SECTION 4

SUMMARIES OF RISK ASSESSMENTS

4.1 POST-REMEDIATION QUANTITATIVE HUMAN HEALTH RISK ASSESSMENT FOR AOC 2

4.1.1 A post-remediation quantitative HHRA was prepared by Parsons for the USACE as part of the RI for AOC 2, the Former Bivouac Area/Post Commander's Landfill. The specific objective of this HHRA is to provide a quantitative risk assessment of the soil remaining at AOC 2 following the non-time critical removal action that was conducted in 2005-2006. The HHRA is intended to determine whether the removal action effectively eliminated unacceptable human health risks, and whether the soil at AOC 2 is safe for continued residential use.

4.1.2 Techniques and methodologies developed or recognized by the USACE and the USEPA were used in this quantitative HHRA. The HHRA was performed to satisfy USACE requirements under the FUDS program. A summary of the post-remediation HHRA at AOC 2 is presented in this section. The full HHRA report can be found in Appendix A1.

4.1.3 This quantitative post-remediation HHRA uses the results of the confirmatory soil data collected after the soil removal was completed at AOC 2. After waste materials and impacted soils were excavated, confirmatory soil samples were collected and analyzed for specific analyte groups, including SVOCs, VOCs, metals, pesticides/herbicides and PCBs. If analyte concentrations exceeded the NYSDEC recommended soil cleanup objectives (hereafter referred to as "NYSDEC criteria"), the excavation resumed and additional confirmatory soil samples were collected until the sample concentrations either did not exceed NYSDEC criteria, or achieved an asymptotic level, and/or a justification was offered to demonstrate that background conditions were apparent.

4.1.4 The waste and soil excavation at AOC 2 occurred in 2005 and 2006, and was performed by Shaw Environmental, Inc (Shaw). Shaw also conducted the confirmatory soil sampling and arranged for laboratory analyses. In addition to the areas of waste and impacted soils identified during the RI, several areas within AOC 2 were identified as Areas of Interest (AOIs) during the remedial action because they appeared to be contaminated. Shaw collected soil samples to characterize each AOI. If concentrations exceeded NYSDEC criteria, soil excavation was conducted in the AOI. After the excavation was completed, confirmatory soil samples were collected and analyzed, as previously described.

4.1.5 After comparing post-remediation sample concentrations to NYSDEC criteria for soil, a risk ratio approach was used to quantify potential risk. USEPA Region 6 risk-based human health medium-specific screening levels (MSSL) were used in the risk ratio analysis to quantify potential risk from exposure to contaminants in soil. The risk ratio analysis quantifies the potential cancer risk and the potential non-cancer hazard as applicable to each individual chemical in soil. The chemical ratios are then summed to determine cumulative cancer risk and non-cancer hazard.

4.1.6 Initially, the maximum concentrations for each chemical of potential concern (COPC) were used as the exposure point concentrations (EPC) to calculate risk. Use of maximum concentrations provides a conservative (*i.e.*, most health-protective) estimate of exposure to that chemical. If an unacceptable risk was calculated using the maximum detected concentration of a particular chemical, then the 95 percent upper confidence limit (95% UCL) was calculated for that chemical and subsequently used in the risk ratio calculations. The 95% UCLs were calculated using the percentile bootstrap method assuming a non-parametric distribution for the concentrations of each chemical.

4.1.7 Based on USEPA (1989) *Risk Assessment Guidance for Superfund* (RAGS) and supplemental guidance related to data evaluation, the list of COPCs can be refined during the initial screening steps. One of the steps is to eliminate essential nutrients from the HHRA. Thus, results for calcium, magnesium, potassium, iron and sodium were removed from the COPC list and were not considered further in the HHRA.

4.1.8 The only other chemical that was not quantified using the risk ratio approach was lead. USEPA guidance calls for lead to be evaluated based on blood lead levels and not the potential for cancer or non-cancer risks. Therefore, lead concentrations detected at the site were directly compared to the screening criteria. For soil, both the residential and the commercial/industrial screening values for lead were used. If lead concentrations at the site exceed the criteria, then unacceptable risk may occur. If lead concentrations are lower than the criteria, then there is no unacceptable risk.

Completed Exposure Pathways

4.1.9 AOC 2 is currently a residential property, and is expected to remain a residential property. The completed exposure pathways for the HHRA at AOC 2 are listed below. The exposure pathways that were evaluated in the risk ratio analysis are also described below.

4.1.10 Exposure to soil may occur via direct contact and via wind dispersion of soil and associated contaminants. The receptors and pathways evaluated for soil are listed below:

- Incidental ingestion of surface soil, inhalation of volatiles from surface soil, and dermal contact with surface soil by a current resident. This provides the most conservative risk assessment (*i.e.*, most health protective evaluation).
- Incidental ingestion of surface soil, inhalation of volatiles from surface soil, and dermal contact with surface soil by a future outdoor worker. This is a potentially complete exposure pathway but is not included separately in the risk ratio analysis because it is assumed to be conservatively evaluated under the current resident scenario.
- Incidental ingestion of surface soil, inhalation of volatiles from surface soil, and dermal contact with surface soil by a future resident. This is a potentially complete exposure pathway but is not included separately in the risk ratio analysis because it is assumed to be conservatively evaluated under the current resident scenario.

4.1.11 In addition to soil exposure, current and future residents may be exposed to groundwater. Exposure to groundwater may occur through ingestion if used as a residential water supply source, and through inhalation of volatiles from groundwater. Even before the remedial action, the residence at AOC 2 was not expected to be affected by vapor intrusion from the source area at AOC 2 because the residence is located more than 500 feet upgradient of the source area, the residential well was sampled during the RI and did not contain VOCs, and there is a small hill between the former source area and the residence that prevents surface water from flowing from the source area toward the residence.

4.1.12 The site is currently a residential property. There was a water supply well on the property, but drinking water for the property is now supplied by the Town of Guilderland public water supply. There are two private wells located on adjacent property that are also no longer in use.

4.1.13 The exposure pathway of concern is the domestic use of groundwater in the area. Although site groundwater is not currently used as a water supply at AOC 2, homes northwest, west, and southwest of AOC 2 currently use private wells. In addition, future groundwater use at, or downgradient of, the site is unknown.

4.1.14 The groundwater pathway was not included in the post-remediation HHRA because post-remediation groundwater data were not yet available. Additional groundwater data are being collected to assess the post-remediation groundwater quality. A post-remediation HHRA for the groundwater pathway will be completed and issued as a supplement to this RI Report during 2008.

Post-Remediation Risk Summary for AOC 2

4.1.15 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to soil following the remedial action at AOC 2. All potentially complete exposure pathways for the site were evaluated, or were assumed to be evaluated based on more protective exposure scenarios (*e.g.*, the residential scenarios provide very conservative estimates for standard worker scenarios).

4.1.16 For soils, no unacceptable risks were calculated for the non-carcinogenic or carcinogenic chemicals and metals detected in soils at AOC 2 (Table 4.1 and Figures 4.1 and 4.2). The cumulative non-carcinogenic and carcinogenic risk ratio results were 0.84 and 8.0×10^{-7}, respectively. These results are below the threshold cumulative non-carcinogenic risk ratio of 1 (one) and below USEPA's recommended risk range of 10^{-6} to 10^{-4}, indicating no unacceptable risk is expected at AOC 2.

4.1.17 A post-remediation HHRA for the groundwater pathway will be completed and issued as a supplement to this RI Report during 2008.

4.2 POST-REMEDIATION QUANTITATIVE HUMAN HEALTH RISK ASSESSMENT FOR AOC 3

4.2.1 A post-remediation HHRA has been prepared by Parsons as part of the RI for AOC 3 to assess whether unacceptable cancer or non-cancer risks exist following the site remediation. AOC 3 is the former Burn Pit Area, located near the north end of the former SADVA. The former Burn Pit Area is less than 10 acres in size. The AOC is adjacent to two warehouses located on the former SADVA property. The site is also adjacent to the west and northwest fence lines of SADVA, near the Guilderland Central School grounds and the new school bus maintenance garage that borders the former SADVA. Historical aerial photographs and former employee interviews indicate that AOC 3 was used for waste burning and/or disposal. Historical air photos for SADVA tend to confirm the presence of a disposal area where materials were burned or otherwise disposed. The historical records and photographs suggest the area has been the site of numerous dump areas and pits, and scarred areas that are thought to have been locations where wastes were burned. This area was the subject of an interim remedial action in 2002-2003. Also, evidence of DoD disposal actions were found on the Guilderland Central School property proximate to the northwest fence line of AOC 3. An emergency removal action of those disposed items, along with impacted soils, took place in 2002.

4.2.2 The RI data assessment for AOC 3 compared all chemicals detected in soil and groundwater to applicable and available NYSDEC soil and groundwater quality criteria. Site-specific background samples were also collected for the environmental media and were used in conjunction with the NYSDEC criteria to evaluate the nature and extent of contamination. Numerous chemicals were found to exceed the NYSDEC and/or background criteria for soil and groundwater. Based on these results, remediation was performed at the site to address the identified contamination.

4.2.3 The site has been remediated based on results of the Focused Feasibility Study (FFS) and Interim Action Plan prepared by Parsons in 2002. Based on conclusions identified in the FFS and Interim Action Plan, it was recommended that Remedial Alternative 3 (Containment, Soil Removal, and Offsite Disposal) be implemented to remediate this AOC. Results of "confirmatory" soil sampling (endpoint soil samples from excavation pits) and groundwater monitoring following site remediation have been used in this HHRA to assess whether unacceptable cancer or non-cancer risks exist following the site remediation.

4.2.4 The specific objective of this HHRA is to provide a quantitative post-remediation risk evaluation of the soil and groundwater at the site. The HHRA will determine if there is potential unacceptable risk to human health associated with exposure to these environmental media based on post-remediation sampling data, and whether the remedial alternative performed at the site adequately mitigated potential unacceptable risks that existed prior to the remediation.

4.2.5 Techniques and methodology developed or recognized by the USACE and the USEPA were used for this quantitative post-remediation HHRA. This HHRA is intended to satisfy USACE requirements for RI projects.

Risk Ratio Analysis

4.2.6 After comparing the confirmatory sample concentrations to NYSDEC criteria for soil and groundwater, the risk ratio approach was used to quantify potential risk. USEPA Region 6 risk-based human health medium-specific screening levels (MSSL) were used in the risk ratio analysis. The risk ratio analysis provides quantification of the potential cancer risk and the potential non-cancer hazard as applicable to each individual chemical in the soil and groundwater. The chemical ratios were then summed to determine cumulative risk for each environmental media.

4.2.7 For soil samples, the maximum chemical concentrations detected in all samples were used as the initial exposure point concentrations (EPC) to calculate risk. Use of the maximum concentration provides a conservative (*i.e.*, most health-protective) estimate of exposure to a particular chemical. If unacceptable risk was calculated based on the maximum detected concentration of a particular chemical, then the 95 percent upper confidence limit (95% UCL) was calculated for that chemical and used in the risk ratio approach. The 95% UCL was calculated using the percentile bootstrap method assuming a non-parametric distribution for the particular chemical (*i.e.*, analyte). A minimum of 10 samples per analyte is needed for purposes of calculating the 95% UCL. A total of 37 endpoint (or confirmatory) samples were collected from the bottoms of the excavation areas at the site, to demonstrate whether all contaminated soil had been removed. Those samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals; however, the analytical suites varied based on the nature of debris in the excavation areas and supporting data collected during the excavation activities. Thus, the number of samples for each individual chemical varied.

4.2.8 For groundwater, maximum detected concentrations were used as the initial EPCs to calculate risk. If unacceptable risk was calculated based on the maximum detected concentration of a particular chemical, then the analytical results for each chemical that was a significant contributor to the risk was plotted against the sampling date. The graph that was generated was used to conduct a qualitative trend analysis for each well. For chemicals where there was an obvious downward (or upward) trend, the latest detected concentration was used as the EPC. For chemicals where there was only one detection, or where there was no obvious trend, the mean concentration was calculated. For each sample that was undetected, half of the detection limit was used in calculating the mean concentration. A total of 62 groundwater samples were collected from seven monitoring wells at and near AOC 3. This included sampling at six monitoring wells on a quarterly basis beginning in September/December 2003 and continuing through June/July 2005, with another two rounds of sampling in August and November 2006. One additional monitoring well (MW-9) was also sampled in August and November 2006. Samples collected between September/December 2003 and June/July 2005 were analyzed for VOCs, PCBs, and lead. Samples collected in 2006 were analyzed for VOCs and lead.

4.2.9 For the chemicals detected at the site, only lead was not quantified using the risk ratio approach. Following USEPA guidance, lead should be evaluated based on blood lead levels and not the potential for cancer or non-cancer risks. Therefore, lead concentrations detected at the site were directly compared to the screening criteria. For groundwater, the USEPA maximum contaminant level (MCL) for lead was used as the screening value. Note that the MCL is

15 µg/L, while the NYSDEC Class GA groundwater standard for lead is 25 µg/L. For soil, both the residential and the commercial/industrial screening values for lead were used. If lead concentrations at the site exceed the criteria, then unacceptable risk may occur. If lead concentrations are lower than the criteria, then there is no risk.

4.2.10 USEPA guidance allows elimination of chemicals of potential concern (COPC) if they are detected in fewer than 5 percent of the samples in a particular medium. This would require at least 20 samples (*i.e.*, 1 detect out of 20 samples equals 5 percent). For this HHRA, detection frequency was qualitatively reviewed following the risk ratio analysis and only on a case by case basis (*e.g.*, chemicals driving an unacceptable risk are identified and then detection frequency is reviewed). Thus, chemicals were not initially screened from the HHRA based on detection frequency.

Completed Exposure Pathways

4.2.11 AOC 3 is located between two warehouses at the northern end of the former SADVA property. Current land use at the site is commercial/industrial and includes indoor workers at the warehouses and outdoor workers that infrequently visit the site (*e.g.*, outdoor workers that maintain the site, such as keeping the site mowed, or outdoor workers that conduct site sampling activities). The site is also adjacent to the west and northwest fence lines of SADVA. Off site and adjacent to the fence lines are the Guilderland Central School grounds and the recently constructed bus maintenance garage for the Guilderland School District. Residential property is located further to the west and north of this area. Because groundwater is shallow and flows in a northwesterly direction, there may be a potential for VOCs to volatilize from shallow groundwater into enclosed buildings (*e.g.*, warehouses, school, and homes).

4.2.12 Based on future land use plans at SADVA, as described in the Master Plan and the Northeastern Industrial Park Generic Environmental Impact Statement (NEIP EIS) (June 2005), the AOC 3 site will remain commercial/industrial. To the south of AOC 3 and south of the southernmost warehouse, the Master Plan indicates an area for future development (including a motel, diner, convenience store, tractor-trailer spaces with hook-ups, and fuel station). This area of development is upgradient of AOC 3. The Master Plan indicates that AOC 3 will not be converted to residential use.

4.2.13 The completed exposure pathways for the HHRA at AOC 3 are listed below. The exposure pathways that were evaluated in the risk ratio analysis are also described below.

Mixed Soil

4.2.14 Soil samples evaluated for this HHRA were the endpoint soil samples collected from six excavation areas (three areas at AOC 3 and three areas at the new Guilderland School Bus Garage where additional soil excavation occurred). The endpoint samples were generally collected between 8 and 20 feet below ground surface, although one excavation area was only 6 inches deep. All endpoint samples were combined for purposes of this HHRA and represent a mixed soil exposure interval. Because this is a post-remediation risk assessment, the concentrations of chemicals remaining in place at the site (*i.e.*, excavation endpoint samples) were used to quantify potential risk. No pre-excavation samples, surface soil samples (*e.g.*, fill samples), or composite samples were used in this HHRA.

4.2.15 The mixed soil exposure scenarios for this HHRA include the following:

- Incidental ingestion of mixed soil, inhalation of volatiles from mixed soil, and dermal contact with mixed soil by an outdoor worker. This calculation assumes an exposure frequency of 225 days per year and an exposure duration of 25 years. Thus, it provides a conservative evaluation (*i.e.*, most health protective evaluation) for a potential current and/or future outdoor worker. It is also very protective of a current and/or future indoor worker because indoor worker exposure to mixed soil would be much less.

- Although the site is not residential and will not be converted to residential use based on the Master Plan, a residential pathway was shown for comparative purposes. Thus, incidental ingestion of mixed soil, inhalation of volatiles from mixed soil, and dermal contact with mixed soil by a future resident were calculated. This provides the most conservative risk evaluation than for other types of receptors and thus is protective of worker exposure scenarios. Since the residential pathway is not a complete exposure pathway, it is considered to be hypothetical and used for comparison only.

Groundwater

4.2.16 The groundwater exposure scenarios for this HHRA include the following:

- AOC 3 is located near the north and west boundaries of the former SADVA where groundwater flow is in a northwesterly direction. In this area of SADVA, the general depth to groundwater in the upper zone/unconfined layer is approximately 24 feet. There is no known use of groundwater in this area. The former SADVA is supplied by the Town of Guilderland Water Department, as are most residents north and west of SADVA. The Guilderland Central School previously used groundwater from the Guilderland School supply well, located downgradient of AOC 3, for irrigation of school grounds and athletic fields; however, the school has not utilized this well for several years. Although groundwater is not known or expected to be used in the area, there may still be a few homes or businesses near SADVA that use private wells for drinking water or other purposes. Because of this, a conservative evaluation of residential use of groundwater was included in the HHRA (*i.e.*, the USEPA residential "tap water" screening level is used in the risk ratio analysis). The routes of exposure include ingestion of groundwater as drinking water and inhalation of volatiles from use of groundwater in the home (*e.g.*, showering, laundering, and dish washing). The residential pathway is protective of worker exposure scenarios.

4.2.17 To evaluate the potential for VOCs to volatilize from shallow groundwater into a building (*e.g.*, warehouses, school, homes), the maximum detected groundwater concentrations were directly compared to USEPA target groundwater concentrations. The target groundwater concentrations are calculated to correspond to target indoor air concentrations assuming that VOCs in groundwater may be intruding into indoor air. The target groundwater concentrations are designed to ensure protection of the public in a residential setting, and thus provide a conservative evaluation for a current and/or future indoor worker at the warehouse, or a student at the Guilderland Central School.

Risk Summary for AOC 3

4.2.18 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to contaminated media at AOC 3. All potentially complete exposure pathways for the site were evaluated or were assumed to be evaluated based on more protective exposure scenarios (*e.g.*, the residential scenarios provide very conservative estimates for standard worker scenarios).

Mixed Soil

4.2.19 No unacceptable risks were calculated for the carcinogenic chemicals detected in mixed soils. The cumulative carcinogenic risk ratio results were 6.48 x 10^{-7} and 2.28 x 10^{-7} for the residential and industrial receptors, respectively (Table 4.2). These results are below the USEPA's acceptable risk range of 1x 10^{-4} to 1x10^{-6} (Figure 4.3)

4.2.20 For the non-carcinogenic chemicals detected in mixed soils, there was no unacceptable risk for potential industrial or residential receptors (Table 4.2). The cumulative non-carcinogenic risk ratio result for the industrial receptor was 0.003. For the potential residential receptor, the cumulative non-carcinogenic risk ratio was 0.01. These values are both below the USEPA's acceptable non-carcinogenic risk ratio of 1.0 (Figure 4.4).

Groundwater

4.2.21 The calculated risks for groundwater were evaluated for individual wells (see Tables 4.3 through 4.9 and Figure 4.3 for carcinogenic risk results). Carcinogenic risks were within the USEPA's acceptable range for MW-1, MW-3, MW-4-2, MW-5, and the Supply Well. Unacceptable carcinogenic risks were calculated for MW-2 and MW-9. The risk at MW-2 was driven almost entirely by 1,2,3-trichloropropane, which was detected at an estimated concentration far below the NYSDEC Class GA groundwater quality criterion during one sampling event in September 2004, and has not been detected in any samples since that time. The carcinogenic risk for MW-2 when 1,2,3-trichloropropane is not included in the cumulative risk is 7.0 x 10^{-5}, which is within the USEPA's acceptable range of carcinogenic risk. At MW-9, carcinogenic risks were based on the two samples collected in 2006, and the risk is driven entirely by trichloroethene (TCE). Non-carcinogenic risks were within the USEPA's acceptable range for all wells at the site (Tables 4.3 through 4.9 and Figure 4.4). For all wells where lead was tested, a general downward trend, combined with concentrations below the screening criterion, indicate that lead does not pose an unacceptable risk in groundwater.

4.2.22 Screening criteria to evaluate vapor intrusion of VOCs from shallow groundwater into buildings were based on USEPA (2002) target groundwater concentrations. The USEPA target groundwater concentrations are calculated to correspond to target indoor air concentrations that are protective of (residential) human health if vapor intrusion occurs. The calculated risks of vapor intrusion were evaluated for each individual well at AOC 3. All wells except MW-9 pose no unacceptable risk. In MW-9, the EPC for TCE exceeds the USEPA screening value (Table 4.10). The calculated risks at MW-9 are based on only two samples collected in 2006. MW-9 is in an open area located about 600 feet downgradient of the NEIP warehouse at AOC 3, and about 300 feet from the old Guilderland School District bus garage where the Supply Well is located. There appears to be no unacceptable risk for vapor intrusion of VOCs into the existing buildings at AOC 3. USACE will continue to sample well MW-9 annually for a period of five years, and will continue to monitor the results for this well as new data are collected. Note that the target screening concentrations are derived to ensure protection of a residential receptor, and thus provide an overly conservative evaluation for the current and/or future worker exposure scenarios expected for the site.

4.3 QUANTITATIVE HUMAN HEALTH RISK ASSESSMENT FOR AOC 1 AND AOC 7

4.3.1 A quantitative HHRA has been prepared by Parsons for the USACE as part of the RI for AOCs 1 and 7 combined, both of which are located in the southeastern portion of the former SADVA. AOC 1 is the former U.S. Army Southern Landfill and AOC 7 is the Triangular Disposal Area. A complete report of this HHRA can be found in Appendix J.

4.3.2 AOCs 1 and 7 are being combined as a single site in this HHRA because the areas are nearly contiguous. The specific objective of this HHRA is to provide a quantitative risk assessment of the soil, groundwater, sediment and surface water at the site. The HHRA will determine if there is potential risk to human health associated with exposure to these environmental media, and whether future action will be required to address any potential risk. The HHRA results may be used to support the evaluation and selection of a remedial action alternative(s) for controlling impacts on soil, groundwater, sediment and surface water related to former waste activities at the site.

4.3.3 The RI prepared by Parsons for USACE for AOCs 1 and 7, and the Malcolm Pirnie 1997 RI for AOC 1, compared all chemicals detected in soil, groundwater, sediment and surface water to applicable and available NYSDEC criteria. Site-specific background samples were also collected for each of the environmental media and were used in conjunction with the NYSDEC criteria to evaluate the nature and extent of contamination. Numerous chemicals were found to be above the NYSDEC and/or background criteria for each environmental media. Based on these results, this HHRA is needed to evaluate the potential impact of exposure to contaminants found in soil, groundwater, sediment and surface water at AOCs 1 and 7.

4.3.4 Buried drums, construction and demolition (C&D) debris, ash, metal debris, chemical solvent odors, floating product, and oil-saturated sand above the water table have been observed in test pits in the AOC 1 landfill area. The fill at AOC 1 consists of black ash, slag, metallic debris, steel cable, C&D material, wood, asphalt, red brick, black fill, and sludge-like materials.

A small amount of fill was encountered in the test pits at AOC 7. The fill at AOC 7 consisted of railroad ties, charred wood, angular gravel, glass bottles, black stain, and asphalt. These sources of contamination have released contaminants into environmental media at the site. Contamination of the surface and subsurface soil, groundwater, sediment and surface water has occurred.

4.3.5 Techniques and methodology developed or recognized by the USACE and the USEPA were used for this quantitative HHRA. USACE requires that an HHRA be performed during the RI project phase.

4.3.6 After comparing RI sample concentrations to NYSDEC criteria for soil, groundwater and surface water, the risk ratio approach was used to quantify potential risk. USEPA Region 6 risk-based human health MSSLs were used in the risk ratio analysis. The Region 6 MSSLs were used to quantify potential risk from exposure to contaminants in soil, groundwater, and surface water. Due to the lack of human health screening levels for sediment from the USEPA, and because the NYSDEC criteria for sediment are for protection of aquatic life only, criteria protective of human health were obtained from the Tier 1 sediment protective concentration levels (PCL) developed by the Texas Commission on Environmental Quality (TCEQ). The risk ratio analysis provides a quantification of the potential cancer risk and the potential non-cancer hazard as applicable to each individual chemical in each environmental media. The chemical ratios are then summed to determine cumulative risk for the environmental media.

4.3.7 Initially, maximum detected chemical concentrations were used as the EPC to calculate risk for soil, surface water, and sediment. Use of maximum concentrations provides a conservative (*i.e.*, most health-protective) estimate of exposure to that chemical. If unacceptable risk was calculated based on the maximum detected concentration of a particular chemical, then the 95% UCL was calculated for that chemical and used in the risk ratio approach. The 95% UCLs were calculated using the percentile bootstrap method assuming a non-parametric distribution for the particular contaminants. A minimum of 10 samples is needed for the purposes of calculating the 95% UCL.

4.3.8 An exception to using 95% UCLs was used for the groundwater results. A total of 68 groundwater samples were collected at AOCs 1 and 7. Many of these samples were collected at the same wells during different time frames and not all sampling activities included analyses for a complete suite of analytes. For example, the June 2006 samples were analyzed for VOC and other discrete water chemistry parameters related to natural attenuation. These types of samples were collected because the purpose of the sampling was to further characterize the VOC plume previously identified in the area. Therefore, SVOC, pesticides, PCBs and metals were not included in the analysis. The EPC for groundwater was the detected concentration, if only one sample was collected from a well. For wells with two sampling events, the average concentration was used as the EPC, unless there was only one detected concentration in the two sampling events. In the latter case, the detected concentration was used as the EPC. In wells with 3 sampling events, for each detected analyte, the data was inspected to determine if there was a consistent downward or upward trend. If there was a consistent downward or upward trend, the latest concentration was used as the EPC. If there were three detected concentrations, and no obvious trend, the average concentration was used as the EPC. For wells where a duplicate sample was collected, the highest result of the primary or duplicate sample was used as the EPC.

4.3.9 Based on USEPA (1989) *Risk Assessment Guidance for Superfund* (RAGS) and supplemental guidance related to data evaluation, the list of COPCs can be refined during initial screening. One of the steps is to screen essential nutrients from the HHRA. Thus, results for calcium, magnesium, potassium, iron and sodium were removed from the COPC list and were not considered further in the HHRA.

4.3.10 The only other chemical that was not quantified using the risk ratio approach was lead. Following USEPA guidance, lead is evaluated based on blood lead levels and not the potential for cancer or non-cancer risks. Therefore, lead concentrations detected at the site were directly compared to the screening criteria. For groundwater and surface water, the USEPA MCL for lead is used as the screening value. For soil, both the USEPA Region 6 residential and the commercial/industrial screening values for lead are used. If lead concentrations at the site exceed the criteria, then unacceptable risk may occur. If lead concentrations are lower than the criteria, then there is no unacceptable risk.

4.3.11 USEPA guidance allows elimination of COPCs if they are detected in fewer than 5 percent of the samples in a particular medium. This would require at least 20 samples (*i.e.*, 1 detect out of 20 samples equals 5 percent). For this HHRA, detection frequency was qualitatively reviewed following the risk ratio analysis and only on a case by case basis (*e.g.*, infrequently detected chemicals that are driving an unacceptable risk). Thus, chemicals were not initially screened from the HHRA based on detection frequency.

Completed Exposure Pathways

4.3.12 AOCs 1 and 7 are currently vacant and located in a remote area of NEIP that has limited access. Current land use includes infrequent visits to the site, such as those that would be performed during site sampling investigations. Based on future land use plans at NEIP as described in the NEIP Generic Environmental Impact Statement (EIS) dated June 2005, future land use may include commercial development of this portion of the property. The Master Plan discussed in the NEIP EIS indicates that office buildings and parking lots are proposed in the area of AOCs 1 and 7. The Plan identifies three 20,000 square foot (ft^2) offices and two parking areas with a total of 800 parking spaces. The AOC 1 and 7 areas will not be converted to residential use, based on the Master Plan.

4.3.13 The completed exposure pathways for the HHRA at AOCs 1 and 7 are listed below. The exposure pathways that were evaluated in the risk ratio analysis are also described below.

Surface Soil

4.3.14 The surface soil exposure pathways are as follows:

- Incidental ingestion of surface soil, inhalation of volatiles from surface soil, and dermal contact with surface soil by an outdoor worker. This calculation assumes an exposure frequency of 225 days per year and an exposure duration of 25 years. Thus, it provides a conservative evaluation (*i.e.*, most health protective evaluation) for a potential future outdoor worker. This evaluation also provides a very conservative evaluation for a current outdoor worker who would have less exposure, since the exposure frequency at the site would be less now than in the future. It is also very protective of a future indoor worker because indoor worker exposure to surface soil would be much less.

- Although the site is not residential and will not be converted to residential use based on the Master Plan, a residential pathway was shown for comparative purposes. Thus, incidental ingestion of surface soil, inhalation of volatiles from surface soil, and dermal contact with surface soil by a future resident were calculated. This provides a more conservative risk assessment than for other types of receptors. Since this is not a complete exposure pathway, it is considered to be hypothetical and used for comparison only.

Mixed (Surface and Subsurface) Soil

4.3.15 For mixed soils, it is generally assumed that surface and subsurface soils are mixed during excavation/construction activities, and that potential exposure to contaminants occurs during the excavation/construction phase, or when contaminants are brought to and remain near the surface.

- For worker exposure, the pathway for mixed soil is evaluated the same as for surface soil (described above).
- For residential exposure, the pathway for mixed soil is evaluated the same as for surface soil (described above).

Groundwater

4.3.16 The groundwater exposure pathways assumptions are as follows:

- AOCs 1 and 7 are located near the southeast boundary of SADVA where groundwater flow is toward the west-southwest. The area to the south of SADVA is composed of agricultural land and scattered country homes and businesses. Although public water is supplied to the area, there may still be homes or businesses that use private wells for drinking water or other purposes. Therefore, a conservative evaluation of residential use of groundwater was included in the HHRA (*i.e.*, the USEPA residential "tap water" screening level is used in the risk ratio analysis). The evaluation uses groundwater data from the site and assumes on-site residential use of groundwater. The routes of exposure include ingestion of groundwater as drinking water and inhalation of volatiles from use of groundwater in the home (*e.g.*, showering, laundering, and dish washing).
- To evaluate the potential for VOCs to volatilize from shallow groundwater into a home or building (*i.e.*, the vapor intrusion pathway), the maximum detected groundwater concentrations were directly compared to USEPA target groundwater concentrations. The target groundwater concentrations are calculated to correspond to target indoor air concentrations, assuming that VOCs in groundwater may be intruding

into indoor air. The target groundwater concentrations are designed to ensure protection of the public in a residential setting, and thus provide a conservative evaluation for a potential future indoor worker.

Sediment

4.3.17 The sediment exposure pathway assumptions are as follows:

- The sediment PCLs are based on incidental ingestion of sediment and dermal contact with sediment by a residential receptor. The residential sediment PCLs provide more conservative values than would be assumed for other types of receptors. Thus, the residential PCLs should be protective for any potential current or future worker scenario.

Surface Water

4.3.18 Surface water in a small pond in AOC 1 was conservatively assumed to be suitable for drinking water. When the pond water level is high, flow from the pond enters a series of ditches leading to a wetland area located to the west. Black Creek flows through this wetland area, and ultimately flows north and west to join the Bozenkill, which flows into the Watervliet Reservoir. SADVA is upgradient of the Watervliet Reservoir, which is a Class A water body suitable for drinking and all other uses. The comparison of the pond samples to Class A criteria was made for information purposes to address Restoration Advisory Board (RAB) concerns that water in Black Creek may make its way to the Watervliet Reservoir drinking water supply. However, the reservoir is approximately 4 miles downstream of AOCs 1 and 7. Note that a separate HHRA was conducted for AOC 8 – Black Creek, and the results from the AOC 8 - Black Creek HHRA do not indicate unacceptable risk from chemicals detected in Black Creek (refer to Appendix K).

4.3.19 With respect to the pond samples from AOC 1, the following statements about the exposure pathways can be made:

- Ingestion of surface water as drinking water and inhalation of volatiles from use of pond water in the home (*e.g.*, showering, laundering, and dish washing) by a current and/or future residential receptor was assumed. For this evaluation, the USEPA residential "tap water" MSSLs were used. These residential screening levels provide the most conservative values (*i.e.*, most health protective values) than for other types of receptors. Thus, the residential screening levels will be protective for potential future workers.

Risk Summary for AOCs 1 and 7

4.3.20 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to contaminated media at AOCs 1 and 7. All potentially complete exposure pathways for the site were evaluated or were assumed to be evaluated based on more protective exposure scenarios (*e.g.*, the residential scenarios provide very conservative estimates for standard worker scenarios).

Surface Soil

4.3.21 No unacceptable risks were calculated for the non-carcinogenic chemicals detected in the surface soils at AOCs 1 and 7. The cumulative non-carcinogenic risk ratio results were 0.94 and 0.26 for the residential and industrial receptors, respectively (Table 4.11 and Figure 4.5). These results are below the cumulative risk ratio of 1 (one) indicating no unacceptable risk is expected.

4.3.22 For the carcinogenic chemicals detected in surface soils, the cumulative carcinogenic risk results were $3.1x10^{-5}$ and $1.0x10^{-5}$ for the residential and industrial receptors, respectively (Table 4.11 and Figure 4.6). These values are within USEPA's acceptable risk range of 10^{-6} to 10^{-4}, therefore, no unacceptable risk is expected.

Mixed Soil

4.3.23 As with surface soils at AOCs 1 and 7, no unacceptable risks were calculated for the non-carcinogenic chemicals detected in the mixed soils at the site. The cumulative non-carcinogenic risk ratio results were 0.72 and 0.16 for the residential and industrial receptors, respectively (Table 4.12 and Figure 4.5). These results are well below the cumulative risk ratio of one, indicating no unacceptable risk occurs for the mixed soil exposure pathways.

4.3.24 For the carcinogenic chemicals detected in mixed soils, the cumulative carcinogenic risk results were $1.7x10^{-5}$ and $6.4x10^{-6}$ for the residential and industrial receptors, respectively (Table 4.12 and Figure 4.6). These values are within USEPA's acceptable risk range of 10^{-6} to 10^{-4}, therefore, no unacceptable risk is expected.

Groundwater

4.3.25 The calculated risks for groundwater were evaluated for each individual well. There were no background concentrations available for groundwater, so the results were qualitatively compared to NYSDEC Class GA groundwater quality criteria prior to the risk ratio calculations,. No analytes were eliminated from consideration in the screening level risk assessment.

Residential Wells

4.3.26 For all of the residential wells except well E5306, there were no unacceptable carcinogenic risks associated with contaminants in the wells. Other than well E5306, the highest carcinogenic risk of the residential wells was 1.1×10^{-6} (well E4801), which is less than the upper end of USEPA's acceptable risk range of 1.0×10^{-4}. The highest cumulative non-carcinogenic risk for any of the residential wells is 0.11 (well E4797), which is significantly less than one, indicating that there is no unacceptable non-carcinogenic risk in any of the residential wells. Figures 4.5a and 4.6a present the non-carcinogenic and carcinogenic risks, respectively, for the residential wells.

4.3.27 For well E5306, the cumulative non-carcinogenic risk (0.0015) is less than one, indicating no unacceptable non-carcinogenic risks (Figure 4.5a). The cumulative carcinogenic risks in well E5306 were 1.8×10^{-4}, which is greater than the upper end of USEPA's acceptable risk range of 1.0 x 10^{-4} (Figure 4.5b). The chemical that is driving the cumulative risk in this well is arsenic, with a detected concentration of 7.9 µg/L. The guidelines of the Safe Drinking Water Act as developed by the USEPA sets a drinking water standard for arsenic at 10 µg/L The safe water drinking water standard is higher than the detected concentration of arsenic at well E5306, indicating that the detected concentration of arsenic in this well is less than the concentration of arsenic allowed in drinking water.

4.3.28 Lead is not assessed in the cumulative risk ratios described above, but is assessed individually. There was lead detected in only one residential well, E4880. The detected concentration of lead in well E4880 exceeded the USEPA screening value by a factor of 3.3, indicating that there is a potential for an unacceptable risk due to lead in well E4880. This well was only sampled in 1990, and it is not known if lead has attenuated in the well since that sampling event. Additionally, well construction was not reviewed to determine if lead pipe was used in the construction of the well. .

Nonresidential Wells

4.3.29 The results of groundwater analyses at nonresidential wells is divided into those wells with calculated non-carcinogenic risk, carcinogenic risk, and risks due to lead.

Non-carcinogenic risks in nonresidential wells

4.3.30 Five nonresidential wells have cumulative non-carcinogenic risks greater than one (Figure 4.5b):

- Well MW-AMW1 has a cumulative non-carcinogenic risk ratio value of 1.6, primarily due to the presence of the VOC cis-1,2-dichlorethene (risk ratio = 1.4). The EPC for cis-1,2-dichlorethene is based on one sample collected in 1996, and because no additional samples have been collected, it is not known if attenuation has occurred at this well.

- Well MW-AMW11 has a cumulative non-carcinogenic risk ratio value of 1.6, primarily due to the presence of several metals (aluminum, antimony, selenium, and vanadium). The EPC for each of the metals is based on 2 samples, which were averaged to determine the final EPC. In all cases, the concentration in the second sample (collected in 2004) was less than the concentration in the first sample (collected in 2001), but without at least one additional sample, it cannot be definitively determined if this is attenuation of contaminant concentrations or simply variation in contaminant concentrations.

- Well AOC7-2AMW-7 has a cumulative non-carcinogenic risk ratio value of 1.8, primarily due to the presence of manganese in the sample. The EPC for manganese is the highest value of the primary and duplicate sample collected at the site, collected in 2000. There is potentially human health risk at this well due to exposure to manganese in drinking water. Since no additional samples have been collected in this well, it is not known if concentrations of manganese have attenuated at this well.

- Well AOC7-HP02 has a cumulative non-carcinogenic risk ratio value of 31, primarily due to the presence of several metals (aluminum, manganese, nickel, thallium and vanadium). The EPC for each of the metals is the detected concentration based on a single sampling event, collected in 2000. This was a temporary wellpoint sample that was suspected to have elevated turbidity; as a result, a permanent well was installed near this location (GW03) and there was no unacceptable risk in that well.

- Well AOC7-HP03 has a cumulative non-carcinogenic risk ratio value of 1.5, primarily due to the presence of two metals (aluminum and manganese). The EPC for each of the metals is the detected concentration based on a single sampling event, colleted in 2000. This was a temporary wellpoint sample that was suspected to have elevated turbidity; as a result, a permanent well was installed near this location (GW02) and there was no unacceptable risk in that well.

Carcinogenic risks in nonresidential wells.

4.3.31 Eighteen nonresidential wells have calculated carcinogenic risk values greater than the upper bound of the CERCLA risk range of 1.0×10^{-4} (Figure 4.6b):

- Well MW-ACE2 has a cumulative carcinogenic risk ratio of 1.7×10^{-2}, primarily due to the VOCs trichloroethene (6×10^{-3}) and vinyl chloride (1.1×10^{-2}), and the metal arsenic (1.3×10^{-4}). The EPC for trichloroethene is based on the average of three sampling events. The first sampling event had a higher concentration than the third (and latest) event, but the second sample collected exhibited a higher concentration than the other two samples. Therefore, there was no obvious trend in the data, and the average was used as the EPC. Additional sampling at the well may reveal that natural attenuation has occurred in the well. A downward trend was observed for vinyl chloride; therefore, the EPC is based on the latest value, indicating that natural attenuation may have occurred in this well. The EPC for arsenic is based on the only sample analyzed for metals collected in 1996 (6 µg/L). The Safe Drinking Water standard of 10 µg/L is greater than the maximum concentration of arsenic in this well, indicating that the detected concentration of arsenic in this well is less than the concentration allowed in drinking water.

- Well MW-AMW1 has a cumulative carcinogenic risk ratio of 1.5×10^{-3}, primarily from the VOC vinyl chloride (1.4×10^{-3}). A downward trend was observed for vinyl chloride; therefore, the EPC is based on the latest value of three sampling events, indicating that natural attenuation may be occurring.

- Well MW-AMW11 has a cumulative carcinogenic risk ratio of 1.6×10^{-3}, primarily due to the presence of arsenic. The EPC is based on the average concentration of two sampling events. The concentration of arsenic in the first sampling event (collected in 2001) is larger than the concentration in the second event (collected in 2004), but without additional sampling, a trend of natural attenuation cannot be verified. Further, the concentration in the second sample collected (15.9 µg/L) is greater than the safe drinking water standard of 10 µg/L, indicating there may be potential risk due to exposure to arsenic in the groundwater at this well.

- Well AMW-104 (a duplicate sample from AMW-1) has a cumulative carcinogenic risk ratio of 2.4×10^{-4}, primarily due to the presence of the VOC vinyl chloride (2.3×10^{-4}). The EPC is based on a single sampling event (collected in 2006).

- Well MW-ACE4 has a cumulative carcinogenic risk ratio of 2.2×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1996). The detected concentration is 10 µg/L, which is equal to the safe drinking water standard of 10 µg/L. Therefore, the detected concentration of arsenic is equal to what would be allowed in drinking water.

- Well MW-ACE3 has a cumulative carcinogenic risk ratio of 1.1×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1996). The detected concentration of 5 µg/L is less than the safe drinking water standard of 10 µg/L, indicating that the detected concentration of arsenic would be allowed in drinking water.

- Well MW-2-2 has a cumulative carcinogenic risk ratio of 1.3×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1996). The detected concentration of 6 µg/L is less than the safe drinking water standard of 10 µg/L, indicating that the detected concentration of arsenic would be allowed in drinking water.

- Well MW-2AMW8 has a cumulative carcinogenic risk ratio of 1.8×10^{-3}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1996). The detected concentration of 82 µg/L is much greater than the safe drinking water standard of 10 µg/L, indicating there may be adverse effects to humans from exposure to arsenic at this well.

- Well MW-2AMW3 has a cumulative carcinogenic risk ratio of 1.1×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1996). The detected concentration of 5 µg/L is less than the safe drinking water standard of 10 µg/L, indicating that the detected concentration of arsenic would be allowed in drinking water.

- Well MW-1 has a cumulative carcinogenic risk ratio of 1.5×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1988). The detected concentration of 6.6 µg/L is less than the safe drinking water standard of 10 µg/L, indicating that the detected concentration of arsenic would be allowed in drinking water.

- Well MW-2 has a cumulative carcinogenic risk ratio of 6.9×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1988). The detected concentration of 31 µg/L is greater than the safe drinking water standard of 10 µg/L, indicating there may be adverse effects to humans from exposure to arsenic at this well. Since no additional samples have been collected in this well, it is not known if concentrations of arsenic are attenuating.

- Well MW-3 has a cumulative carcinogenic risk ratio of 6.2×10^{-4}, primarily due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1988). The detected concentration of 28 µg/L is greater than the safe drinking water standard of 10 µg/L, indicating there may be adverse effects to humans from exposure to arsenic at this well. Since no additional samples have been collected in this well, it is not known if concentrations of arsenic are attenuating.

- Well MW-4 has a cumulative carcinogenic risk ratio of 5.1×10^{-4}, due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 1988). The detected concentration of 23 µg/L is greater than the safe drinking water standard of 10 µg/L, indicating there may be adverse effects to humans from exposure to arsenic at this well. Since no additional samples have been collected in this well, it is not known if concentrations of arsenic are attenuating.

- Well AOC7-2AMW-5 has a cumulative carcinogenic risk ratio of 3.3×10^{-4}, due to the presence of arsenic and bis(2-ethylhexyl)phthalate. The EPC for both chemicals is based on a single sampling event (collected in 2000). The chemical bis(2-ethylhexyl)phthalate is a common laboratory contaminant that may have been detected due to contamination of the sample at the laboratory. The detected concentration of arsenic of 14.7 µg/L is greater than the safe drinking water standard of 10 µg/L, indicating there is may be adverse effects to humans from exposure to arsenic at this well. Since no additional samples have been collected in this well, it is not known if concentrations of arsenic are attenuating.

- Well AOC7-HP01 has a cumulative carcinogenic risk ratio of 1.2×10^{-4}, due to the presence arsenic and bis(2-ethylhexyl)phthalate. The EPC for both chemicals is based on a single sampling event (collected in 2000). The chemical bis(2-ethylhexyl)phthalate is a common laboratory contaminant that may have been detected due to contamination of the sample at the laboratory. The detected concentration of arsenic of 4.8 µg/L is less than the safe drinking water standard of 10 µg/L, indicating that the detected concentration of arsenic would be allowed in drinking water.

- Well AOC7-HP02 has a cumulative carcinogenic risk ratio of 4.6×10^{-3}, primarily due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 2000). The detected concentration of 207 µg/L is much greater than the safe drinking water standard of 10 µg/L. This was a temporary wellpoint sample that was suspected to have elevated turbidity; as a result, a permanent well was installed near this location (GW03) and there was no unacceptable risk in that well.

- Well AOC7-HP03 has a cumulative carcinogenic risk ratio of 2.3 x 10^{-4}, primarily due to the presence of arsenic. The EPC for arsenic is based on a single sampling event (collected in 2000). The detected concentration of 10.2 µg/L is slightly greater than the safe drinking water standard of 10 µg/L. This was a temporary wellpoint sample that was suspected to have elevated turbidity; as a result, a permanent well was installed near this location (GW02) and there was no unacceptable risk in that well.

- Well SC-2AMW5-AOC1 has a cumulative carcinogenic risk ratio of 2.6 x 10^{-4}, primarily due to primarily due to the presence of arsenic and bis(2-ethylhexyl) phthalate. The EPC for both chemicals is based on a single sampling event (collected in 2000). The chemical bis(2-ethylhexyl)phthalate (BEHP) is a common laboratory contaminant and may have been detected due to contamination of the sample at the laboratory. The detected concentration of arsenic at 11.6 µg/L is greater than the safe drinking water standard of 10 µg/L, indicating there may be adverse effects to humans from exposure to arsenic at this well. Since no additional samples have been collected in this well, it is not known if concentrations of arsenic are attenuating.

Risks of lead in nonresidential wells

4.3.32 Lead was detected in 14 nonresidential wells. However, for only 5 wells was the risk ratio for lead greater than one. Therefore, there are not likely to be adverse effects on humans due to exposure to lead in Wells MW-AMW1, MW-AMW2, MW-AMW11, MW-2AMW3, MW-1, AOC7-2AMS-7, AOC7-2AMW-5, AOC7-HP01, AOC7-HP02), or SD-2AMW5-AOC1. Lead concentrations in the remaining wells are assessed below.

- Well MW-ACE2 has detection of lead of 79 µg/L, which exceeded the USEPA screening value by a factor of 5.2, indicating that there is a potential for an unacceptable risk due to lead in this well.

- Well MW-2 has detection of lead of 90 µg/L, which exceeded the USEPA screening value by a factor of 6.0, indicating that there is a potential for an unacceptable risk due to lead in this well.

- Well MW-3 has detection of lead of 66 µg/L, which exceeded the USEPA screening value by a factor of 4.4, indicating that there is a potential for an unacceptable risk due to lead in this well.

- Well MW-4 has detection of lead of 69 µg/L, which exceeded the USEPA screening value by a factor of 4.6, indicating that there is a potential for an unacceptable risk due to lead in this well.

- Well AOC7-HP02 has detection of lead of 388 µg/L, which exceeded the USEPA screening value by a factor of 25.86, indicating that there is a potential for an unacceptable risk due to lead in this well. This was a temporary wellpoint sample that was suspected to have elevated turbidity; as a result, a permanent well was installed near this location (GW03) and there was no unacceptable risk in that well.

4.3.33 Screening criteria to evaluate vapor intrusion of VOCs from shallow groundwater into buildings were based on USEPA (2002) target groundwater concentrations. The target groundwater concentrations are calculated to correspond to target indoor air concentrations that are protective of human health if vapor intrusion occurs. In the vapor intrusion analysis, five VOCs were found to be above the target screening value. The five chemicals were 1,2-dichloroethane (1,2-DCA), *trans*(1,2)dichloroethene (*trans*-1,2-DCE), *cis*(1,2)dichloroethene (*cis*-1,2-DCE), TCE, and vinyl chloride. Only one well had the highest concentrations of these chemicals, which were the concentrations that exceeded the target screening value for groundwater to indoor air. This well was identified as MW-ACE2 (sampled in July 1996) and also identified as ACE-2 (sampled in June 2000 and June 2006). Most of the exceedances of the target screening values were related to the 1996 sampling event. The 2000 sampling event still had high concentrations, but only for three VOCs (*trans*-1,2-DCE, TCE, and vinyl chloride). When this well was sampled in June 2006, the concentrations were all lower but there were still the same three VOCs above the target screening value (*trans*-1,2-DCE, TCE, and vinyl chloride).

Sediment

4.3.34 As shown in the risk calculation table, there are no non-carcinogenic or carcinogenic risks associated with the sediments at the AOC 1 and 7 site (Table 4.13). The non-carcinogenic risk ratio result for the site is 0.73 (Figure 4.5) and the carcinogenic risk result is 7.8×10^{-6} (Figure 4.6). These values are below the target hazard index for non-carcinogens and within USEPA's target risk range, thus there is no unacceptable risk due to exposure to sediments.

Surface Water

4.3.35 Risk calculations indicate that there may be potential for non-carcinogenic and carcinogenic risk for the surface water exposure pathways at the site (Table 4.14). The non-carcinogenic risk was 1.7 (Figure 4.5) and was primarily due to exposure to cadmium in pond water. The carcinogenic risk was 2.8×10^{-4} (Figure 4.6) and was primarily due to exposure to TCE, BEHP, and arsenic in pond water. These results are very conservative and likely overestimate the potential risk; thus, it is very unlikely that the pond water poses a potential risk, given that in the most recent pond samples (collected in 2000) only BEHP exceeded the NYSDEC surface water quality standard. There are several factors in this HHRA that overestimate potential risk. Pond water sampling results were compared to the USEPA "tap water" MSSLs. These MSSLs assume residential exposure to pond water used as drinking water and inhalation of volatiles from use of surface water in the home (*e.g.*, showering, laundering, and dish washing). The pond water is not used for any purpose. The comparison of pond samples to residential criteria was made for information purposes based on RAB concerns that water in Black Creek may make its way to the Watervliet Reservoir drinking water supply. However, the pond water must flow through a wetland area before it can reach the Black Creek.

The Black Creek ultimately joins the Bozenkill, which then flows into the Watervliet Reservoir approximately 4 miles downstream of AOCs 1 and 7. It is expected that pond water will be greatly diluted in the wetland, Black Creek and the Bozenkill before any of the water reaches Watervliet Reservoir. A separate HHRA has been conducted for AOC 8 (Black Creek) and those results show that no potential risk exists, based on the chemicals/metals found in Black Creek water and sediment.

4.4 QUANTITATIVE HUMAN HEALTH RISK ASSESSMENT FOR AOC 8

4.4.1 A quantitative HHRA has been prepared by Parsons for the USACE as part of the RI for Black Creek (AOC 8). Black Creek flows near many of the AOCs and receives surface water runoff from most of the AOCs through the perimeter ditches or by direct inflow. Black Creek is an AOC because previous investigations have shown the presence of volatiles and metals in surface water and/or sediment at concentrations above applicable regulatory criteria.

4.4.2 Black Creek enters the former SADVA at the southern end, between AOCs 1 and 5. The creek flows toward the north along the west side of AOC 7 and continues north along the eastern side of the former SADVA, flowing east of AOCs 9 and 6 before exiting the former depot. There is a long drainage ditch from the northeast corner of AOC 5 that runs to the east to Black Creek, and enters Black Creek near the north end of AOC 1.

4.4.3 The specific objective of this HHRA is to provide a quantitative risk assessment of the sediment and surface water in Black Creek and site ditches. The HHRA will determine whether an unacceptable risk to human health exists associated with exposure to surface water and sediment in Black Creek and associated ditches.

4.4.4 Section 3 of the RI Report compares all chemical and metal (hereafter referred to as "chemicals") concentrations detected in sediment and surface water samples to applicable and available NYSDEC surface water and sediment quality criteria. Site-specific background samples were also collected from surface water and sediment in Black Creek, and those data were used in conjunction with the NYSDEC quality criteria to evaluate the nature and extent of contamination. Numerous chemicals were found to be above the NYSDEC surface water and sediment quality criteria and/or background concentration ranges. Based on those results, this HHRA was undertaken to evaluate the potential impact of exposure to contaminants found in sediment and surface water at AOC 8. Note that the NYSDEC sediment criteria are based on protection of aquatic life, not human health.

4.4.5 Techniques and methodology developed or recognized by USACE and the USEPA were used for this quantitative HHRA. USACE requires that an HHRA be performed during the RI project phase.

4.4.6 After comparing the concentrations of chemicals to NYSDEC criteria for sediment and surface water, a risk ratio approach was used to quantify potential risk. USEPA Region 6 risk-based, human health, MSSLs were used in the risk ratio analysis. The MSSLs were used to quantify potential risk from exposure to contaminants in surface water. Because USEPA does not have human health screening levels for sediment, and because the NYSDEC criteria for sediment quality are for protection of aquatic life, criteria protective of human health were obtained from the Tier 1 sediment PCL developed by the TCEQ. The risk ratio analysis provides quantification of the potential cancer risk and the potential non-cancer hazard as applicable to each individual chemical in each environmental media. The chemical ratios are then summed to determine cumulative risk for each environmental medium.

4.4.7 In the HHRA for Black Creek, maximum chemical concentrations were used in most cases as the EPC to calculate risk. Use of maximum concentrations provides a conservative (*i.e.*, most health-protective) estimate of exposure to that chemical. The 95% UCL of the chemical concentrations were calculated for this HHRA when appropriate (i.e., the single maximum concentration contributed significantly to risk and there was sufficient sample size to calculate the UCL).

4.4.8 Based on USEPA (1989) *Risk Assessment Guidance for Superfund* (RAGS) and supplemental guidance related to data evaluation, the list of COPCs was refined during initial screening. One of the steps was to screen essential nutrients from the HHRA. Thus, results for calcium, magnesium, potassium, iron and sodium were removed from the COPC list and were not considered further in the HHRA.

4.4.9 The only other chemical that was not quantified using the risk ratio approach was lead. According to USEPA guidance, lead should be evaluated using blood lead levels and not the potential for cancer or non-cancer risks. Therefore, lead concentrations detected at the site have been directly compared to the screening criteria. For surface water, the USEPA MCL for lead is used as the screening value. For sediment, the TCEQ sediment PCL for lead is used. If lead concentrations at the site exceed the criteria, then unacceptable risk may exist. If lead concentrations are lower than the criteria, then there is no unacceptable risk.

Completed Exposure Pathways

4.4.10 This HHRA focuses on human health risk posed by sediment and surface water in Black Creek and site ditches leading to the creek. The New York State Bureau of Watershed Management and the NYSDEC have classified the section of Black Creek adjacent to SADVA as a Class C stream. Class C waters are suitable for fishing and fish propagation and primary and secondary recreation. Additionally, the Watervliet Reservoir drinking water supply is located approximately 2.5 miles downstream of SADVA. This water supply is a Class A water body which is suitable for drinking water and all other uses. Thus, to address RAB concerns that contaminated water in Black Creek may make its way to the Watervliet Reservoir, this HHRA quantifies potential residential use of water in Black Creek as drinking water. This pathway has been included for information purposes to address RAB concerns. However, Black Creek flows into the Bozenkill, before the Bozenkill flows into the Watervliet Reservoir. It is expected that significant dilution of runoff from SADVA will occur along the flow path from the SADVA to the Watervliet Reservoir. In addition, the New York State Department of Health and the City of Watervliet monitor water quality in Watervliet Reservoir to ensure the safety of the drinking water supply for the approximately 40,000 residents served.

4.4.11 The current land use near and around Black Creek at the former SADVA includes the industrial/commercial use of the property by the current property owner/operator, the NEIP. The NEIP workers and tenants of the industrial park are not known to use water from the creek. The main human contact with the creek onsite would be a worker that infrequently visits the site for purposes such as site sampling investigations. Based on future land use plans at NEIP, as described in the Generic EIS dated June 2005, future land use will remain commercial/industrial.

4.4.12 The completed exposure pathways for the HHRA at AOC 8 are listed below. The exposure pathways that were evaluated in the risk ratio analysis are also described below.

Sediment

4.4.13 The TCEQ sediment PCLs are based on incidental ingestion of sediment and dermal contact with sediment by a residential receptor. The residential sediment PCLs provide more conservative values (*i.e.*, most health protective values) than would be assumed for other types of receptors. Thus, the residential PCLs should be protective for any potential current or future industrial/commercial worker scenario.

Surface Water

4.4.14 Surface water in Black Creek was conservatively assumed to be suitable for drinking water. SADVA is upgradient of the Watervliet Reservoir, which is a Class A water body suitable for drinking and all other uses. The comparison of site samples to Class A criteria was made for information purposes to address RAB concerns that water in Black Creek may make its way to the reservoir.

4.4.15 Ingestion of surface water as drinking water and inhalation of volatiles from use of surface water in the home (*e.g.*, showering, laundering, and dish washing) by a current and/or future residential receptor was assumed. For this evaluation, the USEPA residential “tap water” screening level was used. These residential screening levels provide more conservative values than for other types of receptors. Thus, the residential PCLs will be protective for potential workers.

Risk Summary for AOC 8 – Sediment

4.4.16 There are no unacceptable non-carcinogenic or carcinogenic risks associated with the sediments at AOC 8 (Table 4.15). The cumulative non-carcinogenic risk ratio for the site was 0.71 (Figure 4.7), well below the acceptable level of one. The carcinogenic risk ratio results were 7.8×10^{-6} (Figure 4.8), within the USEPA acceptable risk range of 10^{-6} to 10^{-4}, indicating that there is no unacceptable risk from exposure to sediments. Because the results are based on residential exposure to contaminants, these results provide a conservative evaluation for the current and/or future worker exposure scenarios expected for the site.

Risk Summary for AOC 8 – Surface Water

4.4.17 The risk ratio results show that there is no unacceptable non-carcinogenic risk for the surface water exposure pathway at the site (Table 4.16). The cumulative risk ratio result is 1

(Figure 4.7), indicating that there is no unacceptable non-cancer risk for potential exposure to surface water. For the carcinogenic chemicals detected in surface water, the cumulative risk ratio result was 8.0×10^{-5} (Figure 4.8), within the USEPA acceptable risk range of 10^{-6} to 10^{-4}, indicating that there is no unacceptable risk from exposure to surface water. However, even this result is overly conservative in the estimate of potential risk. The single chemical driving the risk is arsenic. Arsenic was only detected in one of the surface water samples from Black Creek (SW-09, located at the far downstream end of the SADVA just before Black Creek leaves the site). The concentration detected was 3.6 µg/L "J". This arsenic concentration is well below the drinking water standard (*i.e.*, MCL) for arsenic of 10 µg/L, and the NYSDEC Class A surface water criterion of 50 ug/L.

4.4.18 There are several uncertainties associated with the surface water exposure pathway. Surface water sampling results were compared to the USEPA "tap water" MSSLs. These MSSLs assume residential exposure to surface water used as drinking water and inhalation of volatiles from use of surface water in the home (*e.g.*, showering, laundering, and dish washing). The comparison of site samples to residential criteria was made for information purposes based on RAB concerns that contaminants from SADVA may migrate to the Watervliet Reservoir water supply. The Watervliet Reservoir is tested regularly by the NYSDOH and City of Watervliet to ensure a safe drinking water supply. In the near vicinity of the SADVA, Black Creek is not used as a drinking water source. The only detected concentration of arsenic is well below the MCL. Based on these factors, it is unlikely that surface water of Black Creek poses an unacceptable risk to human health.

4.5 QUALITATIVE ECOLOGICAL RISK ASSESSMENT FOR SADVA

4.5.1 A screening-level ecological risk assessment (SLERA) was conducted to evaluate potential adverse impacts to the ecological receptors at SADVA, due to presence of hazardous contaminants in soil, sediment, and surface water. The SLERA broadly contributes to the site characterization and can be used to develop and evaluate the ecological risks at the site, if any. The objective of the SLERA is to evaluate whether unacceptable adverse risks may be present, or if risks may be posed to ecological receptors in the future. This objective was met by characterizing ecological plant and animal communities at or near the site, defining and describing the contaminants that may affect the environmental media at the site, and identifying the potential pathways for exposure to contaminants at the site. The information used in the SLERA was largely taken from the Generic EIS prepared for the NEIP (Galesi Group, 2005).

4.5.2 An initial screening of chemicals was conducted on the basis of comparison to background concentrations in any given media. If no background concentration was available, the chemical was retained in the analysis. Non-bioaccumulative chemicals were screened by comparison to selected ecological benchmarks. For New York, there were environmental screening concentrations available for sediment. For soils, surface water and groundwater, USEPA Region 5 ecological screening levels were used. To determine if a chemical was retained for analysis, the following rules were used:

- If the chemical concentration was less than the background concentration, it was screened out of the analyses (eliminated).

- If the chemical concentration of sediment was greater than background concentration, but less than the NYS sediment screening criteria, it was eliminated.
- If the chemical concentration is greater than background, and greater than the USEPA Region 5 screening level, then it was retained for analysis.
- Bioaccumulative compounds were retained in the analysis, regardless of whether they exceed screening levels (either background or USEPA screening levels).

4.5.3 An ecological conceptual site model (ECSM) for the terrestrial component and aquatic component of the site were prepared. Terrestrial receptors are primarily exposed to surface soil and surface water, assuming the ponds and creeks are used for drinking water. Aquatic receptors are primarily exposed to sediment and surface water. For this analysis, exposure to sediment will be important for species that occupy territory near water (*e.g.*, raccoons) but are not fully aquatic (*e.g.*, fish), and hereafter these species are referred to as semi-aquatic species.

4.5.4 The qualitative SLERA does not specifically estimate the risk to individual receptors. However, there are several classes of organisms (*e.g.*, aquatic organisms, birds, mammals) that may respond differently to COPECs. Therefore, each COPEC that was included in the analysis after the preliminary screening within each class of COPEC (*i.e.*, VOCs, metals) is addressed and the expected effects on ecological receptors is described. Further, if a COPEC is present in the environment, a qualitative classification of risk (*i.e.*, low, medium, high) has been estimated. The estimated risk values are based on the effects of the chemical, the likelihood that it will remain in the soil, whether it greatly exceeds the USEPA screening values, and if it is bioaccumulative.

4.5.5 In general, VOCs pose a low risk to ecological receptors, because the COPECs are dissipated readily in the environment, and they do not bioaccumulate in receptor tissues.

4.5.6 SVOCs include PAHs, which may bioaccumulate and biomagnify in receptor tissues. If the receptor ingests a large amount of the medium where the PAHs are present (either soil/sediment directly, or lower trophic level organisms), then there is some risk that the receptors will be affected. Other SVOCs have variable effects, depending on if the compound is bioaccumulative.

4.5.7 Pesticides and PCBs are often both bioaccumlative and biomagnified in terrestrial and aquatic food chains. Many of the pesticides are no longer used in the U.S., but are very persistent in the soil/sediment, and therefore may still be affecting ecological receptors, depending on the soil/sediment concentrations. Because of the persistence in the environment of some pesticides, the risk to ecological receptors is considered high.

4.5.8 Metals in soil/sediment have variable effects on ecological receptors. Metals that do not bioaccumulate or biomagnify pose low ecological risk. Metals that bioaccumulate but do not biomagnify pose low ecological risk. Metals that biomagnify pose at least medium levels of ecological risk, and depend in large part on how the metals bind to soil particles.

4.5.9 Although there are chemicals in various media onsite that pose a potentially high risk to aquatic and terrestrial wildlife, the former SADVA site appears to support wildlife typical for the area and for the commercial/industrial setting that the site has retained for over 60 years. These conclusions are reinforced by two other ecological assessments conducted at AOC 1. The 2004 qualitative assessment of the diversity and condition of aquatic life in the pond found that the observed species composition seemed appropriate for the habitat and all species present appeared active. The 2004 macroinvertebrate community analysis of the pond found the sampling stations were slightly impaired, due to the monotonous nature of the man-made pond. Full reports for all three ecological assessments referred to above can be found in Appendix H.