | no | BSV |
| Carbon disulfide | 0.001 | 0.002 | B-62 | 3 / 64 | 0.0022 - 0.27 | 670 | RSL | no | BSV |
| Chlorobenzene | 0.13 | 0.46 | TP-01 | 2 / 64 | 0.00038 - 0.056 | 100 | SCO | no | BSV |
| Chloroethane | 0.006 | 0.0064 | TP-07 | 2 / 64 | 0.0026 - 0.056 | 15000 | RSL | no | BSV |
| cis-1,2-Dichloroethene | 0.001 | 1300 | TP-02A | 39 / 63 | 0.0005 - 0.011 | 100 | SCO | YES | ASV |
| cis-1,3-Dichloropropene | 0.0075 | 0.0075 | TP-02A | 1 / 64 | 0.0004 - 0.056 | 2 | RSL | no | BSV |
| Cumene | 0.0056 | 0.0056 | B-42 | 1 / 4 | 0.00029 - 0.0003 | 2200 | RSL | no | BSV |
| Ethylbenzene | 0.0008 | 220 | TP-02A | 19 / 64 | 0.00069 - 0.027 | 41 | SCO | YES | ASV |
| Isopropylbenzene | 0.002 | 2.2 | TP-02A | 14 / 32 | 0.00032 - 0.011 | 100 | SCO | no | BSV |
| Methylene chloride | 0.0009 | 0.016 | B-24 | 25 / 64 | 0.00086 - 0.056 | 11 | RSL | no | BSV |
| Tetrachloroethene | 0.001 | 4.8 | TP-02A | 5 / 64 | 0.00066 - 0.056 | 19 | SCO | no | BSV |
| Toluene | 0.001 | 8200 | TP-02A | 40 / 64 | 0.00034 - 0.027 | 100 | SCO | YES | ASV |
| trans-1,2-Dichloroethene | 0.0006 | 0.12 | TP-08 | 8 / 39 | 0.00069 - 0.77 | 100 | SCO | no | BSV |
| trans-1,3-Dichloropropene | 0.0003 | 0.0003 | TP-07 | 1 / 62 | 0.00029 - 0.056 | 2 | RSL | no | BSV |
| Trichloroethylene | 0.0014 | 8200 | TP-02A | 37 / 64 | 0.00038 - 0.056 | 21 | SCO | YES | ASV |
| Trichlorotrifluoroethane (freon 113) | 0.0008 | 0.001 | VP-28 | 2 / 35 | 0.004 - 0.056 | 100 | SCO | no | BSV |
| Vinyl chloride | 0.0013 | 0.27 | TP-02A | 20 / 64 | 0.00091 - 0.056 | 1 | SCO | no | BSV |
| Xylene (total) | 0.0006 | 120 | TP-02A | 26 / 56 | 0.001 - 0.011 | 100 | SCO | YES | ASV |
| Xylene-o | 0.0036 | 0.11 | I-3-SB | 8 / 18 | 0.00048 - 0.0057 | 100 | SCO | no | BSV |
| Xylenes - m,p | 0.002 | 0.088 | I-3-SB | 6 / 14 | 0.005 - 0.027 | 100 | SCO | no | BSV |

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Table 2-1. Occurrence, Distribution and Selection of COPCs – Bethpage Park Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 2-6 feet [1]
Exposure Point: Bethpage Park

| Chemical Name | Minimum Detected Value (mg/kg) | Maximum Detected Value (a) (mg/kg) | Location of Maximum Detected Value | Frequency of Detection | Range of SQLs (mg/kg) | Screening Level (mg/kg) | Screening Level Reference | COPC? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Semivolatile Organic Compounds | | | | | | | | | |
| 2,4-Dimethylphenol | 0.084 | 21 | TP-02A | 4 / 38 | 0.055 - 1.2 | 1200 | RSL | no | BSV |
| 2-Methylnaphthalene | 0.041 | 81 | TP-02A | 40 / 53 | 0.045 - 0.36 | 310 | RSL | no | BSV |
| 2-Methylphenol | 0.041 | 0.61 | TP-08 | 3 / 39 | 0.063 - 1.7 | 100 | SCO | no | BSV |
| 2-Phenylbutane | 0.0041 | 0.006 | B-42 | 2 / 4 | 0.00048 - 0.00049 | 100 | SCO | no | BSV |
| 4-Methylphenol | 0.05 | 16 | TP-02A | 11 / 39 | 0.055 - 1.2 | 100 | SCO | no | BSV |
| Benzyl butyl phthalate | 3 | 3 | TP-08 | 1 / 39 | 0.051 - 1.3 | 12000 | RSL | no | BSV |
| Biphenyl | 0.066 | 0.49 | B-17 | 3 / 8 | 0.33 - 1.2 | 3900 | RSL | no | BSV |
| Bis(2-chloroethyl)ether | 1.1 | 1.1 | TP-21 | 1 / 39 | 0.047 - 1.3 | 0.19 | RSL | YES | ASV |
| Bis(2-ethylhexyl)phthalate | 0.056 | 1500 | TP-01 | 32 / 39 | 0.051 - 0.77 | 35 | RSL | YES | ASV |
| Carbazole | 0.045 | 4.7 | O9 | 23 / 39 | 0.058 - 0.88 | 24 | RSL | no | BSV |
| Dibenzofuran | 0.037 | 5.1 | O9 | 35 / 53 | 0.033 - 0.51 | 100 | SCO | no | BSV |
| Diethyl phthalate | 1.8 | 1.8 | O9 | 1 / 39 | 0.048 - 1.3 | 49000 | RSL | no | BSV |
| di-n-Butylphthalate | 0.045 | 13 | TP-02A | 10 / 39 | 0.048 - 1.2 | 6100 | RSL | no | BSV |
| di-n-Octyl phthalate | 0.015 | 0.015 | B-70 | 1 / 39 | 0.04 - 1.2 | 100 | NA | no | BSV |
| Hexachloro-1,3-butadiene | 0.087 | 0.087 | TP-13 | 1 / 39 | 0.057 - 1.5 | 6 | RSL | no | BSV |
| Isophorone | 0.54 | 0.54 | TP-21 | 1 / 39 | 0.035 - 1.2 | 510 | RSL | no | BSV |
| Methylcylohexane | 0.001 | 0.8 | B-60 | 11 / 27 | 0.004 - 0.011 | 3400 | NA | no | BSV |
| Phenol | 0.05 | 2.1 | TP-08 | 5 / 39 | 0.047 - 1.3 | 100 | SCO | no | BSV |
| Polycyclic Aromatic Hydrocarbons | | | | | | | | | |
| Acenaphthene | 0.041 | 31 | TP-09 | 38 / 52 | 0.035 - 0.54 | 100 | SCO | no | BSV |
| Acenaphthylene | 0.04 | 1.5 | O9 | 6 / 53 | 0.035 - 1.2 | 100 | SCO | no | BSV |
| Anthracene | 0.053 | 8.5 | O9 | 36 / 53 | 0.057 - 1.5 | 100 | SCO | no | BSV |
| Benzo(a)anthracene | 0.059 | 17 | O9 | 45 / 53 | 0.061 - 1.6 | 1 | SCO | YES | ASV |
| Benzo(a)pyrene | 0.042 | 16 | O9 | 45 / 53 | 0.048 - 1.3 | 1 | SCO | YES | ASV |
| Benzo(b)fluoranthene | 0.064 | 21 | O9 | 46 / 53 | 0.065 - 1.7 | 1 | SCO | YES | ASV |
| Benzo(g,h,ii)perylene | 0.042 | 2.9 | O9 | 40 / 53 | 0.084 - 2.2 | 100 | SCO | no | BSV |
| Benzo(k)fluoranthene | 0.047 | 6.5 | O9 | 42 / 53 | 0.045 - 1.2 | 4 | SCO | YES | ASV |
| Chrysene | 0.073 | 17 | O9 | 46 / 53 | 0.06 - 1.6 | 4 | SCO | YES | ASV |
| Dibenzo(a,h)anthracene | 0.044 | 1.7 | O9 | 34 / 53 | 0.068 - 1.8 | 0.33 | SCO | YES | ASV |
| Fluoranthene | 0.11 | 41 | O9 | 47 / 53 | 0.047 - 0.082 | 100 | SCO | no | BSV |
| Fluorene | 0.044 | 10 | O9 | 40 / 53 | 0.036 - 0.55 | 100 | SCO | no | BSV |
| Indeno(1,2,3-cd)pyrene | 0.088 | 4.4 | O9 | 38 / 53 | 0.07 - 1.9 | 1 | SCO | YES | ASV |
| Naphthalene | 0.036 | 68 | TP-02A | 39 / 53 | 0.042 - 1.2 | 100 | SCO | no | BSV |
| Perylene | 0.82 | 0.82 | B-28 | 1 / 1 | NA - NA | 100 | NA | no | BSV |
| Phenanthrene | 0.056 | 35 | O9 | 48 / 53 | 0.044 - 0.047 | 100 | SCO | no | BSV |
| Pyrene | 0.099 | 35 | O9 | 47 / 53 | 0.049 - 0.086 | 100 | SCO | no | BSV |

Table 2-1. Occurrence, Distribution and Selection of COPCs – Bethpage Park Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 2-6 feet [1]
Exposure Point: Bethpage Park

| Chemical Name | Minimum Detected Value (mg/kg) | Maximum Detected Value (a) (mg/kg) | Location of Maximum Detected Value | Frequency of Detection | Range of SQLs (mg/kg) | Screening Level (mg/kg) | Screening Level Reference | COPC? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Polychlorinated Biphenyls | | | | | | | | | |
| Total PCBs | 0.076 | 880 | P-31 | 139 / 191 | NA - 0.067 | 1 | SCO | YES | ASV |
| Metals | | | | | | | | | |
| Aluminum (fume or dust) (b) | 849 | 110000 | TP-01 | 26 / 26 | NA - NA | 77000 | RSL | YES | ASV |
| Antimony | 0.69 | 1180 | TP-08N | 20 / 26 | 0.57 - 3 | 31 | RSL | YES | ASV |
| Arsenic | 0.39 | 1110 | TP-08N | 138 / 139 | 0.79 - 0.79 | 16 | SCO | YES | ASV |
| Barium | 2.5 | 5470 | P-5 | 139 / 139 | NA - NA | 400 | SCO | YES | ASV |
| Beryllium | 0.13 | 24 | TP-21 | 24 / 26 | 0.45 - 0.47 | 72 | SCO | no | BSV |
| Cadmium | 0.04 | 480 | TP-01 | 147 / 162 | 0.03 - 0.7 | 4 | SCO | YES | ASV |
| Calcium metal | 43 | 86300 | TP-08N | 25 / 26 | 22 - 22 | NA | NA | no | NSV |
| Chromium - soluble | 1.1 | 124000 | P-5 | 176 / 176 | NA - NA | 180 | SCO | YES | ASV |
| Chromium (hexavalent compounds) | 6.28 | 560 | B-18 | 5 / 41 | 1.1 - 11 | 110 | SCO | YES | ASV |
| Cobalt | 1.4 | 9980 | TP-08 | 26 / 26 | NA - NA | 10000 | SCO | no | BSV |
| Copper | 1.8 | 4100 | TP-01 | 26 / 26 | NA - NA | 270 | SCO | YES | ASV |
| Iron | 3130 | 42700 | TP-08 | 26 / 26 | NA - NA | 10000 | SCO | YES | ASV |
| Lead | 0.61 | 2000 | TP-21 | 143 / 143 | NA - NA | 400 | SCO | YES | ASV |
| Magnesium | 148 | 2600 | TP-06 | 26 / 26 | NA - NA | 10000 | SCO | no | BSV |
| Manganese | 42.1 | 393 | TP-08 | 26 / 26 | NA - NA | 2000 | SCO | no | BSV |
| Mercury | 0.01 | 19 | P-5 | 101/ 139 | 0.029 - 0.1 | 1 | SCO | YES | ASV |
| Nickel | 1.7 | 230 | TP-01 | 26 / 26 | NA - NA | 310 | SCO | no | BSV |
| Potassium | 94.2 | 2770 | TP-08 | 26 / 26 | NA - NA | 10000 | SCO | no | BSV |
| Selenium | 0.38 | 14 | TP-01 | 54 / 139 | 0.1 - 9 | 180 | SCO | no | BSV |
| Silver | 0.12 | 26 | TP-01 | 78 / 139 | 0.14 - 2 | 180 | SCO | no | BSV |
| Sodium | 4.9 | 2790 | TP-08N | 22 / 26 | 27 - 32 | NA | NA | no | ENUT |
| Thallium | 0.1 | 17 | TP-21 | 9 / 26 | 0.54 - 3 | 5 | RSL | YES | ASV |
| Vanadium (fume or dust) | 2.1 | 93.4 | TP-08 | 24 / 26 | 0.033 - 2 | 390 | RSL | no | BSV |
| Zinc | 3.1 | 29200 | TP-08 | 26 / 26 | NA - NA | 10000 | SCO | YES | ASV |

Notes:
[1] Also includes select samples from deeper utility easements up to 10 feet in depth (samples G-5-B, P-3 through P-16, B-28, B-60, and TP-1).
(a) Maximum detected concentrations were compared to screening levels to identify COPCs.
(b) The maximum concentration was detected at 10 feet bgs. Therefore, aluminum is retained as a COPC for the utility worker, but not for the construction worker who is only exposed to 0-6 foot soils. The maximum concentration for the 0-6 foot soils is 15,000 mg/kg.
ASV – Above screening value
BSV – Below screening value
COPC – Chemical of potential concern
ENUT – Essential nutrient
mg/kg – Milligrams per kilogram
NA – Not available
RSL – USEPA regional screening level for residential soil
SCO – NYSDEC restricted residential soil cleanup objective
SQL – Sample quantitation limit

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Table 2-2. Occurrence, Distribution and Selection of COPCs – Access Road Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 0-10 feet
Exposure Point: Access Road

| Chemical Name | Minimum Detected Value (mg/kg) | Maximum Detected Value (a) (mg/kg) | Location of Maximum Detected Value | Frequency of Detection | Range of SQLs (mg/kg) | Screening Level (mg/kg) | Screening Level Reference | COPC? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Volatile Organic Compounds | | | | | | | | | |
| 1,1-Dichloroethene | 0.018 | 0.021 | B-46 | 2 / 5 | 0.0017 - 0.006 | 100 | SCO | no | BSV |
| 1,2,4-Trimethylbenzene | 20 | 30 | B-46 | 2 / 3 | 0.00036 - 0.00036 | 52 | SCO | no | BSV |
| 1,2-Dichloroethane | 0.0037 | 0.0037 | B-46 | 1 / 5 | 0.00082 - 0.006 | 3 | SCO | no | BSV |
| 1,2-Dichloroethene | 0.027 | 0.061 | B-46 | 2 / 5 | 0.00074 - 0.006 | 100 | SCO | no | BSV |
| 1,3,5-Trimethylbenzene | 0.67 | 10 | B-46 | 2 / 3 | 0.00029 - 0.00029 | 52 | SCO | no | BSV |
| Acetone | 0.01 | 0.13 | B-46 | 3 / 7 | 0.0019 - 0.006 | 100 | SCO | no | BSV |
| Benzene | 0.0018 | 0.0018 | B-46 | 1 / 5 | 0.00038 - 0.006 | 5 | SCO | no | BSV |
| Benzene, 1-methylethyl- | 0.22 | 0.22 | B-46 | 1 / 5 | 0.00032 - 0.006 | 100 | SCO | no | BSV |
| Carbon disulfide | 0.003 | 0.0058 | B-46 | 2 / 5 | 0.0024 - 0.006 | 670 | RSL | no | BSV |
| cis-1,2-Dichloroethene | 0.003 | 38 | B-46 | 5 / 7 | 0.00053 - 0.00053 | 100 | SCO | no | BSV |
| Cumene | 0.24 | 3.6 | B-46 | 2 / 3 | 0.0003 - 0.0003 | 2200 | RSL | no | BSV |
| Ethylbenzene | 2.2 | 4 | B-46 | 2 / 5 | 0.00075 - 0.006 | 41 | SCO | no | BSV |
| Methylene chloride | 0.001 | 0.0044 | B-46 | 4 / 7 | 0.00092 - 0.006 | 11 | RSL | no | BSV |
| p-Xylene | 7.5 | 13 | B-46 | 2 / 3 | 0.00074 - 0.00074 | 100 | SCO | no | BSV |
| Tetrachloroethene | 0.023 | 0.034 | B-46 | 3 / 7 | 0.00072 - 0.006 | 19 | SCO | no | BSV |
| Toluene | 0.001 | 0.93 | B-46 | 6 / 7 | 0.00036 - 0.00036 | 100 | SCO | no | BSV |
| Trichloroethylene | 0.012 | 0.064 | B-46 | 5 / 7 | 0.0004 - 0.0004 | 21 | SCO | no | BSV |
| Xylene (total) | 0.004 | 21 | B-46 | 4 / 6 | 0.0011 - 0.005 | 100 | SCO | no | BSV |
| Xylene-o | 4.7 | 7.5 | B-46 | 2 / 3 | 0.00049 - 0.00049 | 100 | SCO | no | BSV |
| Semivolatile Organic Compounds | | | | | | | | | |
| 2-Methylnaphthalene | 0.28 | 0.87 | B-46 | 2 / 5 | 0.048 - 0.4 | 310 | RSL | no | BSV |
| 2-Phenylbutane | 5.3 | 7.4 | B-46 | 2 / 3 | 0.00049 - 0.00049 | 100 | SCO | no | BSV |
| Bis(2-ethylhexyl)phthalate | 0.13 | 6 | VP-09 | 4 / 4 | NA - NA | 35 | RSL | no | BSV |
| n-Butylbenzene | 9.8 | 13 | B-46 | 2 / 3 | 0.00061 - 0.00061 | 100 | SCO | no | BSV |
| n-Propylbenzene | 4.9 | 7.7 | B-46 | 2 / 3 | 0.00071 - 0.00071 | 100 | SCO | no | BSV |
| Polycyclic Aromatic Hydrocarbons | | | | | | | | | |
| Anthracene | 0.11 | 0.11 | B-46 | 1 / 5 | 0.06 - 1.8 | 100 | SCO | no | BSV |
| Benzo(a)anthracene | 0.044 | 0.29 | B-65 | 3 / 5 | 0.067 - 0.085 | 1 | SCO | no | BSV |
| Benzo(a)pyrene | 0.11 | 0.19 | B-65 | 2 / 5 | 0.054 - 0.4 | 1 | SCO | no | BSV |
| Benzo(b)fluoranthene | 0.17 | 0.2 | B-65 | 2 / 5 | 0.071 - 0.4 | 1 | SCO | no | BSV |
| Benzo(k)fluoranthene | 0.083 | 0.083 | B-46 | 1 / 5 | 0.05 - 1.8 | 4 | SCO | no | BSV |
| Chrysene | 0.13 | 0.32 | B-65 | 3 / 5 | 0.066 - 0.4 | 4 | SCO | no | BSV |
| Fuoranthene | 0.058 | 0.51 | B-65 | 3 / 5 | 0.052 - 0.066 | 100 | SCO | no | BSV |
| Fluorene | 0.097 | 0.097 | B-46 | 1 / 5 | 0.038 - 1.8 | 100 | SCO | no | BSV |
| Naphthalene | 0.15 | 1.3 | B-46 | 3 / 5 | 0.047 - 0.4 | 100 | SCO | no | BSV |
| Phenanthrene | 0.045 | 0.53 | B-46 | 4 / 5 | 0.049 - 0.049 | 100 | SCO | no | BSV |
| Pyrene | 0.059 | 0.44 | B-65 | 4 / 5 | 0.055 - 0.055 | 100 | SCO | no | BSV |

Table 2-2. Occurrence, Distribution and Selection of COPCs – Access Road Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 0-10 feet
Exposure Point: Access Road

| Chemical Name | Minimum Detected Value (mg/kg) | Maximum Detected Value (a) (mg/kg) | Location of Maximum Detected Value | Frequency of Detection | Range of SQLs (mg/kg) | Screening Level (mg/kg) | Screening Level Reference | COPC? | Rationale |
|---|---|---|---|---|---|---|---|---|---|
| Polychlorinated Biphenyls | | | | | | | | | |
| Total PCBs | 0.04 | 3400 | B-15E20 | 392 / 500 | 0.035 - 0.067 | 1 | SCO | YES | ASV |
| Metals | | | | | | | | | |
| Aluminum | 13200 | 13200 | VP-09 | 1 / 1 | NA - NA | 77000 | RSL | no | BSV |
| Arsenic | 1.5 | 97.5 | VP-09 | 3 / 3 | NA - NA | 16 | SCO | YES | ASV |
| Barium | 5.6 | 152 | VP-09 | 3 / 3 | NA - NA | 400 | SCO | no | BSV |
| Cadmium | 0.01 | 267 | VP-09 | 5 / 5 | NA - NA | 4 | SCO | YES | ASV |
| Chromium - soluble | 1.2 | 26300 | VP-09 | 48 / 48 | NA - NA | 180 | SCO | YES | ASV |
| Cobalt | 6.2 | 6.2 | VP-09 | 1 / 1 | NA - NA | 10000 | SCO | no | BSV |
| Copper | 62 | 62 | VP-09 | 1 / 1 | NA - NA | 270 | SCO | no | BSV |
| Iron | 5720 | 5720 | VP-09 | 1 / 1 | NA - NA | 10000 | SCO | no | BSV |
| Lead | 0.96 | 285 | VP-09 | 3 / 3 | NA - NA | 400 | SCO | no | BSV |
| Manganese | 119 | 119 | VP-09 | 1 / 1 | NA - NA | 2000 | SCO | no | BSV |
| Mercury | 0.19 | 0.19 | VP-09 | 1 / 1 | NA - NA | 0.81 | SCO | no | BSV |
| Nickel | 13 | 13 | VP-09 | 1 / 1 | NA - NA | 310 | SCO | no | BSV |
| Silver | 0.1 | 0.1 | B-16810 | 1 / 1 | NA - NA | 180 | SCO | no | BSV |
| Vanadium | 16.8 | 16.8 | VP-09 | 1 / 1 | NA - NA | 390 | RSL | no | BSV |
| Zinc | 4020 | 4020 | VP-09 | 1 / 1 | NA - NA | 10000 | SCO | no | BSV |
| Miscellaneous | | | | | | | | | |
| Carbon | 28000 | 28000 | VP-09 | 1 / 1 | NA - NA | 100 | SCO | YES | ASV |
| Chloride | 9.7 | 9.7 | VP-09 | 1 / 1 | NA - NA | 100 | SCO | no | BSV |
| Cyanide | 76.3 | 76.3 | VP-09 | 1 / 1 | NA - NA | 27 | SCO | YES | ASV |
| Sulfate | 145 | 145 | VP-09 | 1 / 1 | NA - NA | 10000 | SCO | no | BSV |

Notes:
(a) Maximum detected concentrations were compared to screening levels to identify COPCs.
ASV – Above screening value
BSV – Below screening value
COPC – Chemical of potential concern
mg/kg – Milligrams per kilogram
NA – Not available
RSL – USEPA regional screening level for residential soil
SCO – NYSDEC restricted residential soil cleanup objective
SQL – Sample quantitation limit

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Table 3-1. Exposure Point Concentration Summary – Bethpage Park Soil, Utility Worker
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 2-6 feet (a)
Exposure Point: Bethpage Park

| Chemicals of Potential Concern | Mean (b) (mg/kg) | Data Distribution | 95% UCL (mg/kg) | 95% UCL Method | Maximum Detected Concentration (mg/kg) | Exposure Point Concentration (mg/kg) | EPC Statistic (c) |
|---|---|---|---|---|---|---|---|
| Volatile Organic Compounds | | | | | | | |
| 1,1,2-Trichloroethane | 1.2 | NP | 0.48 | 95 KM t | 4 | 0.48 | UCL |
| cis-1,2-dichloroethene | 61 | NP | 139 | 97 KM | 1300 | 139 | UCL |
| Ethylbenzene | 29 | NP | 34 | 97 KM | 220 | 34 | UCL |
| Toluene | 167 | NP | 691 | 97 KM | 8200 | 691 | UCL |
| Trichloroethylene | 139 | NP | 667.2 | 97 KM | 8200 | 667 | UCL |
| Xylene (total) | 50 | NP | 64 | 97 KM | 120 | 64 | UCL |
| Semivolatile Organic Compounds | | | | | | | |
| bis(2-chloroethyl)ether | 0.27 | NP | 0.25 | 95 KM t | 1.1 | 0.25 | UCL |
| bis(2-ethylhexyl)phthalate | 116 | NP | 549 | 99 KM | 1500 | 549 | UCL |
| Polycyclic Aromatic Hydrocarbons | | | | | | | |
| Benzo(a)anthracene | 1.2 | NP | 1.6 | 95 KM (BCA) | 17 | 1.6 | UCL |
| Benzo(a)pyrene | 1.1 | NP | 1.4 | 95 KM (BCA) | 16 | 1.4 | UCL |
| Benzo(b)fluoranthene | 1.4 | NP | 1.8 | 95 KM (BCA) | 21 | 1.8 | UCL |
| Benzo(k)fluoranthene | 1.8 | NP | 2.4 | 95 KM | 6.5 | 2.4 | UCL |
| Chrysene | 2.2 | NP | 3.2 | 95 KM | 17 | 3.2 | UCL |
| Dibenzo(a,h)anthracene | 0.24 | NP | 0.25 | 95 KM (BCA) | 1.7 | 0.25 | UCL |
| Indeno(1,2,3-cd)pyrene | 0.49 | NP | 0.56 | 95 KM (BCA) | 4.4 | 0.56 | UCL |
| Polychlorinated Biphenyls (PCBs) | | | | | | | |
| Total PCBs | 13 | NP | 31 | 97 KM | 880 | 31 | UCL |
| Metals | | | | | | | |
| Aluminum | 14938 | NP | 36697 | 95 KM | 110000 | 36697 | UCL |
| Antimony | 183 | NP | 709 | 99 KM | 1180 | 709 | UCL |
| Arsenic | 17 | NP | 37 | 95 KM | 1110 | 37 | UCL |
| Barium | 244 | NP | 418.7 | Cnp97 | 5470 | 419 | UCL |
| Cadmium | 7.1 | NP | 13.9 | 99 KM | 480 | 13.9 | UCL |
| Chromium - Soluble | 1202 | NP | 4153 | Cnp97 | 124000 | 4153 | UCL |
| Chromium (Hexavalent Compounds) | 114 | NP | 72 | 95 KM t | 560 | 72 | UCL |
| Copper | 237 | LN | 499 | Cln95 | 4100 | 499 | UCL |
| Iron | 10845 | G | 13050 | Gapx | 42700 | 13050 | UCL |
| Lead | 223 | NP | 370 | Cnp99 | 2000 | 370 | UCL |
| Mercury | 0.62 | NP | 0.9 | 97 KM | 19 | 0.9 | UCL |
| Thallium | 4.4 | NP | 3.3 | 95 KM t | 17 | 3.3 | UCL |
| Zinc | 3684 | LN | 21395 | Cln97 | 29200 | 21395 | UCL |

Notes:
(a) Also includes select samples from deeper utility easements up to 10 feet in depth (samples G-5, P-3 through P-16, B-28, B-60, TP-1, TP-2, GP-P5A and GP-P5B).
(b) The mean is calculated based on the distribution.
(c) The EPC is the lesser of the 95% UCL and the maximum detected concentration.
EPC – Exposure point concentration
LN – Indicates that data were lognormally distributed
G – Indicates that data were gamma distributed
NP – Indicates non-parametric data (data follows no distribution pattern)
mg/kg – Milligrams per kilogram
MVUE – Minimum variance unbiased estimate
UCL – The 95 percent one-tailed upper confidence limit (UCL) on the mean
95 KM t – 95% Kaplan-Meier (Student's t) UCL
95 KM – 95% Kaplan-Meier (Chebyshev) UCL
95 KM (BCA) – 95% Kaplan-Meier (bias-corrected accelerated bootstrap method) UCL
97 KM – 97.5% Kaplan-Meier (Chebyshev) UCL
99 KM – 99% Kaplan-Meier (Chebyshev) UCL
Gapx – Approximate Gamma 95% UCL
Cln95 – 95% Chebyshev (MVUE) UCL
Cln97 – 97.5% Chebyshev (MVUE) UCL
Cnp97 – 97.5% Chebyshev (mean, standard deviation) UCL
Cnp99 – 99% Chebyshev (mean, standard deviation) UCL

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Table 3-2. Exposure Point Concentration Summary – Bethpage Park Soil, Construction Worker
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 2-6 feet
Exposure Point: Bethpage Park

| Chemicals of Potential Concern | Mean (b) (mg/kg) | Data Distribution | 95% UCL (mg/kg) | 95% UCL Method | Maximum Detected Concentration (mg/kg) | Exposure Point Concentration (mg/kg) | EPC Statistic (c) |
|---|---|---|---|---|---|---|---|
| Volatile Organic Compounds | | | | | | | |
| 1,1,2-Trichloroethane | 1.2 | NP | 0.50 | 95 KM t | 4 | 0.50 | UCL |
| cis-1,2-dichloroethene | 63 | NP | 143 | 97.5 KM | 1300 | 143 | UCL |
| Ethylbenzene | 31 | NP | 34 | 97.5 KM | 220 | 34 | UCL |
| Toluene | 169 | NP | 713 | 97.5 KM | 8200 | 713 | UCL |
| Trichloroethylene | 141 | NP | 690.2 | 97.5 KM | 8200 | 690 | UCL |
| Xylene (total) | 51 | NP | 64 | 97.5 KM | 120 | 64 | UCL |
| Semivolatile Organic Compounds | | | | | | | |
| bis(2-chloroethyl)ether | 0.27 | NP | 0.25 | 95 KM Bootstrap | 1.1 | 0.25 | UCL |
| bis(2-ethylhexyl)phthalate | 83 | NP | 443 | 99 KM | 1200 | 443 | UCL |
| Polycyclic Aromatic Hydrocarbons | | | | | | | |
| Benzo(a)anthracene | 1.2 | NP | 1.7 | 95 KM (BCA) | 17 | 1.7 | UCL |
| Benzo(a)pyrene | 1.1 | NP | 1.4 | 95 KM (BCA) | 16 | 1.4 | UCL |
| Benzo(b)fluoranthene | 1.4 | NP | 1.9 | 95 KM (BCA) | 21 | 1.9 | UCL |
| Benzo(k)fluoranthene | 1.8 | NP | 2.6 | 95 KM | 6.5 | 2.6 | UCL |
| Chrysene | 2.3 | NP | 3.4 | 95 KM | 17 | 3.4 | UCL |
| Dibenzo(a,h)anthracene | 0.24 | NP | 0.26 | 95 KM (BCA) | 1.7 | 0.26 | UCL |
| Indeno(1,2,3-cd)pyrene | 0.49 | NP | 0.57 | 95 KM (BCA) | 4.4 | 0.57 | UCL |
| Polychlorinated Biphenyls (PCBs) | | | | | | | |
| Total PCBs | 14 | NP | 32 | 97.5 KM | 880 | 32 | UCL |
| Metals | | | | | | | |
| Aluminum (a) | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Antimony | 163 | NP | 688 | 99 KM | 1180 | 688 | UCL |
| Arsenic | 18 | NP | 39 | 95 KM | 1110 | 39 | UCL |
| Barium | 255 | NP | 438.5 | Cnp97 | 5470 | 439 | UCL |
| Cadmium | 5.7 | NP | 8.1 | 95 KM | 96 | 8.1 | UCL |
| Chromium - Soluble | 1208 | NP | 4297 | Cnp97 | 124000 | 4297 | UCL |
| Chromium (Hexavalent Compounds) | 114 | NP | 73 | 95 KM t | 560 | 73 | UCL |
| Copper | 94 | G | 143 | Gapx | 396 | 143 | UCL |
| Iron | 10321 | G | 12365 | Gapx | 42700 | 12365 | UCL |
| Lead | 231 | NP | 378 | Cnp99 | 2000 | 378 | UCL |
| Mercury | 0.61 | NP | 0.9 | 95 KM | 19 | 0.9 | UCL |
| Thallium | 4.4 | NP | 3.4 | 95 KM t | 17 | 3.4 | UCL |
| Zinc | 3594 | ln | 18126 | Cln97 | 29200 | 18126 | UCL |

Notes:

[1] Aluminum was not detected above its associated screening level in the 2-6 foot soils. The maximum detected concentration was detected at 10 feet bgs in sample TP-01. Therefore, aluminum is not retained as a COPC for the construction worker.

(a) The mean is calculated based on the distribution.

(b) The EPC is the lesser of the 95% UCL and the maximum detected concentration.

COPC – Chemical of potential concern
EPC – Exposure point concentration
ln – Indicates that data were lognormally distributed
G – Indicates that data were gamma distributed
NP – Indicates non-parametric data (data follows no distribution pattern)
mg/kg – Milligrams per kilogram
MVUE – Minimum variance unbiased estimate
N/A – Not applicable
UCL – The 95 percent one-tailed upper confidence limit (UCL) on the mean
95 KM t – 95% Kaplan-Meier (Student's t) UCL
95 KM – 95% KM (Chebyshev) UCL
95 KM (BCA) – 95% Kaplan-Meier (bias-corrected accelerated bootstrap method) UCL
95 KM Bootstrap – 95% Kaplan-Meier Bootstrap
97.5 KM – 97.5% Kaplan-Meier (Chebyshev) UCL
99 KM – 99% Kaplan-Meier (Chebyshev) UCL
Gapx – Approximate Gamma 95% UCL
Cln97 – 97.5% Chebyshev (MVUE) UCL
Cnp97 – 97.5% Chebyshev (mean, standard deviation) UCL
Cnp99 – 99% Chebyshev (mean, standard deviation) UCL

Table 3-3. Exposure Point Concentration Summary – Access Road Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil, 0-10 feet
Exposure Point: Access Road

| Chemicals of Potential Concern | Mean (a) (mg/kg) | Data Distribution | 95% UCL (mg/kg) | 95% UCL Method | Maximum Detected Concentration (mg/kg) | Exposure Point Concentration (mg/kg) | EPC Statistic (b) |
|---|---|---|---|---|---|---|---|
| Polychlorinated Biphenyls (PCBs) | | | | | | | |
| Total PCBs | 16.26 | NP | 55.733 | 97.5 KM | 3400 | 56 | UCL |
| Metals | | | | | | | |
| Arsenic (c) | N/A | N/A | N/A | N/A | 97.5 | 98 | MAX |
| Cadmium (d) | 133.85 | N/A | N/A | N/A | 267 | 267 | MAX |
| Chromium | 661 | NP | 7038 | 99 Chebyshev | 26300 | 7038 | UCL |
| Miscellaneous | | | | | | | |
| Cyanide (c) | N/A | N/A | N/A | N/A | 76.3 | 76 | MAX |
| Carbon (c) | N/A | N/A | N/A | N/A | 28000 | 28000 | MAX |

Notes:
(a) The mean is calculated based on the distribution.
(b) The EPC is the lesser of the 95% UCL and the maximum detected concentration.
(c) Only one sample was analyzed for arsenic, carbon, and cyanide.
(d) Only two samples were analyzed for cadmium.
EPC – Exposure point concentration
N/A – Not applicable
NP – Indicates non-parametric data (data follows no distribution pattern)
mg/kg – Milligrams per kilogram
MAX – Maximum detected concentration
UCL – The 95 percent one-tailed upper confidence limit (UCL) on the mean
97.5 KM – 97.5% Kaplan-Meier (Chebyshev) UCL
99 Chebyshev – 99% Chebyshev (Mean, Sd) UCL

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Table 4-1. Summary of Exposure Factors for Industrial/Commercial Receptors
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface/Subsurface Soil

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Utility Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake (mg/kg-d) = |
| | | | | IR | Ingestion Rate | 100 | mg/day | MADEP 2002; USEPA 2002a | CS x IR x EF x ED x CF x FI |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | BW x AT |
| | | | | ED | Exposure Duration | 25 | years | USEPA 2004 | |
| | | | | FI | Fraction Ingested from Site | 1 | unitless | USEPA 1989a | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |
| Dermal | Utility Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake (mg/kg-d) = |
| | | | | SA | Surface Area | 3,300 | $cm^2$ | USEPA 2004 | CS x SA x AF x ABS x EF x ED x CF |
| | | | | AF | Adherence Factor | 0.20 | $mg/cm^2/day$ | USEPA 2004 | BW x AT |
| | | | | ABS | Dermal absorption fraction | chemical specific | unitless | USEPA 2004 | |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | |
| | | | | ED | Exposure Duration | 25 | years | USEPA 2004 | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |
| Inhalation | Utility Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake ($mg/m^3$) = |
| | | | | ET | Exposure Time | 8 | hours/day | Professional judgment | CS x ET x EF x ED x 1/PEF or 1/VF |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | AT x CF |
| | | | | ED | Exposure Duration | 25 | years | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |
| | | | | CF | Conversion Factor | 24 | hours/day | | |
| | | | | PEF | Particulate Emission Factor | 1.4E+09 | $m^3/kg$ | USEPA 2002a | |
| | | | | VF | Volatilization Factor | chemical specific | $m^3/kg$ | | |
| Ingestion | Utility Worker | Adult | Plant 24 Access Road | CS | Chemical Concentration in Soil | See Table 3-2 | mg/kg | See Table 3-2 | Intake (mg/kg-d) = |
| | | | | IR | Ingestion Rate | 100 | mg/day | MADEP 2002; USEPA 2002a | CS x IR x EF x ED x CF x FI |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | BW x AT |
| | | | | ED | Exposure Duration | 25 | years | USEPA 2004 | |
| | | | | FI | Fraction Ingested from Site | 1 | unitless | USEPA 1989a | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |

Table 4-1. Summary of Exposure Factors for Industrial/Commercial Receptors
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface/Subsurface Soil

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|
| Dermal | Utility Worker | Adult | Plant 24 Access Road | CS | Chemical Concentration in Soil | See Table 3-2 | mg/kg | See Table 3-2 | Intake (mg/kg-d) = |
| | | | | SA | Surface Area | 3,300 | $cm^2$ | USEPA 2004 | CS x SA x AF x ABS x EF x ED x CF |
| | | | | AF | Adherence Factor | 0.20 | $mg/cm^2/day$ | USEPA 2004 | BW x AT |
| | | | | ABS | Dermal absorption fraction | chemical specific | unitless | USEPA 2004 | |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | |
| | | | | ED | Exposure Duration | 25 | years | USEPA 2004 | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |
| Inhalation | Utility Worker | Adult | Plant 24 Access Road | CS | Chemical Concentration in Soil | See Table 3-2 | mg/kg | See Table 3-2 | Intake ($mg/m^3$) = |
| | | | | ET | Exposure Time | 8 | hours/day | Professional judgment | CS x ET x EF x ED x 1/PEF or 1/VF |
| | | | | EF | Exposure Frequency | 3 | days/year | Professional judgment | AT x CF |
| | | | | ED | Exposure Duration | 25 | years | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 9,125 | days | USEPA 1989a | |
| | | | | CF | Conversion Factor | 24 | hours/day | | |
| | | | | PEF | Particulate Emission Factor | 1.4E+09 | $m^3/kg$ | USEPA 2002a | |
| | | | | VF | Volatilization Factor | chemical specific | $m^3/kg$ | | |
| Ingestion | Construction Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake (mg/kg-d) = |
| | | | | IR | Ingestion Rate | 100 | mg/day | MADEP 2002; USEPA 2002a | CS x IR x EF x ED x CF x FI |
| | | | | EF | Exposure Frequency | 60 | days/year | Professional judgment | BW x AT |
| | | | | ED | Exposure Duration | 1 | years | USEPA 2004 | |
| | | | | FI | Fraction Ingested from Site | 1 | unitless | USEPA 1989a | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 365 | days | USEPA 1989a | |
| Dermal | Construction Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake (mg/kg-d) = |
| | | | | SA | Surface Area | 3,300 | $cm^2$ | USEPA 2004 | CS x SA x AF x ABS x EF x ED x CF |
| | | | | AF | Adherence Factor | 0.10 | $mg/cm^2/day$ | USEPA 2004 | BW x AT |
| | | | | ABS | Dermal absorption fraction | chemical specific | unitless | USEPA 2004 | |
| | | | | EF | Exposure Frequency | 60 | days/year | Professional judgment | |
| | | | | ED | Exposure Duration | 1 | years | USEPA 2004 | |
| | | | | CF | Conversion Factor | 1.00E-06 | kg/mg | | |
| | | | | BW | Body Weight | 70 | kg | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 365 | days | USEPA 1989a | |

Table 4-1. Summary of Exposure Factors for Industrial/Commercial Receptors
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface/Subsurface Soil

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Value | Units | Rationale/ Reference | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Construction Worker | Adult | Bethpage Park | CS | Chemical Concentration in Soil | See Table 3-1 | mg/kg | See Table 3-1 | Intake ($mg/m^3$) = |
| | | | | ET | Exposure Time | 8 | hours/day | Professional judgment | CS x ET x EF x ED x 1/PEF or 1/VF |
| | | | | EF | Exposure Frequency | 60 | days/year | Professional judgment | AT x CF |
| | | | | ED | Exposure Duration | 1 | years | USEPA 1989a | |
| | | | | ATc | Averaging Time - cancer | 25,550 | days | USEPA 1989a | |
| | | | | ATnc | Averaging Time - noncancer | 365 | days | USEPA 1989a | |
| | | | | CF | Conversion Factor | 24 | hours/day | | |
| | | | | PEF | Particulate Emission Factor | 1.4E+09 | $m^3$/kg | USEPA 2002a | |
| | | | | VF | Volatilization Factor | chemical specific | $m^3$/kg | | |

Notes:

Surface/subsurface soil for Bethpage Park is defined as 0-6 feet below ground surface, with the exception of select utility locations within the park that extend down to 10 feet.

Surface/subsurface soil for the Access Road is defined as 0-10 feet below ground surface.

$cm^2$ – Square centimeter

kg – Kilogram

kg/mg – Kilograms per milligram

$m^3$/kg – Cubic meters per kilogram

mg/$cm^2$/day – Milligrams per square centimeter per day

mg/day – Milligrams per day

mg/kg – Milligrams per kilogram

Table 4-2. Calculation of Volatilization and Particulate Emission Factors for Soil Exposure
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Constituent | Solubility in Water (mg/L) (S) | Saturation Limit in Soil (mg/kg) (Csat) | Diffusivity in Air ($cm^2$/sec) ($D_{air}$) | Diffusivity in Water ($cm^2$/sec) ($D_{wat}$) | Henry's Law Constant (unitless) ($H_o$) | Partition Coefficient (L/kg) (Koc) | Apparent Diffusivity ($cm^2$/sec) ($D_A$) | Volatilization Factor (a) ($m^3$/kg) (VF) | Combined VF and PEF ($m^3$/kg) (VF/PEF) |
|---|---|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | |
| 1,1,2-Trichloroethane | 4,400 | 1,800 | 7.80E-02 | 8.80E-06 | 3.70E-02 | 5.01E+01 | 3.77E-04 | 6.39E+03 | 6.39E+03 |
| cis-1,2-dichloroethene | 6,410 | 2,500 | 7.36E-02 | 1.13E-05 | 1.67E-01 | 4.38E+01 | 1.66E-03 | 3.05E+03 | 3.05E+03 |
| Ethylbenzene | 169 | 550 | 7.50E-02 | 7.80E-06 | 3.22E-01 | 5.18E+02 | 3.94E-04 | 6.25E+03 | 6.25E+03 |
| Toluene | 526 | 930 | 8.70E-02 | 8.60E-06 | 2.71E-01 | 2.68E+02 | 7.14E-04 | 4.64E+03 | 4.64E+03 |
| Trichloroethylene | 1,280 | 750 | 7.90E-02 | 9.10E-06 | 4.03E-01 | 6.77E+01 | 2.91E-03 | 2.30E+03 | 2.30E+03 |
| Xylene (total) | 106 | 300 | 7.14E-02 | 9.34E-06 | 2.71E-01 | 4.43E+02 | 3.67E-04 | 6.48E+03 | 6.48E+03 |

**Particulate Emission Factor:**

| | | | |
|---|---|---|---|
| PEF = | 1.40E+09 | $m^3$/kg | Particulate emission factor ($m^3$/kg) |

**Model Parameters**

| | | | |
|---|---|---|---|
| Foc = | 0.006 | unitless | Fraction organic carbon (USEPA 2002a, default) |
| $r_b$ = | 1.5 | g/$cm^3$ | Soil dry bulk density (USEPA 2002a, default) |
| $q_T$ = | 0.434 | unitless | Total soil porosity (USEPA 2002a, default) |
| $q_{as}$ = | 0.284 | unitless | Air-filled soil porosity (USEPA 2002a, default) |
| $q_{ws}$ = | 0.15 | unitless | Water-filled soil porosity (USEPA 2002a, default) |
| Q/C = | 68.18 | (g/$m^2$/sec)/(kg/$m^3$) | Volatilization flux per unit concentration (USEPA 2002a, default) |
| RPF = | 0.036 | g/$m^2$/hour | Respirable particle fraction (USEPA 2002a). |
| T = | 9.5E+08 | sec | Exposure interval (USEPA 2002a) |

Notes:
(a) See equation 4-8 in USEPA 2002a.
cm – Centimeter
g – Gram
kg – Kilogram
L – Liter
m – Meter
mL – Milliliter
sec – Second

ARCADIS

Table 4-3. Summary of Parameter Values Used in the Adult Lead Model (ALM) for Evaluation of Non-Residential Lead Risks Associated with Exposure to Soils at Bethpage Park
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Variable | Description | Units | Construction Worker |
|---|---|---|---|
| PbS | Average lead concentration in soil from Bethpage Park | ppm | 219 |
| $R_{fetal/maternal}$ | Fetal/maternal PbB ratio | -- | 0.9 (a) |
| BKSF | Biokinetic Slope Factor | µg/dL per µg/day | 0.4 (a) |
| $GSD_i$ | Geometric standard deviation PbB | -- | 2.0 (b) |
| $PbB_0$ | Baseline PbB | µg/dL | 1.9 (b) |
| $IR_{S,D}$ | Soil ingestion rate (including soil-derived indoor dust) | g/day | 0.10 (c) |
| $AF_{S,D}$ | Absorption fraction, Pb in soil and dust | -- | 0.12 (a) |
| $EF_{S,D}$ | Exposure frequency, Pb pathway | days/year | 60 (d) |
| $AT_{S,D}$ | Averaging time, Pb pathway | days/year | 84 (e) |

Notes:

Lead exposures were evaluated based on parameters for non-Hispanic white ethnicity in the Northeast Region because this is the predominant race in Bethpage, New York (94% of total population). Statistics obtained from the 2002 U.S. Census Bureau. Available at www.census.gov.

Consistent with the ALM guidance (USEPA 2003a; 2007b), the arithmetic mean of lead concentrations was used in the ALM.

Consistent with USEPA (2003a; 2004; 2007b) guidance, dermal exposures to lead in aqueous and non-aqueous media were not quantitatively evaluated with the ALM due to the uncertainty in assigning a dermal absorption fraction that would apply to the numerous inorganic forms of lead that are typically found in environmental settings.

(a) Default value (USEPA 2003a).

(b) Default value for non-Hispanic white populations from the Northeast region (USEPA 2002b).

(c) Default central tendancy exposure (CTE) value for soil ingestion for contact-intensive adult scenarios (USEPA 2007b).

(d) Exposure frequency represents 5 days per week for 12 weeks (5 days/wk x 12 weeks = 60 days/year).

(e) Averaging time is based on exposure frequency (EF) to avoid diluting exposures over the entire year (7 days per week x 12 weeks/year = 84 days/year).

µg/dL – Micrograms per deciliter

g/day – Grams per day

ppm – Parts per million

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Table 5-1. Non-Cancer Toxicity Data (Oral/Dermal)
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Chemical of Potential Concern | Chronic/ Subchronic (a) | Oral RfD | | Oral Absorption Efficiency for Dermal (b) | Absorbed RfD for Dermal | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | | Value | Units | | | Source(s) | Date(s) (MM/DD/YYYY) |
| 1,1,2-Trichloroethane | Chronic | 4.0E-03 | mg/kg/day | >0.50 | 4.0E-03 | mg/kg/day | liver | 1000 | IRIS | 02/01/1995 |
| Aluminum | Chronic | 1.0E+00 | mg/kg/day | >0.50 | 1.0E+00 | mg/kg/day | NI | NI | PPRTV | 09/2008 |
| Antimony | Chronic | 4.0E-04 | mg/kg/day | 0.15 | 6.0E-05 | mg/kg/day | blood | 1000 | IRIS | 02/01/1991 |
| Arsenic | Chronic | 3.0E-04 | mg/kg/day | 0.95 | 3.0E-04 | mg/kg/day | skin | 3 | IRIS | 02/01/1993 |
| Barium | Chronic | 2.0E-01 | mg/kg/day | 0.07 | 1.4E-02 | mg/kg/day | kidney | 300 | IRIS | 07/11/2005 |
| Benzo(a)anthracene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(a)pyrene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(b)fluoranthene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(k)fluoranthene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Bis(2-chloroethyl)ether | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Bis(2-ethylhexyl)phthalate | Chronic | 2.0E-02 | mg/kg/day | >0.50 | 2.0E-02 | mg/kg/day | liver | 1000 | IRIS | 05/01/1991 |
| Cadmium | Chronic | 1.0E-03 | mg/kg/day | 0.025 | 2.5E-05 | mg/kg/day | kidney | 10 | IRIS | 02/01/1994 |
| Carbon | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium III | Chronic | 1.5E+00 | mg/kg/day | 0.013 | 2.0E-02 | mg/kg/day | NI | 1000 | IRIS | 09/03/1998 |
| Chromium VI (particulates) | Chronic | 3.0E-03 | mg/kg/day | 0.025 | 7.5E-05 | mg/kg/day | NI | 900 | IRIS | 09/03/1998 |
| Chromium VI (aerosols) | Chronic | 3.0E-03 | mg/kg/day | >0.50 | 3.0E-03 | mg/kg/day | NI | 900 | IRIS | 09/03/1998 |
| Chrysene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Cis-1,2-dichloroethylene | Chronic | 1.0E-02 | mg/kg/day | >0.50 | 1.0E-02 | mg/kg/day | NI | NI | PPRTV | 09/2008 |
| Cis-1,2-dichloroethylene | Subchronic | 1.0E-01 | mg/kg/day | >0.50 | 1.0E-01 | mg/kg/day | blood | 300 | HEAST | 07/1997 |
| Cobalt | Subchronic | 1.0E-02 | mg/kg/day | >0.50 | 1.0E-02 | mg/kg/day | liver | 100 | ATSDR | 10/2004 |
| Copper | Chronic | 1.4E-01 | mg/kg/day | >0.50 | 1.4E-01 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Cyanide | Chronic | 2.0E-02 | mg/kg/day | >0.50 | 2.0E-02 | mg/kg/day | NI | 500 | IRIS | 02/01/1993 |
| Dibenz(a,h)anthracene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Ethylbenzene | Chronic | 1.0E-01 | mg/kg/day | >0.50 | 1.0E-01 | mg/kg/day | liver, kidney | 1000 | IRIS | 06/01/1991 |
| Indeno(123-cd)pyrene | Chronic | 3.0E-02 | mg/kg/day | 0.89 | 3.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Iron | Chronic | 7.0E-01 | mg/kg/day | >0.50 | 7.0E-01 | mg/kg/day | NI | NI | PPRTV | 09/2008 |
| Lead | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mercury (mercuric sulfide) | Subchronic | 3.0E-04 | mg/kg/day | 0.07 | 2.1E-05 | mg/kg/day | immune system | 1000 | IRIS | 05/01/1995 |
| PCBs (Aroclor 1254) | Chronic | 2.0E-05 | mg/kg/day | 0.96 | 2.0E-05 | mg/kg/day | immune system | 300 | IRIS | 11/01/1996 |
| Thallium (sulfate) | Chronic | 8.0E-05 | mg/kg/day | 1 | 8.0E-05 | mg/kg/day | NI | 3000 | IRIS | 09/01/1990 |
| Toluene | Chronic | 8.0E-02 | mg/kg/day | >0.50 | 8.0E-02 | mg/kg/day | kidney | 3000 | IRIS | 09/23/2005 |
| Trichloroethene | Chronic | 1.5E-03 | mg/kg/day | >0.50 | 1.5E-03 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Vinyl chloride | Chronic | 3.0E-03 | mg/kg/day | >0.50 | 3.0E-03 | mg/kg/day | liver | 30 | IRIS | 08/07/2000 |
| Xylenes | Chronic | 2.0E-01 | mg/kg/day | >0.50 | 2.0E-01 | mg/kg/day | body weight; mortality | 1000 | IRIS | 02/21/2003 |
| Zinc | Chronic | 3.0E-01 | mg/kg/day | >0.50 | 3.0E-01 | mg/kg/day | blood | 3 | IRIS | 08/03/2005 |

Notes:
(a) The same toxicity value was used for both chronic and subchronic exposures when only one toxicity value was available.
(b) USEPA 2004. RAGS Part E. Dermal RfD adjusted when oral absorption <0.50.
mg/kg/day – milligrams per kilogram per day
NA – Not available
NI – No Information
RfD – Reference dose

ATSDR – Agency for Toxic Substances and Disease Registry, Minimal Risk Levels (MRLs)
NYSDEC/NYSDOH – New York State Department of Environmental Conservation/New York State Department of Health. Toxicity values taken from NYS Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, September 2006
PPRTV– Provisional Peer-Reviewed Toxicity Value
IRIS – Integrated Risk Information System
HEAST – Health Effects Assessment Summary Tables

Table 5-2. Non-Cancer Toxicity Data (Inhalation)
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Chemical of Potential Concern | Chronic/ Subchronic (a) | Inhalation RfC | | Extrapolated RfDi | | Primary Target Organ(s) | Combined Uncertainty/Modifying Factors | RfC/RfDi | |
|---|---|---|---|---|---|---|---|---|---|
| | | Value | Units | Value | Units | | | Source(s) | Date(s) (MM/DD/YYYY) |
| 1,1,2-Trichloroethane | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Aluminum | Chronic | 5.0E-03 | $mg/m^3$ | 1.4E-03 | mg/kg/day | NI | NI | PPRTV | 09/2008 |
| Antimony | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Arsenic | Chronic | 3.0E-05 | $mg/m^3$ | 8.6E-06 | mg/kg/day | development, cardiovascular system, CNS | NI | CalEPA (b) | 10/8/2007 |
| Arsenic | Subchronic | 1.9E-04 | $mg/m^3$ | 5.4E-05 | mg/kg/day | reproduction, development | NI | CalEPA | 10/8/2007 |
| Barium | Chronic | 5.0E-04 | $mg/m^3$ | 1.4E-04 | mg/kg/day | fetus | 1000 | HEAST (b) | 07/01/1997 |
| Benzo(a)anthracene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(a)pyrene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(b)fluoranthene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Benzo(k)fluoranthene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Bis(2-chloroethyl)ether | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Bis(2-ethylhexyl)phthalate | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cadmium | Chronic | 2.0E-05 | $mg/m^3$ | 5.7E-06 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Carbon | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium III | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium VI (particulates) | Subchronic | 1.0E-04 | $mg/m^3$ | 2.9E-05 | mg/kg/day | lung | 300 | IRIS | 09/03/1998 |
| Chromium VI (aerosols) | Subchronic | 8.0E-06 | $mg/m^3$ | 2.3E-06 | mg/kg/day | respiratory | 90 | IRIS | 09/03/1998 |
| Chrysene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Cis-1,2-dichloroethylene | Chronic | 3.5E-02 | $mg/m^3$ | 1.0E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Cobalt | Chronic | 1.0E-04 | $mg/m^3$ | 2.9E-05 | mg/kg/day | respiratory | 10 | ATSDR | 10/2004 |
| Copper | Chronic | 4.9E-01 | $mg/m^3$ | 1.4E-01 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Cyanide | Chronic | 2.5E-02 | $mg/m^3$ | 7.1E-03 | mg/kg/day | NI | 100 | NYSDEC/NYSDOH | 09/2006 |
| Dibenz(a,h)anthracene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Ethylbenzene | Chronic | 1.0E+00 | $mg/m^3$ | 2.9E-01 | mg/kg/day | development | 300 | IRIS | 03/01/1991 |
| Indeno(123-cd)pyrene | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Iron | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Lead | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mercury (elemental) | Chronic | 3.0E-04 | $mg/m^3$ | 8.6E-05 | mg/kg/day | neurophysiological | 30 | IRIS | 06/01/1995 |
| PCBs | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Thallium (sulfate) | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Toluene | Chronic | 5.0E+00 | $mg/m^3$ | 1.4E+00 | mg/kg/day | neurological | 10 | IRIS | 09/23/2005 |
| Trichloroethene | Chronic | 4.0E-02 | $mg/m^3$ | 1.1E-02 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |
| Vinyl chloride | Chronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | liver | 30 | IRIS | 08/07/2000 |
| Xylenes | Subchronic | 1.0E-01 | $mg/m^3$ | 2.9E-02 | mg/kg/day | musculoskeletal | 300 | IRIS | 02/21/2003 |
| Zinc | Chronic | 1.0E+00 | $mg/m^3$ | 2.9E-01 | mg/kg/day | NI | NI | NYSDEC/NYSDOH | 09/2006 |

Notes:

(a) The same toxicity value was used for both chronic and subchronic exposures when only one toxicity value was available.
(b) This toxicity value was used by NYSDEC/NYSDOH to calculate soil remediation objectives.
ATSDR – Agency for Toxic Substances and Disease Registry, Minimal Risk Levels (MRLs)
IRIS – Integrated Risk Information System
CalEPA – California EPA
CNS – Central nervous system
HEAST – Health Effects Assessment Summary Tables
mg/kg/day – Milligrams per kilogram per day
$mg/m^3$ – Milligrams per cubic meter
NA – Not available
NI – No information
NYSDEC/NYSDOH – New York State Department of Environmental Conservation/New York State Department of Health. Toxicity values taken from NYS Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, September 2006
PPRTV – Provisional Peer-Reviewed Toxicity Value
RfC – Reference dose
RfDi – Reference dose, inhalation

Table 6-1. Cancer Toxicity Data (Oral/Dermal)
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Chemical of Potential Concern | Oral Cancer Slope Factor | | Oral Absorption Efficiency for Dermal (1) | Absorbed Cancer Slope Factor for Dermal | | Weight of Evidence/ Cancer Guideline Description | CSF | |
|---|---|---|---|---|---|---|---|---|
| | Value | Units | | Value | Units | | Source(s) | Date(s) (MM/DD/YYYY) |
| 1,1,2-Trichloroethane | 5.7E-02 | (mg/kg/day)-1 | >0.50 | 5.7E-02 | (mg/kg/day)-1 | C | IRIS | 02/01/1994 |
| Aluminum | NA | NA | NA | NA | NA | NA | NA | NA |
| Antimony | NA | NA | NA | NA | NA | NA | NA | NA |
| Arsenic | 1.5E+00 | (mg/kg/day)-1 | 0.95 | 1.5E+00 | (mg/kg/day)-1 | A | IRIS | 04/10/1998 |
| Barium | NA | NA | NA | NA | NA | NA | NA | NA |
| Benzo(a)anthracene | 7.3E-01 | (mg/kg/day)-1 | 0.89 | 7.3E-01 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Benzo(a)pyrene | 7.3E+00 | (mg/kg/day)-1 | 0.89 | 7.3E+00 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Benzo(b)fluoranthene | 7.3E-01 | (mg/kg/day)-1 | 0.89 | 7.3E-01 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Benzo(k)fluoranthene | 7.3E-02 | (mg/kg/day)-1 | 0.89 | 7.3E-02 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Bis(2-chloroethyl)ether | 1.1E+00 | (mg/kg/day)-1 | >0.50 | 1.1E+00 | (mg/kg/day)-1 | B2 | IRIS | 02/01/1994 |
| Bis(2-ethylhexyl)phthalate | 1.4E-02 | (mg/kg/day)-1 | >0.50 | 1.4E-02 | (mg/kg/day)-1 | B2 | IRIS | 02/01/1993 |
| Cadmium | 3.8E-01 | (mg/kg/day)-1 | 0.025 | 1.5E+01 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Carbon | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium III | NA | NA | NA | NA | NA | NA | NA | NA |
| Chromium VI | NA | NA | NA | NA | NA | NA | NA | NA |
| Chrysene | 7.3E-03 | (mg/kg/day)-1 | 0.89 | 7.3E-03 | (mg/kg/day)-1 | B2 | IRIS | 03/01/1994 |
| Cis-1,2-dichloroethylene | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | NA | NA | NA | NA | NA | NA | NA | NA |
| Copper | NA | NA | NA | NA | NA | NA | NA | NA |
| Cyanide | NA | NA | NA | NA | NA | NA | NA | NA |
| Dibenz(a,h)anthracene | 7.3E+00 | (mg/kg/day)-1 | 0.89 | 7.3E+00 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Ethylbenzene | 3.5E-03 | (mg/kg/day)-1 | >0.50 | 3.5E-03 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Indeno(123-cd)pyrene | 7.3E-01 | (mg/kg/day)-1 | 0.89 | 7.3E-01 | (mg/kg/day)-1 | B2 | IRIS | 11/01/1994 |
| Iron | NA | NA | NA | NA | NA | NA | NA | NA |
| Lead | 5.7E-03 | (mg/kg/day)-1 | >0.50 | 5.7E-03 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Mercury | NA | NA | NA | NA | NA | NA | NA | NA |
| PCBs (high risk) | 2.0E+00 | (mg/kg/day)-1 | 0.96 | 2.0E+00 | (mg/kg/day)-1 | B2 | IRIS | 06/01/1997 |
| Thallium | NA | NA | NA | NA | NA | NA | NA | NA |
| Toluene | NA | NA | NA | NA | NA | NA | NA | NA |
| Trichloroethene | 5.7E-03 | (mg/kg/day)-1 | >0.50 | 5.7E-03 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Vinyl chloride (adult) | 7.2E-01 | (mg/kg/day)-1 | >0.50 | 7.2E-01 | (mg/kg/day)-1 | A | IRIS | 08/07/2000 |
| Vinyl chloride (child + adult) | 1.4E+00 | (mg/kg/day)-1 | >0.50 | 1.4E+00 | (mg/kg/day)-1 | A | IRIS | 08/07/2000 |
| Xylenes | NA | NA | NA | NA | NA | NA | NA | NA |
| Zinc | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:

A – Human carcinogen, sufficient evidence in humans
B2 – Probable human carcinogen
C – Possible human carcinogen
CSF – Cancer slope factor
IRIS – Integrated Risk Information System
mg/kg/day – Milligrams per kilogram per day
NA – Not available
NI – No information
NYSDEC/NYSDOH – New York State Department of Environmental Conservation/New York State Department of Health. Toxicity values taken from New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, September 2006.

Table 6-2. Cancer Toxicity Data (Inhalation)
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Chemical of Potential Concern | Unit Risk | | Inhalation Cancer Slope Factor | | Weight of Evidence/ Cancer Guideline Description | Unit Risk/Inhalation CSF | |
|---|---|---|---|---|---|---|---|
| | Value | Units | Value | Units | | Source(s) | Date(s) (MM/DD/YYYY) |
| 1,1,2-Trichloroethane | 1.6E-05 | $(\mu g/m^3)^{-1}$ | 5.6E-02 | (mg/kg/day)-1 | C | IRIS | 02/01/1994 |
| Aluminum | NA | NA | NA | NA | NA | NA | NA |
| Antimony | NA | NA | NA | NA | NA | NA | NA |
| Arsenic | 4.3E-03 | $(\mu g/m^3)^{-1}$ | 1.5E+01 | (mg/kg/day)-1 | A | IRIS | 04/10/1998 |
| Barium | NA | NA | NA | NA | NA | NA | NA |
| Benzo(a)anthracene | 1.1E-04 | $(\mu g/m^3)^{-1}$ | 3.9E-01 | (mg/kg/day)-1 | B2 | CalEPA (a) | 09/2008 |
| Benzo(a)pyrene | 1.1E-03 | $(\mu g/m^3)^{-1}$ | 3.9E+00 | (mg/kg/day)-1 | B2 | CalEPA (a) | 09/2008 |
| Benzo(b)fluoranthene | 1.1E-04 | $(\mu g/m^3)^{-1}$ | 3.9E-01 | (mg/kg/day)-1 | B2 | CalEPA (a) | 09/2008 |
| Benzo(k)fluoranthene | 1.1E-05 | $(\mu g/m^3)^{-1}$ | 3.9E-02 | (mg/kg/day)-1 | B2 | NYSDEC/NYSDOH | 09/2006 |
| Bis(2-chloroethyl)ether | 3.3E-04 | $(\mu g/m^3)^{-1}$ | 1.2E+00 | (mg/kg/day)-1 | B2 | IRIS | 02/01/1994 |
| Bis(2-ethylhexyl)phthalate | NA | NA | NA | NA | NA | NA | NA |
| Cadmium | 1.8E-03 | $(\mu g/m^3)^{-1}$ | 6.3E+00 | (mg/kg/day)-1 | B1 | IRIS | 06/01/1992 |
| Carbon | NA | NA | NA | NA | NA | NA | NA |
| Chromium III | NA | NA | NA | NA | NA | NA | NA |
| Chromium VI (particulates) | 1.2E-02 | $(\mu g/m^3)^{-1}$ | 4.2E+01 | (mg/kg/day)-1 | A | IRIS | 09/03/1998 |
| Chromium VI (aerosols) | 1.2E-02 | $(\mu g/m^3)^{-1}$ | 4.2E+01 | (mg/kg/day)-1 | A | IRIS | 09/03/1998 |
| Chrysene | 1.1E-05 | $(\mu g/m^3)^{-1}$ | 3.9E-02 | (mg/kg/day)-1 | B2 | IRIS | 03/01/1994 |
| Cis-1,2-dichloroethylene | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | NA | NA | NA | NA | NA | NA | NA |
| Copper | NA | NA | NA | NA | NA | NA | NA |
| Cyanide | NA | NA | NA | NA | NA | NA | NA |
| Dibenz(a,h)anthracene | 1.1E-03 | $(\mu g/m^3)^{-1}$ | 3.9E+00 | (mg/kg/day)-1 | B2 | NYSDEC/NYSDOH | 09/2006 |
| Ethylbenzene | 1.0E-06 | $(\mu g/m^3)^{-1}$ | 3.5E-03 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Indeno(123-cd)pyrene | 1.1E-04 | $(\mu g/m^3)^{-1}$ | 3.9E-01 | (mg/kg/day)-1 | B2 | CalEPA (a) | 09/2008 |
| Iron | NA | NA | NA | NA | NA | NA | NA |
| Lead | 1.2E-05 | $(\mu g/m^3)^{-1}$ | 4.2E-02 | (mg/kg/day)-1 | NI | NYSDEC/NYSDOH | 09/2006 |
| Mercury | NA | NA | NA | NA | NA | NA | NA |
| PCBs (high risk) | 5.7E-04 | $(\mu g/m^3)^{-1}$ | 2.0E+00 | (mg/kg/day)-1 | B2 | CalEPA | 09/2008 |
| Thallium | NA | NA | NA | NA | NA | NA | NA |
| Toluene | NA | NA | NA | NA | NA | NA | NA |
| Trichloroethene | 2.0E-06 | $(\mu g/m^3)^{-1}$ | 7.0E-03 | (mg/kg/day)-1 | NI | CalEPA (a) | 09/2008 |
| Vinyl chloride (adult) | 4.4E-06 | $(\mu g/m^3)^{-1}$ | 1.5E-02 | (mg/kg/day)-1 | A | IRIS | 08/07/2000 |
| Vinyl chloride (child + adult) | 8.8E-06 | $(\mu g/m^3)^{-1}$ | 3.1E-02 | (mg/kg/day)-1 | A | IRIS | 08/07/2000 |
| Xylenes | NA | NA | NA | NA | NA | NA | NA |
| Zinc | NA | NA | NA | NA | NA | NA | NA |

Notes:

(a) This toxicity value was used by NYSDEC/NYSDOH to calculate soil remediation objectives.

A – Human carcinogen, sufficient evidence in humans.

B2 – Probable human carcinogen

C – Possible human carcinogen

CalEPA – California Environmental Protection Agency

CSF – Cancer slope factor

IRIS – Integrated Risk Information System

mg/kg/day – milligrams per kilogram per day

$\mu g/m^3$ – micrograms per cubic meter

NA – Not available

NI – No information

NYSDEC/NYSDOH – New York State Department of Environmental Conservation/New York State Department of Health. Toxicity values taken from New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document, September 2006

Table 7-1. Calculation of Potential Risks and Hazards - Future Utility Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.48 | — | — | 5.7E-09 | 4.0E-03 | 1.4E-06 | 2.0E-09 | 5.7E-02 | 1.2E-10 |
| | cis-1,2-dichloroethene | 139 | — | — | 1.6E-06 | 1.0E-02 | 1.6E-04 | 5.8E-07 | NA | — |
| | Ethylbenzene | 34 | — | — | 3.9E-07 | 1.0E-01 | 3.9E-06 | 1.4E-07 | 3.5E-03 | 4.9E-10 |
| | Toluene | 691 | — | — | 8.1E-06 | 8.0E-02 | 1.0E-04 | 2.9E-06 | NA | — |
| | Trichloroethylene | 667 | — | — | 7.8E-06 | 1.5E-03 | 5.4E-03 | 2.8E-06 | 5.7E-03 | 1.6E-08 |
| | Xylene (total) | 64 | — | — | 7.5E-07 | 2.0E-01 | 3.7E-06 | 2.7E-07 | NA | — |
| | Semivolatile Organic Compounds | | | | | | | | | |
| | bis(2-chloroethyl)ether | 0.25 | — | — | 2.9E-09 | NA | — | 1.0E-09 | 1.1E+00 | 1.1E-09 |
| | bis(2-ethylhexyl)phthalate | 549 | — | — | 6.4E-06 | 2.0E-02 | 3.2E-04 | 2.3E-06 | 1.4E-02 | 3.2E-08 |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.6 | — | — | 1.9E-08 | 3.0E-02 | 6.2E-07 | 6.7E-09 | 7.3E-01 | 4.9E-09 |
| | Benzo(a)pyrene | 1.4 | — | — | 1.7E-08 | 3.0E-02 | 5.6E-07 | 6.0E-09 | 7.3E+00 | 4.4E-08 |
| | Benzo(b)fluoranthene | 1.8 | — | — | 2.1E-08 | 3.0E-02 | 7.0E-07 | 7.5E-09 | 7.3E-01 | 5.5E-09 |
| | Benzo(k)fluoranthene | 2.4 | — | — | 2.9E-08 | 3.0E-02 | 9.6E-07 | 1.0E-08 | 7.3E-02 | 7.5E-10 |
| | Chrysene | 3.2 | — | — | 3.8E-08 | 3.0E-02 | 1.3E-06 | 1.3E-08 | 7.3E-03 | 9.9E-11 |
| | Dibenzo(a,h)anthracene | 0.25 | — | — | 2.9E-09 | 3.0E-02 | 9.8E-08 | 1.0E-09 | 7.3E+00 | 7.7E-09 |
| | Indeno(1,2,3-cd)pyrene | 0.56 | — | — | 6.6E-09 | 3.0E-02 | 2.2E-07 | 2.3E-09 | 7.3E-01 | 1.7E-09 |
| | Polychlorinated Biphenyls (PCBs) | | | | | | | | | |
| | Total PCBs | 31 | — | — | 3.6E-07 | 2.0E-05 | 1.8E-02 | 1.3E-07 | 2.0E+00 | 2.6E-07 |
| | Metals | | | | | | | | | |
| | Aluminum | 36697 | — | — | 4.3E-04 | 1.0E+00 | 4.3E-04 | 1.5E-04 | NA | — |
| | Antimony | 709 | — | — | 8.3E-06 | 4.0E-04 | 2.1E-02 | 3.0E-06 | NA | — |
| | Arsenic | 37 | — | — | 4.3E-07 | 3.0E-04 | 1.4E-03 | 1.5E-07 | 1.5E+00 | 2.3E-07 |
| | Barium | 419 | — | — | 4.9E-06 | 2.0E-01 | 2.5E-05 | 1.8E-06 | NA | — |
| | Cadmium | 14 | — | — | 1.6E-07 | 1.0E-03 | 1.6E-04 | 5.8E-08 | 3.8E-01 | 2.2E-08 |
| | Chromium - Soluble | 4153 | — | — | 4.9E-05 | 1.5E+00 | 3.3E-05 | 1.7E-05 | NA | — |
| | Chromium (Hexavalent Compounds) | 72 | — | — | 8.4E-07 | 3.0E-03 | 2.8E-04 | 3.0E-07 | NA | — |
| | Copper | 499 | — | — | 5.9E-06 | 1.4E-01 | 4.2E-05 | 2.1E-06 | NA | — |
| | Iron | 13050 | — | — | 1.5E-04 | 7.0E-01 | 2.2E-04 | 5.5E-05 | NA | — |
| | Lead | 370 | — | — | 4.3E-06 | NA | — | 1.6E-06 | 5.7E-03 | 8.8E-09 |
| | Mercury | 0.86 | — | — | 1.0E-08 | 3.0E-04 | 3.4E-05 | 3.6E-09 | NA | — |
| | Thallium | 3.3 | — | — | 3.9E-08 | 8.0E-05 | 4.9E-04 | 1.4E-08 | NA | — |
| | Zinc | 21395 | — | — | 2.5E-04 | 3.0E-01 | 8.4E-04 | 9.0E-05 | NA | — |
| | (Total) | | | | | | 4.9E-02 | | | 6.4E-07 |

Table 7-1. Calculation of Potential Risks and Hazards - Future Utility Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dermal | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.48 | — | — | — | 4.0E-03 | — | — | 5.7E-02 | — |
| | cis-1,2-dichloroethene | 139 | — | — | — | 1.0E-02 | — | — | NA | — |
| | Ethylbenzene | 34 | — | — | — | 1.0E-01 | — | — | 3.5E-03 | — |
| | Toluene | 691 | — | — | — | 8.0E-02 | — | — | NA | — |
| | Trichloroethylene | 667 | — | — | — | 1.5E-03 | — | — | 5.7E-03 | — |
| | Xylene (total) | 64 | — | — | — | 2.0E-01 | — | — | NA | — |
| | Semivolatile Organic Compounds | | | | | | | | | |
| | bis(2-chloroethyl)ether | 0.25 | 0.1 | — | 1.9E-09 | NA | — | 6.9E-10 | 1.1E+00 | 7.6E-10 |
| | bis(2-ethylhexyl)phthalate | 549 | 0.1 | — | 4.3E-06 | 2.0E-02 | 2.1E-04 | 1.5E-06 | 1.4E-02 | 2.1E-08 |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.59 | 0.13 | — | 1.6E-08 | 3.0E-02 | 5.3E-07 | 5.7E-09 | 7.3E-01 | 4.2E-09 |
| | Benzo(a)pyrene | 1.44 | 0.13 | — | 1.5E-08 | 3.0E-02 | 4.8E-07 | 5.2E-09 | 7.3E+00 | 3.8E-08 |
| | Benzo(b)fluoranthene | 1.79 | 0.13 | — | 1.8E-08 | 3.0E-02 | 6.0E-07 | 6.4E-09 | 7.3E-01 | 4.7E-09 |
| | Benzo(k)fluoranthene | 2.45 | 0.13 | — | 2.5E-08 | 3.0E-02 | 8.2E-07 | 8.8E-09 | 7.3E-02 | 6.4E-10 |
| | Chrysene | 3.22 | 0.13 | — | 3.2E-08 | 3.0E-02 | 1.1E-06 | 1.2E-08 | 7.3E-03 | 8.5E-11 |
| | Dibenzo(a,h)anthracene | 0.25 | 0.13 | — | 2.5E-09 | 3.0E-02 | 8.4E-08 | 9.0E-10 | 7.3E+00 | 6.6E-09 |
| | Indeno(1,2,3-cd)pyrene | 0.56 | 0.13 | — | 5.6E-09 | 3.0E-02 | 1.9E-07 | 2.0E-09 | 7.3E-01 | 1.5E-09 |
| | Polychlorinated Biphenyls | | | | | | — | | | |
| | Total PCBs | 31 | 0.14 | — | 3.4E-07 | 2.0E-05 | 1.7E-02 | 1.2E-07 | 2.0E+00 | 2.4E-07 |
| | Metals | | | | | | | | | |
| | Aluminum | 36697 | — | — | — | 1.0E+00 | — | — | NA | — |
| | Antimony | 709 | — | — | — | 6.0E-05 | — | — | NA | — |
| | Arsenic | 37 | 0.03 | — | 8.6E-08 | 3.0E-04 | 2.9E-04 | 3.1E-08 | 1.5E+00 | 4.6E-08 |
| | Barium | 419 | — | — | — | 1.4E-02 | — | — | NA | — |
| | Cadmium | 14 | 0.001 | — | 1.1E-09 | 2.5E-05 | 4.3E-05 | 3.8E-10 | 1.5E+01 | 5.8E-09 |
| | Chromium - Soluble | 4153 | — | — | — | 2.0E-02 | — | — | NA | — |
| | Chromium (Hexavalent Compounds) | 72 | — | — | — | 7.5E-05 | — | — | NA | — |
| | Copper | 499 | — | — | — | 1.4E-01 | — | — | NA | — |
| | Iron | 13050 | — | — | — | 7.0E-01 | — | — | NA | — |
| | Lead | 370 | — | — | — | NA | — | — | 5.7E-03 | — |
| | Mercury | 0.86 | — | — | — | 2.1E-05 | — | — | NA | — |
| | Thallium | 3.3 | — | — | — | 8.0E-05 | — | — | NA | — |
| | Zinc | 21395 | — | — | — | 3.0E-01 | — | — | NA | — |
| | (Total) | | | | | | 1.7E-02 | | | 3.7E-07 |

ARCADIS

Table 7-1. Calculation of Potential Risks and Hazards - Future Utility Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| Inhalation | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.48 | — | 6.4E+03 | 2.1E-07 | NA | — | 7.4E-08 | 1.6E-02 | 1.2E-09 |
| | cis-1,2-dichloroethene | 139 | — | 3.0E+03 | 1.2E-04 | 3.5E-02 | 3.6E-03 | 4.5E-05 | NA | — |
| | Ethylbenzene | 34 | — | 6.3E+03 | 1.5E-05 | 1.0E+00 | 1.5E-05 | 5.2E-06 | 1.0E-03 | 5.2E-09 |
| | Toluene | 691 | — | 4.6E+03 | 4.1E-04 | 5.0E+00 | 8.2E-05 | 1.5E-04 | NA | — |
| | Trichloroethylene | 667 | — | 2.3E+03 | 7.9E-04 | 4.0E-02 | 2.0E-02 | 2.8E-04 | 2.0E-03 | 5.7E-07 |
| | Xylene (total) | 64 | — | 6.5E+03 | 2.7E-05 | 1.0E-01 | 2.7E-04 | 9.6E-06 | NA | — |
| | Semivolatile Organic Compounds | | | | | | — | | | |
| | bis(2-chloroethyl)ether | 0.25 | — | 1.4E+09 | 4.9E-13 | NA | — | 1.7E-13 | 3.3E-01 | 5.7E-14 |
| | bis(2-ethylhexyl)phthalate | 549 | — | 1.4E+09 | 1.1E-09 | NA | — | 3.8E-10 | NA | — |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.59 | — | 1.4E+09 | 3.1E-12 | 1.0E-01 | 3.1E-11 | 1.1E-12 | 1.1E-01 | 1.2E-13 |
| | Benzo(a)pyrene | 1.44 | — | 1.4E+09 | 2.8E-12 | 1.0E-01 | 2.8E-11 | 1.0E-12 | 1.1E+00 | 1.1E-12 |
| | Benzo(b)fluoranthene | 1.79 | — | 1.4E+09 | 3.5E-12 | 1.0E-01 | 3.5E-11 | 1.2E-12 | 1.1E-01 | 1.4E-13 |
| | Benzo(k)fluoranthene | 2.45 | — | 1.4E+09 | 4.8E-12 | 1.0E-01 | 4.8E-11 | 1.7E-12 | 1.1E-02 | 1.9E-14 |
| | Chrysene | 3.22 | — | 1.4E+09 | 6.3E-12 | 1.0E-01 | 6.3E-11 | 2.2E-12 | 1.1E-02 | 2.5E-14 |
| | Dibenzo(a,h)anthracene | 0.25 | — | 1.4E+09 | 4.9E-13 | 1.0E-01 | 4.9E-12 | 1.7E-13 | 1.1E+00 | 1.9E-13 |
| | Indeno(1,2,3-cd)pyrene | 0.56 | — | 1.4E+09 | 1.1E-12 | 1.0E-01 | 1.1E-11 | 3.9E-13 | 1.1E-01 | 4.3E-14 |
| | Polychlorinated Biphenyls | | | | | | — | | | |
| | Total PCBs | 31 | — | 1.4E+09 | 6.1E-11 | NA | — | 2.2E-11 | 5.7E-01 | 1.2E-11 |
| | Metals | | | | | | — | | | |
| | Aluminum | 36697 | — | 1.4E+09 | 7.2E-08 | 5.0E-03 | 1.4E-05 | 2.6E-08 | NA | — |
| | Antimony | 709 | — | 1.4E+09 | 1.4E-09 | NA | — | 5.0E-10 | NA | — |
| | Arsenic | 37 | — | 1.4E+09 | 7.2E-11 | 3.0E-05 | 2.4E-06 | 2.6E-11 | 4.3E+00 | 1.1E-10 |
| | Barium | 419 | — | 1.4E+09 | 8.2E-10 | 5.0E-04 | 1.6E-06 | 2.9E-10 | NA | — |
| | Cadmium | 14 | — | 1.4E+09 | 2.7E-11 | 2.0E-05 | 1.4E-06 | 9.7E-12 | 1.8E+00 | 1.7E-11 |
| | Chromium - Soluble | 4153 | — | 1.4E+09 | 8.1E-09 | NA | — | 2.9E-09 | NA | — |
| | Chromium (Hexavalent Compounds) | 72 | — | 1.4E+09 | 1.4E-10 | 1.0E-04 | 1.4E-06 | 5.0E-11 | 1.2E+01 | 6.0E-10 |
| | Copper | 499 | — | 1.4E+09 | 9.8E-10 | 4.9E-01 | 2.0E-09 | 3.5E-10 | NA | — |
| | Iron | 13050 | — | 1.4E+09 | 2.6E-08 | NA | — | 9.1E-09 | NA | — |
| | Lead | 370 | — | 1.4E+09 | 7.2E-10 | NA | — | 2.6E-10 | 1.2E-02 | 3.1E-12 |
| | Mercury | 0.86 | — | 1.4E+09 | 1.7E-12 | 3.0E-04 | 5.6E-09 | 6.0E-13 | NA | — |
| | Thallium | 3.3 | — | 1.4E+09 | 6.5E-12 | NA | — | 2.3E-12 | NA | — |
| | Zinc | 21395 | — | 1.4E+09 | 4.2E-08 | 1.0E+00 | 4.2E-08 | 1.5E-08 | NA | — |
| | (Total) | | | | | | 2.4E-02 | | | 5.7E-07 |
| | | | | | | Hazard Index | 0.1 | | Total Risk | 2E-06 |

Notes:

(a) Non-cancer intakes for oral and dermal pathways are in mg/kg/day. Non-cancer intakes for the inhalation pathway are in $mg/m^3$.

(b) Non-cancer toxicity values for oral and dermal pathways, i.e., $RfD_o$ and $RfD_d$, are in mg/kg/day. Non-cancer toxicity values for the inhalation pathway, i.e., RfC, are in $mg/m^3$.

(c) Cancer intakes for oral and dermal pathways are in mg/kg/day. Cancer intakes for the inhalation pathway are in $mg/m^3$.

(d) Cancer toxicity values for oral and dermal pathways, i.e., CSFo and $CSF_d$, are in $(mg/kg/day)^{-1}$. Cancer toxicity values for the inhalation pathway, i.e., URF, are in $(mg/m^3)^{-1}$.

RfD – Reference dose
RfC – Reference concentration
EPC – Exposure point concentration
$ABS_d$ – Dermal absorption factor
PEF – Particulate emission factor
VF – Volatilization factor
NA –Not available

CSF – Cancer slope factor
URF – Unit risk factor
$m^3$/kg – Cubic meters/kilogram
mg/kg – Milligrams/kilogram
mg/kg/day – Milligrams/kilogram/day
$mg/m^3$ – Milligrams per cubic meter

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Table 7-2. Calculation of Potential Risks and Hazards - Future Utility Worker Exposure to Access Road Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ingestion | Polychlorinated Biphenyls | | | | | | | | | |
| | Total PCBs | 56 | — | — | 6.6E-07 | 2.0E-05 | 3.3E-02 | 2.3E-07 | 2.0E+00 | 4.7E-07 |
| | Arsenic | 98 | — | — | 1.1E-06 | 3.0E-04 | 3.8E-03 | 4.1E-07 | 1.5E+00 | 6.1E-07 |
| | Cadmium | 267 | — | — | 3.1E-06 | 1.0E-03 | 3.1E-03 | 1.1E-06 | 3.8E-01 | 4.3E-07 |
| | Chromium | 7038 | — | — | 8.3E-05 | 1.5E+00 | 5.5E-05 | 3.0E-05 | NA | — |
| | Cyanide | 76 | — | — | 9.0E-07 | 2.0E-02 | 4.5E-05 | 3.2E-07 | NA | — |
| | Carbon | 28000 | — | — | 3.3E-04 | NA | — | 1.2E-04 | NA | — |
| | (Total) | | | | | | 4.0E-02 | | | 1.5E-06 |
| Dermal | Polychlorinated Biphenyls | | | | | | — | | | |
| | Total PCBs | 56 | 0.14 | — | 6.1E-07 | 2.0E-05 | 3.0E-02 | 2.2E-07 | 2.0E+00 | 4.3E-07 |
| | Arsenic | 98 | 0.03 | — | 2.3E-07 | 3.0E-04 | 7.6E-04 | 8.1E-08 | 1.5E+00 | 1.2E-07 |
| | Cadmium | 267 | 0.001 | — | 2.1E-08 | 2.5E-05 | 8.3E-04 | 7.4E-09 | 1.5E+01 | 1.1E-07 |
| | Chromium | 7038 | NA | — | — | 2.0E-02 | — | — | NA | — |
| | Cyanide | 76 | NA | — | — | 2.0E-02 | — | — | NA | — |
| | Carbon | 28000 | NA | — | — | NA | — | — | NA | — |
| | (Total) | | | | | | 3.2E-02 | | | 6.7E-07 |
| Inhalation | Polychlorinated Biphenyls | | | | | | | | | |
| | Total PCBs | 56 | — | 1.4E+09 | 1.1E-10 | NA | — | 3.9E-11 | 5.7E-01 | 2.2E-11 |
| | Arsenic | 98 | — | 1.4E+09 | 1.9E-10 | 3.0E-05 | 6.4E-06 | 6.8E-11 | 4.3E+00 | 2.9E-10 |
| | Cadmium | 267 | — | 1.4E+09 | 5.2E-10 | 2.0E-05 | 2.6E-05 | 1.9E-10 | 1.8E+00 | 3.4E-10 |
| | Chromium | 7038 | — | 1.4E+09 | 1.4E-08 | 1.0E-04 | 1.4E-04 | 4.9E-09 | 1.2E+01 | 5.9E-08 |
| | Cyanide | 76 | — | 1.4E+09 | 1.5E-10 | 2.5E-02 | 6.0E-09 | 5.3E-11 | NA | — |
| | Carbon | 28000 | — | 1.4E+09 | 5.5E-08 | NA | — | 2.0E-08 | NA | — |
| | (Total) | | | | | | 1.7E-04 | | | 6.0E-08 |
| | | | | | | Hazard Index | 0.07 | | Total Risk | 2E-06 |

Notes:

(a) Non-cancer intakes for oral and dermal pathways are in mg/kg/day. Non-cancer intakes for the inhalation pathway are in mg/$m^3$.

(b)] Non-cancer toxicity values for oral and dermal pathways, i.e., $RfD_o$ and $RfD_d$, are in mg/kg/day. Non-cancer toxicity values for the inhalation pathway, i.e., RfC, are in mg/$m^3$.

(c) Cancer intakes for oral and dermal pathways are in mg/kg/day. Cancer intakes for the inhalation pathway are in mg/$m^3$.

(d) Cancer toxicity values for oral and dermal pathways, i.e., $CSF_o$ and $CSF_d$, are in $(mg/kg/day)^{-1}$. Cancer toxicity values for the inhalation pathway, i.e., URF, are in $(mg/m^3)^{-1}$.

RfD – Reference dose
RfC – Reference concentration
EPC – Exposure point concentration
$ABS_d$ – Dermal absorption factor
PEF – Particulate emission factor
VF – Volatilization factor
NA –Not available

CSF – Cancer slope factor
URF – Unit risk factor
$m^3$/kg – Cubic meters/kilogram
mg/kg – Milligrams/kilogram
mg/kg/day – Milligrams/kilogram/day
mg/$m^3$ – Milligrams per cubic meter

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Table 7-3. Calculation of Potential Risks and Hazards - Future Construction Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.50 | — | — | 1.2E-07 | 4.0E-03 | 2.9E-05 | 1.7E-09 | 5.7E-02 | 9.5E-11 |
| | cis-1,2-dichloroethene | 143 | — | — | 3.4E-05 | 1.0E-01 | 3.4E-04 | 4.8E-07 | NA | — |
| | Ethylbenzene | 34 | — | — | 8.1E-06 | 1.0E-01 | 8.1E-05 | 1.2E-07 | 3.5E-03 | 4.0E-10 |
| | Toluene | 713 | — | — | 1.7E-04 | 8.0E-02 | 2.1E-03 | 2.4E-06 | NA | — |
| | Trichloroethylene | 690 | — | — | 1.6E-04 | 1.5E-03 | 1.1E-01 | 2.3E-06 | 5.7E-03 | 1.3E-08 |
| | Xylene (total) | 64 | — | — | 1.5E-05 | 2.0E-01 | 7.5E-05 | 2.2E-07 | NA | — |
| | Semivolatile Organic Compounds | | | | | | | | | |
| | bis(2-chloroethyl)ether | 0.25 | — | — | 5.8E-08 | NA | — | 8.4E-10 | 1.1E+00 | 9.2E-10 |
| | bis(2-ethylhexyl)phthalate | 443 | — | — | 1.0E-04 | 2.0E-02 | 5.2E-03 | 1.5E-06 | 1.4E-02 | 2.1E-08 |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.7 | — | — | 3.9E-07 | 3.0E-02 | 1.3E-05 | 5.6E-09 | 7.3E-01 | 4.1E-09 |
| | Benzo(a)pyrene | 1.4 | — | — | 3.3E-07 | 3.0E-02 | 1.1E-05 | 4.7E-09 | 7.3E+00 | 3.4E-08 |
| | Benzo(b)fluoranthene | 1.9 | — | — | 4.4E-07 | 3.0E-02 | 1.5E-05 | 6.3E-09 | 7.3E-01 | 4.6E-09 |
| | Benzo(k)fluoranthene | 2.6 | — | — | 6.0E-07 | 3.0E-02 | 2.0E-05 | 8.6E-09 | 7.3E-02 | 6.3E-10 |
| | Chrysene | 3.4 | — | — | 7.9E-07 | 3.0E-02 | 2.6E-05 | 1.1E-08 | 7.3E-03 | 8.2E-11 |
| Ingestion | Dibenzo(a,h)anthracene | 0.26 | — | — | 6.1E-08 | 3.0E-02 | 2.0E-06 | 8.7E-10 | 7.3E+00 | 6.3E-09 |
| | Indeno(1,2,3-cd)pyrene | 0.57 | — | — | 1.3E-07 | 3.0E-02 | 4.5E-06 | 1.9E-09 | 7.3E-01 | 1.4E-09 |
| | Polychlorinated Biphenyls | | | | | | | | | |
| | Total PCBs | 32 | — | — | 7.6E-06 | 2.0E-05 | 3.8E-01 | 1.1E-07 | 2.0E+00 | 2.2E-07 |
| | Metals | | | | | | | | | |
| | Antimony | 688 | — | — | 1.6E-04 | 4.0E-04 | 4.0E-01 | 2.3E-06 | NA | — |
| | Arsenic | 39 | — | — | 9.1E-06 | 3.0E-04 | 3.0E-02 | 1.3E-07 | 1.5E+00 | 1.9E-07 |
| | Barium | 439 | — | — | 1.0E-04 | 2.0E-01 | 5.1E-04 | 1.5E-06 | NA | — |
| | Cadmium | 8.112 | — | — | 1.9E-06 | 1.0E-03 | 1.9E-03 | 2.7E-08 | 3.8E-01 | 1.0E-08 |
| | Chromium - Soluble | 4297 | — | — | 1.0E-03 | 1.5E+00 | 6.7E-04 | 1.4E-05 | NA | — |
| | Chromium (Hexavalent Compounds) | 73 | — | — | 1.7E-05 | 3.0E-03 | 5.7E-03 | 2.4E-07 | NA | — |
| | Copper | 143 | — | — | 3.4E-05 | 1.4E-01 | 2.4E-04 | 4.8E-07 | NA | — |
| | Iron | 12365 | — | — | 2.9E-03 | 7.0E-01 | 4.1E-03 | 4.1E-05 | NA | — |
| | Lead | 378 | — | — | 8.9E-05 | NA | — | 1.3E-06 | 5.7E-03 | 7.2E-09 |
| | Mercury | 0.89 | — | — | 2.1E-07 | 3.0E-04 | 6.9E-04 | 3.0E-09 | NA | — |
| | Thallium | 3.4 | — | — | 8.0E-07 | 8.0E-05 | 1.0E-02 | 1.1E-08 | NA | — |
| | Zinc | 18126 | — | — | 4.3E-03 | 3.0E-01 | 1.4E-02 | 6.1E-05 | NA | — |
| | (Total) | | | | | | 9.7E-01 | | | 5.2E-07 |

Table 7-3. Calculation of Potential Risks and Hazards - Future Construction Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.50 | — | — | — | 4.0E-03 | — | — | 5.7E-02 | — |
| | cis-1,2-dichloroethene | 143 | — | — | — | 1.0E-01 | — | — | NA | — |
| | Ethylbenzene | 34 | — | — | — | 1.0E-01 | — | — | 3.5E-03 | — |
| | Toluene | 713 | — | — | — | 8.0E-02 | — | — | NA | — |
| | Trichloroethylene | 690 | — | — | — | 1.5E-03 | — | — | 5.7E-03 | — |
| | Xylene (total) | 64 | — | — | — | 2.0E-01 | — | — | NA | — |
| | Semivolatile Organic Compounds | | | | | | — | | | |
| | bis(2-chloroethyl)ether | 0.25 | 0.1 | — | 1.9E-08 | NA | — | 2.8E-10 | 1.1E+00 | 3.0E-10 |
| | bis(2-ethylhexyl)phthalate | 443 | 0.1 | — | 3.4E-05 | 2.0E-02 | 1.7E-03 | 4.9E-07 | 1.4E-02 | 6.9E-09 |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.7 | 0.13 | — | 1.7E-07 | 3.0E-02 | 5.6E-06 | 2.4E-09 | 7.3E-01 | 1.7E-09 |
| | Benzo(a)pyrene | 1.4 | 0.13 | — | 1.4E-07 | 3.0E-02 | 4.7E-06 | 2.0E-09 | 7.3E+00 | 1.5E-08 |
| | Benzo(b)fluoranthene | 1.9 | 0.13 | — | 1.9E-07 | 3.0E-02 | 6.3E-06 | 2.7E-09 | 7.3E-01 | 2.0E-09 |
| | Benzo(k)fluoranthene | 2.6 | 0.13 | — | 2.6E-07 | 3.0E-02 | 8.6E-06 | 3.7E-09 | 7.3E-02 | 2.7E-10 |
| | Chrysene | 3.4 | 0.13 | — | 3.4E-07 | 3.0E-02 | 1.1E-05 | 4.8E-09 | 7.3E-03 | 3.5E-11 |
| Dermal | Dibenzo(a,h)anthracene | 0.26 | 0.13 | — | 2.6E-08 | 3.0E-02 | 8.7E-07 | 3.7E-10 | 7.3E+00 | 2.7E-09 |
| | Indeno(1,2,3-cd)pyrene | 0.57 | 0.13 | — | 5.8E-08 | 3.0E-02 | 1.9E-06 | 8.2E-10 | 7.3E-01 | 6.0E-10 |
| | Polychlorinated Biphenyls | | | | | | — | | | |
| | Total PCBs | 32.41 | 0.14 | — | 3.5E-06 | 2.0E-05 | 1.8E-01 | 5.0E-08 | 2.0E+00 | 1.0E-07 |
| | Metals | | | | | | — | | | |
| | Antimony | 688 | — | — | — | 6.0E-05 | — | — | NA | — |
| | Arsenic | 39 | 0.03 | — | 9.0E-07 | 3.0E-04 | 3.0E-03 | 1.3E-08 | 1.5E+00 | 1.9E-08 |
| | Barium | 439 | — | — | — | 1.4E-02 | — | — | NA | — |
| | Cadmium | 8.112 | 0.001 | — | 6.3E-09 | 2.5E-05 | 2.5E-04 | 9.0E-11 | 1.5E+01 | 1.4E-09 |
| | Chromium - Soluble | 4297 | — | — | — | 2.0E-02 | — | — | NA | — |
| | Chromium (Hexavalent Compounds) | 73 | — | — | — | 7.5E-05 | — | — | NA | — |
| | Copper | 143 | — | — | — | 1.4E-01 | — | — | NA | — |
| | Iron | 12365 | — | — | — | 7.0E-01 | — | — | NA | — |
| | Lead | 378 | — | — | — | NA | — | — | 5.7E-03 | — |
| | Mercury | 0.89 | — | — | — | 2.1E-05 | — | — | NA | — |
| | Thallium | 3.4 | — | — | — | 8.0E-05 | — | — | NA | — |
| | Zinc | 18126 | — | — | — | 3.0E-01 | — | — | NA | — |
| | (Total) | | | | | | 1.8E-01 | | | 1.5E-07 |

Table 7-3. Calculation of Potential Risks and Hazards - Future Construction Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Pathway | Chemicals of Potential Concern | EPC (mg/kg) | $ABS_d$ | VF + PEF ($m^3$/kg) | Non-Cancer Intake (a) | Non-Cancer Toxicity Value (b) | Hazard Quotient (unitless) | Cancer Intake (c) | Cancer Toxicity Value (d) | Excess Cancer Risk (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Volatile Organic Compounds | | | | | | | | | |
| | 1,1,2-Trichloroethane | 0.50 | — | 6.4E+03 | 4.3E-06 | NA | — | 6.1E-08 | 1.6E-02 | 9.8E-10 |
| | cis-1,2-dichloroethene | 143 | — | 3.0E+03 | 2.6E-03 | 3.5E-02 | 7.4E-02 | 3.7E-05 | NA | — |
| | Ethylbenzene | 34 | — | 6.3E+03 | 3.0E-04 | 1.0E+00 | 3.0E-04 | 4.3E-06 | 1.0E-03 | 4.3E-09 |
| | Toluene | 713 | — | 4.6E+03 | 8.4E-03 | 5.0E+00 | 1.7E-03 | 1.2E-04 | NA | — |
| | Trichloroethylene | 690 | — | 2.3E+03 | 1.6E-02 | 4.0E-02 | 4.1E-01 | 2.3E-04 | 2.0E-03 | 4.7E-07 |
| | Xylene (total) | 64 | — | 6.5E+03 | 5.4E-04 | 1.0E-01 | 5.4E-03 | 7.8E-06 | NA | — |
| | Semivolatile Organic Compounds | | | | | | — | | | |
| | bis(2-chloroethyl)ether | 0.25 | — | 1.4E+09 | 9.7E-12 | NA | — | 1.4E-13 | 3.3E-01 | 4.6E-14 |
| | bis(2-ethylhexyl)phthalate | 443 | — | 1.4E+09 | 1.7E-08 | NA | — | 2.5E-10 | NA | — |
| | Polycyclic Aromatic Hydrocarbons | | | | | | — | | | |
| | Benzo(a)anthracene | 1.7 | — | 1.4E+09 | 6.5E-11 | 1.0E-01 | 6.5E-10 | 9.3E-13 | 1.1E-01 | 1.0E-13 |
| | Benzo(a)pyrene | 1.4 | — | 1.4E+09 | 5.5E-11 | 1.0E-01 | 5.5E-10 | 7.8E-13 | 1.1E+00 | 8.6E-13 |
| | Benzo(b)fluoranthene | 1.9 | — | 1.4E+09 | 7.4E-11 | 1.0E-01 | 7.4E-10 | 1.1E-12 | 1.1E-01 | 1.2E-13 |
| | Benzo(k)fluoranthene | 2.6 | — | 1.4E+09 | 1.0E-10 | 1.0E-01 | 1.0E-09 | 1.4E-12 | 1.1E-02 | 1.6E-14 |
| | Chrysene | 3.4 | — | 1.4E+09 | 1.3E-10 | 1.0E-01 | 1.3E-09 | 1.9E-12 | 1.1E-02 | 2.1E-14 |
| Inhalation | Dibenzo(a,h)anthracene | 0.26 | — | 1.4E+09 | 1.0E-11 | 1.0E-01 | 1.0E-10 | 1.4E-13 | 1.1E+00 | 1.6E-13 |
| | Indeno(1,2,3-cd)pyrene | 0.57 | — | 1.4E+09 | 2.2E-11 | 1.0E-01 | 2.2E-10 | 3.2E-13 | 1.1E-01 | 3.5E-14 |
| | Polychlorinated Biphenyls | | | | | | — | | | |
| | Total PCBs | 32 | — | 1.4E+09 | 1.3E-09 | NA | — | 1.8E-11 | 5.7E-01 | 1.0E-11 |
| | Metals | | | | | | — | | | |
| | Antimony | 688 | — | 1.4E+09 | 2.7E-08 | NA | — | 3.8E-10 | NA | — |
| | Arsenic | 39 | — | 1.4E+09 | 1.5E-09 | 1.9E-04 | 8.0E-06 | 2.2E-11 | 4.3E+00 | 9.3E-11 |
| | Barium | 438.5 | — | 1.4E+09 | 1.7E-08 | 5.0E-04 | 3.4E-05 | 2.5E-10 | NA | — |
| | Cadmium | 8.112 | — | 1.4E+09 | 3.2E-10 | 2.0E-05 | 1.6E-05 | 4.5E-12 | 1.8E+00 | 8.2E-12 |
| | Chromium - Soluble | 4297 | — | 1.4E+09 | 1.7E-07 | NA | — | 2.4E-09 | NA | — |
| | Chromium (Hexavalent Compounds) | 73 | — | 1.4E+09 | 2.9E-09 | 1.0E-04 | 2.9E-05 | 4.1E-11 | 1.2E+01 | 4.9E-10 |
| | Copper | 143 | — | 1.4E+09 | 5.6E-09 | 4.9E-01 | 1.1E-08 | 8.0E-11 | NA | — |
| | Iron | 12365 | — | 1.4E+09 | 4.8E-07 | NA | — | 6.9E-09 | NA | — |
| | Lead | 378 | — | 1.4E+09 | 1.5E-08 | NA | — | 2.1E-10 | 1.2E-02 | 2.5E-12 |
| | Mercury | 0.89 | — | 1.4E+09 | 3.5E-11 | 3.0E-04 | 1.2E-07 | 5.0E-13 | NA | — |
| | Thallium | 3.4 | — | 1.4E+09 | 1.3E-10 | NA | — | 1.9E-12 | NA | — |
| | Zinc | 18126 | — | 1.4E+09 | 7.1E-07 | 1.0E+00 | 7.1E-07 | 1.0E-08 | NA | — |
| | (Total) | | | | | | 4.9E-01 | | | 4.8E-07 |
| | | | | | | Hazard Index | 2 | | Total Risk | 1E-06 |

Notes:

(a) Non-cancer intakes for oral and dermal pathways are in mg/kg/day. Non-cancer intakes for the inhalation pathway are in $mg/m^3$.

(b) Non-cancer toxicity values for oral and dermal pathways, i.e., $RfD_o$ and $RfD_d$, are in mg/kg/day. Non-cancer toxicity values for the inhalation pathway, i.e., RfC, are in $mg/m^3$.
Subchronic toxicity values were used when available.

(c) Cancer intakes for oral and dermal pathways are in mg/kg/day. Cancer intakes for the inhalation pathway are in $mg/m^3$.

(d) Cancer toxicity values for oral and dermal pathways, i.e., $CSF_o$ and $CSF_d$, are in $(mg/kg/day)^{-1}$. Cancer toxicity values for the inhalation pathway, i.e., URF, are in $(mg/m^3)^{-1}$.

RfD – Reference dose
RfC – Reference concentration
EPC – Exposure point concentration
$ABS_d$ – Dermal absorption factor
PEF – Particulate emission factor
VF – Volatilization factor
NA –Not available

CSF – Cancer slope factor
URF – Unit risk factor
$m^3$/kg – Cubic meters/kilogram
mg/kg – Milligrams/kilogram
mg/kg/day – Milligrams/kilogram/day
$mg/m^3$ – Milligrams per cubic meter

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Table 7-4. Calculation of Blood Lead Concentrations (PbBs) for the Construction Worker Exposed to Soils at Bethpage Park
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Exposure Variable | Description of Exposure Variable | Units | Construction Worker |
|---|---|---|---|
| PbS | Soil lead concentration | ug/g or ppm | 219 |
| $R_{fetal/maternal}$ | Fetal/maternal PbB ratio | -- | 0.9 |
| BKSF | Biokinetic Slope Factor | ug/dL per ug/day | 0.4 |
| $GSD_i$ | Geometric standard deviation PbB | -- | 2.0 |
| $PbB_0$ | Baseline PbB | ug/dL | 1.9 |
| $IR_S$ | Soil ingestion rate (including soil-derived indoor dust) | g/day | 0.100 |
| $IR_{S+D}$ | Total ingestion rate of outdoor soil and indoor dust | g/day | -- |
| $W_S$ | Weighting factor; fraction of $IR_{S+D}$ ingested as outdoor soil | -- | -- |
| $K_{SD}$ | Mass fraction of soil in dust | -- | -- |
| $AF_{S, D}$ | Absorption fraction (same for soil and dust) | -- | 0.12 |
| $EF_{S, D}$ | Exposure frequency (same for soil and dust) | days/year | 60 |
| $AT_{S, D}$ | Averaging time (same for soil and dust) | days/year | 84 |
| **$PbB_{adult}$** | **PbB of adult worker, geometric mean** | **ug/dL** | **2.7** |
| $PbB_{fetal, 0.95}$ | 95th percentile PbB among fetuses of adult workers | ug/dL | 7.5 |
| $PbB_t$ | Target PbB level of concern (e.g., 10 ug/dL) | ug/dL | 10.0 |
| **$P(PbB_{fetal} > PbB_t)$** | **Probability that fetal PbB > $PbB_t$, assuming lognormal distribution** | **%** | **1.9%** |

Notes:

Equation 1 does not apportion exposure between soil and dust ingestion (excludes $W_S$, $K_{SD}$).

When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

ALM Version date 5/19/05

See Table 4-3 for sources of exposure variables.

g/day – Grams per day

ug/dL – micrograms per deciliter

ug/g – micrograms per gram

ppm – parts per million

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Table 9-1. Summary of Receptor Risks and Hazards for COPCs - Future Utility Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Non-Carcinogenic Hazard Quotient | | | | | Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Soil | Soil | Bethpage Park | Volatile Organic Compounds | | | | | | | | | |
| | | | 1,1,2-Trichloroethane | liver | 1.4E-06 | — | — | 1.4E-06 | 1.2E-10 | 1.2E-09 | — | 1.3E-09 |
| | | | cis-1,2-dichloroethene | NI | 1.6E-04 | 3.6E-03 | — | 3.7E-03 | — | — | — | — |
| | | | Ethylbenzene | liver, kidney | 3.9E-06 | 1.5E-05 | — | 1.9E-05 | 4.9E-10 | 5.2E-09 | — | 5.7E-09 |
| | | | Toluene | kidney | 1.0E-04 | 8.2E-05 | — | 1.8E-04 | — | — | — | — |
| | | | Trichloroethylene | NI | 5.4E-03 | 2.0E-02 | — | 2.5E-02 | 1.6E-08 | 5.7E-07 | — | 5.8E-07 |
| | | | Xylene (total) | body weight; mortality | 3.7E-06 | 2.7E-04 | — | 2.7E-04 | — | — | — | — |
| | | | Semivolatile Organic Compounds | | | | | | | | | |
| | | | bis(2-chloroethyl)ether | NA | — | — | — | — | 1.1E-09 | 5.7E-14 | 7.6E-10 | 1.9E-09 |
| | | | bis(2-ethylhexyl)phthalate | liver | 3.2E-04 | — | 2.1E-04 | 5.3E-04 | 3.2E-08 | — | 2.1E-08 | 5.3E-08 |
| | | | Polycyclic Aromatic Hydrocarbons | | | | | | | | | |
| | | | Benzo(a)anthracene | NI | 6.2E-07 | 3.1E-11 | 5.3E-07 | 1.2E-06 | 4.9E-09 | 1.2E-13 | 4.2E-09 | 9.1E-09 |
| | | | Benzo(a)pyrene | NI | 5.6E-07 | 2.8E-11 | 4.8E-07 | 1.0E-06 | 4.4E-08 | 1.1E-12 | 3.8E-08 | 8.2E-08 |
| | | | Benzo(b)fluoranthene | NI | 7.0E-07 | 3.5E-11 | 6.0E-07 | 1.3E-06 | 5.5E-09 | 1.4E-13 | 4.7E-09 | 1.0E-08 |
| | | | Benzo(k)fluoranthene | NI | 9.6E-07 | 4.8E-11 | 8.2E-07 | 1.8E-06 | 7.5E-10 | 1.9E-14 | 6.4E-10 | 1.4E-09 |
| | | | Chrysene | NI | 1.3E-06 | 6.3E-11 | 1.1E-06 | 2.3E-06 | 9.9E-11 | 2.5E-14 | 8.5E-11 | 1.8E-10 |
| | | | Dibenzo(a,h)anthracene | NI | 9.8E-08 | 4.9E-12 | 8.4E-08 | 1.8E-07 | 7.7E-09 | 1.9E-13 | 6.6E-09 | 1.4E-08 |
| | | | Indeno(1,2,3-cd)pyrene | NI | 2.2E-07 | 1.1E-11 | 1.9E-07 | 4.1E-07 | 1.7E-09 | 4.3E-14 | 1.5E-09 | 3.2E-09 |
| | | | Polychlorinated Biphenyls | | | | | | | | | |
| | | | Total PCBs | immune system | 1.8E-02 | — | 1.7E-02 | 3.5E-02 | 2.6E-07 | 1.2E-11 | 2.4E-07 | 5.0E-07 |
| | | | Metals | | | | | | | | | |
| | | | Aluminum | NI | 4.3E-04 | 1.4E-05 | — | 4.5E-04 | — | — | — | — |
| | | | Antimony | blood | 2.1E-02 | — | — | 2.1E-02 | — | — | — | — |
| | | | Arsenic | skin | 1.4E-03 | 2.4E-06 | 2.9E-04 | 1.7E-03 | 2.3E-07 | 1.1E-10 | 4.6E-08 | 2.8E-07 |
| | | | Barium | kidney | 2.5E-05 | 1.6E-06 | — | 2.6E-05 | — | — | — | — |
| | | | Cadmium | kidney | 1.6E-04 | 1.4E-06 | 4.3E-05 | 2.1E-04 | 2.2E-08 | 1.7E-11 | 5.8E-09 | 2.8E-08 |
| | | | Chromium - Soluble | NI | 3.3E-05 | — | — | 3.3E-05 | — | — | — | — |
| | | | Chromium (Hexavalent Compounds) | NI | 2.8E-04 | 1.4E-06 | — | 2.8E-04 | — | 6.0E-10 | — | 6.0E-10 |
| | | | Copper | NI | 4.2E-05 | 2.0E-09 | — | 4.2E-05 | — | — | — | — |
| | | | Iron | NI | 2.2E-04 | — | — | 2.2E-04 | — | — | — | — |

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Table 9-1. Summary of Receptor Risks and Hazards for COPCs - Future Utility Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Non-Carcinogenic Hazard Quotient | | | | | Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Soil | Soil | Bethpage Park | Lead | NA | — | — | — | — | 8.8E-09 | 3.1E-12 | — | 8.8E-09 |
| | | | Mercury | immune system | 3.4E-05 | 5.6E-09 | — | 3.4E-05 | — | — | — | — |
| | | | Thallium | NI | 4.9E-04 | — | — | 4.9E-04 | — | — | — | — |
| | | | Zinc | blood | 8.4E-04 | 4.2E-08 | — | 8.4E-04 | — | — | — | — |
| | | | Chemical Total | | 5E-02 | 2E-02 | 2E-02 | 0.1 | 6E-07 | 6E-07 | 4E-07 | 2.E-06 |
| | | Exposure Point Total | | | | | | 0.1 | | | | 2.E-06 |
| | Exposure Medium Total | | | | | | | 0.1 | | | | 2.E-06 |
| Soil Total | | | | | | | | 0.1 | | | | 2.E-06 |
| Receptor Total | | | | | | | Receptor HI Total | 0.1 | | | Receptor Risk Total | 2.E-06 |

| | |
|---|---|
| Total Liver HI Across All Media = | 0.0006 |
| Total Kidney HI Across All Media = | 0.0004 |
| Total Mortality HI Across All Media = | 0.0003 |
| Total Immune HI Across All Media = | 0.04 |
| Total Blood HI Across All Media = | 0.02 |
| Total Body Weight HI Across All Media = | 0.0003 |
| Total Skin HI Across All Media = | 0.002 |

Notes:
NA – Not available
NI – No information

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Table 9-2. Summary of Receptor Risks and Hazards for COPCs - Future Utility Worker Exposure to Access Road Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Receptor Population: Utility Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Non-Carcinogenic Hazard Quotient | | | | | Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Soil | Soil | Access Road | Polychlorinated Biphenyls | | | | | | | | | |
| | | | Total PCBs | immune system | 3.3E-02 | — | 3.0E-02 | 6.3E-02 | 4.7E-07 | 2.2E-11 | 4.3E-07 | 9.0E-07 |
| | | | Arsenic | skin | 3.8E-03 | 6.4E-06 | 7.6E-04 | 4.6E-03 | 6.1E-07 | 2.9E-10 | 1.2E-07 | 7.4E-07 |
| | | | Cadmium | kidney | 3.1E-03 | 2.6E-05 | 8.3E-04 | 4.0E-03 | 4.3E-07 | 3.4E-10 | 1.1E-07 | 5.4E-07 |
| | | | Chromium | NI | 5.5E-05 | 1.4E-04 | — | 1.9E-04 | — | 5.9E-08 | — | 5.9E-08 |
| | | | Cyanide | NI | 4.5E-05 | 6.0E-09 | — | 4.5E-05 | — | — | — | — |
| | | | Carbon | NA | — | — | — | — | — | — | — | — |
| | | | Chemical Total | | 4.0E-02 | 1.7E-04 | 3.2E-02 | 7.2E-02 | 1.5E-06 | 6.0E-08 | 6.7E-07 | 2.2E-06 |
| | | Exposure Point Total | | | | | | 0.07 | | | | 2.E-06 |
| | Exposure Medium Total | | | | | | | 0.07 | | | | 2.E-06 |
| Soil Total | | | | | | | | 0.07 | | | | 2.E-06 |
| Receptor Total | | | | | | | Receptor HI Total | 0.07 | | | Receptor Risk Total | 2.E-06 |

| | |
|---|---|
| Total Immune HI Across All Media = | 0.06 |
| Total Skin HI Across All Media = | 0.005 |
| Total Kidney HI Across All Media = | 0.004 |

Notes:
NA – Not available
NI – No information

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Table 9-3. Summary of Receptor Risks and Hazards for COPCs - Future Construction Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Non-Carcinogenic Hazard Quotient | | | | | Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| Soil | Soil | Bethpage Park | Volatile Organic Compounds | | | | | | | | | |
| | | | 1,1,2-Trichloroethane | liver | 2.9E-05 | — | — | 2.9E-05 | 9.5E-11 | 9.8E-10 | — | 1.1E-09 |
| | | | cis-1,2-dichloroethene | NI | 3.4E-04 | 7.4E-02 | — | 7.4E-02 | — | — | — | — |
| | | | Ethylbenzene | liver, kidney | 8.1E-05 | 3.0E-04 | — | 3.8E-04 | 4.0E-10 | 4.3E-09 | — | 4.7E-09 |
| | | | Toluene | kidney | 2.1E-03 | 1.7E-03 | — | 3.8E-03 | — | — | — | — |
| | | | Trichloroethylene | NI | 1.1E-01 | 4.1E-01 | — | 5.2E-01 | 1.3E-08 | 4.7E-07 | — | 4.8E-07 |
| | | | Xylene (total) | body weight; mortality | 7.5E-05 | 5.4E-03 | — | 5.5E-03 | — | — | — | — |
| | | | Semivolatile Organic Compounds | | | | | | | | | |
| | | | bis(2-chloroethyl)ether | NA | — | — | — | — | 9.2E-10 | 4.6E-14 | 3.0E-10 | 1.2E-09 |
| | | | bis(2-ethylhexyl)phthalate | liver | 5.2E-03 | — | 1.7E-03 | 6.9E-03 | 2.1E-08 | — | 6.9E-09 | 2.8E-08 |
| | | | Polycyclic Aromatic Hydrocarbons | | | | | | | | | |
| | | | Benzo(a)anthracene | NI | 1.3E-05 | 6.5E-10 | 5.6E-06 | 1.9E-05 | 4.1E-09 | 1.0E-13 | 1.7E-09 | 5.8E-09 |
| | | | Benzo(a)pyrene | NI | 1.1E-05 | 5.5E-10 | 4.7E-06 | 1.6E-05 | 3.4E-08 | 8.6E-13 | 1.5E-08 | 4.9E-08 |
| | | | Benzo(b)fluoranthene | NI | 1.5E-05 | 7.4E-10 | 6.3E-06 | 2.1E-05 | 4.6E-09 | 1.2E-13 | 2.0E-09 | 6.6E-09 |
| | | | Benzo(k)fluoranthene | NI | 2.0E-05 | 1.0E-09 | 8.6E-06 | 2.9E-05 | 6.3E-10 | 1.6E-14 | 2.7E-10 | 8.9E-10 |
| | | | Chrysene | NI | 2.6E-05 | 1.3E-09 | 1.1E-05 | 3.8E-05 | 8.2E-11 | 2.1E-14 | 3.5E-11 | 1.2E-10 |
| | | | Dibenzo(a,h)anthracene | NI | 2.0E-06 | 1.0E-10 | 8.7E-07 | 2.9E-06 | 6.3E-09 | 1.6E-13 | 2.7E-09 | 9.0E-09 |
| | | | Indeno(1,2,3-cd)pyrene | NI | 4.5E-06 | 2.2E-10 | 1.9E-06 | 6.4E-06 | 1.4E-09 | 3.5E-14 | 6.0E-10 | 2.0E-09 |
| | | | Polychlorinated Biphenyls | | | | | | | | | |
| | | | Total PCBs | immune system | 3.8E-01 | — | 1.8E-01 | 5.6E-01 | 2.2E-07 | 1.0E-11 | 1.0E-07 | 3.2E-07 |
| | | | Metals | | | | | | | | | |
| | | | Antimony | blood | 4.0E-01 | — | — | 4.0E-01 | — | — | — | — |
| | | | Arsenic | skin | 3.0E-02 | 8.0E-06 | 3.0E-03 | 3.3E-02 | 1.9E-07 | 9.3E-11 | 1.9E-08 | 2.1E-07 |
| | | | Barium | kidney | 5.1E-04 | 3.4E-05 | — | 5.5E-04 | — | — | — | — |
| | | | Cadmium | kidney | 1.9E-03 | 1.6E-05 | 2.5E-04 | 2.2E-03 | 1.0E-08 | 8.2E-12 | 1.4E-09 | 1.2E-08 |
| | | | Chromium - Soluble | NI | 6.7E-04 | — | — | 6.7E-04 | — | — | — | — |
| | | | Chromium (Hexavalent Compounds) | NI | 5.7E-03 | 2.9E-05 | — | 5.7E-03 | — | 4.9E-10 | — | 4.9E-10 |
| | | | Copper | NI | 2.4E-04 | 1.1E-08 | — | 2.4E-04 | — | — | — | — |
| | | | Iron | NI | 4.1E-03 | — | — | 4.1E-03 | — | — | — | — |

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Table 9-3. Summary of Receptor Risks and Hazards for COPCs - Future Construction Worker Exposure to Bethpage Park Surface and Subsurface Soil
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Chemical of Potential Concern | Non-Carcinogenic Hazard Quotient | | | | | Carcinogenic Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary Target Organ(s) | Ingestion | Inhalation | Dermal | Exposure Routes Total | Ingestion | Inhalation | Dermal | Exposure Routes Total |
| | | | Lead | NA | — | — | — | — | 7.2E-09 | 2.5E-12 | — | 7.2E-09 |
| | | | Mercury | immune system | 6.9E-04 | 1.2E-07 | — | 6.9E-04 | — | — | — | — |
| | | | Thallium | NI | 1.0E-02 | — | — | 1.0E-02 | — | — | — | — |
| | | | Zinc | blood | 1.4E-02 | 7.1E-07 | — | 1.4E-02 | — | — | — | — |
| | | | Chemical Total | | 1E+00 | 5E-01 | 2E-01 | 1.6 | 5E-07 | 5E-07 | 2E-07 | 1.1E-06 |
| | | Exposure Point Total | | | | | | 2 | | | | 1.E-06 |
| | Exposure Medium Total | | | | | | | 2 | | | | 1.E-06 |
| Soil Total | | | | | | | | 2 | | | | 1.E-06 |
| Receptor Total | | | | | | | Receptor HI Total | 2 | | | Receptor Risk Total | 1.E-06 |

| | |
|---|---|
| Total Liver HI Across All Media = | 0.007 |
| Total Kidney HI Across All Media = | 0.007 |
| Total Mortality HI Across All Media = | 0.006 |
| Total Immune System HI Across All Media = | 0.6 |
| Total Blood HI Across All Media = | 0.4 |
| Total Body Weight HI Across All Media = | 0.006 |
| Total Skin HI Across All Media = | 0.03 |

Notes:
NA – Not available
NI – No information

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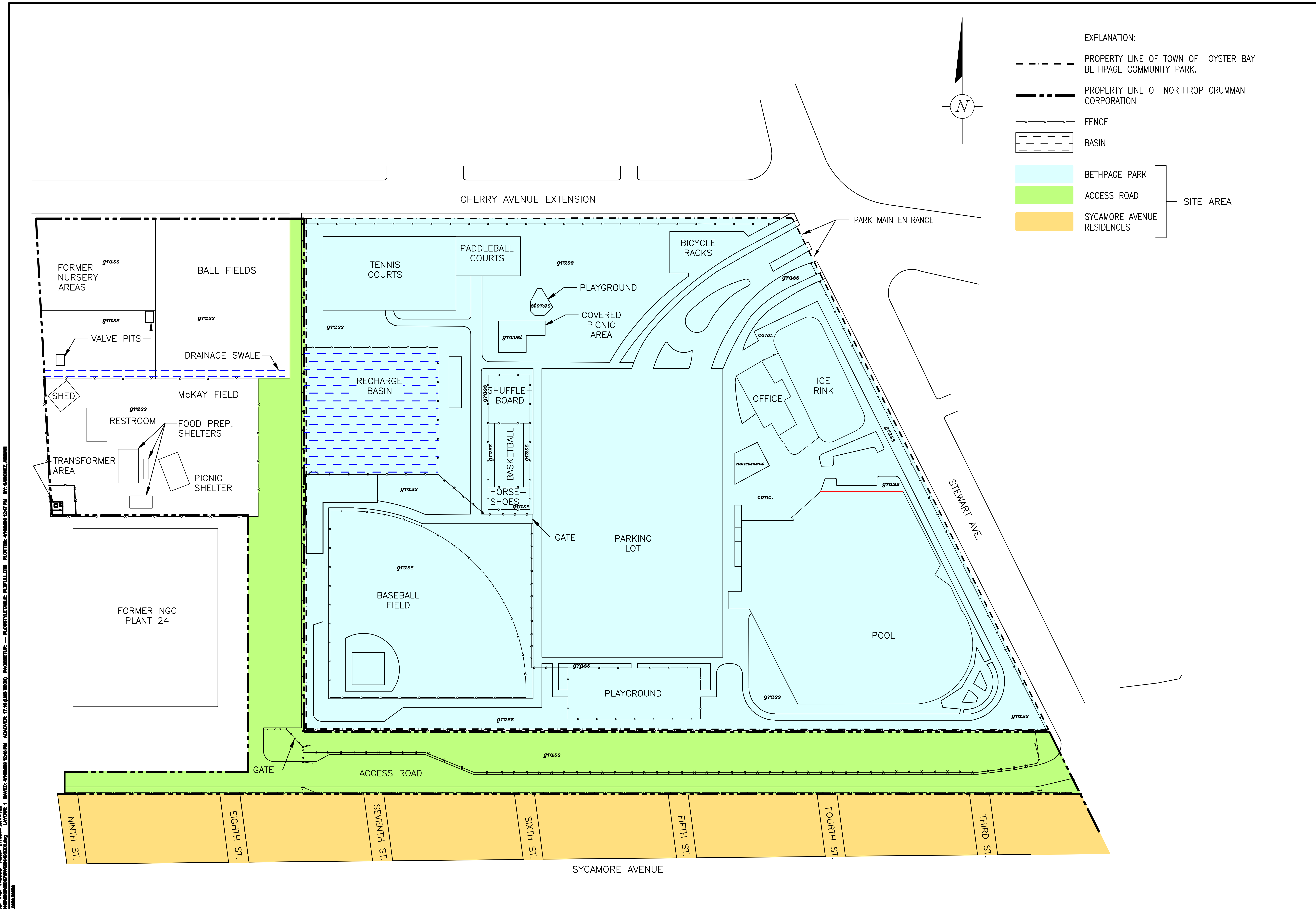
Table 9-4. Summary of Cancer Risks and Non-Cancer Hazards
Human Health Risk Assessment, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York

| Receptor | Exposure Point | Total Cancer Risk (a) | Hazard Index |
|---|---|---|---|
| Utility Worker | Bethpage Park | 2.E-06 | 0.1 |
| | Access Road | 2.E-06 | 0.07 |
| Construction Worker | Bethpage Park | 1.E-06 | <1 (b) |

Notes:

(a) When evaluating potential individual cancer risks, USEPA has established an acceptable risk range of 1 in 1,000,000 ($1 \times 10^{6}$) to 1 in 10,000 ($1 \times 10^{-4}$). All cancer risks are on the low end of USEPA's target risk management range.

(b) All organ-specific HI's were found to be less than the target HI of 1.0.




DRAWING REFERENCE:
DVIRKA AND BARTILUCCI 2003

NORTHROP GRUMMAN SYSTEM CORPORATION
BETHPAGE, NEW YORK
**OPERABLE UNIT 3**
**FORMER GRUMMAN SETTLING PONDS**

**SITE AREA**

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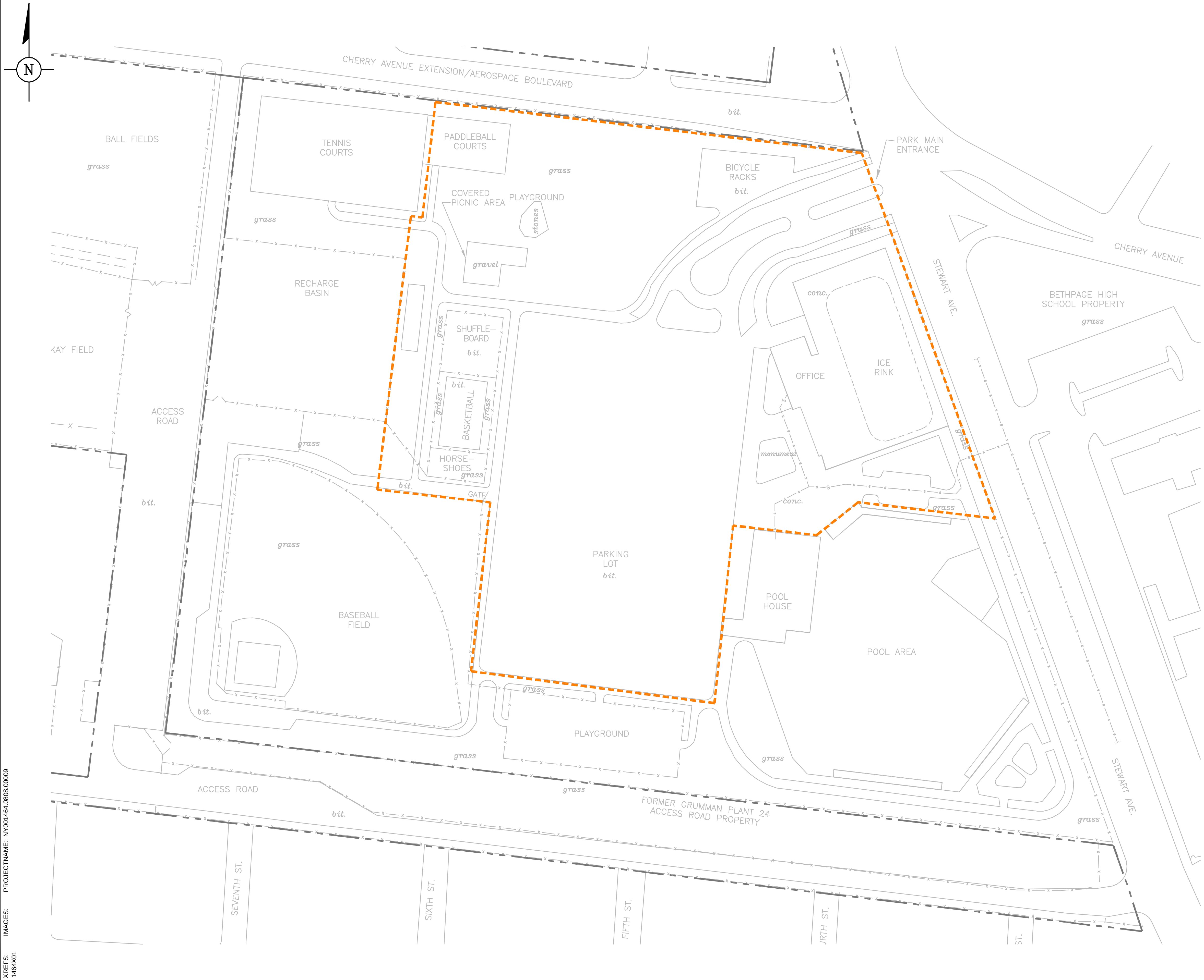
FIGURE
**1**




EXPLANATION

- NORTHROP GRUMMAN PROPERTY LINE
- FENCE
- bit. BITUMINOUS PAVEMENT
- APPROXIMATE LIMITS OF TOWN OF OYSTER BAY INTERIM REMEDIAL MEASURES

NOTES:

1. PARK FEATURES SHOWN WERE PRESENT PRIOR TO TOWN OF OYSTER BAY REDEVELOPMENT IN 2005.

0 60' 120'
SCALE IN FEET

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

**OPERABLE UNIT 3**
**FORMER GRUMMAN SETTLING PONDS**

**TOWN OF OYSTER BAY**
**INTERIM REMEDIAL MEASURES**

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FIGURE
**2**

CITY:MELVILLE-NY DIV/GROUP:ENVcad DB:AS LD:AS PIC: PM:CSG TM:SM LYR:ON=*;OFF=*REF*
G:\APROJECT\Northrop Grumman\Cadd\OU3\2009\NY001493\0809\00007\DWG\090416 01493G02.dwg LAYOUT: 2SAVED: 4/16/2009 12:50 PM ACADVER: 17.1S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: ARCADIS_MELVILLE.CTB PLOTTED: 4/16/2009 12:51 PM BY: SANCHEZ, ADRIAN
XREFS: 1464X01 IMAGES: PROJECTNAME: NY001464.0808.00009

CITY:MELVILLE-NY DIV/GROUP:141 DB:AS GHS LD:AS PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF* G:\APROJECT\Northrop Grumman\Cadd\OU3\2009\NY001493\0809\00007\DWG\090416 01493G03.dwg LAYOUT: 3SAVED: 4/16/2009 12:55 PM ACADVER: 17.1S (LMS TECH) PAGESETUP: ----PLOTSTYLETABLE: ARCADIS_MELVILLE.CTB PLOTTED: 4/16/2009 1:27 PM BY: SANCHEZ, ADRIAN

XREFS: 1464X01 IMAGES: PROJECTNAME: ----


LEGEND:

- NORTHROP GRUMMAN PROPERTY LINE
- FENCE
- bit. BITUMINOUS PAVEMENT
- EXTENT OF METALS IN SOIL (ABOVE RESTRICTED-RESIDENTIAL CLEANUP OBJECTIVE)
- EXTENT OF PCBs IN SOIL (ABOVE RESTRICTED-RESIDENTIAL CLEANUP OBJECTIVE)
- EXTENT OF VOCs IN SOIL (ABOVE RESTRICTED-RESIDENTIAL CLEANUP OBJECTIVE)
- MP MP EXTENT OF METALS AND PCBs IN SOIL
- PV PV EXTENT OF PCBs AND VOCs IN SOIL
- EXTENT OF METALS, PCBs AND VOCs IN SOIL
- APPROXIMATE LIMITS OF TOWN OF OYSTER BAY IRM PROGRAM
- PCB POLYCHLORINATED BIPHENYL
- VOC VOLATILE ORGANIC COMPOUND
- BGS BELOW GROUND SURFACE

NOTES:

1. PARK FEATURES SHOWN WERE PRESENT PRIOR TO TOWN OF OYSTER BAY REDEVELOPMENT IN 2005.

NORTHROP GRUMMAN SYSTEMS CORPORATION
BETHPAGE, NEW YORK

**EXTENT OF BETHPAGE PARK SOILS ASSUMED TO BE REMOVED 0-2 FEET BELOW GROUND SURFACE**

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FIGURE
3