U.S. ARMY ENGINEER DIVISION
HUNTSVILLE, ALABAMA

00438
20

FINAL
FEASIBILITY STUDY REPORT AT THE OPEN BURNING (OB) GROUNDS

JUNE 1996

Final Feasibility Study Report
Open Burning Grounds
Seneca Army Depot
Romulus, New York

Prepared for:

Seneca Army Depot
Romulus, New York

Prepared by:

Parsons Engineering Science, Inc.
Prudential Center
Boston, Massachusetts

June 1996

TABLE OF CONTENTS

Table of Contents
(Con't)

Table of Contents
(Con't)

Table of Contents
(Con't)

Table of Contents
(Con't)

Table of Contents
(Con't)

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

REFERENCES

Engineering-Science, Inc., "Remedial Investigation Report at the Open Burning Grounds, March 1994

Environmental Protection Agency (EPA), "Handbook for Stabilization/Solidification of Hazardous Waste. EPA/540/2-86/001, 1986.

Environmental Protection Agency (EPA), "Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA," October 1988a.

Environmental Protection Agency (EPA), "Technology Screening Guide for Treatment of CERCLA Soils and Sludges." EPA/540/2-88/004, 1988b.

Environmental Protection Agency (EPA), "Stabilization/Solidification of CERCLA and RCRA Wastes." EPA/625/6-89/022, 1989.

Environmental Protection Agency (EPA), "Handbook on In Situ Treatment of Hazardous Waste - Contaminated Soils,"January 1990.

Environmental Protection Agency (EPA), "Handbook on Remediation of Contaminated Sediments," April 1991a.

Environmental Protection Agency (EPA), 1991b, "Guide for Conducting Treatability Studies Under CERCLA," Interim Guidance, EPA/540/2-91/020A, September 1991.

Environmental Protection Agency (EPA), "The Superfund Innovative Technology Evaluation Program," November 1992a.

Environmental Protection Agency (EPA), 1992b "Guide for Conducting Treatability Studies Under CERCLA," Final. EPA/540/R-92/071a, October 1992.

Environmental Protection Agency (EPA), "Vendor Information System for Innovative Treatment Technologies," April 1993.

MAIN, "Workplan for the Remedial Investigation/Feasibility Study (RI/FS) of the Open -Burning (OB) Grounds, August 1991.

REFERENCES
(Con't)

Means, "Building Construction Cost Data, 51st Ed., 1993.

United States Army Environmental Hygiene Agency (USAEHA), 1987, Evaluation of Solid Waste Management Units, Seneca Army Depot, Interim Final Report, Groundwater Contamination Survey, No. 38-26-0868-88.

United States Army Toxic and Hazardous Materials Agency (USATHAMA), 1980, Installation Assessment of Seneca Army Depot, Report No. 157, AMXTH-IR-A-157, January 1980.

Section 1

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

This Feasibility Study report is a continuation of the Remedial Investigation/Feasibility Study process required by the Environmental Protection Agency (EPA) for the Open Burning (OB) Grounds at the Seneca Army Depot Activity (SEDA). The Remedial Investigation portion of this process was completed in 1992 and the final Remedial Investigation report (Engineering-Science 1994) submitted for agency review. The Remedial Investigation has served to fully characterize the nature and extent of risks posed by the OB Grounds.

Previously, the open burning of Propellants Explosives and Pyrotechnics (PEPs) was performed directly on the ground surface at each burn pad. This practice has been discontinued and burning is currently performed in steel trays at the burning ground. This process is regulated as a miscellaneous unit, under Subpart X, with a Resource Conservation and Recovery Act (RCRA) permit. Although the current use of the OB grounds is as a munitions deactivation area, the intended future use of this facility is uncertain because SEDA has been placed on the BRAC95 list. The intended future use of the site has not been finalized but will be determined by the Local Redevelopment Authority (LRA) in conjunction with the Army. As required by the Comprehensive Environmental Responsibility, Compensation and Liability Act (CERCLA) and Army regulations, as the control of this facility is transferred and the use changes, the Army will perform any remedial actions necessary to assure that the site conditions are protective of human health and the environment.

The risk calculations of the RI indicate that, under the current and intended future land use scenarios, the site conditions are protective of human health and the environment. For the current on-site worker, the carcinogenic and non-carcinogenic risk values are 6.3×10^{-6} and 0.25, respectively. These values are within the EPA target range for carcinogenic risks of 1×10^{-4} to 1×10^{-6} and below the target Hazard Index (HI) value of 1.0 for non-carcinogenic risks. The risk assessment analyzed the risks associated with on-site residential use, which is considered to be the potential, worst-case, future land use scenario. The results of the assessment indicate that the risks to human health associated with on-site residential exposure are also within the target range for both noncarcinogenic and carcinogenic risks.

Although the risk assessments indicate that a remedial action is not required, it was recognized that lead, which was not part of the risk analysis, was found at high concentrations in the soils and sediments associated with the OB grounds and should be considered. As a result, site-specific remedial action objectives for the on-site soils with high concentrations of lead and for sediments in Reeder Creek with high concentrations of copper and lead have been established and agreed upon by the EPA, New York State Department of Environmental Conservation (NYSDEC), and the Army.

Volumes of soil to be remediated have been evaluated for five cases. The effect of each case upon both carcinogenic and non-carcinogenic risks for residential exposure, the blood lead level, and the maximum concentrations of lead in the on-site soils is considered in this feasibility study.

The need to conduct a remedial action for this site will be determined from the intended future use of this site. A future residential scenario is considered in this feasibility study as a potential, worst-case future land use and will be used to select a remedial action.

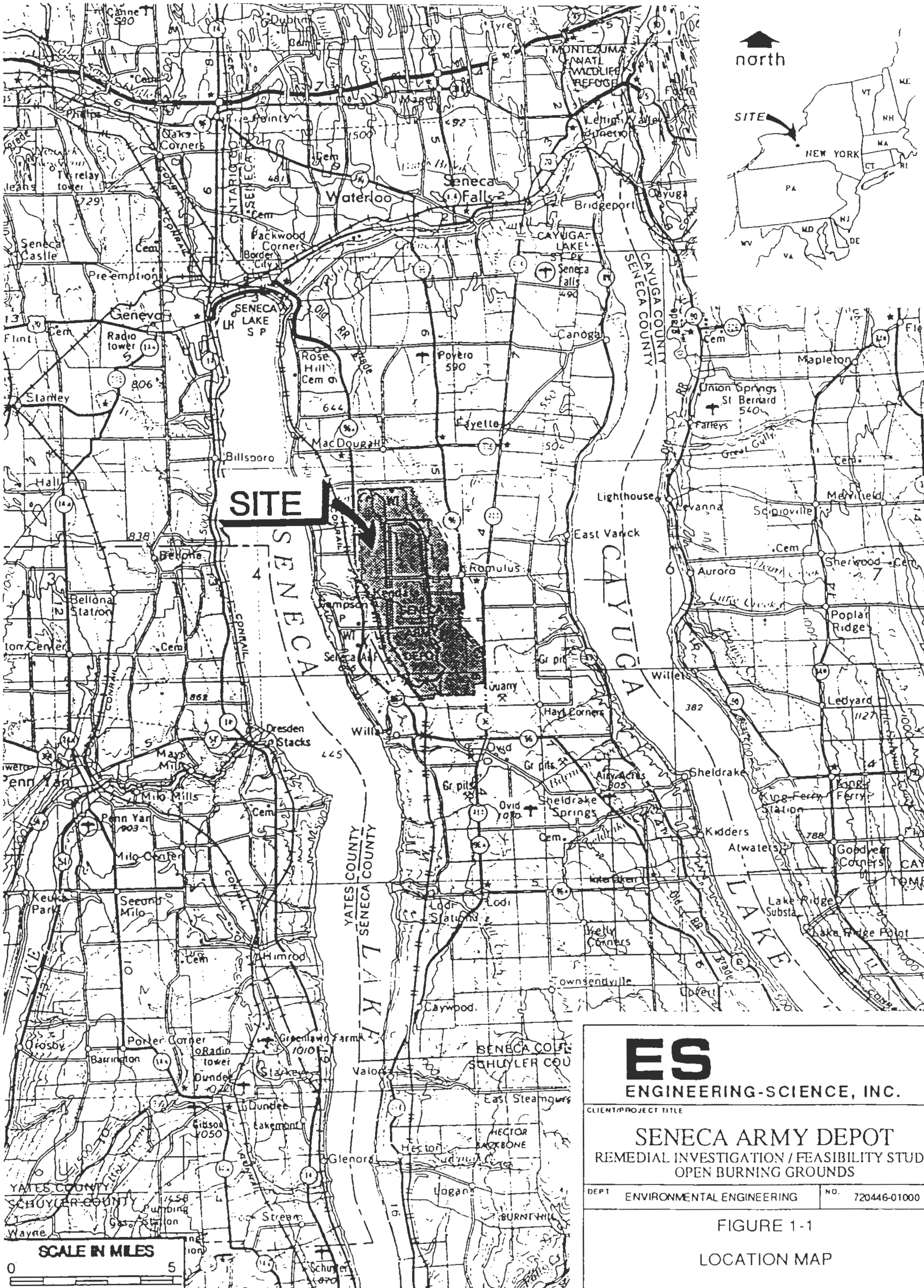
The purpose of the Feasibility Study is to develop and screen a range of appropriate remedial alternatives, identify the key trade-offs of selected alternatives and present these results to the agencies for final selection of the remedial alternative to be implemented. The Feasibility Study has been conducted and organized in accordance with EPA guidance (EPA 1988) as follows:

Section	
2.0	Identification and Screening of Technologies
3.0	Development and Screening of Alternatives
4.0	Treatability Investigation
5.0	Detailed Analysis of Alternatives

These sections detail the development, evaluation and selection of the final remedial alternatives.

1.2 SITE DESCRIPTION

SEDA is an active military facility constructed in 1941. The site is located near Romulus, New York as shown on Figure 1-1. The facility is located in an uplands area, at an elevation



ES

ENGINEERING-SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT

REMEDIAL INVESTIGATION / FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT	ENVIRONMENTAL ENGINEERING	NO.	720446-01000

FIGURE 1-1

LOCATION MAP

SCALE 1" = 4 MILES

of approximately 600 feet Mean Sea Level (MSL), that forms a divide separating two of the New York Finger Lakes, Cayuga Lake on the east and Seneca Lake on the west. Sparsely populated farmland covers most of the surrounding area. New York State Highways 96 and 96A adjoin SEDA on the east and west boundaries, respectively. Since its inception in 1941 SEDA's primary mission has been the receipt, storage, maintenance, and supply of military items. This function includes the disposal of military ammunition and explosives by burning and detonation.

The OB grounds area is situated on gently sloping terrain, vegetated with grasses and brush. Drainage is generally to the east-northeast via a series of drainage ditches and culverts into Reeder Creek. Shallow groundwater flow at the OB grounds site is also directed northeast into Reeder Creek which is in a sub-basin within the main Seneca Lake drainage basin. There are several poor drainage areas where water collects at certain times of the year. Low surface gradients of less than 40 feet in 2,500 feet, and a high fine content in the surface soils and underlying glacial till deposits contribute to poor drainage conditions.

1.3 SITE HISTORY

Open burning-open detonation operations have been conducted for more than forty years in the 90-acre munitions destruction area. The OB grounds occupy an area of approximately 30 acres within the southern portion of the munitions destruction area. Originally open burning was conducted directly upon the clay ground surface. Due to the seasonally wet nature of the local soils the individual burn pads were subsequently built up with shale fill to provide a drier environment in which to perform the munitions burning. The berms around the burn pads were formed by bull-dozing of the surrounding soils, including those soils containing residues of the burning process. The burning of munitions was performed at the nine burning pads labeled A through H and J beginning in the early 1960s (USATHAMA, 1980).

The burning process was performed by preparing combustible beds of pallets and wooden boxes on the pads and placing the ammunition or components to be destroyed on the beds. A trail of propellant approximately 5 feet long, 6 inches wide and 3 inches deep was placed on the ground leading to the combustible bed. Electric squib was placed in the propellant trail and connected to firing wires. The operator fired the circuits from an office (USAEHA, July 1987). Also, according to this report, pads G and J were only used for trash and rubbish, while pads A, B, C, D, E, F, and H were used for projectiles, explosives and propellants.

Pads A and J were the first to be abandoned for open burning. The practice of open burning on all pads was discontinued in 1987. At present the burning of munitions is done within an open air, steel enclosure located immediately west of burning Pad D.

An elongated, low hill is located in the southern portion of the open burning area. The low hill is mostly covered by brush and trees and forms a pseudo barrier in this portion of the site. Based on the vegetation which covers the hill and its geographic location relative to the burn pad berms (i.e., it is far from the access roads and the most recent open burning activity), the formation of the low hill is believed to have been at the same time as the berms around the nine burn pads. According to SEDA personnel, the hill was formed during clearing activities early in the history of the open burning area. The clearing of surface vegetation and some soil was performed as a safety measure to prevent high grass from causing a potential fire hazard in the burn pad areas. There has been more than one clearing event over the lifetime of the OB grounds area.

A burn kettle is located between Pads C and J. The burn kettle is a small rectangular-shaped furnace formerly used to burn small caliber arms.

1.4 NATURE AND EXTENT OF CONSTITUENTS OF CONCERN

The nature and extent of the constituents of concern at the OB grounds were evaluated through a comprehensive remedial investigation program. Primary media investigated at the OB grounds included soil (from grid and pad borings, berm and low hill excavations, and downwind and burn kettle surface samples), surface water and sediment (from Reeder Creek and on-site wetlands and drainage swales), and groundwater (from monitoring wells). The primary constituents of concern at the OB grounds are explosive compounds, metals and semivolatile organics, mainly polynuclear aromatic hydrocarbons (PAHs) and phthalates. These are believed to have been released to the environment during former open burning activities conducted on the nine burn pads.

Concentrations of explosives, metals and semivolatiles are generally highest in the soil from the surface of the burn pads and the berms when compared to the concentrations in the areas around the burn pads. This is expected because the pads and the berms were used to contain the open burns. Generally, only the upper two feet of the burn pads are affected with constituents while the berms are believed to be affected throughout. There are defined areas outside the pads which contain anomalous concentrations of explosives, metals and semivolatiles. The most significantly affected area, off the pads, is between Pads B and C. In the southern portion of the site there is one section of the low hill which also contains elevated concentrations of explosives, metals and semivolatiles. Since the low hill was formed by bulldozing the surface soils from and near the burn pads, the presence of constituents in the berms is expected. The analytical data from the downwind sampling indicated that there has been no impact to the surface soils collected along the azimuth of the prevailing wind direction at the OB grounds.

The geographic distribution of the constituents in the surface water and sediment samples is explained by the surface water runoff patterns defined by the topographic contours at the site. The highest concentrations of the constituents of concern are present in the topographic lows (i.e. the drainage swales and wetlands) which drain major portions of the site encompassing the burn pads. While most of the surface water at the OB grounds drains to the east toward Reeder Creek, very small amounts if any, of chemical constituents are carried to Reeder Creek. This is due to the elevated roads and the invert elevations of the drainage pipes which allow settling of entrained sediment. Constituent concentrations in Reeder Creek surface water were low.

Sediments in one stretch of Reeder Creek north of the Open Denotation grounds have been impacted by OB/OD operations. The constituents of concern are primarily the metals copper, lead, mercury and zinc, which were detected at concentrations above the NYSDEC sediment criteria. The sediment samples containing high concentrations of these metals were located on a section of Reeder Creek beginning just downstream of the OD ground and extending approximately 900 feet further downstream. Maximum concentrations of copper (2380 mg/kg), lead (332 mg/kg), and zinc (497 mg/kg) were detected in the sediment sample SD300; the maximum concentrations of mercury (0.83 mg/kg) was found in sediment sample SD290.

Groundwater was found to be only minimally affected by metals. There is no continuous distribution of metals in the groundwater. The higher concentration of metals in the groundwater do not correlate with the location of the most significantly affected burn pads or the areas beyond the burn pads which have also been affected. Additionally, only low concentrations (<1.0 ug/L) of Hexahydro-1,3,5 - Trinitro-1,3,5 - Trinzine (RDX), Trinitrotoluene (TNT), and Dinitrotoluene (DNT) were detected in 4 of 39 monitoring wells on-site.

1.5 FATE AND TRANSPORT

The fate and transport of the constituents of concern at the OB grounds considered site specific factors and the chemical/physical properties of the target analytes. Soil, sediment, and surface water samples collected off-site, downstream, and/or downwind of the site showed no evidence of an observed release. There was also no evidence of a substantial release to groundwater, though only on-site groundwater samples were collected.

Constituents of concern for this site are barium, copper, lead and zinc (Ba, Cu, Pb and Zn), primarily lead. These constituents are persistent in the soil and sediments. Secondary constituents of concern are explosives, PAH's, and phthalates. These organic constituents tend to adsorb readily in the organic fraction of the soil. The metals are likely to be present as insoluble oxide and in elemental forms.

Since the forms of these chemical constituent precludes migration via water, two particular migration mechanisms, sediment transport and wind erosion, were evaluated in detail. In both of these mechanisms, chemicals migrate as adsorbed species to the soil particulates which are then suspended in either water or air.

The results of the sediment transport evaluation indicated a low potential for off-site migration. While there is movement of sediment across the site, runoff flows are generally low, and the surface water and sediment is contained in the low lying areas and wetland, on the site. Soil and sediment samples collected in the low lying areas on the site indicate elevated concentrations, while sediment samples collected in Reeder Creek show little or no impacts except for a stretch north of the Open Detonation (OD) grounds.

An analysis of wind erosion also showed little potential for off-site migration. In addition, SEDA worker exposure associated with windborne particulates was shown to be insignificant.

1.6 RISK ASSESSMENT

1.6.1 <u>Baseline Human Health Risk Assessment</u>

The human health risk assessment has been completed and presented in the Remedial Investigation report. The assessment is for remediation of soil and sediment containing barium, copper, lead and zinc and is risk-based. The baseline assessment of risk (no action) was calculated for the three exposure scenarios of: (1) current on-site OB workers, (2) current off-site residents and (3) future on-site residents. Note that under no action the site cancer and non-cancer health risks are within acceptable ranges for risk-based human health criteria. The soil and sediment mean concentrations however exceed the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) for a number of metals and PAH's.

Current on-site workers do not exhibit cancer or non-carcinogenic risk above the established EPA target risk ranges as shown in Table 1-1. The carcinogenic risk level for this exposure group is 6.3×10^{-6} which is within the USEPA's target risk range. The HI is 0.25, well below the EPA target value of 1.0.

The baseline health risk assessment shows potential future residents of the site do not exhibit a risk of cancer above the EPA target risk range of 1×10^{-4} to 1×10^{-6} nor is the noncarcinogenic health threats above the EPA target value of a Hazard Index (HI) of 1.0. The cancer risk is 1.0×10^{-5}, and the non-cancer (HI) risk is 0.33.

Current off-site residents who could be exposed to surface water and sediments during swimming in Reeder Creek do not exhibit risk of cancer or non-carcinogenic health risks in excess of the EPA target risk ranges or adverse noncarcinogenic health threats as shown in Table 1-1. Carcinogenic risks is 3.9×10^{-7} and is within the USEPA's target risk range. The non-carcinogenic hazard index is 0.007 and is less than the EPA target level of 1.0.

Although the outcome of this baseline health risk assessment indicates the current site conditions are within acceptable EPA target ranges, the risk analysis could not consider the presence of lead in soil, as the Reference Dose (RfD) for lead has been withdrawn for use by EPA. Protection of human health from lead impacts was considered by application of the UBK model. The allowable lead level in blood is 10 ug/dL, which corresponds to an allowable concentration of lead in soil of approximately 500 mg/kg. this model is considered conservative, since it evaluated the impacts to children from a residential exposure scenario at the OB Grounds.

1.6.2 Ecological Risk Assessment

The OB grounds ecological risk assessment has included both a qualitative and quantitative assessment of the ecological status of the OB grounds. During Phase I and Phase II, field evaluations included fish trapping and counting, benthic macroinvertibrate sampling and counting and small mammal species sampling and counting. In addition, a vegetation survey was performed, identifying major vegetation and understory types. The conclusions

TABLE 1-1
SUMMARY OF BASELINE HUMAN HEALTH RISK ASSESSMENT

CASE	EXPOSURE SCENARIO	TOTAL HAZARD INDEX	TOTAL CANCER RISK	AVERAGE LEAD IN SOIL (mg/kg)
Baseline	Current on-site industrial workers	0.25	6.3×10^{-6}	1,888
	Current local off-site residents	.007	3.9×10^{-7}	1,888
	Future on-site residents	0.33	1.0×10^{-5}	1,888

determined from these field efforts indicated a diverse and healthy aquatic and terrestrial environment. No overt acute toxic impacts were evidenced during the field evaluation. Quantitative soil, sediment and surface water analytical data was compared to New York State Department of Environmental Conservation (NYSDEC) guidelines for the protection of aquatic and macroinvertebrate life in sediments and surface water. Additionally, as a supplement to specific NYSDEC guidelines criteria is presented from the literature which is considered to be protective of terrestrial wildlife and vegetation in soils. Other than the ambient water quality criteria for surface water, these criteria are not promulgated standards, and are not Applicable or Relevant and Appropriate Requirements (ARARs).

The quantitative evaluation, which involved comparison of the 95th UCL of site data with the media specific criteria, suggested potential chronic risk from heavy metals, specifically lead and copper. The acute effects from these metals have not been observed during fieldwork, i.e. the ecological community appears diverse and normal, however long term chronic impacts are more subtle. For example, the NYSDEC guidelines to protect wildlife that consumes aquatic life in contact with copper contaminated sediments in 19 mg/kg. The 95th UCL for sediments is 401 mg/kg. For lead the NYSDEC guidelines is 27 mg/kg, the 95th UCL is 652 mg/kg.

For the protection of aquatic life in contact with contaminated sediments, the 95th Upper Confidence Limite (UCL) for both copper and lead exceed both the NYSDEC guidelines and the Limits of Tolerance (LOT) criteria for the protection of benthic macroinvertebrates.

For protection of terrestrial vegetation, soil concentrations considered to be phytotoxic to terrestrial vegetation were obtained from the scientific literature. Copper and lead at the 95th UCL exceed the range of concentrations considered to be phytotoxic to vegetation in soils.

Surface water criteria for the protection of aquatic life are not exceeded for copper and lead.

In summary, soils and sediment, in particular on-site soils and sediment, suggest the site conditions may pose an elevated ecological risk due to the presence of heavy metals, especially copper and lead. This risk is increased in the low lying areas where sediment from runoff accumulates.

Section 2

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

The purpose of this section is to develop remedial action technologies that will undergo screening in Section 3.0. Alternatives were developed following the standard USEPA method of identifying and screening technologies/processes and assembling them into alternatives. The approach consists of six steps:

- Develop remedial action objectives that are risk-based, with consideration given to ARARs for public health and environmental items. The remedial action objectives are also based on media of interest and chemical constituents of concern, exposure pathways and the remediation goals established between the Army, EPA and NYSDEC.

- Develop general response actions for each medium of interest that will satisfy each remedial action objective for the site.

- Estimate quantities of media to which general response actions will be applied to meet remedial action objectives.

- Identify remediation technologies/processes associated with each general response action. Screen and eliminate technologies/processes based on technical implementibility.

- Evaluate technologies/processes and retain processes that are representative of each technology.

- In Section 3.0 the retained technologies/processes will be assembled into a range of alternatives as appropriate and screened further. In Section 5.0 the surviving alternatives will be analyzed in detail.

This six-step approach to technology screening and alternatives development is described in the following subsections and summarized on Tables 2-6 and 2-7.

2.2 REMEDIAL ACTION OBJECTIVES

2.2.1 General Remedial Action Objectives

The CERCLA clean-up process is a risk based process, whose objectives are described in the National Contingency Plan (NCP). The NCP requires that any CERCLA remedial response reduce the environmental and human health risks of the chemicals present in the various environmental media, to within established EPA target ranges. Additionally, the NCP requires that CERCLA remedial action objectives comply with all ARARs. ARARs are promulgated standards that are applicable to the process of site clean-up and include chemical specific standards, action specific standards and location specific standards. Currently, there are no promulgated state or federal standards that establish soil and/or sediment quality.

While there are no media specific standards applicable to soil or sediment quality, NYSDEC has established guidelines for these media. Although these criteria are not ARARs, since they are not promulgated, these criteria are To Be Considered (TBC) in the CERCLA decision making process. TBCs are non-ARAR criteria that have been considered during the screening process as a factor for the protection of human health and the environment. These considerations generally involve a comparison between site concentrations and guidelines or criteria. Exceedance of a TBC does not necessarily require a remedial action, since a promulgated standard has not been exceeded, however, this information can be an indication that there is a potential for increased risk.

Finally, CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, requires that a CERCLA remedial action must:

- Use remedial alternatives that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances;

- Select remedial actions that protect human health and the environment, are cost effective, and involve permanent solutions, alternative solutions and resource recovery technologies to the maximum extent possible;

- Avoid off-site transport and disposal of untreated hazardous substances or contaminated materials where practical technologies exist to treat these materials on-site.

Remedial action objectives have been developed that consist of medium-specific objectives for the protection of human health and the environment. These objectives are risk based and comply with ARARs to the greatest extent possible. Where practicable, consideration was given to the NCP preference for permanent solutions. The following sections describe how these remedial objectives were determined and describe the development of remedial actions to attain these objectives.

2.2.2 Media of Interest

The media of interest was determined to be on-site soils and sediment in Reeder Creek. The selection of the media of interest was based upon the two general remedial action objectives of not exceeding the EPA target risk levels and compliance with ARARs. The remedial investigation has examined all media at the OB grounds. Discrete samples of the on-site and off-site surface water, the on-site and off-site sediment, the on-site soil and the on-site groundwater have been sampled and analyzed using EPA and NYSDEC established analytical techniques. This process has yielded high quality data for determining both the need to remediate and the extent of the remediation program.

The media of interest and the locations that may require a remedial action were selected by evaluating the benefits gained by implementing such an action. The benefits of a CERCLA remedial effort is defined by the extent that a proposed action will eliminate or decrease the risk to within acceptable levels and comply with ARARs. Reasonable decisions are then possible regarding the media and the extent of specific areas that need to be addressed. In this manner, if the conclusion is reached to perform a remedial action then the volume of material to be treated and the benefits produced by such an action are clear.

The results of the quantitative human health baseline risk assessment, performed as part of the RI for the OB Grounds, indicates that the total site non-carcinogenic and carcinogenic risk are within the acceptable range of EPA target values. The risk evaluation considered scenarios that included a current on-site industrial worker exposure scenario and a current offsite residential scenario (Table 1-1). The worst case site Hazard Index (HI), the indicator of non-carcinogenic risk is 0.25, which is below the EPA target value of 1.0. The worst case total site carcinogenic risk is 6.3×10^{-6}, which is within the EPA target range of 1×10^{-4} to 1×10^{-6}. As an indication of worst case future risks, the risk evaluation considered a future on-site residential exposure scenario (Table 1-1). The HI for this receptor was determined to be 0.33, which is also below the EPA target value of 1.0. The total site carcinogenic risk for this scenario was 1.0 X 10^{-5}, which is also within the EPA target range of 1 X 10^{-4} to 1 X 10^{-6}. This suggests that from a human health perspective, the conditions at the site would not require a remedial action.

The remedial investigation has collected data from on-site and off-site (Reeder Creek) surface water and sediments, on-site soils and the on-site groundwater at the OB grounds. Table 2-1 provides a comparison of the 95th UCL of the mean of the compounds of concern in the baseline risk assessment versus the various media standards or guidance. This table is comprised of six pages, with each page summarizing the sampling data for a particular media. Sheet 1 of Table 2-1 summarizes the on-site groundwater data. For the volatiles, only acetone was retained as being of potential concern. For the semivolatile compounds, only two phthalate compounds were retained. For the explosives, three explosives were retained. All the metals were deleted from consideration because they were either determined not to be significantly different than background or were considered essential nutrients. For all the constituents listed on Sheet 1 of Table 2-1 the 95th UCL is below the specified standard and therefore groundwater was eliminated as a media of interest. In this case the NY Drinking Water Quality Standards (DWQS) were determined to be the appropriate ARAR.

2.2.2.1 Soils

For the purposes of this analysis the on-site sediment data has been included with the on-site soil database because the on-site sediment was determined to be more alike soils than sediment. The ecological evaluation of the on-site wetlands, where the sediment samples were collected from, concluded that the macroinvertebrates found in these samples were terrestrial in nature, not aquatic. The consideration of the on-site sediment as soil is also consistent with site observations that indicated that the on-site wetlands only contained standing water during spring flood conditions or after a heavy precipitation event. For a majority of the year, the wetlands lacked water and therefore the on-site sediment was combined with on-site soil in order to provide an reasonable understanding of the impacts to the on-site soils and sediments. In addition to the inclusion of the on-site sediment samples in this database, the soil samples collected from the pads, the pad berms, the low lying hill, the grid borings, the burn kettle area, the geophysical anomalies and the downwind samples were also included. The sixth sheet of Table 2-1 presents an evaluation of the data collected from these areas. The potential constituents of concern for each chemical class are presented in addition to the NYSDEC TAGM values, the number of samples used to calculate the 95th UCL of the mean and the maximum value detected for a particular analyte. Since this media

TABLE 2-1

GROUNDWATER SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	NY DWQS%
Volatile Organics						
Acetone	ug/L	28	15.00	3.68	2.95	50
Semivolatiles						
Di-n-butylphthalate	ug/L	27	5.00	5.05	4.72	50
Di-n-octylphthalate	ug/L	27	5.00	5.10	4.85	50
Explosives						
RDX	ug/L	27	0.06	0.06	0.06	NA
2,4,6-Trinitrotoluene	ug/L	27	0.06	0.06	0.06	NA
2,6-Dinitrotoluene	ug/L	27	0.06	0.06	0.06	NA

TABLE 2-1

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN
Volatile Organics					
1,2-Dichloroethane	ug/L	19	5.00	4.30	3.82
Trichloroethene	ug/L	19	17.00	5.69	4.45
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	19	71.00	9.37	8.50
Explosives					
RDX	ug/L	19	9.40	1.93	0.93
Tetryl	ug/L	19	0.52	0.18	0.14
Metals					
Aluminum	ug/L	13	5,220.00	18,766.22	882.22
Arsenic	ug/L	19	4.40	1.97	1.50
Barium	ug/L	16	523.00	190.85	141.61
Beryllium	ug/L	18	1.30	0.56	0.41
Chromium	ug/L	19	8.60	3.10	2.37
Copper	ug/L	19	59.80	70.79	15.33
Lead	ug/L	19	74.20	53.03	10.70
Manganese	ug/L	16	1,080.00	1,090.08	198.79
Nickel	ug/L	19	17.50	6.83	5.27
Vanadium	ug/L	19	37.20	32.41	9.10

TABLE 2-1

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	NY AWQC[2]
Volatile Organics						
1,2-Dichloroethane	ug/L	11	5.00	3.73	3.14	NA
Trichloroethene	ug/L	11	5.00	3.76	3.18	NA
Explosives						
RDX	ug/L	12	0.67	0.17	0.12	NA
Tetryl	ug/L	12	0.20	0.13	0.10	NA
Metals						
Aluminum	ug/L	9	300.00	139.41	93.23	100
Arsenic	ug/L	11	1.85	1.44	1.23	190
Barium	ug/L	11	66.60	57.50	52.15	NA
Beryllium	ug/L	5	1.40	6.71	0.49	1100
Chromium	ug/L	11	4.80	4.27	3.43	367
Copper	ug/L	11	9.85	8.90	6.93	22
Lead	ug/L	11	2.20	0.99	0.70	8
Manganese	ug/L	10	236.00	130.42	88.02	NA
Nickel	ug/L	11	17.60	15.10	11.49	162
Vanadium	ug/L	11	39.20	18.95	13.63	14

TABLE 2-1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	NYSDEC SEDIMENT CRITERIA[3]
Semivolatiles						
2-Methylnaphthalene	ug/kg	17	500.00	362.54	312.35	NA
Phenanthrene	ug/kg	20	600.00	395.15	330.85	1390
Benzo(a)anthracene	ug/kg	18	500.00	366.89	311.28	NA
Benzo(b)fluoranthene	ug/kg	18	500.00	366.93	311.50	NA
benzo(k)fluoranthene	ug/kg	18	500.00	366.95	311.61	NA
Benzo(a)pyrene	ug/kg	18	500.00	366.78	310.72	NA
Indeno(1,2,3-cd)pyrene	ug/kg	18	500.00	366.77	310.67	NA
Explosives						
4-amino-2,6-Dinitrotoluene	ug/kg	22	160.00	72.20	64.55	NA
2-amino-4,6-Dinitrotoluene	ug/kg	22	180.00	75.88	66.59	NA
Metals						
Aluminum	mg/kg	22	25,800.00	17,742.74	16,486.36	NA
Antimony	mg/kg	12	28.30	10.60	7.25	NA
Arsenic	mg/kg	19	9.50	5.66	4.85	5
Barium	mg/kg	19	1,780.00	366.08	271.98	NA
Beryllium	mg/kg	18	1.60	1.09	0.98	NA
Cadmium	mg/kg	22	9.70	3.38	2.55	0.8
Chromium	mg/kg	19	41.80	26.72	24.56	26
Cobalt	mg/kg	19	17.70	12.70	11.64	NA
Copper	mg/kg	22	3,790.00	489.13	288.04	19
Lead	mg/kg	22	7,400.00	1,674.71	526.09	27
Manganese	mg/kg	22	1,520.00	597.58	502.05	428
Mercury	mg/kg	20	2.00	0.93	0.32	0.11
Nickel	mg/kg	19	64.40	40.25	36.55	22
Selenium	mg/kg	18	1.80	0.91	0.73	NA
Vanadium	mg/kg	19	37.90	27.22	25.23	NA
Zinc	mg/kg	21	1,200.00	446.43	273.22	85

TABLE 2-1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	NYSDEC SEDIMENT CRITERIA[3]
Semivolatiles						
2-Methylnaphthalene	ug/kg	8	490.00	411.83	314.63	NA
Phenanthrene	ug/kg	8	490.00	396.75	269.38	1390
Benzo(a)anthracene	ug/kg	8	490.00	407.76	336.25	NA
Benzo(b)fluoranthene	ug/kg	8	490.00	407.76	336.25	NA
benzo(k)fluoranthene	ug/kg	8	490.00	407.76	336.25	NA
Benzo(a)pyrene	ug/kg	8	490.00	407.76	336.25	NA
Indeno(1,2,3-cd)pyrene	ug/kg	8	490.00	407.76	336.25	NA
Explosives						
4-amino-2,6-Dinitrotoluene	ug/kg	9	60.00	60.00	60.00	NA
2-amino-4,6-Dinitrotoluene	ug/kg	9	60.00	60.00	60.00	NA
Metals						
Aluminum	mg/kg	10	15,600.00	12,202.89	10,104.50	NA
Antimony	mg/kg	4	4.05	4.06	3.71	NA
Arsenic	mg/kg	6	7.40	6.66	5.28	5
Barium	mg/kg	6	94.80	66.24	47.33	NA
Beryllium	mg/kg	5	0.71	0.65	0.47	NA
Cadmium	mg/kg	10	3.40	2.27	1.71	0.8
Chromium	mg/kg	6	24.50	22.85	18.08	26
Cobalt	mg/kg	6	11.20	10.23	8.03	NA
Copper	mg/kg	10	2,380.00	1,032.68	262.51	19
Lead	mg/kg	10	332.00	418.55	94.17	27
Manganese	mg/kg	10	596.00	474.62	420.00	428
Mercury	mg/kg	7	0.69	1.22	0.20	0.11
Nickel	mg/kg	6	42.30	37.97	29.63	22
Selenium	mg/kg	6	1.40	1.02	0.62	NA
Vanadium	mg/kg	6	20.10	18.02	13.90	NA
Zinc	mg/kg	6	497.00	899.80	148.22	85

TABLE 2-1

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	NYSDEC TAGM
Semivolatiles						
2-Methylnaphthalene	ug/kg	208	1,300.00	300.38	283.51	36400
3-Nitroaniline	ug/kg	209	2,950.00	1,269.92	1,187.99	500
2,4-Dinitrotoluene	ug/kg	216	33,000.00	698.13	848.61	50000
Phenanthrene	ug/kg	213	2,600.00	318.84	292.35	50000
Benzo(a)anthracene	ug/kg	207	3,900.00	348.74	313.43	220
Chrysene	ug/kg	209	8,900.00	350.63	339.84	400
Benzo(b)fluoranthene	ug/kg	207	11,000.00	352.57	352.59	1100
Benzo(k)fluoranthene	ug/kg	207	4,500.00	333.52	317.58	1100
Benzo(a)pyrene	ug/kg	207	3,700.00	350.19	314.43	61
Indeno(1,2,3-cd)pyrene	ug/kg	206	2,300.00	327.40	304.97	3200
Dibenz(a,h)anthracene	ug/kg	201	670.00	301.48	289.95	14
Benzo(g,h,i)perylene	ug/kg	202	960.00	301.77	293.60	50000
Pesticides/PCBs						
Dieldrin	ug/kg	211	50.00	11.56	10.61	44
4,4'-DDE	ug/kg	214	830.00	17.97	16.55	2100
4,4'-DDT	ug/kg	215	2,800.00	18.66	26.41	2100
Explosives						
RDX	ug/kg	217	4,800.00	91.42	121.24	NA
1,3,5-Trinitrobenzene	ug/kg	217	7,800.00	110.19	172.72	NA
Tetryl	ug/kg	217	1,000.00	149.59	137.79	NA
2,4,6-Trinitrotoluene	ug/kg	217	80,000.00	130.68	607.24	NA
4-amino-2,6-Dinitrotoluene	ug/kg	217	8,900.00	130.03	181.53	NA
2-amino-4,6-Dinitrotoluene	ug/kg	217	11,000.00	143.50	212.08	NA
Metals						
Barium	mg/kg	194	34,400.00	1,445.67	1,479.39	300
Cadmium	mg/kg	217	28.20	5.74	3.49	1.8
Chromium	mg/kg	198	1,430.00	31.62	35.98	26.6
Copper	mg/kg	211	38,100.00	678.04	796.94	25
Lead	mg/kg	208	56,700.00	2,836.27	1,888.27	30
Thallium	mg/kg	214	38.00	0.32	0.46	0.3
Zinc	mg/kg	216	127,000.00	884.31	1,317.65	89.1

NA = not applicable
1. New York State Drinking Water Regulations, 10 NYCRR Part 5
2. New York State Ambient Water Quality Standards and Guidelines for Class C surface waters. Selected metals values are based on a hardness of 201.
3. NYSDEC Sediment Criteria, December, 1989.

is soil, the clean-up values, presented in NYSDEC TAGM HWR-94-4046, are used for comparison. This guidance is considered to be a TBC. The analytes which exceed these guidance values are the semi-volatiles benzo(a)anthracene, benzo(a)pyrene and dibenz(a,h,)anthracene and the metals barium, copper, lead, mercury, and zinc. The list of the metals considered in this analysis has been shortened following a test for significance between the on-site concentration and the background concentrations.

Although the outcome of the risk evaluation did not suggest that a remedial action is required, it was recognized that since lead, a heavy metal found in the pads, berms and soils, was not part of the risk analysis, it should be considered. Lead was not considered as part of the risk assessment because EPA has withdrawn the allowable Reference Dose (RfD) values for lead.

Parsons ES performed modeling using the EPA model, Biokinetic Uptake Model for Lead in Children, (UBK). This model evaluates the impacts of children, in a residential setting ingesting lead from various sources, including soil. The results of this model suggested the range of allowable lead in soil would be approximately 500 mg/kg to 1000 mg/kg. The UBK results were not included as part of the RI because the intended future use of the OB Grounds was as it currently is, a munitions disposal area, not a residential area. However, since the preparation of the RI, the depot has been listed as a facility to be closed under the BRAC95 program. As a result, the Army considered alternative land uses to a munitions destruction facility, and the UBK was considered as a factor in establishing a soil clean-up value for lead in soil.

Since there are exceedances of these NYSDEC TAGM soil clean-up guidance values and leaching models suggest that metals could adversely leach from soil, this media has been retained as a media of interest.

2.2.2.2 Sediment

The ecological risk assessment identified instances where specific data points exceeded the NYSDEC Sediment Criteria values. Unlike the human health risk, the ecological risk assessment does not calculate a quantitative total site risk value, instead ecological risks were determined as a comparison of established NYSDEC criteria and supplemental literature values that are considered to be protective of the ecological community. The 95th UCL of the mean was used as the value of comparison against the appropriate criteria. The results of this effort indicated that the sediment of Reeder Creek were media of concern due to measurable concentrations of copper and lead.

On-site sediments are samples of soil collected from the small low lying areas at the site where surface water and sediment accumulate. The ecological assessment of these areas suggest that these areas are more terrestrial in nature rather than aquatic. This is likely due to the short time period that water actually exists in these areas. The fourth sheet of Table 2-1 presents an evaluation of the data collected from these on-site accumulation areas, which have similarities to wetlands. The potential constituents of concern for each chemical class are presented in addition to the NYSDEC sediment criteria, the number of samples used to calculate the 95th UCL of the mean and the maximum value detected for a particular analyte. Although this media is considered similar to soil, for the purposes of the risk evaluation, the NY Sediment Criteria values were considered as a TBC. The NY Sediment Criteria values require lower allowable concentrations than the NYSDEC TAGM values for soil clean-up due to the increased potential for bioaccumulation by aquatic species. However, since the risk assessment was completed, the on-site sediment was combined with on-site soil. Since the sediment criteria are not promulgated standards, they are not ARARs. The analytes that exceeded this TBC are the metals: arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel and zinc. The most significant exceedances are for copper, lead, mercury and zinc. Since there are exceedances for this TBC, on-site sediment has been retained as a media of interest but has been combined with the on-site soil and will not be considered as a separate media.

Off-site sediments samples were collected from areas in Reeder Creek where sediments accumulate. Unlike the on-site sediment samples, the ecological sediment samples collected from the off-site stations in Reeder Creek were abundant with aquatic macroinvertebrates. The fifth sheet of Table 2-1 presents an evaluation of the data collected from these off-site areas of sediment accumulation. The potential constituents of concern analytes for each chemical class are presented in addition to the NYSDEC sediment criteria, the number of samples used to calculate the 95th UCL of the mean and the maximum value detected for a particular analyte. Since this media is sediment, the NY Sediment Criteria values were considered a TBC. The analytes that exceed this TBC are the metals arsenic, copper, lead, manganese, mercury, nickel and zinc. The most significant exceedances are for copper, lead, mercury and zinc. Since there are exceedances for the TBC, this media has also been retained as a media of interest.

2.2.2.3 Groundwater

On-site groundwater was not determined to be a media of interest based upon the two rounds of groundwater sampling performed. Both unfiltered and filtered groundwater samples were collected as part of the first round of groundwater sampling. No filtered groundwater samples exceeded the federal action criteria or the NYSDEC GA standard. Several of the unfiltered samples did exceed these criteria due to the presence of turbidity in the samples. A sampling protocol was established prior to the performance of the second round of groundwater sampling that involved low flow sampling. This procedure was developed with the cooperation of representatives of NYSDEC and EPA with the goal of collecting a turbid-free groundwater sample that has an Nephelometric Turbidity Units (NTU) of less than 50. In accordance with these sampling procedures, only unfiltered samples were collected for the second round using low flow sampling procedures. The results of the second round indicated that for lead, only 2 exceedances were detected out of the 33 wells sampled. These exceedances were slight and detected at wells MW-14, that had a lead concentration of 85.5 ug/L, and MW-19, that had a lead concentration of 35.7 ug/L. Due to the high clay content of the on-site soils, even with the low flow sampling techniques, both of these two wells produced samples that had NTU values that were higher than the 50 target value. MW-14 yielded a turbidity of 155 NTU and MW-19 yielded a turbidity of >200 NTU and the exceedances could be an artifact of the elevated turbidity.

Further, since the two exceedances of lead in groundwater are approximately 875 feet apart from each other there is no indication of a contiguous groundwater plume. The data would suggest that these two exceedances are isolated occurrences of variation due to sample collection techniques. Due to the nature of a groundwater pumping strategy, any remedial program aimed at decreasing the concentration of lead in these two wells would involve extracting groundwater from surrounding wells that would not be considered impacted. The efficacy of such a strategy is questionable, especially since the data collected from Phase One suggests that filtration of the groundwater would produce acceptable quality water. In addition, MW-14 and MW-19 are downgradient of Pad D and Pad J, respectively. Pad D and J are not the locations of the most severely impacted soils, which further suggests that the exceedances are sampling artifacts. Monitoring wells downgradient of the most severely impacted pads, such as MW-13, located downgradient of Pad F, and MW-15, located downgradient of Pad B would be expected to produce concentrations of lead in groundwater above the concentrations of lead measured for MW-14 and MW-19, due to the increased presence of lead in soil detected at these pads. Since there is a poor correlation between the location of the most impacted soils and groundwater it is unlikely that metals, such as lead, have impacted groundwater. Since the same leaching forces are present throughout the site, it was concluded that current groundwater conditions were not of sufficient concern to warrant a remedial action. As a result, groundwater was not determined to be a media of interest, although protection of groundwater due to the leaching of metals from soils in the future was deemed appropriate.

2.2.2.4 Surface Water

The on-site surface water samples have been separated from the surface water samples collected from Reeder Creek. The nature of the on-site surface water, essentially small intermittent pools, is unlike the surface water in Reeder Creek, which is a year round flowing stream. The on-site surface water pools have not been classified by NYSDEC as a surface water body and NY Ambient Water Quality Concentrations (AWQC) do not apply to the surface water that accumulates at the OB Grounds. The on-site surface water data from the RI is summarized and presented on Sheet 2 of Table 2-1. The potential constituents of concern for each chemical class are presented in addition to the standard or guidance value that was used to screen the data for potential impacts. The number of samples used to calculate the 95th UCL of the mean and the maximum value detected for a particular analyte is also presented. For on-site surface water, the AWQCs were not used for comparison as AWQC to do apply to on-site surface water. However, any remedial action will consider the on-site surface water by implementing proper runoff/runon controls thereby preventing interactions with on-site soils, both during construction activities and as part of a permanent design. Since AWQC do not apply, the on-site surface water has been eliminated as a media of interest.

As mentioned previously, the off-site surface water samples were considered separately from the on-site surface water samples and are presented as Sheet 3 of Table 2-1. The potential constituents of concern for each chemical class are presented in addition to the applicable ARAR, the number of samples used to calculate the 95th UCL of the mean and the maximum value detected for a particular analyte. Since this media is surface water, the NY AWQC were considered as an appropriate ARAR to protect aquatic life and wildlife consumers of fish. During the elapsed time between the RI and the FS, NYSDEC reclassified the quality of Reeder Creek, upgrading the stream from Class D to Class C. Table 2-1 of the FS will therefore not agree with the original table in the RI. No analytes exceed the AWQC for Reeder Creek. Since there are no exceedances of any AWQC, the surface water in Reeder Creek has been eliminated as a media of interest.

2.2.2.5 Air

Air was evaluated as a potential media of interest but was discounted as a media of interest for the following reasons. As part of the risk assessment process, the human health impacts due to the inhalation of fugitive dust was considered using EPA approved atmospheric dispersion models of the on-site soil material. This evaluation indicated that ingestion of fugitive dust was generally an order of magnitude lower in both carcinogenic and non-carcinogenic risk than the most significant risk pathway, which was ingestion of on-site soil. For example, for the current industrial on-site worker, the carcinogenic risk due to inhalation of fugitive dust is 1.7 E-07 and the non-carcinogenic risk due to inhalation of fugitive dust is 0.020, whereas the carcinogenic risk due to ingestion of soil is 6.0 E-06 and the non-carcinogenic risk due to ingestion of soil is 0.183. Even if this pathway was considered significant, the focus of any risk reduction efforts would be with the on-site surface soils rather than the air.

Additional supporting data for discounting air as a media of concern can be drawn from the field data that was collected during the RI. In support of the field health and safety activities, ambient air monitoring for Volatile Organic Compounds (VOCs), particulate matter and radioactivity, at each drilling location and 100 feet downwind, was performed. In no instances did this ambient air monitoring effort indicate that ambient air was impacted due to field activities. Although this data was qualitative in nature, it is useful as an overall indication of air quality at the site.

In summary, the media of interest are on-site soil (including on-site sediment) and off-site sediment in Reeder Creek.

2.2.3 Risk-Based Remedial Action Objectives

The intent of risk-based remedial action objectives is to reduce non-carcinogenic and carcinogenic risks to acceptable levels. Acceptable levels are defined by EPA criteria established under CERCLA and SARA. As stated in Subsection 1.6.1, the baseline human health risk assessment indicates that, under the current and intended future use of this site, the risk-based carcinogenic and non-carcinogenic human health risk values are within EPA target ranges. Therefore, if risk-based health criteria are applied to the OB grounds, remedial objectives have been met with no further action.

Although the outcome of the human health risk analysis indicated the current site conditions are within acceptable EPA target ranges, the risk analysis could not consider the presence of lead in soil, as the Reference Dose (RfD) for lead has been withdrawn for use by EPA. Protection of human health from lead impacts was considered by application of the UBK model. The model calculated a distribution of blood lead levels in children. The current EPA policy is to set soil cleanup levels to ensure that 95 percent of the distribution falls below 10 ug/dL. This blood lead level corresponds to an allowable concentration of lead in soil of approximately 500 mg/kg. This model is considered conservative, since it evaluated the impacts to children from a residential exposure scenario at the OB Grounds. Initially, this exposure scenario was considered unrealistic, since the Army intended to continue to use this site as a munitions destruction area, not residential, but with the inclusion of SEDA on the BRAC95 list, residential exposure was considered as a potential, worst-case, future land use. The UBK evaluation of conditions at the OB Grounds indicated that lead levels in children would be above the allowable cutoff of 10 ug/dL and therefore a remedial action for lead in soil was deemed appropriate.

Unlike the human health risk assessment, there are no allowable carcinogenic or non-carcinogenic target ranges established for protection of ecological receptors. Instead, the ecological risk analysis was based upon a comparison with available state and federal guidelines and supplemented with literature derived guidelines. This comparison suggested that there may exist a potential risk from the presence of heavy metals, specifically lead and copper. As a result of this comparison, it was determined that a remedial action would be appropriate for copper and lead, in order to assure the protection of the aquatic life and wildlife consumers of aquatic life. The remedial action objective for protection of ecological receptors was established as those presented in the NYSDEC guidance document "Technical Guidance for Screening Contaminated Sediments, November, 1993". For lead and copper, the values adopted by NYSDEC and referenced in the guidance were the Lowest Effect Level (LEL) presented by Persaud et al. (1992).

2.2.4 ARAR-Based Remedial Action Objectives

The remedial action objectives at the OB Grounds involves compliance with ARARs from both the State of New York, administered by NYSDEC, and federal regulations, administered by USEPA, Region II. Three categories of potentially applicable state and federal requirements were reviewed and evaluated as to the applicability to this site. The three categories of ARARs are: chemical-specific, location specific and action specific. A brief regulatory discussion of ARARs is given below.

In 40 CFR 300.5, EPA defines applicable requirements as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are defined as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Any standard, requirement, criterion, or limitation under any federal or state environmental or facility siting law may be either applicable or relevant and appropriate to a specific action. The only state laws that may become ARARs are those promulgated such that they are legally enforceable and generally applicable and equivalent to or more stringent than federal laws. A determination of applicability is made for the requirements as a whole, whereas a determination of relevance and appropriateness may be made for only specific portions of a requirement. An action must comply with relevant and appropriate requirements to the same extent as an applicable requirement with regard to substantive conditions, but need not comply with the administrative conditions of the requirement.

As mentioned earlier in this section, three categories of ARARs were analyzed. The are as follows: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain contaminants or a class of contaminants and relate to the level of contamination allowed for a specific pollutant in various environmental media (water, soil, air). Location-specific ARARs are based on the specific setting and nature of the site. Action-specific ARARs relate to specific actions proposed for implementation at a site. Both location-specific and action-specific ARARs are independent of the media. In addition to ARARs, advisories, criteria or guidance may be evaluated as "To Be Considered" (TBC) regulatory items. CERCLA indicates that the TBC category could include advisories, criteria or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies. These advisories, criteria or guidance are not promulgated and, therefore, are not legally enforceable standards such as ARARs.

Appendix A lists ARARs, TBCs and Standards, Criteria and Guidelines (SCGs) that apply to the OB Grounds during and after remedial action.

An additional CERCLA remedial action objective is that the OB Grounds must comply with ARARs. If a remedial action to be performed is action-based ARARs must be met including remediation worker health protection.

2.2.5 Summary of Remedial Action Objectives and Site Specific Clean-up Goals

Site-specific clean-up goals have been established between NYSDEC, the USEPA (Region II) and the Army for the OB Grounds. For on-site surface and subsurface soils, the goal is to remediate soil with concentrations of lead greater than 500 mg/kg. This concentration is based on the output of the UBK model indicating that 500 mg/kg would be protective of human, residential exposure.

The remedial action goal for sediments in Reeder Creek was established as the concentrations of copper and lead presented in the NYSDEC "Technical Guidance for Screening of Contaminated Sediments". This guidance sets the clean-up goal for lead at 31 mg/kg and for copper the goal was established as 16 mg/kg. These values were established as maximum values that would be protective of the aquatic community in Reeder Creek. Additionally, to prevent further run-off from the OB Grounds into Reeder Creek, a sedimentation basin was also established as a requirement of the proposed remedial action.

Soil and sediment remedial action objectives for the OB Grounds are summarized in Table 2-2.

Human Health Risk Concerns

In their letter of November 7, 1995, NYSDEC confirmed that the proposed cleanup levels for soils at the OB Grounds would "satisfy human health concerns and allow unrestricted future use of the site from the viewpoint of remaining lead concentrations".

In their letter of December 29, 1995, the EPA, Region II, confirmed that the cleanup levels would be acceptable for surface soils, subsurface soils, and sediments on the OB Grounds. According to their letter, "the 500 mg/kg lead soil cleanup level would satisfy human health risk concerns for lead in soils only". Regarding the groundwater, EPA will require appropriate post remediation groundwater monitoring to assure that the quality of the groundwater remains protective of human health.

Both letters are included in Appendix F of this report.

Ecological Risk Concerns

The EPA confirmed that the 500 mg/kg soil cleanup level would be acceptable for the protection of ecological receptors if future land use at the site were limited to industrial, commercial, or residential use. The EPA also agreed that the clean-up goal for sediment in Reeder Creek would be protective of ecological receptors within the creek. However, the potential for soil with 500 mg/kg lead to enter Reeder Creek through surface water runoff must be prevented.

Table 2-2

SENECA ARMY DEPOT ACTIVITY
OPEN BURNING GROUNDS
FEASIBILITY STUDY

SUMMARY OF REMEDIAL ACTION OBJECTIVES

Environmental Media	Remedial Action Objectives	Clean-up Goals	Basis
On-site Soil & Sediment	1) Prevent leaching to groundwater causing lead in groundwater to exceed 25 ug/L,	500 mg/kg lead	Protection of groundwater
	2) Prevent ingestion/direct contact with soil having lead in excess of 500 mg/kg,		Allow residential or industrial land use
	3) Prevent soil loading to Reeder Creek,		Protect ecological receptors in Reeder Creek
	4) Meet RCRA requirements for closure.		Compliance with ARARs
Reeder Creek Sediment	Prevent bioaccumulation of copper and lead	16 mg/kg for copper and 31 mg/kg for lead	Protect ecological receptors in Reeder Creek

NYSDEC agreed that the cleanup levels for copper and lead for sediments in Reeder Creek would be protective of aquatic life. NYSDEC requires vegetative stabilization of the remaining soil at the OB grounds to minimize erosion and possible recontamination of Reeder Creek and periodic monitoring of the sediments in Reeder Creek to ensure that it is not being recontaminated by the lead left on site.

Future Land Use

The EPA stated that the future use of the groundwater would be restricted until post remediation monitoring proves that there will be no risks to human health. In addition, the EPA states that future use of the site would be restricted until the issue of unexploded ordnance (UXO) is adequately addressed.

In addition, NYSDEC also requires that the Army remove all UXOs from the site and certify in writing that the land is free of all UXOs before releasing the land for unrestricted use. The Army will conduct UXO clearance to support remediation activities. That is, UXO clearance will be conducted in the areas of the site which will be remediated, but will not be conducted on a sitewide basis. If the property is transferred, a qualifier will be added to the deed stating that UXO clearance has been conducted by the Army, however, there will always be a risk involved and the Army cannot certify that the site is free of all UXOs.

In summary, soils/sediment remedial action alternatives will be developed to accomplish the following:

- Remediate on-site soils with concentrations of lead greater than 500 mg/kg;
- Remediate sediment in Reeder Creek until the remaining sediment is below 31 mg/kg for lead and 16 mg/kg for copper, which is protective of the aquatic community in Reeder Creek;
- Conduct post-remediation groundwater monitoring to prove that human health risk is not a concern in the groundwater;
- Prevent surface water runoff from the OB Grounds to Reeder Creek;

- As an initial step in the remediation process, remove all UXOs from the areas of the site whcih will undergo remediation;

- Develop vegetative stabilization of the remaining soil at the OB Grounds to minimize erosion and possible recontamination of Reeder Creek; and

- Conduct periodic monitoring of the sediments in Reeder Creek to ensure that it is not being recontaminated by the lead left in the soils at the site.

2.3 GENERAL RESPONSE ACTIONS

This section presents the general response actions that have been considered applicable at the OB Grounds. This initial effort involves screening the universe of general response actions for application at this facility. The screening process involves relating media specific remedial action objectives to various general response actions. Ultimately, these action will be used to identify specific remedial technologies. The process of selecting general response actions has involved a qualitative engineering evaluation of response actions that have been developed for application to Superfund sites. This evaluation is based upon engineering experience, EPA Superfund Innovative Technology Evaluation (SITE) demonstration evaluation reports, vendor information, EPA technology databases and Department of Defense (DoD) technology evaluation reports.

Based upon the characteristics of the waste and the site conditions, determined during the RI, the appropriateness of an action was based upon effectiveness, implementabilty and cost. General response actions that have the potential to meet the previously described remedial action objectives were considered along with remedial technologies and process options that are associated with these general actions.

Appropriate response actions are those actions that involve control of inorganics in soil and sediment and removal of UXOs from the site. Controlling these materials will assure that exposure to humans and ecological receptors are prevented and will accomplish the remedial action goals for soil and sediments. The initial response action for each alternative, except the no-action, will be the removal of UXOs from the areas of the site to be remediated. Since groundwater, surface water and air are not a media of concern, other than preventing further degradation to the quality of these various media, general response actions for these media have not been considered. Unlike actions for organics compounds, response actions for inorganic constituents, do not involve breaking down the components, via a treatment process, to a less innocuous substance. Instead, the actions that are appropriate for metals are those that prevent exposure by isolation, such as within a landfill, or by chemically or physically binding the metals into a stabilized matrix. In some cases, if site conditions are favorable, it is possible to accomplish this in-situ, otherwise some excavation and consolidation of materials from disperse locations will be required prior to isolation or treatment.

The screening process has identified the following general response actions as applicable for site remediation:

- No Action,
- Institutional Control Actions,
- Containment Actions,
- In-situ Treatment Actions,
- Excavation/Ex-situ Treatment Actions and
- Excavation/Disposal Actions.

A brief synopsis of the screening process and the reasons for selecting these general response actions is provided.

No Action involves leaving the site in the current conditions and allowing unrestricted use of the property. This action does not involve additional monitoring, security or any measures to minimize the risk to ecological receptors or human health. Since No Action does not involve any remedial action, there are no remedial technologies or process options that are applicable. This action has been retained for further consideration as it will provide a baseline for comparing the benefits of implementing other actions.

Institutional control actions represent the lowest level of response activity and consists of monitoring, security, physical restrictions such as fencing, and land use restrictions such as deed restrictions. Institutional control actions minimize the possibility of receptor contact with wastes by removing the receptor or modifying the exposure pathway. Since institutional control actions are only applicable to the receptor, they do not involve reductions in the volume, toxicity or control of wastes at the site.

Unlike many CERCLA sites that are abandoned, the OB Grounds is located within the boundaries of the an active military installation, consequently, land use is restricted to only authorized personnel. Security measures are currently in place that prevent unauthorized use of the site. In addition, there are institutional controls currently in-place that require the Army to disclose the conditions of the site and restrict land use, as appropriate, to meet the risks associated with the future use of the site. These requirements include: CERCLA, 42 United States Code Section 120 (h)(1), as amended by the Community Environmental Response Facilitation Act (CERFA) (Public Law 102-426), that requires that any prospective owner of a site regulated under CERCLA must be notified that hazardous substances were stored and Army Regulation, AR 200-1, paragraph 12-5, that requires that the Army must perform an Environmental Baseline Study (EBS) prior to the transfer of any Army property and must provide disclosure to the potential owner of all the potential hazards. The EBS follows similar processes required under CERCLA and includes an assessment of the risks associated with the use of the property to be transferred. These regulations are intended to assure that agreements between the Army and prospective property owners have considered the risks associated with future land use. Deed restrictions as part of an agreement for the transfer of property are actions that will allow limited, yet productive, use of the property.

The property transfer issue has become more of a possibility now that the future use of this parcel has been changed from when the RI was prepared. This change in future land use was due to the inclusion of SEDA on the base closure list for BRAC95. The intended future use of this parcel was identified in the RI as a munitions destruction area. The current intended future land use of the OB Grounds has not been finalized but will be determined by the Local Redevelopment Authority (LRA), in conjunction with the Army. Since the depot will be closed, the use of the land will not be under the control of the Army. The risk assessment, performed as part of the RI did consider, as a worst case alternative, the risks associated with on-site residential use. The outcome of the assessment indicated that the risks associated with on-site residential exposure to human health were within the target range for both carcinogenic and non-carcinogenic risks.

The risk analysis is essential in determining what exposure scenarios are allowable for future land uses. This can be the basis for a land use restriction in the property deed or if the exposure scenario indicates unacceptable risk in one portion of a parcel then that portion can be restricted for use by limiting access via a physical barrier, security or other means. In general, some form of monitoring will be associated with this action to assure that the conditions remain constant.

Containment actions are applicable to source control actions by restricting the movement or migrations of waste materials and minimizing potential impacts to receptors. These actions would involve placement of a physical barrier, that may include both horizontal and vertical barriers, isolate the waste materials. Some consolidation of materials may be required to minimize the area that will require isolation. The range of containment technologies include capping, slurry walls, sheet pilings or horizontal barriers using the block displacement method of grouting. Since these actions do not involve volume or toxicity reductions they will require a monitoring program to assure the integrity of the action.

In-situ treatment actions have been identified as applicable general response actions. This effort generally involves either in-situ mixing the waste with an agent preventing further migration or could include in-situ heating of the waste/soil matrix until vitrification is achieved. In either case, the soil/waste matrix is transformed into a stabilized, non-leaching, mass, without excavation. Vendors with specialized equipment are required to achieve the proper mixing with solidification agents or the high temperatures required to achieve vitrification.

General response actions that involve excavation followed by treatment using either solidification/stabilization or soil washing techniques was also identified as applicable. These actions involve technologies that treat the waste/soil matrix in a treatment train. This train involves unit operations combined in a manner that produces the desired affect, be it solidification via mixing with an appropriate admixture, volume reduction via soil washing or acid leaching.

Another action that was considered viable for consideration at this facility is excavation followed by disposal in a landfill. The landfill could be an off-site facility or a facility that would be constructed on-site. Under such an action, waste materials would be excavated, placed in the landfill and monitored. If a landfill facility were to be constructed on-site, a facility siting study would be required to assure compliance with the requirements of 6 NYCRR Part 360.

2.4 ESTIMATE OF QUANTITIES TO BE REMEDIATED

The amount of material that will require a remedial action has been estimated by considering how various volume scenarios, i.e. cases, will meet the remedial action objectives. As part of this effort, Parsons ES has quantified the reduction in risk, for both non-carcinogenic and carcinogenic. The remedial action objectives involve reducing the concentration of the on-site soil and Reeder Creek sediment to the clean-up levels agreed upon by EPA (Region II), NYSDEC, and the Army. The goals have been presented previously.

The data analysis has been structured to consider a logical progression of adding soil until the final goal is achieved. This analysis has determined the volume of soil requiring a remedial action as well as the corresponding reductions in risk and lead levels achieved by removing this volume of soil. As a consequence to meeting the remedial action objectives, that is based primarily on lead, other compounds not specifically identified as part of the remedial action objectives are also reduced. The most significant contributor of carcinogenic risk in soil is the class of semivolatile organic compounds called Polynuclear Aromatic Hydrocarbons (PAH)s. Several of these compounds, identified by EPA as carcinogens, have been detected in the on-site surface soil samples. The presence of these compounds are not unexpected since PAHs are produced as Products of Incomplete Combustion (PIC)s. It is known that the processes performed at these pads involved open burning of munitions and therefore it is likely that this process resulted in the formation of these residual burning products. The data is also consistent with the conceptual site model which predicted the occurrence of these compounds as predominately a surface phenomenon. In all cases, the samples which contained these compounds were collected at the surface of either the former burning pads or at the surface of the surrounding soil.

The most significant contributors to the non-carcinogenic risk are the metals. Metals such as Ba, Cu and Zn contribute to the non-carcinogenic risk level. The current risk analysis indicates that the non-carcinogenic risk levels are below the EPA target value of a HI less than 1 for all exposure scenarios considered, including residential. This analysis provides an indication of the additional reductions in the non-carcinogenic risk produced.

Five cases have been considered in determining the areas and volume of material that will require remedial attention. Each of these scenarios are based upon a logical progression of increasing soil volumes and are provided on Table 2-3 and shown in Figures 2-1 and 2-2. Table 2-4 provides a comparison of the NYSDEC TAGM value and the 95th UCL of the mean used in calculating the Baseline Risk Assessment. In addition, Table 2-4 presents the number of samples used to calculate the 95th UCL and the maximum concentration of a particular analyte remaining in the database once the samples included as part of the remediation scheme have been removed. As shown in Table 2-4, as the soil volumes associated with the various remedial strategies depicted as Cases 1 through Case 5 are removed, the 95th UCL of the mean and the maximum concentration decrease. The impacts

TABL_

AREAS FOR SOIL REMEDIATION

SENECA ARMY DEPOT
OB GROUNDS

CASE	LOGIC	DESCRIPTION OF AREA TO BE REMEDIATED	TOTAL AREA-ft2	AVERAGE DEPTH-ft	TOTAL VOLUME-yd3	SAMPLING LOCATIONS TO BE EXCAVATED
1	Soils exceeding the TCLP limits	Pad B - Whole berm	1,640	3.3	200	BE-B-1 thru 4
		Pad B - Whole pad from 0 to 2 feet	2,800	2.0	207	PB-B-1
		Pad B - Whole pad from 2 to 9 feet	2,800	7.0	726	
		Pad F - Southeast side of berm	7,000	4.6	1,193	BE-F-1, 2, 5 & 6
		Pad F - Whole pad from 0 to 2 feet	12,000	2.0	889	PB-F-1 thru 6
		Pad H - South side of berm	1,700	7.2	453	BE-H-2 & 3
		Pad H - Half of eastern berm	1,050	2.0	78	BE-H-5
		TOTAL			3,746	
				Cumulative Total	3,746	
2	Reeder Creek sediments with lead and copper concs. above criteria	Reeder Creek sediments North of OD Grounds	7,000	1.0	259	SW-120 ,300 ,310 , & 320
		Reeder Creek sediments near OB Grounds and upstream	7,200	1.0	267	SW-140, 150
	Low hill soils with lead concs. above 500 mg/kg	Eastern portion of Low Hill	2,500	4.0	370	LH-31 &32 &33
		TOTAL			896	
				Cumulative Total	4,643	
3	All berms with lead concs. above 500 mg/kg	Pad A - North half of berm	1,280	3.3	156	BE-A-1 & 3
		Pad C - Eastern half of berm	920	3.8	129	BE-C-2,3,6
		Pad D - North section of berm	1,430	4.3	228	BE-D-1 & 3
		Pad G - South side of berm	11,000	5.9	2,404	BE-G-2, 3, 4,5,6,9,10 & 11
		Pad J - Hot spots around BEJ-10 and BEJ-14	1,110	4.6	189	BE-J-10/14
		Pad E-Northern half of berm	3,600	2.0	267	BE-E-1 &BE-E-3
		Pad G - Northwestern tip of berm	800	4.0	119	BE-G-14
		Pad J - Hot spot in Western berm around BE-J-5	600	4.0	89	BE-J-5
		Pad J - Hot spot in Southern berm around BE-J-8	1,500	2.0	111	BE-J-8 *
		Pad J - Hot spot in Northern berm around BE-J-13	1800	2.0	133	BE-J-13 *
		TOTAL			3,825	
				Cumulative Total	8,468	
4	All pads surface soils with lead concs. above 500 mg/kg	Pad A - Whole pad from 0 to 2 feet	2,240	2.0	166	PB-A-1 & 2
		Pad C - Whole pad from 0 to 2 feet	2,100	2.0	156	PB-C-3,4,&5, PB-C-1 &2 *
		Pad G - Hot spot around PBG-7	9,200	2.0	681	PB-G-7, PB-G-6 *, GAE-G-2 *
		Pad J - Hot spot around PB-J-4,5 7	14,350	2.0	1,063	PB-J-4,5 &7
		Pad J - Remainder of pad from 0 to 2 feet	45,650	2.0	3,381	PB-J-1., 2, 3, 6, 8, 9, &10, GAE-J-1 *
		Pad G - Hot spots around PBG-1 & PB-G-4	8,500	2.0	630	PB-G-1 & PB-G-4
		Pad D - Whole pad from 0 to 4 feet	2,000	4.0	296	PB-D-1-3
		Pad G - Around PB-G-1 from 2 to 4 feet	3,500	2.0	259	PB-G-1-3
		Pad H - Around PB-H-2 from 0 to 4 feet	3,200	4.0	474	PB-H-2
		TOTAL			7,107	
				Cumulative Total	15,574	
5	All grid soils with lead concs. above 500 mg/kg	Pad A - Hot spot around GB-1(Northern end of Pad A))	400	2.0	30	GB-1
		Pad B - Hot spot around GB-24 (Southern end of Pad B))	2,400	2.0	178	GB-24
		Pad C - Hot spot around Pad C	21,200	2.0	1,570	GB-2,GB-23,GB-12, SD-200,SD-210,SD-220
		Pad D - Hot spot around GB-13 (NE end of Pad D)	1,600	2.0	119	GB-13
		Pad F - Hot spot around GB-15 (Southern end of Pad F)	2,500	2.0	185	GB-15
		Pad H - Hot spot around Northeastern end of Pad H	3,500	2.0	259	GB-19,GB-34
		TOTAL			2,341	
				Cumulative Total	**17,915**	

* Included due to high metals content

Table 2 - 4
SENECA ARMY DEPOT
OB GROUNDS
SOIL/SEDIMENT
COMPARISON TO NYSDEC TAGM VALUES
FOR ALTERNATIVE REMEDIATION CASES

COMPOUND	NYDEC TAGM (1)	CASE 3 COUNT	CASE 3 Maximum	CASE 3 95 th UCL of the mean	CASE 4 COUNT	CASE 4 Maximum	CASE 4 95 th UCL of the mean	CASE 5 COUNT	CASE 5 Maximum	CASE 5 95 th UCL of the mean
Semivolatiles (ug/kg)										
2-Methylnaphthalene	36400	171	1,100.00	307.07	134	1,100.00	302.36	120	1,100.00	299.93
3-Nitroaniline	500	173	2,950.00	1,312.54	136	2,950.00	1,207.45	123	2,950.00	1,208.47
2,4-Dinitrotoluene	50000	178	33,000.00	552.23	138	7,000.00	493.32	124	7,000.00	476.11
Phenanthrene	50000	175	1,800.00	311.63	137	1,800.00	317.16	123	1,800.00	320.69
Benzo(a)anthracene	220	171	2,400.00	324.64	134	2,400.00	325.73	120	2,400.00	327.84
Chrysene	400	172	2,700.00	305.14	135	2,700.00	298.88	121	2,700.00	301.64
Benzo(b)fluoranthene	1100	171	3,900.00	317.44	134	3,900.00	333.82	120	3,900.00	326.57
benzo(k)fluoranthene	1100	171	2,800.00	303.58	134	2,800.00	297.73	120	2,800.00	300.40
Benzo(a)pyrene	61	171	2,800.00	330.46	134	2,800.00	330.44	120	2,800.00	333.27
Indeno(1,2,3-cd)pyrene	3200	170	1,600.00	317.55	133	1,600.00	313.05	120	1,600.00	315.18
Dibenz(a,h)anthracene	14	166	670.00	306.76	129	670.00	295.29	118	670.00	296.59
Benzo(g,h,i)perylene	50000	167	960.00	303.81	130	960.00	291.08	118	960.00	290.73
Pesticides/PCBs (ug/kg)										
Dieldrin	44	176	90.00	12.78	137	28.50	10.72	124	28.50	10.85
4,4'-DDE	2100	178	830.00	19.51	138	32.00	10.07	124	32.00	9.82
4,4'-DDT	2100	178	320.00	17.39	138	29.50	9.88	124	29.50	9.66
Explosives (ug/kg)										
RDX	NA	179	4,800.00	80.54	139	4,800.00	77.67	125	4,800.00	79.61
1,3,5-Trinitrobenzene	NA	179	350.00	71.58	139	350.00	70.35	125	350.00	69.13
Tetryl	NA	179	270.00	137.81	139	270.00	126.49	125	270.00	126.66
2,4,6-Trinitrotoluene	NA	179	910.00	70.84	139	910.00	71.95	125	910.00	73.04
4-amino-2,6-Dinitrotoluene	NA	179	810.00	85.75	139	810.00	86.36	125	810.00	85.86
2-amino-4,6-Dinitrotoluene	NA	179	1,300.00	88.99	139	1,300.00	92.20	125	1,300.00	91.34
Metals (mg/kg)										
Barium	300	157	10,300.00	722.06	123	4,520.00	334.14	112	1,810.00	213.21
Cadmium	1.8	176	20.70	4.63	136	9.70	3.05	122	9.70	2.85
Chromium	26.6	172	1,430.00	31.40	132	263.00	27.98	118	263.00	28.77
Copper	25	170	15,500.00	339.67	133	3,790.00	158.41	119	730.00	74.89
Lead (2)	500	167	7,400.00	660.43	131	7,400.00	476.13	116	463.00	134.43
Thallium	0.3	173	38.00	0.35	133	0.80	0.14	119	0.67	0.16
Zinc	89.1	175	127,000.00	561.78	135	1,200.00	239.50	121	1,060.00	199.41

Notes
1. NYSDEC TAGM HWR-94-4046, January 24, 1994.
2. Clean-up level agreed upon by the EPA (letter of Dec. 29, 1995), NYSDEC (letter of Nov. 7, 1995) , and Army.

Table 2 - 4
SENECA ARMY DEPOT
OB GROUNDS
SOIL/SEDIMENT
COMPARISON TO NYSDEC TAGM VALUES
FOR ALTERNATIVE REMEDIATION CASES

COMPOUND	NYDEC TAGM (1)	CASE 3 COUNT	CASE 3 Maximum	CASE 3 95 th UCL of the mean	CASE 4 COUNT	CASE 4 Maximum	CASE 4 95 th UCL of the mean	CASE 5 COUNT	CASE 5 Maximum	CASE 5 95 th UCL of the mean
Semivolatiles (ug/kg)										
2-Methylnaphthalene	36400	171	1,100.00	307.07	134	1,100.00	302.36	120	1,100.00	299.93
3-Nitroaniline	500	173	2,950.00	1,312.54	136	2,950.00	1,207.45	123	2,950.00	1,208.47
2,4-Dinitrotoluene	50000	178	33,000.00	552.23	138	7,000.00	493.32	124	7,000.00	476.11
Phenanthrene	50000	175	1,800.00	311.63	137	1,800.00	317.16	123	1,800.00	320.69
Benzo(a)anthracene	220	171	2,400.00	324.64	134	2,400.00	325.73	120	2,400.00	327.84
Chrysene	400	172	2,700.00	305.14	135	2,700.00	298.88	121	2,700.00	301.64
Benzo(b)fluoranthene	1100	171	3,900.00	317.44	134	3,900.00	333.82	120	3,900.00	326.57
benzo(k)fluoranthene	1100	171	2,800.00	303.58	134	2,800.00	297.73	120	2,800.00	300.40
Benzo(a)pyrene	61	171	2,800.00	330.46	134	2,800.00	330.44	120	2,800.00	333.27
Indeno(1,2,3-cd)pyrene	3200	170	1,600.00	317.55	133	1,600.00	313.05	120	1,600.00	315.18
Dibenz(a,h)anthracene	14	166	670.00	306.76	129	670.00	295.29	118	670.00	296.59
Benzo(g,h,i)perylene	50000	167	960.00	303.81	130	960.00	291.08	118	960.00	290.73
Pesticides/PCBs (ug/kg)										
Dieldrin	44	176	90.00	12.78	137	28.50	10.72	124	28.50	10.85
4,4'-DDE	2100	178	830.00	19.51	138	32.00	10.07	124	32.00	9.82
4,4'-DDT	2100	178	320.00	17.39	138	29.50	9.88	124	29.50	9.66
Explosives (ug/kg)										
RDX	NA	179	4,800.00	80.54	139	4,800.00	77.67	125	4,800.00	79.61
1,3,5-Trinitrobenzene	NA	179	350.00	71.58	139	350.00	70.35	125	350.00	69.13
Tetryl	NA	179	270.00	137.81	139	270.00	126.49	125	270.00	126.66
2,4,6-Trinitrotoluene	NA	179	910.00	70.84	139	910.00	71.95	125	910.00	73.04
4-amino-2,6-Dinitrotoluene	NA	179	810.00	85.75	139	810.00	86.36	125	810.00	85.86
2-amino-4,6-Dinitrotoluene	NA	179	1,300.00	88.99	139	1,300.00	92.20	125	1,300.00	91.34
Metals (mg/kg)										
Barium	300	157	10,300.00	722.06	123	4,520.00	334.14	112	1,810.00	213.21
Cadmium	1.8	176	20.70	4.63	136	9.70	3.05	122	9.70	2.85
Chromium	26.6	172	1,430.00	31.40	132	263.00	27.98	118	263.00	28.77
Copper	25	170	15,500.00	339.67	133	3,790.00	158.41	119	730.00	74.89
Lead (2)	500	167	7,400.00	660.43	131	7,400.00	476.13	116	463.00	134.43
Thallium	0.3	173	38.00	0.35	133	0.80	0.14	119	0.67	0.16
Zinc	89.1	175	127,000.00	561.78	135	1,200.00	239.50	121	1,060.00	199.41

Notes
1. NYSDEC TAGM HWR-92-4046, November 16, 1992.
2. Clean-up level agreed upon by the EPA (letter of Dec. 29, 1995), NYSDEC (letter of Nov. 7, 1995) , and Army.

TABLE 2 - 4

REEDER CREEK SEDIMENT
COMPARISON TO NYSDEC TAGM VALUES
FOR ALTERNATIVE REMEDIATION CASES

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	NYSDEC SEDIMENT CRITERIA²	BASELINE CASE/CASE 1			CASE 2 - CASE 5	
		COUNT	Maximum	95 th UCL of the mean	COUNT	Maximum
Semivolatiles (ug/kg)						
2-Methylnaphthalene	NA	8	490.00	411.83	1	ND
Phenanthrene	1390	8	490.00	396.75	1	ND
Benzo(a)anthracene	NA	8	490.00	407.76	1	ND
Benzo(b)fluoranthene	NA	8	490.00	407.76	1	ND
Benzo(k)fluoranthene	NA	8	490.00	407.76	1	ND
Benzo(a)pyrene	NA	8	490.00	407.76	1	ND
Indeno(1,2,3-cd)pyrene	NA	8	490.00	407.76	1	ND
Explosives (ug/kg)						
RDX	NA	9	60.00	60.00	1	ND
1,3,5-Trinitrobenzene	NA	9	60.00	60.00	1	ND
Metals (ug/kg)						
Aluminum	NA	10	15,600.00	12,202.89	1	8,310.00
Antimony	NA	4	4.05	4.06	1	ND
Arsenic	5	6	7.40	6.66	1	4.40
Barium	NA	6	94.80	66.24	1	44.10
Beryllium	NA	5	0.71	0.65	1	0.71
Cadmium	0.8	10	3.40	2.27	1	2.00
Chromium	26	6	24.50	22.85	1	15.20
Cobalt	NA	6	11.20	10.23	1	7.50
Copper (3)	16	10	2,380.00	1,032.68	1	(4) 22.40
Lead (3)	31	10	332.00	418.55	1	(4) 15.40
Manganese	428	10	596.00	474.62	1	468.00
Mercury	0.11	7	0.69	1.22	1	0.17
Nickel	22	6	42.30	37.97	1	23.30
Selenium	NA	6	1.40	1.02	1	0.19
Vanadium	NA	6	20.10	18.02	1	10.90
Zinc	85	6	497.00	899.80	1	76.00

q
NA = not applicable
ND = not detected
3. The criteria for copper and lead have been proposed by NYSDEC and agreed to by EPA, Region II.
4. The maximum concentration of copper is above the criteria because of the concentrations of copper in the background sediment sample.
For the reach of the creek adjacent to the OB grounds, the maximum concentration of copper is 9.5 mg/kg.

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

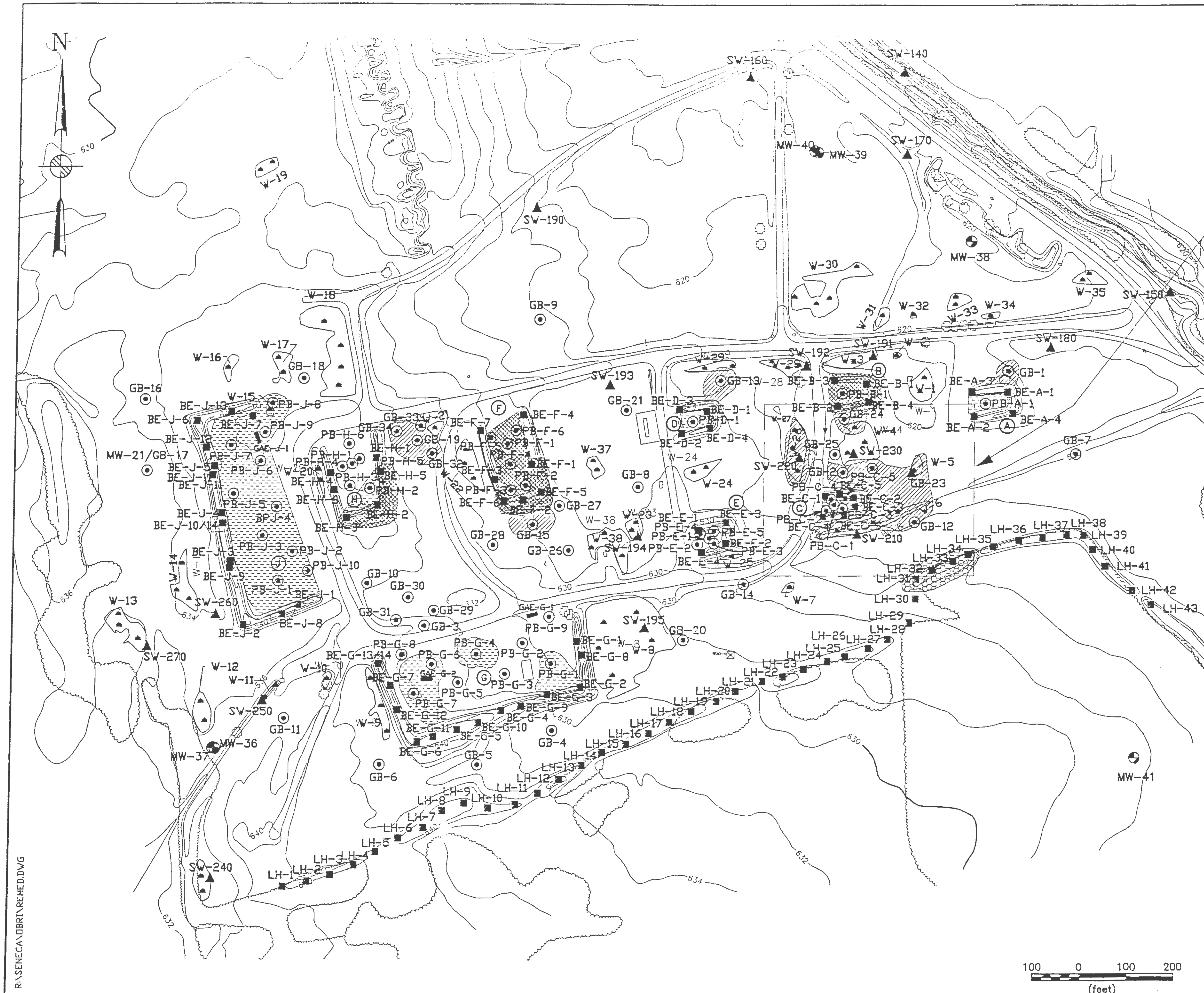
CLIENT/PROJECT TITLE

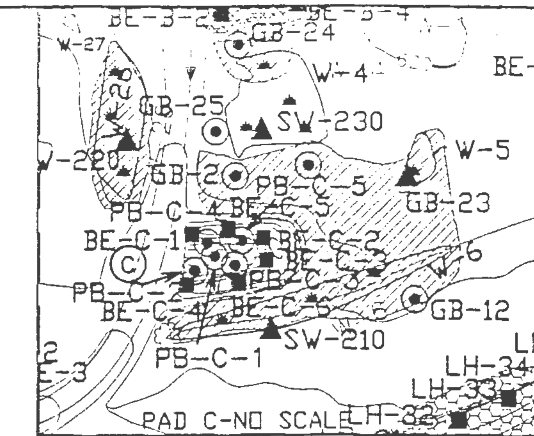
SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No.

FIGURE 2-1
LOCATION OF SOIL & SEDIMENT TO BE REMEDIATED AT REMOTE AREAS

SCALE 1" = 500' | DATE MARCH 1996 | REV A





LEGEND:

Ⓖ	BURNING PAD DESIGNATION
BE-G-1 ■	BERM EXCAVATION & DESIGNATION
PB-G-1 GB-2 ⊙	PAD OR GRID BORING DESIGNATION
GAE-G-2	GEOPHYSICAL ANOMOLY EXCAVATION & DESIGNATION
630	GROUND CONTOUR AND ELEVATION
W-1	WETLAND & DESIGNATION
MW-17	MONITORING WELL & DESIGNATION
	UTILITY POLE
	TREE
	BRUSH
SW-210 ▲	SURFACE WATER/SEDIMENT SAMPLE & DESIGNATION
	CASE 1
	CASE 2 (AREAS TO BE REMEDIATED IN REEDER CREEK NOT SHOWN)
	CASE 3
	CASE 4
	CASE 5

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No.

FIGURE 2-2
LOCATION OF SOIL TO BE REMEDIATED
(GREATER THAN 500mg/kg LEAD)

SCALE 1" = 200' | DATE MARCH 1996 | REV. A that these different scenarios have upon the carcinogenic and non-carcinogenic risk values as well as the effect on the child's lead blood level for future residential site use are presented in Table 2-5.

Case 1 includes those soils that produced concentrations that exceed the allowable EP Toxicity criteria or would likely exceed TCLP limits. Previous Army soil sampling at Pad B determined that the soils and the berms produced a leachate with a lead concentration that exceeded the limit of 5 milligrams per liter (mg/L). This information is presented in "Hazardous Waste Study No. 37-26-0479-85, Phase 4 of AMC Open-Burning/Open Detonation Grounds Evaluation Investigation of Soil Contamination at the Open Burning Grounds; Seneca Army Depot, Romulus, New York; 13-19 August 1984". Since these soils would be considered a RCRA characteristic hazardous waste, this material will require special handling and treatment to remove this characteristic prior to final disposal.

In addition to the Pad B soils, the soils from the berms of Pads F and H and the soils from Pad F have also been included in the volume estimate for Case 1 because they would likely exceed the TCLP (EP Toxicity) limits for lead. Although no TCLP testing was performed as part of our investigation, from our review of the data presented in the AEHA Phase 4 report, it appears that soils at or about 10,000 mg/kg would likely exceed TCLP limits. Therefore, we have included theses soils in Case 1.

It was deemed appropriate to identify this volume of soil separately due to the requirement for special handling and treatment of a RCRA characteristic hazardous waste. For Pad B, the impacts extend to approximately nine feet below the ground surface and therefore all the surface and subsurface soils have been included as part of the Case 1 remedial volume estimate. For Pad F, the impacts extend down to a depth of approximately 2 feet. Approximately 3,700 yd^3 of soil are included as part of Case 1. Calculation of this volume is presented in Table 2-3 and the locations are shown in plan view on Figure 2-1. Elimination of this volume of material produces the effects described in Table 2-4. Table 2-4 indicates that removal and remediation of the Case 1 soil volume will result in a maximum concentration of lead of 56,700 mg/kg, which is greater than the soil clean-up level of 500 mg/kg established for the site. The corresponding blood lead level, shown on Table 2-5 is 10.19 micrograms per deciliter (ug/dL) for Case 1. This level is above the target value of 10 ug/Dl. Both the non-carcinogenic and carcinogenic risk values decrease and are within the target values established by EPA.

Table 2 - 5
SENECA ARMY DEPOT
OPEN BURNING GROUNDS
FEASIBILITY STUDY

ALTERNATIVE AREAS FOR SOIL REMEDIATION
RISK ASSESSMENT

CASE	EXPOSURE SCENARIO	SOIL REMEDIATION QUANTITY cu. yds.	AVERAGE LEAD IN SOIL mg/kg	GEOMETRIC MEAN OF LEAD IN BLOOD-ug/dl	% ABOVE 10 ug/dl	MAXIMUM LEAD IN BLOOD ug/dl	HAZARD INDEX				CARCINOGENIC RISK		
							SOIL INGESTION	SOIL DERMAL	ALL OTHER PATHWAYS	TOTAL SITE HI	SOIL INGESTION	ALL OTHER PATHWAYS	TOTAL SITE RISK
BASELINE	CURRENT ON-SITE INDUSTRIAL	0	NA	NA	NA	NA	0.1800	0.0058	0.0680	0.2538	6.00E-06	3.30E-07	6.33E-06
	CURRENT OFF-SITE RESIDENTIAL	0	NA	NA	NA	NA	NA	NA	0.0071	0.0071	NA	3.91E-07	3.91E-07
	FUTURE ON-SITE RESIDENTIAL	0	1888.0	9.91	57%	11.85	0.2400	0.0170	0.0700	0.3270	9.40E-06	9.86E-07	1.04E-05
1	CURRENT ON-SITE INDUSTRIAL	3,746	NA	NA	NA	NA	0.1600	0.0056	0.0352	0.2008	6.10E-06	1.87E-07	6.29E-06
	CURRENT OFF-SITE RESIDENTIAL	3,746	NA	NA	NA	NA	NA	NA	0.0071	0.0071	NA	3.91E-07	3.91E-07
	FUTURE ON-SITE RESIDENTIAL	3,746	1405.0	8.45	14.0%	10.19	0.2200	0.0170	0.0650	0.3020	9.40E-06	5.82E-07	9.98E-06
2	CURRENT ON-SITE INDUSTRIAL	4,643	NA	NA	NA	NA	0.1600	0.0057	0.0192	0.1849	6.10E-06	1.60E-07	6.26E-06
	CURRENT OFF-SITE RESIDENTIAL	4,643	NA	NA	NA	NA	NA	NA	0.0064	0.0064	NA	3.41E-07	3.41E-07
	FUTURE ON-SITE RESIDENTIAL	4,643	1405.0	8.45	14%	10.19	0.2100	0.0170	0.0229	0.2499	9.50E-06	4.58E-07	9.96E-06
3	CURRENT ON-SITE INDUSTRIAL	8,468	NA	NA	NA	NA	0.1200	0.0047	0.0192	0.1439	5.90E-06	1.60E-07	6.06E-06
	CURRENT OFF-SITE RESIDENTIAL	8,468	NA	NA	NA	NA	NA	NA	0.0064	0.0064	NA	3.40E-07	3.40E-07
	FUTURE ON-SITE RESIDENTIAL	8,468	492.0	5.65	0	6.91	0.1500	0.0140	0.0229	0.1869	9.10E-06	4.60E-07	9.56E-06
4	CURRENT ON-SITE INDUSTRIAL	15,574	NA	NA	NA	NA	0.0700	0.0031	0.0192	0.0923	5.70E-06	1.60E-07	5.86E-06
	CURRENT OFF-SITE RESIDENTIAL	15,574	NA	NA	NA	NA	NA	NA	0.0064	0.0064	NA	3.40E-07	3.40E-07
	FUTURE ON-SITE RESIDENTIAL	15,574	165.0	4.49	0	5.49	0.0910	0.0090	0.0228	0.1228	8.90E-06	4.60E-07	9.36E-06
5	CURRENT ON-SITE INDUSTRIAL	17,915	NA	NA	NA	NA	0.0590	0.0029	0.0192	0.0811	5.80E-06	1.60E-07	5.96E-06
	CURRENT OFF-SITE RESIDENTIAL	17,915	NA	NA	NA	NA	NA	NA	0.0064	0.0064	NA	3.40E-07	3.40E-07
	FUTURE ON-SITE RESIDENTIAL	17,915	96.2	4.23	0	5.17	0.0760	0.0085	0.0228	0.1073	9.00E-06	4.60E-07	9.46E-06

Case 2 includes the soil volume of Case 1, plus portions of Reeder Creek sediment which were determined to exceed NYSDEC Sediment Criteria for lead and copper, and the eastern portion of the low lying hill. This case eliminates the remote areas that have metal concentrations greater than 500 mg/kg or exceed the NYSDEC sediment criteria. The location of these areas are shown on Figure 2-2 and described on Table 2-3. The total cumulative volume removed is approximately 4,600 yd^3 of soil and sediment. Removal of Case 2 soils will result in a maximum lead concentration of 56,700 mg/kg for on-site soils.

The off-site sediment concentrations are presented on the second page of Table 2-4 because the sediment criteria are different than the soil criteria. For off-site sediment, the maximum lead concentration is reduced from 332 mg/kg to 10.5 mg/kg. As discussed in the footnote on Table 2-4, this maximum concentration for lead is for the reach of Reeder Creek influenced by the OB grounds. The maximum concentration for lead presented in the table reflects the concentration of lead in the background sediment sample. The maximum concentration of copper in the sediment is reduced from 332 mg/kg to 9.5 mg/kg for the reach influenced by the OB grounds. The established sediment criteria for copper and lead are 16 mg/kg and 31 mg/kg, respectively.

As shown on Table 2-5, the removal of this volume for Case 2 does not effect the blood lead level, which remains at 10.19 ug/dL. Additionally, there are no significant effects on the risk values because the volume of on-site soil to be removed is small, i.e. only a portion of the low lying hill.

Case 3 includes the soil volume of Cases 1 and 2 plus soils from the berms which have concentrations of lead above 500 mg/kg. Two locations were also included in this volume because they contained high concentrations of other metals. These areas are shown on Figure 2-2 and are described in Table 2-3. For this volume, portions of berms from Pads A, C, D, E, G, and J will be removed and treated. A hot spot on the berm of Pad J around BE-J-8 and BE-J-13 will also be removed because the soils in these areas contain high concentrations of other metals. The cumulative total volume to be remediated for Case 3 is approximately 8,500 yd^3 of material. The effects of Case 3 on the maximum concentration of lead are described in Table 2-4. The maximum lead concentration for on-site soils is decreased to 7,400 mg/kg, which is still above the established criteria of 500 mg/kg. Table 2-4 also indicates that maximum concentration of barium is reduced to 10,300 mg/kg. As would be expected with the decrease in the on-site lead concentration, the blood lead level is 6.91 ug/dL which is below the EPA target value of 10 ug/dL. The non-carcinogenic and carcinogenic risk is also decreased as shown in Table 2-5.

Case 4 includes the soil volume from Cases 1 through 3 plus soils from pads which have lead concentrations above 500 mg/kg. Three additional areas were also included in this volume because they contained high concentrations of other metals. The areas are shown on Figure 2-2 and are described in Table 2-3. For this volume, whole pads from Pads A, C, D, and J in addition to three hot spots on Pad G and one hotspot on Pad H will be removed and treated. At Pads D, G, and H, the soils will be removed to a depth of 4 feet. The cumulative total volume to be remediated for Case 4 is approximately 15,600 c.y.of material. The effect of Case 4 on the maximum concentration of lead is described in Table 2-4. The maximum lead concentration for on-site soils remains at 7,400 mg/kg, which is above the established soil clean-up level of 500 mg/kg. However, the maximum concentrations of barium, chromium, copper, and zinc are substantially reduced. The blood lead level is 5.49 ug/dL which is below the EPA target value of 10 ug/DL. Table 2-5 also indicates that the non-carcinogenic and carcinogenic risk is also decreased.

Case 5 adds the grid soils and sediments with lead concentrations above 500 mg/kg to the Cases 1 through 4 soil volumes. The areas are depicted on Figure 2-2 and are described in Table 2-3. Included in these areas to be removed and treated are the hot spots near Pad A, B, C, D, F, and H; The cumulative total volume to be remediated for Case 5 is approximately 18,000 yd3 of material. The effect of Case 5 on the maximum concentration of lead is described in Table 2-4. The maximum lead concentration is decreased to 463 mg/kg, which is below the established soil clean-up level of 500 mg/kg. In addition, the concentrations of the metals barium, copper, and zinc were reduced. The blood lead level is 5.17 ug/dL which is below the EPA target value of 10 ug/DL. The non-carcinogenic and carcinogenic risk is also decreased. This information is presented on Table 2-5.

For the evaluation of future residential exposure technologies and cost estimation purposes, Case 5 will be used as the estimate of the volume of soil which will require remedial attention. This will constitute a combined volume of approximately 18,000 yd^3 of material that will be managed and processed as contaminated soil and sediment material.

2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section involves the identification and screening of technologies associated with the various general response actions. The screening criteria at this point is only based upon technical implementability. A brief description of each technology is provided as well as the reasons for either retaining or eliminating the technology. Once these technologies have been identified and screened the next step will be to assemble the remaining technologies into remedial alternatives.

2.5.1 Identification of Technologies

Remedial action technologies and processes have been identified for consideration as possible remediation options for clean-up of soil and sediment at the OB grounds. The list of technologies and processes, presented on Table 2-6, were taken from several sources as follows:

- Standard engineering handbooks,
- Remediation equipment and service vendors,
- Engineering experience in remedial actions,
- EPA references including but not limited to :
  - "Technology Screening Guide for Treatment of CERCLA Soils and Sludges " (EPA 1988),
  - "Handbook on In Situ Treatment of Hazardous Waste - Contaminated Soils" (EPA 1990),
  - "Handbook for Stabilization/Solidification of Hazardous Waste (EPA 1986),
  - "Handbook on Remediation of Contaminated Sediments" (EPA 1991a),
  - "The Superfund Innovative Technology Evaluation (SITE) Program" (EPA 1992a) and
  - "Vendor Information System for Innovative Treatment Technologies (VISITT)" (EPA 1993)
  - "Alternative Treatment Technology Information Center (ATTIC) Database"

Table 2-6 presents remedial action technologies sorted according to specific general response actions for soil/sediment. The process operations and a description of the technology is also presented. The decision to retain a technology is summarized in the screening comments portion of the table. Those technologies that have been shaded have been removed from

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
No Action	None	Not Applicable	No Action.	Required as baseline response for comparison to other technologies. Will not meet the objectives for lead in soil or lead and copper in sediment. Will not prevent leaching of lead to groundwater.
Institutional Controls	Access Control	Fencing	Access to OB Grounds is restricted by construction of a permanent, low-maintenance fence. Warning signs posted.	Technically feasible and effective in reducing or eliminating human exposure. Dependent on the U.S. Government's continued stewardship.
	Land Use Restrictions	Deed Modifications	Deed for property modified to restrict future sales and land use, or U.S. Government holds deed into perpetuity.	Technically feasible and effective for restricting future exposure. Will not meet the objectives for lead in soil or lead and copper in sediment. Will not prevent leaching of lead to groundwater.
	Monitoring	Soil and Groundwater Monitoring	Periodic soil or groundwater sampling. Documents the extent that affected media have been impacted by constituents.	Usually used in conjunction with other actions to monitor the effectiveness of a technology. Technically feasible but not effective in reducing or eliminating human exposure. Dependent on the U.S. Government's continued stewardship.
	Alternative Water Supply	City water line or bottled water	Extend city supply line to area or provide bottled water.	Not applicable since no drinking water wells are affected.
Containment	Capping	Soil cap	Consolidate, level and contour as necessary. Place two to five feet of clean fill on OB Grounds, grade and seed.	Technically feasible and effective in restricting future exposure. Dependent on the U.S. Government's continued stewardship to maintain cap. Will not meet remedial action objective for preventing continued leaching to groundwater.
		Clay cap	Add one to two foot clay layer beneath soil cap.	Technically feasible and effective in restricting future exposure. Dependent on the U.S. Government's continued stewardship to maintain cap. Will meet remedial action objective for preventing continued leaching or unsaturated soils to groundwater.
		Synthetic Membrane cap	Substitute a synthetic membrane material such as High Density Polyethylene (HDPE) or similar material for the clay.	Technically feasible and effective in restricting future exposure. Dependent on the U.S. Government's continued stewardship to maintain cap. Will meet remedial action objective for preventing continued leaching of unsaturated soils to groundwater.

(shaded) = screened out

(unshaded) = retained

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION
(Cont.)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
Containment (Cont.)	Vertical barriers	Sheet pile	Steel barrier wall driven into soil in sections using a drop-hammer or vibrating hammer to restrict groundwater flow.	Technically feasible but not effective due to high leakage rates through the sheet piles.
		Slurry wall	Trench around affected area and fill trench with cement/bentonite or soil/bentonite slurry. Used to prevent groundwater flow from the source area.	Technically feasible and effective at restricting groundwater flow from the site.
		Grout Curtain	Pressure injection of grout in a regular pattern of drill holes. Used to prevent groundwater flow from the source area.	Technically feasible but not as effective for restricting flow as a slurry wall.
	Horizontal Barriers	Grout Injection	Grout is injected into boreholes, spaced closely.	Technically unfeasible due to the thin layer of soils above the bedrock surface.
		Block Displacement	Low permeability materials are pumped as a slurry through injection holes under low pressure, causing uplift pressures that displace the volume of slurry pumped.	Technically unfeasible due to the thin layer of soils above the bedrock surface.
In-Situ Treatment	Solidification/ Stabilization	Direct Injection of Grout/Portland Cement or Other Admixtures	Grount/cement/additive mixed, in-situ, with soil/sediment, under pressure, using auger type mechanism.	Technically feasible and effective in controlling leaching of metals in soil. Not feasible for sediments in Reeder Creek due to the presence of running water.
	Vitrification	Soil Melting	Electrodes placed in-ground and electrical energy applied to electrodes. Soil vitrified to form molten glass that cools to a stable non-crystalline solid.	Not feasible for sediments in Reeder Creek due to the presence of running water or the on-site soils due to the thin layer of overburden.
	Electrical Extraction	Electrokinetics	Ionic metal species migrate in the saturated soil system through the influence of a charged electrical field.	Not technically feasible since much of the soil to be treated is above the water table. Ineffective for sediments in Reeder Creek due to running water.

(shaded) = screened out

(unshaded box) = retained

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION
(Cont.)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
In-Situ Treatment (Cont.)	Chemical Extraction	Soil Flushing	Constituents are extracted using solvent (polar or non-polar). Solvent treated and re-introduced into soil.	Not technically feasible nor effective in removing inorganics from soil or sediments. Treatment is more effective and controllable ex-situ with a soil washing treatment process train.
	Biological Removal/Extraction	Biodegradation/ Bioventing	Landtreatment involves cultivating microbes to degrade constituents by controlling moisture content, oxygen, pH, nutrients and temperature. Bioventing invovles injecting air, under low flow conditions, to stimulate biodegradation. Feasible but not effective in removing inorganics from soil or sediment.	Not feasible nor effective in removing inorganics from soil or sediment.
		Vegetative Uptake	Area is planted with coniferous and deciduous trees that uptake constituents through root system and incorporate them into wood mass.	Not feasible nor effective in removing inorganics from soil or sediment. Soils at the OB Grounds are not fertile enough to sustain plant growth. Degree of removal depends on solubility of constituents, inorganics are not soluble. Unproven technology.
	Vapor Removal/Extraction	Vacuum Extraction	Apply negative pressure to vadose zone well system and treat soil vapor off-gas (via carbon filter, biofilter, catalytic incinerator, chemical oxidation or plasma reactor.	Feasible but not effective in removing inorganics from soil or sediment.
		Radiowave Enhanced Volatilization	Apply radio frequency to soil, extract soil vapor and treat.	Feasible but not effective in removing inorganics from soil or sediment.
Removal	Mechanical Excavation	Soil or Sediment Removed using Heavy Equipment	Track or tire-mounted equipment such as an excavator, front-end loader as appropriate.	Technically feasible and effective. Used in conjunction with other response actions. Applicable for excavations at this site.
	Slurrying	Mix Soil or Sediment as a Slurry and Remove using Pumps	Mix soil/sediment and water using propeller mixers and water jets. Pump slurry to receiving tank.	Unfeasible and ineffective for site conditions. Used for relatively large quantities of material that has high moisture content or where wet processing is to follow.

(shaded) = screened out

(unshaded) = retained

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION
(Cont.)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
Ex-Situ Treatment	Biological	Aerobic	Microbes cultivated to degrade constituents under aerobic conditions. Includes composting and land farming.	Unfeasible and ineffective for site conditions. Will not achieve RAOs for decreasing lead concentration in soils and sediments. Not applicable to heavy metals.
		Anaerobic	Microbes cultivated to degrade constituents under anaerobic conditions, typically an in-vessel process.	Unfeasible and ineffective for site conditions. Will not achieve RAOs for decreasing lead concentration in soils and sediments. Not applicable to heavy metals.
	Stabilization/ Solidification	Pozzolan/portland cement	Pozzolan/cement mixed with soil/sediment using auger type mechanism binding metals into a monolithic, non-leaching, matrix.	Technically feasible when used in conjunction with excavation. Effective in controlling migration of soil constituents from leaching or erosion.
		Pozzolan/lime/flyash	Pozzolan-lime/fly ash mixed with soil/sediment using auger type mechanism.	Technically feasible when used in conjunction with excavation. Effective in controlling migration of soil constituents from leaching or erosion. Similar to pozzolan-portland cement
		Micro-encapsulation	A compatible, dried, waste is dispersed within a matrix of hot asphalt, polypropylene or polyethylene, extruded into a mold to form an encapsulated asphaltic or plastic mass.	Unfeasible due to the presence of large metal object fragments that would cause extrusion problems and the high water content of sediments from Reeder Creek. Most applications have involved specialized industrial wastes or nuclear wastes, not soils/sediments.
		Sorption	Dry, inert, solid, such as fly ash or kiln dust, is mixed with waste to produce a solidified mass.	Technically feasible but not effective for soils. Used to improve handling characteristics of a waste by binding with water. Most applicable for use with sludges with a high oil or water content.

(shaded) = screened out

(unshaded box) = retained

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION
(Cont.)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
Ex-Situ Treatment (Cont.)	Physical Separation/ Aqueous Extraction	Soil Washing (Wet Separation and Extraction using Aqueous Solutiion)	Mix soil/sediment with water and wet-classify soil particles by size and density. Includes dry screening (grizzly, vibratory, trommel), attrition scrub, hydrocyclones, flotation, water treatment/recycle. Constituents can extracted using dilute acids or surfactant solutions. Rinsewater is treated to remove metals and recycled. Metals can be recovered using electrochemical processes such as the Bureau of Mines' fluosilicic acid system leaching process.	Technically feasible and effective when used in conjunction with excavation. Volume reductions achieved. Coarse materials and large fragments separated from fines. Metals consolidated in the fine fraction. Metals reductions can be achieved via extraction. Used primarily in the mining industry. Innovative technology: treatability study required. Vendors are available that have achieved some success, such as at Twin City Army Ammunition Plant.
		Magnetic Classification	Soils subjected to magnetic field to remove ferrous metals.	Technically feasible but ineffective since ferrous objects are not the focus of the RAO nor are ferrous objects present in appreciable quantities. Most objects present are non-magnetic.
	Thermal Oxidation/ Vitrification	High Temperature Processes	Soils are converted to an inert slag in a molten metal bath. Involves heating in a specialized furnace/smelting reactors. Reactors include electric arc, fluid bed, molten salt, cement kiln and plasma arc.	Technically feasible but ineffective for inorganics. Technology is normally used for organics. Vendors are available including: Horsehead Resource Development Corp and Molten Metals Technology Corp. Considered innovative technology.
	Other Oxidation Technologies	Wet Air Oxidation	Soil mixed with water and excess air under supercritical pressure and temperature.	Unfeasible and ineffective for meeting the RAOs for lead and copper. Used primarily for destruction of organic compounds. Not applicable for heavy metals.
	Chemical Extraction	Soil Extraction using Supercritical Fluids	Constituents extracted in countercurrent process using carbon dioxide, propane or other highly volatile solvent under supercritical temperature and pressure conditions. Solvent is separated from extracted constituents (flashed or distilled) and recycled.	Unfeasible and ineffective for meeting the RAOs for lead and copper. Used primarily for extraction of organic compounds. Not applicable for heavy metals recovery.

(shaded) = screened out

(unshaded box) = retained

TABLE 2-6
TECHNOLOGY SCREENING FOR SOIL/SEDIMENT REMEDIATION
(Cont.)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPERATIONS	DESCRIPTION	SCREENING COMMENTS
Disposal	On-Site	Backfill On-Site	Reuse of treated soil that meet the Remedial Action Objectives (RAOs) as backfill in excavated areas.	Technically feasible and effective when used in conjunction with excavation and a treatment option. Treated soil must demonstrate compliance with RAOs prior to backfilling.
		Non-Hazardous Waste Landfill	Soil, treated to remove the RCRA characteristics of toxicity, is disposed of in an on-site Subtitle D landfill, permitted to accept industrial solid waste in accordance with the requirements of 6 NYCCR Part 360.	Technically feasible and effective when used in conjunction with excavation or an appropriate treatment option. Must comply with EPA Land Disposal Restrictions (LDR), Subtitle D and 6 NYCRR Part 360 requirements.
		RCRA Hazardous Waste Landfill	A listed hazardous waste, treated to meet the requirements of the LDRs, is disposed of in an on-site Subtitle C landfill, permitted to accept hazardous waste in accordance with the requirements of 6 NYCCR Part 373.	Not applicable since no waste is a listed hazardous waste, therefore the soil does not need to be disposed of in a permitted RCRA, Subtitle C, landfill in accordance with the requirements of 6 NYCRR Part 373 requirements.
	Off-Site	Non-Hazardous Waste Landfill	Soil, treated to remove the RCRA characteristics of toxicity, is disposed of in a local or regional, Subtitle D landfill, permitted to accept industrial solid waste in accordance with the requirements of 6 NYCCR Part 360.	Technically feasible and effective when used in conjunction with excavation. Hazardous waste characteristic of toxicity must be removed prior to disposal. Must comply with EPA Land Disposal Restrictions (LDR), Subtitle D and 6 NYCRR Part 360 requirements.
		RCRA Hazardous Waste Landfill	A listed hazardous waste, treated to meet the requirements of the LDRs, is disposed of in an on-site Subtitle C landfill, permitted to accept hazardous waste in accordance with the requirements of 6 NYCCR Part 373.	Not applicable since no waste is a listed hazardous waste, therefore the soil does not need to be disposed of in a permitted RCRA, Subtitle C, landfill in accordance with the requirements of 6 NYCRR Part 373 requirements.

(shaded) = screened out

(unshaded box) = retained

consideration due to the screening requirements of this section.

Technology screening considers only the technical implementability of a process. Technical implementability involves an evaluation of the waste characteristics that would limit the effectiveness or feasibility of technology, and the site characteristics, such as the depth of the water table, that would preclude the use of a technology. Also considered as a factor is the reliability of a technology.

The screening of the various technologies was based on the following criteria:

- The technology must be reliable, based either on successful implementation at other hazardous waste sites or in comparable bench- or lab-scale applications.

- The technology must be technically applicable to site conditions and waste characteristics at the OB Grounds.

General response actions, technology types, and process options that did not meet all of the foregoing criteria were excluded from further consideration.

The following remedial technologies were considered to meet the RAOs for soil and sediment:

2.5.1.1 No Action

The No Action response will result in leaving waste on-site and the soil source areas intact. This remedial action will not meet the RAOs for the site. Access and direct contact with soil and sediment will continue. A No Action response for the soil at the OB Grounds allows for the continued release of suspended and dissolved materials into surface water. Since the groundwater currently meets the NYSDEC GA standards, the No Action response is appropriate, particularly since the site groundwater is not used as a drinking water source. However, protection against future impacts to this resource is also appropriate. This response does not address the potential future releases of materials into groundwater.

2.5.1.2 Institutional Control Technologies

Institutional control technologies that have been considered includes:

- Access Controls, such as fencing,
- Land use restrictions, such as modifications to the deed,
- Monitoring of soil and/or groundwater or
- Alternative water supply.

Institutional control technologies are only applicable to the receptor and do not involve reductions in the volume, toxicity or control of wastes at the site and do not meet the RAOs. Physical barriers that restrict access to the site are feasible and effective in preventing humans from becoming exposed to on-site impacts.

Land use restrictions, such as deed modifications, are also feasible and effective in restricting exposure to humans, particularly due to residential development.

Providing an alternative water supply to affected populations is also technically feasible and effective when implemented but in this instance this technology is unnecessary since the on-site groundwater is not a source of potable water. This technology was considered since off-site residences adjacent to the OB Grounds do obtain water from private wells. A survey has been done to identify these receptors and since on-site groundwater concentrations currently meet the NYSDEC Class GA groundwater standards for potable water there is no concern regarding the impacts to the off-site wells. However, for completeness this alternative was considered.

These technologies, by themselves will not meet the RAOs for the site, however, these technologies may be appropriate as part of other alternative. Monitoring is an example of such a technology that will not meet the site's RAOs but can be used in conjunction with almost any other technology to form a viable alternative and therefore monitoring has been retained.

2.5.1.3 Containment Technologies

Containment technologies entail securing existing soil source areas and include: capping, horizontal barriers and vertical barriers. Caps are shells that cover buried waste materials to prevent their contact with the land surface and groundwater. Caps can be impermeable to restrict mixing of infiltration with buried waste, eliminating leachate generation. Vertical barriers, such as slurry walls, are used to surround the waste to limit flow to or from the waste horizontally. Horizontal barriers, such as block displacement, are installed below the waste to stop flow vertically through the waste. On-site technologies, such as containment, pose less of a risk to on-site workers than technologies requiring excavation because there is less opportunity for the spread of the constituents of concern and exposure.

Long-term maintenance of any containment technology will be necessary to ensure its effectiveness. For example, capping technologies include surface water runon/runoff controls, cap inspection and repair, and collection and treatment of any gases. This response is aimed at preventing exposure to soils via direct contact and precluding migration of by dust generation, surface runoff, and leaching. It does not totally prevent migration into underlying groundwater, but it does reduce this migration because of the decrease in precipitation infiltration or flow through of groundwater. This response is generally preferred when removal of source areas are not advisable or feasible. Containment does not satisfy the preference for permanent solutions and alternative treatment technologies of SARA.

Capping is a feasible technology that involves placing a barrier over the impacted soils. The area considered for capping would likely be almost the entire OB Grounds area since, it would be impractical to cap only the localized areas that were of interest. However, consolidation of some disperse areas would be advantageous by minimizing the size and area to be capped. This option would require a significant amount of regrading of the site for proper runoff/runon control since the pads are elevated above the surrounding land surface. The berms surrounding each pad would also need to be regraded as well. Clean fill borrow materials would be required in order to achieve the proper grade for capping and provide a cushion for the placement of the cap. The regraded and borrow materials would also be compacted to obtain the proper density, thereby avoiding irregularities in the cap due to uneven settlement. Sediments from Reeder Creek would likely be removed and consolidated under the capped area. Although the majority of the impacts at the site are surficial, some vertical impacts have been identified, such as at Pad B. Caps will not be effective in controlling the release of metals to groundwater resulting from the presence of buried material below the water table. This would be especially true during the seasonal high groundwater table, although the high water conditions are likely only to occur during a small portion of the spring.

Vertical barriers involve preventing interaction between groundwater and buried wastes by placing surrounding the waste materials with an impermeable vertical wall. Three process operations for vertical walls were considered and include:

- Steel Sheet Pilings,
- Slurry Walls and
- Grout Curtains.

Steel sheet piling are commonly used in construction projects to support a soil slope during excavation. The steel sheets are typically driven into the subsurface using specialized heavy equipment. The steel sheets are interlocking allowing for a continuous barrier around an area. At the proper depth the soil within the steel sheeted area is excavated. For excavations below the water table, pumps are required to remove any infiltrating groundwater as the interlocking sheets are not water-tight joints.

Slurry walls involves installing a trench filled with low permeable materials, such as cement and bentonite, below the water table and around the area to be isolated. Like steel sheet piling, slurry walls are commonly used in construction projects to provide lateral support during deep excavations but unlike sheet piling, slurry walls can be constructed in such a way that the wall provides an impermeable seal against the inflow of water. The installation of the wall involves specialized equipment that involves proper mixing and injection of the slurry as the soil is removed and is normally "keyed" into an impermeable soil or bedrock zone. Leakage occurs due to flow through these zones into the isolated areas. Slurry walls can be used to capture of contain the groundwater that has mixed with buried wastes and prevent continued mixing with clean groundwater, providing the bottom of the wall is anchored in an impermeable zone.

Soil-bentonite walls are composed of soil materials mixed with bentonite and generally provides a lower permeability and compatibility to a wider range of wastes that other containment barrier types. Although soil-bentonite slurry wall construction requires a large work area for mixing and is restricted to relatively flat topography, the OB Grounds is amenable to these stipulations.

Cement-bentonite slurry walls are constructed in a manner similar to soil-bentonite slurry walls, except portland cement is mixed with the bentonite instead of soil. These walls are adaptable to more extreme topography and do not require an extensive mixing work area.

Cement-bentonite walls provide more structural strength than soil-bentonite wall, however, they are typically more permeable and less chemical resistant.

Grouting is the practice of injecting, under pressure, a fluid, such as cement, cement-bentonite or a chemical grout, into soil or rock to decrease the soil/rock permeability and/or strengthen the formation. Grout curtains have been used int eh construction industry for several decades, but their application to source isolation form groundwater has not been practiced as frequently as slurry walls. An inherent drawback of grouting is the indefinite extent and integrity of the final grout curtain that is created.

In instances where it is not feasible to install a barrier, such as a liner, prior to placing the wastes requiring isolation it is possible to install a horizontal barrier under the wastes. This is usually required due to unacceptable leakage and mixing of groundwater with buried wastes and is most applicable where unweathered bedrock or some other impermeable strata are not sufficiently near the surface for a vertical barrier to sufficiently isolate and contain the waste. Horizontal barriers involve injecting impermeable materials below the buried materials. Two process operations were considered. These include :

- Grout Injection and
- Block Displacement.

Grout injection techniques involve pressure injecting cement, cement-bentonite or a chemical grout into soil or rock to strengthen and decrease the permeability of the formation. The grout is forced into the void spaces of the soil, forming a solidified zone of soil and grout in the area of injection. Through a sufficient number of overlapping injection points, an impermeable seal is created below the waste materials. This process works best if the grout is injected through permeable formations such as sands that will allow the grout to cover a larger area. Excessive injection pressures are required for dense strata, such as glacial till, that are not particularly permeable. Once injected over an area, the grout would act as a bottom seal preventing interactions between the waste that would be buried below the water table and groundwater.

The block displacement method is another technique for the in-situ horizontal isolation of waste. This technique involves placing a barrier around the sides as well as underneath the contaminated ground and vertically displacing the enclosed earth mass or block. The barrier is formed by pumping slurry into a series of notched injection holes. Continued pumping of the slurry under low pressures produces a large uplift force against the bottom of the block an results in vertical displacement proportional to the volume of the slurry pumped. This technique has not been used in full-scale application but has been demonstrated on a small scale. During the demonstrations, problems were encountered with maintaining adequate injection hole pressures and with perimeter separation (drill, notch and blast) technique. The technology is best suited to a site where a natural impermeable bottom barrier does not exist sufficiently near the surface for a vertical perimeter barrier to act alone as an isolation technique.

2.5.1.4 In-Situ Treatment Technologies

The in-situ treatment technologies involve control of soil source areas to be treated in-place. In-situ treatment immobilizes, separates, degrades, detoxifies, or destroys contaminants without the added cost of excavation, materials handling or treatment equipment. In-situ treatment is advantageous as it does not involve construction of a treatment facility and limits the exposure of treatment operators to contaminated soils. Treatment of soils in-place is most appropriate when the nature and extent of the source areas are well defined, the sources are homogeneous, the surrounding hydrogeology is well defined, and soil permeabilities are suitable for in-situ treatment. Treatment process operations generally entails soil modification via either the injection of air, water, or chemical reagents into the soil or application of an electric current causing either vitrification or migration of metal ions. In-situ treatments are classified generally as innovative or advanced technologies. This means they require more pilot testing prior to design and implementation, and more monitoring during implementation compared to conventional technologies. The primary difficulties associated with in-situ treatment applications are the inability to control the environment under which the process occurs; the inability to ensure contact between treatment reagents (i.e., heat, microorganisms, air, water, or chemical contaminants in the source areas); the difficulty of maintaining effectiveness with depth; and the possibility that toxic byproducts may be released. However, in-situ treatment applications are potentially preferable over on-site or off-site treatment because waste excavation and corresponding site restoration activities are not required, and minimal disruption of hazardous constituents occurs.

The following in-situ treatment technologies were considered as potential remedial alternatives :

- Solidification Technologies
  - Cement-based Immobilization/Fixation
- Vitrification,
- Electrical Extraction Technology
  - Electrokinetics,

- Chemical Extraction Technology
  - Soil Flushing,
- Biological Extraction Technologies
  - Bioventing/Biostimulation,
  - Vegatative Uptake,
- Vapor Extraction Technologies
  - Vacuum Extraction and
  - Radiowave Enhanced Volatilization.

The application of each in-situ technology to this site is discussed in the following sections.

Solidification is similar to process of installing vertical barriers except that the intent is to convert an area into a monolithic mass of soil and cementous material. The operation involves pressure injecting an appropriate cement-based admixture while soil is turned using large augers. This process is repeated until the area of interest has been completely mixed. As the soil/cement cure, the waste materials are incorporated into the cement matrix and prevented from further leaching or from exposure to receptors. Soil above and below the water table can be mixed in this manner. Limitations as to the depth of efficient mixing is a function of the type and power of equipment used. Large rocks/cobbles and dense soil conditions can provide difficulty in turning the soil due to binding of the augers and the large power requirements. To achieve successful mixing involves the use of large, highly specialized equipment capable of providing sufficient torque to turn the soil at depth. As the augers mix the soil, cement is injected through the center of the auger and into the subsurface through ports, located at the auger tip. This ensures adequate mixing of the cement and the soil. This technique was demonstrated by IWT Corp. and Geo-Con, Inc. at a Superfund site in Hialeah Florida in 1989 as part of the SITE program. IWT Corp developed the solidifying/stabilization agent and Geo-Con, Inc. provided the waste mixing technology. The operation successfully produced a stable, high strength, cementous mass in the soil that was shown to be low permeability and non-leaching for metals and PCBs. A similar process would be technically feasible at the OB Grounds. In this instance, the pads and berms would be mixed with the cementous admixture using augers until the appropriate level of treatment was achieved.

In-situ vitrification (ISV) involves applying a large voltage, as much as 4,160 V, between molybdenum or graphite electrodes installed and arranged in a grid pattern, usually square, into the soil. A conductive mixture of flaked graphite and glass frit is placed in an X pattern among the electrodes in 5 cm deep trenches to initiate electrical conductance. The application of the large voltage cause a current to develop in the soil matrix. As a result, the soil is heated due to the electrical resistance that occurs between the electrodes. As the soil melts the soil becomes electrically conductive causing the melting process to perpetuate down the soil column. During the soil temperature rise, soil moisture is boiled away and organic matter is destroyed, until temperatures of approximately 2000°F are reached. At these high temperatures, the soil begins to melt, essentially becoming a glass-like mass. As the vitrified melt is allowed to cool, the mass becomes solidified, entombing the waste materials. Due to the large amount of off-gassing that occurs in this process, many of which are toxic, a cover is typically placed over the soil as it is heated to collect and treat the gases. The process is considered innovative and has been identified as an appropriate technology for application at radioactive waste sites. Full scale, widespread, operation of this technology has not been performed, probably due to the excessive power requirements that this technology requires, although pilot testing has been conducted. Geosafe Corp. successfully demonstrated this process at a site in Region V.

Electrokinetics involves converting the saturated soil to an electrochemical cell through the application of sufficient voltage to the soil electrodes. Electrodes, one an anode and the other a cathode, are installed into the soil that allow an electric current to flow in the soil. Once sufficient voltage is applied, the soil is essentially transformed into an electrochemical cell. As in any cell, dissolved soil anions and cations migrate to the appropriate electrode. Metallic cations migrate to the negatively charged electrode, the anode, where the metals are removed as the cations plate out.

Soil flushing involves the in-situ application of water, hot water/steam, solvents, either polar or non-polar, acids or surfactants to buried waste materials with the intent of solubilizing the constituents of concern into the groundwater. This technology is typically used for extracting organic compounds from soils when excavation is not possible. The solubilizing agent along with the pollutants are then recovered from the groundwater using extraction wells. When possible, the solvent or surfactant is then separated and recovered for recycling back into the soil in order to extract additional waste material. The use of solvents to solubilize pollutants is of concern as this process has the potential to increase the pollutant loading to groundwater, if the solubilized materials are not completely recovered. In addition, as residual concentrations of this agent will permeate the subsurface, the extracting agent should be as non-toxic as possible. This restricts the number and types of flushing agents and limits the effectiveness of soil flushing process.

Some of this technology was developed from the petroleum industry that utilized solubilizing agents for many years as ways of revitalizing spent oil fields. Recently, attempts have been made to apply this technology to hazardous waste site. One vendor, The Western Research Institute has applied a technology called Contained Recovery of Oily Wastes (CROW) has attempted to extract coal tar wastes at former manufactured gas plant sites by injecting a combination of low quality steam and hot water to the contaminated soil/groundwater system using specially designed injection wells. The process has achieved some success at recovering additional qualities of coal tar but has not achieved complete clean-up. Researchers at Carnegie Mellon University have evaluated numerous flushing agents for use at hazardous waste sites. Of the agents evaluated, two organic compounds, one an amine, n-butylamine, and the other solvent was 1,2-dimethoxyethane were deemed the most promising.

While this technology has promise at heavily contaminated sites where excavation is impractical it was eliminated from further consideration for application at the OB Grounds since this technology is most appropriate for use with sites impacts with organic compounds. The constituents of concern at the OB Grounds are inorganic compounds, such as lead, and it is unlikely that any useable soil flushing agent would be successful at extracting the metals of interest. Further, the thin soil thicknesses and the low permeability of the groundwater suggests that the collection of the extracted materials would be slow and inefficient.

Bioventing/Biostimulation involves adding air (oxygen) to the subsurface in order to stimulate the natural microbiological community to degrade the waste materials. The air is typically added, under pressure, through properly spaced and screened injection wells. The wells are constructed so that air is added a rate greater than what is lost due to consumption by the microorganisms and movement beyond the area of remediation. The soil microorganisms are abundant in the subsurface, many species are of the type known to degrade organic molecules, such as hydrocarbons. With maintenance of proper conditions in the subsurface, it has been shown that these organisms will effectively degrade pollutants.

Recent development regarding the extraction of metals via the vegatative uptake of plants has shown promise. Studies suggest that metals and in some instances organics can be removed through the transfer of these materials into the root system of selected plants. This technology is experimental and unreliable.

Vacuum or vapor extraction is one of the most widely applied in-situ technologies at hazardous waste sites. Several vendors are available that have successfully applied this technology. It is most applicable for recovery of volatile organics in soil. The process involves application of a vacuum to the subsurface through a well screened in the unsaturated zone. The applied vacuum is transferred to the soil pores causing increased volatilization of organics and the movement of air to the extraction well as a result of pressure differences. A continuous air stream laden with extracted organics are removed and treated, if necessary, prior to discharge. This process continues until the soil is free of the target compounds. The technology is cost effective to apply with the cost of a blower being the only major component of the extraction system. Treatment of the off-gas can range from thermal oxidizers, if the gas concentrations are sufficiently high, to carbon adsorption, if the concentrations are low.

Radiowave enhanced volatilization is a variation of vacuum extraction and involves the application of radiowaves directly to the subsurface causing the soil temperatures to rise. As the temperature of the soil increases, the vapor pressures of constituents in the soil also increase. This allows compounds that normally would not have been removed, to be removed from the soil. This technology is considered innovative and experimental with only limited pilot scale applications. It is most appropriate for sites where excavation is impractical and semi-volatile organic compounds are the constituents of concern.

2.5.1.5 Removal Technologies

Complete or partial removal of source soils and sediments are an integral component of many remedial alternatives. This can be accomplished using standard mechanical excavation technologies or could involve methods that slurry the soil and then remove the slurry using slurry pumps. Typical heavy equipment such as backhoes, excavators, front-end loaders, scrapers, bulldozers and draglines are commonly used for the mechanical excavation of soil.

For soil/sediment that is highly organic and contains a high water content, the soil/sediment is removed using a pump.

2.5.1.6 Ex-situ Treatment Technologies

Ex-situ treatment technologies involves addressing source areas with aboveground process unit operations within the site boundaries or could involve transporting soil to an off-site facility for treatment. It will require removal, storage and consolidation of source material.

On-site treatment in aboveground reactors entails the construction of a temporary treatment facility. This facility can be one that is fixed, requiring the assembly of modular treatment units brought to the site on trailer trucks (which can be disassembled and moved off-site upon completion of treatment), or the use of mobile treatment trailers temporarily parked on-site. Fixed facilities are costly and difficult to build and become obsolete once treatment is complete unless wastes from other sites can be shipped on-site for treatment. The current trend is toward temporary on-site treatment units, mobile, modular, or transportable, that can be removed and transported to another site for reuse.

Several treatment processes are available in mobile or modular units. This type of treatment will generally require laboratory of pilot studies using site-specific source material to determine level of performance and optimal process operating parameters. The more complex a process and the more variable the waste composition and volume, the greater the possibility of operational upsets and delays. Because of the variability of physical and chemical characteristics of the waste at the OB Grounds, the most desirable treatment schemes will be those that are simpler, less susceptible to shock loading, able to operate in batch processing modes, and capable of handling a wide range of chemical and physical constituents.

On-site treatment also will entail further responses to handle treatment of residuals, byproducts, or sidestreams. The residuals must be disposed of, although some may be nonhazardous and the volume may be only a fraction of the initial waste volume.

On-site treatment of soil source material has several advantages over in-situ treatment. On-site treatment allows for the treatment of contaminated material in aboveground reactors where the process environment can be easily monitored and controlled to provide greater reliability and effectiveness for any given treatment scheme. The state-of-the-art technology for aboveground technologies are generally considered to be more advanced than it is for in-situ treatments. Processes used for sanitary, industrial, or nuclear wastes can be more easily adapted for aboveground treatment. Where excavation and handling of source material is not feasible or appropriate (i.e., where risk of exposure during handling exceeds risk associated with other alternatives), on-site treatment may not be preferred.

On-site treatment of soils is preferred because off-site transportation is very expensive, and off-site permitted RCRA hazardous waste treatment, storage, and disposal facilities do not have the capacity to accept all the CERCLA wastes found at NPL sites. When treatment technologies are needed to address the hazardous nature of the source material are unavailable, off-site treatment may be necessary. This may be necessary if existing mobile units do not have the volumetric capacity to treat, in a timely manner, the amount of soil source material found on-site.

On-site treatment of soil source material is preferable over containment or on-site disposal responses because it can provide a permanent solution to the contamination problem. However, it would not be preferable when: (a) removal is inappropriate based on screening criteria, (b) available treatments increase the volume of the material to be handled to unacceptable levels, (c) available treatments result in other environmental releases (such as air emissions) when these releases result in greater risk than other response, or (d) no suitable treatment method is available.

Off-site treatment allows source area material to be removed completely from the site and treated at a full-scale fixed facility. Off-site treatment requires excavation, consolidation, and off-site transportation of source material. It entails identification of RCRA-permitted hazardous waste treatment, storage, and disposal (TSD) facilities with the capability and capacity to treat material removed from source areas. Off-site handling of source materials would require permits for transportation and disposal. This response eliminates both continued releases on-site and direct contact with source material by on-site receptors. However, given that handling of source materials occurs for this response, the potential for releases, worker exposure, or off-site exposure is possible. Off-site treatment, however, may be preferable if on-site treatment units are not available or do not have the capability or capacity to handle all the source material on-site.

Off-site treatment could be adopted for the OB Grounds by one of three approaches: (1) all contaminated source material found at the site would be transported off-site for treatment,

(2) only the waste and source material that is not treatable by a selected on-site treatment technology would be transported off-site, or (3) only waste and source materials subject to the land ban would be transported off-site for treatment. The selected off-site TSD facility must be capable of treating wastes containing metals and semi-volatile organic compounds. Pretreatment may be required before shipping material off-site. This may include dewatering or removing any hazardous waste characteristics such as toxicity.

The following technology types and process options were determined to be applicable based on the screening criteria:

- Biological Technologies
  - Aerobic
  - Anaerobic

- Stabilization/Solidification Technologies
  - Pozzolan-portland cement
  - Pozzolan-lime-fly ash
  - Micro-encapsulation
  - Sorption

- Physical Separation Technologies
  - Soil Washing
  - Magnetic Classification

- Thermal Oxidation/Vitrification Technologies
  - High Temperature Processes

- Other Oxidation Technologies
  - Wet Air Oxidation

- Chemical Extraction Technologies
  - Supercritical Fluids
  - Non-Aqueous Fluids (Amines, etc.)

Ex-situ biological treatment of soil involves degradation of contaminants that are entrained in the soil pores through the actions of microorganisms. Land treatment has been successfully utilized by the petroleum industry for many years as a cost effective way of stabilizing oily wastes produced during the refining process. Land treatment facilities are normally found in areas, near the refineries, that have large tracts of available land and are in climates that have temperatures favorable for stimulating biological growth. The above ground biological treatment methods vary and include: landfarming (land treatment), slurry bioreactors, digestors and composting. The process involves providing the proper ratio of pH, nutrients, oxygen (if aerobic conditions are required) and temperature to stimulate the natural microorganisms to utilize the organic contaminants as a source of cellular energy. Several micorogranisms have been identified that can utilize petroleum hydrocarbons and other hydrocarbons as sources of energy. In addition to maintaining control of previously mentioned factors, a key factor in achieving a successful clean-up using this technology is to assure that toxic concentrations of contaminants and/or byproducts are not produced to hamper the growth rates of the microorganisms. In additional it is important to provide adequate contact between the microorganisms and the contaminants. For recalcitrant hydrocarbons, such as the Polynuclear Aromatic Hydrocarbons (PAHs), slurry bioreators have been utilized to improve the contact between microorganisms and waste materials.

Solidification refers to techniques that encapsulate waste materials in a solid matrix that is resistant to weathering due to its structural integrity. Stabilization involves technologies that convert constituents to a less soluble or less toxic form. In general, the technology is a combination of both processes and is usually referred to as solidification/stabilization (S/S). On a microscale, constituents such as metals in an ionic form and water, are either chemically bonded to the solidification materials or are converted into an insoluble form, such as a metal hydroxide, within the solid matrix. Particulates or solids are encapsulated in the solid matrix and prevented from migration or exposure to receptors. The most common agents that are used for S/S are cement, lime, pozzolans (siliceous) materials and fly ash. These materials are combined in various ratios to produce the most stable and non-leaching monolithic mass.

Any material or process that causes incomplete mixing or prevents the S/S matrix from forming a uniform slurry prior to properly curing will interfere with the success of the treatment effectiveness. Large materials are normally screened out prior to the mixing process to assure a uniform mixture. Materials that have a high moisture content, such as sediments, have a high oil content or are coated with oil can also contribute to ineffectiveness and poor performance of S/S during prove-out testing. The technology is not typically used for treatment of oily waste although some vendors claim the their proprietary solidification agents will treat such wastes up to 10%. Extremely dry wastes can also contribute to poor mixing and uniformity in the formation of the S/S slurry by causing lumps.

Microencapsulation involves encapsulating a particle within a thermoplastic matrix of asphalt, polyethylene or polypropylene. This technique requires heating the plastic and mixing the waste as the plastic is extruded and cooled. The final mass incorporates the waste in a matrix that is inert to normal weathering and structurally stable.

Sorption is a technique that involves mixing semi-solid sludges with a dry solid adsorbent to improve the solids handling characteristics of the sludge. The sorbent material may interact chemically with the waste or may simply be wetted by the liquid, usually water or oil, as part of the waste, retaining the liquid within the matrix of the solid.

Physical separation technologies include soil washing and magnetic classification. Soil washing involves physically separating the various fraction of soil using a series of unit operations such as grizzly bars, trommel screens, flotation units, flocculation tanks and clarifiers. The process removes contaminants from soils by either dissolving or suspending them in the wash solution or by concentrating the pollutants into a smaller volume through a series of particle size separation steps. In some instances, the washing fluid, which is normally water, can be supplemented with an aqueous surfactant for improved separation. The key concept associated with soil washing is to reduce the volume of soil that will require treatment allowing for the washed soil to be returned to the site as clean backfill. This process takes advantage of the fact that, in most instances, pollutants tend to distribute into the fine fraction of soil. The wash water is typically recycled back to the washing process once it has been treated.

Magnetic classification of soils is another volume reduction process that involves the use of electromagnets to separate magnetic materials such as iron from non-magnetic materials. This is a common process used in many recycling facilities.

Thermal oxidation/vitrification technologies involve heating soils/sludges in a high temperature reactor causing the solid fraction of the waste to become incorporated into either a molten metal bath or a slag. The technology has several variations depending upon the equipment and the vendor. The conditions within the bath are reducing and involve addition of hydrogen gas. Under these conditions, soils, that are comprised mostly of alumina and silica, partition into a slag phase above the molten bath and are removed as a vitrified mass when allowed to cool. The slag, now a vitrified mass is essentially an inert, non-leaching solid that can be placed into a landfill or returned to the site for disposal. Volatile metals in the waste feed, such as lead, are vaporized, oxidized in a secondary combustion chamber and recovered as a dust in a collection system. Several vendors are available to provide this treatment including Horsehead Resource Development Company, Inc., Molten Metals and ECO Logic Inc.

Other thermal oxidation processes have been considered that are used to treat organic waste sludges. One process, Wet Air Oxidation (WAO), involves heating and pressurizing a mixture of the waste materials with air up to approximately 600°F and 2000 to 3000 psig. At these high temperatures and pressures the high solubility and diffusivity of O_2 provides ideal conditions for oxidation to occur. This process is typically used for treatment of biological sludges or other high organic waste such as spent caustic liquors from the pulping industry.

Chemical extraction of soils can be accomplished using materials, such as carbon dioxide or propane, that are normally gases at ambient temperatures and pressures. However, when these gases are pressurized to a liquified state they have the capability to efficiently extract oil and other organic wastes. The process involves mixing a liquified solvent with the solid waste material, extracting the contaminants, separating the solids from the liquified solvent and releasing the pressure causing the liquified solvent to vaporize back to a gas, leaving an oil. The oil is then treated further or disposed of in accordance with all pertinent regulations. Vendors, such as CF Systems, Inc. and The Institute of Gas Technology have systems that are available to provide this treatment.

Chemical extraction of soils can also involve mixing an appropriate non-aqueous chemical solvent with soil/sediments in order to remove contaminants by solubilizing the contaminants, separating the solvent from the soil/sediments and recycling the solvent. There are a variety of solvents available that can be used to extract materials and the choice of solvent is largely dependent upon the type of contaminant that is the focus of the extraction. Several vendors can provide this treatment technology with each vendor focusing on a specific extraction agent. Some of the more widely known solvents include: triethly amine (TEA), liquified propane or liquified carbon dioxide. The solvent TEA is used for the Basic Extraction Sludge Treatment (BEST), developed by Resources Conservation Company. In this process, soils/sludges are mixed with TEA at low temperatures. The essential feature of this technology is that it takes advantage of the large changes in the solubility of TEA and water and temperature. At temperatures less than 18°C TEA is completely miscible with oil and water. When mixed with oily soils or sludges at or below this temperature, TEA is able to remove, by dissolution, any oily materials and the contaminants associated with the oil. The TEA/water/oil mixture is centrifuged or filtered to separate the extracted soil/sludges from the extracting fluid. The recovered solids are then dried to remove any residual TEA, which is then recovered any recycled back for continued extraction. The extracting liquid, containing TEA/oil/water, is then heated causing the TEA to become insoluble with water producing a two-phased system. The top phase contains the TEA/oil phase and is decanted off, distilled to separate and recycle the volatile solvent TEA, leaving the extracted oil. The oil is either treated further of disposed of as a hazardous waste, recycled as a recyclable spent oil. The bottom portion of the heated liquid that was not decanted is primarily water is also distilled to remove any residual TEA and discharged.

2.5.1.7 Disposal

SARA states that treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants is to be preferred over remedial actions not involving treatment. On-site disposal would, therefore, not address this preference unless used in an alternative that also included a technology that would reduce volume, toxicity, or mobility. On-site disposal of treated soils/sediments would involve backfilling the treated material as clean fill and is not a factor in meeting the preference of SARA for reductions in volume. On-site disposal as clean fill has been retained as a technology to be considered.

Disposal could be at either an on-site landfill or at an off-site landfill. On-site disposal would allow source material to be secured on-site. On-site disposal may be preferable to off-site disposal because this eliminates off-site transportation of source material. This eliminates the potential for off-site spills and off-site receptor impacts. On-site disposal responses require removal and consolidation of source material into an on-site disposal facility. Excavated areas will have to be filled and regraded.

At the site, an on-site landfill may be applicable for the containment of soils, treated to remove any RCRA characteristic, and for untreated nonhazardous wastes. The following process operations have been considered for the on-site disposal technologies :

- Backfilling of clean soil,
- RCRA hazardous waste landfill and
- Solid waste landfill.

Construction of a new on-site landfill, designed to meet RCRA and/or state standards could be constructed within the present boundaries of the depot. Consolidation of on-site waste within a future landfill would be feasible and would be appropriate for the OB Grounds soils. Two types of landfills have been considered, one type is an industrial type landfill, i.e a solid waste management landfill regulated under Title 6 Part 360 of the New York Codes, Rules and Regulations (NYCRR), the other type is a RCRA, Subtitle C, hazardous waste type landfill regulated under Title 6 Part 373 of the NYCRR. Both facilities would require siting studies and permitting prior to construction however, the requirements for a new RCRA hazardous waste landfill at the OB Grounds is more extensive and exhaustive. The permitting, monitoring, design and construction required to comply with all the requirements of such a facility under RCRA is beyond the need for this project. The need to construct a RCRA hazardous waste landfill is required if the wastes to be disposed of are considered to be RCRA hazardous. Wastes are hazardous if they possess the characteristics of either ignitability, corrosivity, reactivity or toxicity or if the wastes are listed by EPA as hazardous from non-specific or specific sources. In the case of the OB Grounds, there are no known listed hazardous wastes to be disposed of. However, a portion of the soils at the site exhibit the characteristic of toxicity as a result of lead concentrations exceeding the limits of the EP Toxicity test, now called the Toxicity Characteristic Leaching Procedure (TCLP). If the characteristic of the waste is removed, i.e. the soil no longer exceeds the limits for toxicity due to treatment, then the waste is no longer a hazardous waste and can be landfilled in an on-site, non-hazardous, solid waste landfill.

Off-site disposal involves source area materials to be completely removed from a site. This entails removal of source material and consolidation into containers for off-site transportation. All excavated areas must be filled and graded with clean imported fill. This technology eliminates continued on-site exposure to source materials by humans or ecological receptors. It also allows unimpaired future use of the site. However, releases and impacts may occur that could affect public health and environment at off-site locations. Off-site disposal is preferable when on-site disposal is precluded or limited by site characteristics and when unimpaired future use of the site is a high priority. Two options were considered for off-site disposal. These included:

- State-permitted RCRA hazardous waste landfill and
- State-permitted solid waste landfill.

A permitted, off-site RCRA TSD facility with the capacity and capability to handle this source material must be identified. Due to the RCRA Land Ban Restrictions (LDR), waste, if hazardous, will need to be treated prior to disposal in the facility. If the waste is a listed waste then the treated waste will still be required to be disposed of in a TSD facility. If the waste is a characteristic waste the waste will not need to be disposed of in a TSD facility once the characteristic is removed due to treatment. For the OB Ground, this means that soil that exceeds the TCLP limit for lead would be a D008 hazardous waste. However, if the soil is treated and is shown to be below the limits for toxicity as defined by the TCLP test then the soil is no longer hazardous and does not need to be disposed of in a TSD facility.

At the site, off-site disposal of waste and soils from contaminated areas is a feasible option. Since there are no wastes at the OB Grounds that are listed wastes the need to dispose of any soil in an off-site TSD facility does not apply and has been removed from further consideration. Soil that may be characteristic by toxicity would need to be treated to remove the characteristic prior to disposal in an off-site landfill but the landfill does not need to be a hazardous waste landfill, since the waste is no longer hazardous once the characteristic has been removed.

2.5.2 Screening of Technologies

Remedial action technologies and processes are screened on Table 2-6, based on whether a process is technically feasible and effective for remediating soils/sediment and whether it meets the remedial action objectives. As shown on Table 2-6, processes that are shaded have been screened out based on screening comments listed.

2.5.2.1 No Action

The No Action response may be appropriate for source areas where natural environmental mechanisms will result in degradation or immobilization of the constituents of concern within a reasonable period of time or where the risks are acceptable. Although No Action would not meet the requirements of the RAOs for protectiveness of groundwater or human health, due to the presence of lead, this response provides the baseline against which other responses can be compared and has been retained.

2.5.2.2 Institutional Control Technologies

Institutional control technologies that have been considered includes:

- Access Controls, such as fencing,
- Land use restrictions, such as modifications to the deed,
- Monitoring of soil and/or groundwater or
- Alternative water supply.

Institutional control technologies are only applicable to the receptor and do not involve reductions in the volume, toxicity or control of wastes at the site and do not meet the RAOs. Physical barriers that restrict access to the site are feasible and effective in preventing humans from becoming exposed to on-site impacts. However, since there will be continued sediment loading to Reeder Creek, affecting aquatic life in the creek, and there is the potential for these impacts to migrate off-site, this technology has been eliminated. Further, wildlife, such as migrating birds, will still have access to the site and will not be protected. As a result, the use of access restricting technologies were eliminated from further consideration.

Land use restrictions, such as deed modifications, are also feasible and effective in restricting exposure to humans, particularly due to residential development. However, as with access controls, deed modifications do not protect the ecological community nor is the groundwater protected. As a result, this technology has also been eliminated from further consideration.

Providing an alternative water supply to affected populations is also technically feasible and effective when implemented but in this instance this technology is unnecessary since the on-site groundwater is not a source of potable water. This technology was considered since off-site residences adjacent to the OB Grounds do obtain water from private wells. A survey has been done to identify these receptors and since on-site groundwater concentrations currently meet the NYSDEC Class GA groundwater standards for potable water there is no concern regarding the impacts to the off-site wells and this alternative was removed from further consideration.

These technologies, by themselves will not meet the RAOs for the site, however, these technologies may be appropriate as part of other alternative. Monitoring is an example of such a technology that will not meet the site's RAOs but can be used in conjunction with almost any other technology to form a viable alternative and therefore monitoring has been retained.

2.5.2.3 Containment Technologies

Three types of caps were considered in this evaluation. These include caps comprised of :

- Soil,
- Clay and,
- Synthetic Membranes,

A soil cap would involve covering the previously prepared and graded berms and pad areas with soil of sufficient thickness and quality in order to promote a grass cover. The cap would control the exposure from inhalation of soil dust, prevent runoff of impacted particles and prevent exposure to humans and ecological receptors due to ingestion of metals in soil. However, the use of the cap alone would not be effective in meeting the RAO of protecting groundwater because although the cap would prevent infiltration it would not prevent leaching of contaminants from the soil into the groundwater.

The second option for capping would involve placing an impermeable cap below a soil cover. The impermeable material could be either clay, a bentonite admixture or a synthetic material such as High Density Polyethylene (HDPE). Caps that include the use of synthetics are referred to as multimedia caps since they involve combining the use of natural soil materials, such as sand and loam, for use as base materials, drainage layers and protective covers with impermeable synthetic membranes. Slope stability is a factor that must be considered when planning a cap, especially if membranes are being considered. This is due to the low friction factors that occur between the natural soils and the membrane surface. However, recent developments in the manufacturing of membranes have allowed vendors to provide membranes that have rough membrane surfaces, allowing for the use of membranes on steeper slopes. Impermeable caps are preferred over a soil cap because impermeable caps would be more effective in eliminating infiltration of precipitation. As a result, the soil cap option was eliminated from consideration. However, the remaining two caps, clay and synthetic membranes, were retained for combination as alternatives.

Vertical barriers involve preventing interaction between groundwater and buried wastes by placing surrounding the waste materials with an impermeable vertical wall. Three process operations for vertical walls were considered and include:

- Steel Sheet Pilings,

- Slurry Walls and
- Grout Curtains.

Of the three vertical technologies considered, only slurry walls were retained for combination as a remedial alternative since this technology was considered that most effective for preventing groundwater flow. Slurry walls are the most reliable and have numerous applications in the field of hazardous waste remediation.

Two horizontal barrier technologies were considered. These include :

- Grout Injection and
- Block Displacement.

Horizontal barrier techniques were eliminated from further consideration since unweathered bedrock is sufficiently near to the surface that the bedrock would act as a horizontal barrier if combined with a vertical barrier to prevent mixing of groundwater with buried waste. Further, the selected areas that would require this technology are generally elevated pads, such as at Pad B, that are comprised of built up soil. The surrounding soil horizons are thin and injection of grout below the waste pads would produce breakout of the grout along the thin soil zone. This would prevent the injected grout from forming a continuous barrier over the entire area.

2.5.2.4 In-Situ Treatment Technologies

The following in-situ treatment technologies were considered as potential remedial alternatives :

- Solidification Technologies
  - Cement-based Immobilization/Fixation
- Vitrification,
- Electrical Extraction Technology
  - Electrokinetics,

- Chemical Extraction Technology
  - Soil Flushing,
- Biological Extraction Technologies

    - Bioventing/Biostimulation,
    - Vegatative Uptake,
- Vapor Extraction Technologies
    - Vacuum Extraction and
    - Radiowave Enhanced Volatilization.

A solidification/stabilization process would be technically feasible at the OB Grounds. In this instance, the pads and berms would be mixed with the cementous admixture using augers until the appropriate level of treatment was achieved. Since this process is technically feasible this technology was retained for further consideration as a potential remedial alternative.

The ISV process is considered innovative but has been identified as an appropriate technology for application at hazardous and radioactive waste sites. Full scale, widespread, operation of this technology has not been performed, probably due to the excessive power requirements that this technology requires, although pilot demonstration testing has been conducted. Geosafe Corp. successfully demonstrated this process at a site in Region V.

This technology was not retained for further consideration since the site conditions are not ideal for application of this technology. This is because of the wide variability of the thickness of the soil layers at the OB Grounds. The pads are generally the locations where the soil horizon is thick, in some cases approximately eight feet, however, the areas away from the pads contain thin layers of soil above the bedrock. These thin zones of soil are not sufficiently thick to allow proper installation of the electrodes. This process would not be successful for the sediments in Reeder Creek.

Electrokinetics is possible but is only capable of removing dissolved metals in the saturated soil. Since much of the metals at the site are located above the water table as solid particles, this technology was screened out from further consideration. This process would not be feasible for the sediments in Reeder Creek, since this is a surface water body, not groundwater.

Soil flushing has promise at heavily contaminated sites where excavation is impractical but was eliminated from further consideration for application at the OB Grounds since this technology is most appropriate for use with sites impacts with organic compounds. The constituents of concern at the OB Grounds are inorganic compounds, such as lead, and it is unlikely that any useable soil flushing agent would be successful at extracting the metals of interest. Further, the thin soil thicknesses and the low permeability of the groundwater suggests that the collection of the extracted materials would be slow and inefficient.

Bioventing/Biostimulation is not effective for inorganic components and therefore has been eliminated from further consideration.

Extraction of metals via the vegatative uptake of plants is experimental and unreliable. The conditions of the pads and berms at the site would not promote vegatative growth and this technology was screened from further consideration.

Vacuum or vapor extraction was screened from further consideration since the constituents of concern at this site are inorganics, making this technology ineffective.

Radiowave enhanced volatilization is considered innovative and experimental with only limited pilot scale applications. It is most appropriate for sites where excavation is impractical and semi-volatile organic compounds are the constituents of concern. Since lead, an inorganic compound with a boiling point of 1300°F, this technology would not be effective in removing lead from soil and was screened out from further consideration.

Of the technologies considered in the in-situ treatment general response category, only solidification was retained for consideration.

2.5.2.5 Removal Technologies

Since the soil at the OB Grounds can be easily removed using standard mechanical excavation techniques, only this technology was retained for further consideration. Excavation using slurry techniques was screened out of further consideration since it would not be practical as the sediments in Reeder Creek are easily removed using standard techniques.

2.5.2.6 Ex-situ Treatment Technologies

The following technology types and process options were considered as potential remedial altenatives:

- Biological Technologies
  - Aerobic

- Anaerobic

- Stabilization/Solidification Technologies
  - Pozzolan-portland cement
  - Pozzolan-lime-fly ash
  - Micro-encapsulation
  - Sorption

- Physical Separation Technologies
  - Soil Washing
  - Magnetic Classification

- Thermal Oxidation/Vitrification Technologies
  - High Temperature Processes

- Other Oxidation Technologies
  - Wet Air Oxidation

- Chemical Extraction Technologies
  - Supercritical Fluids
  - Non-Aqueous Fluids (Amines, etc.)

Ex-situ biological treatment of soil has been screened out since it is effective for soils that have been impacted with organic constituents and would not meet the objectives for reducing the concentration of lead in soil. Biological treatment would have little if any effect on the soils at the OB Ground that are impacted with lead.

The S/S technology using a mixture of pozzolan/cement/lime/fly ash has been identified by EPA as effective and is feasible for treatment of the soils at the OB Ground. The EPA policy regarding the use of this technology indicates that it is appropriate for materials that contain inorganics and non-volatile organics. With the wide range of solidifying agents available, this technology usually requires the performance of a site-specific treatability study to determine the most effective solidifying agent and the optimal ratio of waste to admixture. Since the constituents of concern at the site are inorganics with some amounts of semi-volatile organics, such as PAHs, present, this technology meets the requirements for application at this site and was retained for further consideration.

Microencapsulation has been used primarily in the nuclear industry to encapsulate radioactive sludges and is not considered feasible at the OB Grounds due to the non-uniform nature of the soils and sediments that will require treatment.

Sorption is most appropriate for use with semi-solid sludges and was eliminated from consideration a part of a remedial alternative since there are no sludges requiring treatment.

Physical separation technologies include soil washing and magnetic classification. Soil washing is considered to be effective and feasible remedial technology for this site and has been retained for incorporation as a remedial alternative. Magnetic classification of soils would not be effective at this site since most of the constituents of concern are non-magnetic.

Thermal oxidation/vitrification technologies are feasible, providing a vendor can be found to accept this material at an off-site location and have been retained for future consideration as part of a remedial alternative.

Other thermal oxidation processes, such as WAO, was not considered feasible or effective of use at this site since it is most applicable for high organic sludges and has been screened from future consideration.

Chemical extraction of soils are effective for extracting organics or oily waste materials but are not effective for removing inorganic constituents. Since the RAO for this project is inorgancs, i.e. lead, and the soil and sediments at the OB Grounds are not impacted with oily waste, this technology was not considered effective and was screened out.

2.5.2.7 Disposal

The following process operations have been considered for the on-site disposal technologies:

- Backfilling of clean soil,
- RCRA hazardous waste landfill and
- Solid waste landfill.

In the case of the OB Grounds, there are no known listed hazardous wastes to be disposed of. However, a portion of the soils at the site exhibit the characteristic of toxicity as a result of lead concentrations exceeding the limits of the EP Toxicity test, now called the Toxicity Characteristic Leaching Procedure (TCLP). If the characteristic of the waste is removed, i.e. the soil no longer exceeds the limits for toxicity due to treatment, then the waste is no longer a hazardous waste and can be landfilled in an on-site, non-hazardous, solid waste landfill. Accordingly, the on-site solid waste landfill option and the backfilling clean treated soil have been retained for inclusion with other technologies as remedial alternatives.

Two options were considered for off-site disposal. These included:

- State-permitted RCRA hazardous waste landfill and
- State-permitted solid waste landfill.

Since there are no wastes at the OB Grounds that are listed wastes the need to dispose of any soil in an off-site TSD facility does not apply and has been removed from further consideration. Soil that may be characteristic by toxicity would need to be treated to remove the characteristic prior to disposal in an off-site landfill but the landfill does not need to be a hazardous waste landfill, since the waste is no longer hazardous once the characteristic has been removed.

Section 3

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 INTRODUCTION

In this section the remaining general response actions and the various remaining remedial technologies are combined to form remedial alternatives. The rationale is presented for how and why the selected technologies were assembled into remedial action alternatives. Only source control alternatives and the technologies that comprise them are described. Alternative for remediation of groundwater and surface water are not part of the RAOs for this site and are not considered, other than protecting these resources from any degradation.

Once the alternatives have been assembled, the alternatives are evaluated with respect to three broad remedial alternatives screening criteria: effectiveness, implementability and cost. A brief description of the screening criteria is provided:

- Effectiveness is a key aspect of the screening process as each alternative must be capable in meeting the requirements established as RAOs for this site. In this instance, the RAOs define the required degree of protectiveness for human health and the environment. A remedial action alternative is considered effective, and therefore protective, if the alternative can reduce the toxicity, mobility or volume to the level identified by the RAOs. Both short and long term components of protectiveness were considered. Short term protectiveness refers to the construction and implementation period. Long term protectiveness refers to changes that can be expected in the characteristics of the constituents of concern that have been treated.

- Implementability is a measure of both the technical and administrative feasibility of constructing, operating and maintaining a remedial action alternative.
  Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete; it also includes maintenance, replacement, and monitoring the technical components of an alternative during and after the remedial action is complete. Administrative feasibility refers to the availability of treatment, storage, and disposal services and capacity; and the requirements for and availability of specific equipment and technical specialists.

- Cost estimations during screening is required as a comparative measure of the costs for a remedial action. The level of accuracy for cost estimates required at this point is similar to that required for the detailed analysis and is considered to be +50% to -30%. The only difference would be in the amount of alternative refinement and in the degree that the cost components are developed. Both capital and O&M costs were considered, where appropriate. The evaluation included O&M costs that would be incurred for up to 30 years. Present worth analyses were used during the alternative screening to evaluate expenditures over different time periods in order to provide a common basis to compare costs.

Six alternatives (five plus the no action alternative) were assembled and screened based these three criteria. The initial alternatives list of six were then reduced to four alternatives that were analyzed in detail in Section 5.0.

3.2 ASSEMBLY OF ALTERNATIVES

In this section the rationale is presented for assembling technologies and processes remaining from the technology screening into remedial action alternatives. These retained technologies and processes, summarized on Table 2-7, are representative of the general response actions that were retained: 1) No Action, 2) Containment, 3) In-situ treatment, 4) Ex-situ treatment and, 5) Disposal, i.e. Landfilling. These general response actions and the technologies associated with these actions have been combined as remedial alternatives and are listed in order of increasing complexity. Variations have been created for on-site vs. off-site treatment/disposal and for solidification vs washing treatment. An innovative technology has also been included to comply with the SARA (1986) requirement that alternative solutions be used to the maximum extent possible. The alternatives that have been assembled from the remaining general response actions and associated technologies are as follows:

- Alternative 1 is the No Action Alternative,
- Alternative 2, is the On-site Containment Alternative,
- Alternative 3, is the In-situ Treatment Alternative,
- Alternative 4, is the Off-Site Disposal Alternative,

- Alternative 5 is the On-Site Disposal Alternative,

- Alternative 6 is the Innovative Treatment Alternative.

A brief description of the alternatives, the technologies and processes associated with these actions are assembled and summarized and presented on Table 3-1.

Table 3-1

Assembled Remedial Alternatives

Alternative	Alternative Description	Technologies and Processes
1	No Action	No remedial action taken, No further monitoring.
2	Containment	Consolidation of sediment/slurry wall/cap/sedimentation basin/groundwater monitoring
3	In-situ Treatment using Solidification	Consolidation of sediment/solidify soils and sediments/sedimentation basin/groundwater monitoring
4	Off-site Disposal	Excavation/solidification/off-site landfill disposal/sedimentation basin/groundwater monitoring.
5	On-site Disposal	Excavation/solidification/on-site landfill disposal/sedimentation basin/groundwater monitoring.
6	Innovative Treatment (Soil Washing)	Excavation/wash/backfill coarse soil fraction/treatment of fine soil fraction/fine fraction to off-site landfill or backfill/residual to off-site landfill

3.3 DESCRIPTION OF TECHNOLOGIES, PROCESSES AND ALTERNATIVES

3.3.1 General

Up until this point remedial response actions, technologies and processes have been evaluated in general. The generality is necessary in order to consider the large number of possible remedial actions that may be appropriate; however, because the alternatives retained are relatively similar it is now necessary to define the project in more detail to better distinguish, evaluate and screen the assembled alternatives for a detailed alternatives evaluation that will be performed in Section 5.0.

The technologies and processes that make up the six assembled alternatives will be described in sufficiently greater detail to allow each assembled alternatives to be screened. In addition to better defining technologies and processes, the quantity of material to be remediated has also been considered. Order of magnitude unit costs have been developed based on technology definitions and material quantities. These costs were then utilized as one of the alternatives screening criteria. It is important to note that the final decision regarding specific remedial technologies and processes to be utilized may be dependent on the results of treatability studies proposed in Section 4.0.

3.3.2 Alternative 1 - The No Action Alternative

Alternative 1 is the No Action alternative. This alternative allows the site to remain as it currently is, with no further consideration given to any remedial actions.

3.3.3 Alternative 2 - The On-site Containment Alternative

Alternative 2, the containment alternative, involves consolidating, via mechanical excavation, any sediments in Reeder Creek exceeding the 31 mg/kg limit for lead and the 16 mg/kg limit for copper in the containment area, followed by on-site containment of all soils exceeding the 500 mg/kg limit for lead using a slurry wall as the vertical barrier and a cap as a horizontal barrier.
The cap would be placed over the area isolated by the vertical barrier. The intent of this alternative is to isolate the waste from receptors and prevent any further releases to the groundwater, beyond the area of the slurry wall, or to surface water via soil erosion. The

volume or toxicity of waste materials will not reduced as part of this alternative and long term maintenance of the cap and the slurry wall will be required. This alternative will also involve construction of a sedimentation basin to prevent any further runoff of sediment into Reeder Creek.

The slurry wall would be installed from the surface to a depth in the bedrock that would be considered impermeable. The exact depth is uncertain but would be anticipated to be approximately five to ten feet. The cap would be constructed after the slurry wall was installed to eliminate the continued infiltration of precipitation within the slurry wall. Capping involves leveling and grading the OB Grounds, as required, in order to place an impermeable cap over the area followed by a protective soil cap over an impermeable layer. The impermeable material for the cap would be either clay or synthetic membrane. This would be covered with a soil cover to physically protect the cap from mechanical puncture and erosion. Included in this alternative would be a provision to monitor the releases from the within the cap. A long term groundwater monitoring plan will be required to assure effectiveness of the containment system.

On-site hauling is estimated to be done at a rate of 100 cy/hr/dumper truck. Off-site hauling to a Subtitle D landfill is estimated to be done at a rate of 40 cy/day/truck (60 ton/day/truck).

3.3.4 Alternative 3 - The In-Situ Treatment Alternative

Solidification/Stabilization is a process in which the waste material is mixed with a variety of solidifying agents including: 1) Portland cement, 2) pozzolanic materials , and 3) proprietary additives. Lime or fly ash are typical stabilization reagents that may also be added. In this case, the mixing process is performed in-situ. There are several solidification/stabilization mixtures that may be feasible for in-situ remediation, pending treatability testing (refer to Section 4.0). Once treated, the waste material is allowed to solidify into a monolithic mass having significant unconfined compressive strength, physical stability and rigid, cement-like texture. This process decreases constituent mobility by binding constituents into a leach-resistant, concrete-like matrix while increasing the waste material volume as much as 20 to 50%.

Alternative 3, the in-situ treatment alternative involves in-place solidification of soil and sediments using large hollow stem augers and injecting a grout or cemetous slurry during the mechanical mixing process. Any sediments in Reeder Creek exceeding the 31 mg/kg limit for lead and the 16 mg/kg limit for copper will be consolidated by excavation in the area that will be solidified. The remaining soils exceeding the 500 mg/kg limit for lead will be solidified and stabilized, in-situ, using a large specialized auger or equivalent mixing equipment. Following the in-place mixing, the soil and solidification mixture would cure to form a solidified mass of sufficient structural integrity to resist weathering and leaching. Monitoring would be required to assure that the treatment would continue to be effective.

This alternative would also involve construction of a sedimentation basin in order to prevent any further runoff of sediment into Reeder Creek. A long term groundwater monitoring plan will also be required to assure effectiveness of the containment system.

3.3.5 Alternative 4 - The Off-Site Disposal Alternative

Alternative 4, is the off-site disposal alternative and involves excavation of soils that are expected to exceed the TCLP limits and processing the soils through a mechanical mixing operation where a solidifying agent, either pozzolan/portland cement or pozzolan/lime/fly ash, is added in sufficient quantity to completely solidify the soils that exceeded the TCLP limit to remove the characteristic of toxicity. The solidified soils and the remainder of the contaminated soils, i.e. those soils that exceed the 500 mg/kg RAO for lead in soil, in addition to any sediments in Reeder Creek exceeding the 31 mg/kg limit for lead and the 16 mg/kg limit for copper, would then be transported to an off-site, Subtitle D, solid waste, industrial, landfill for disposal. Removal would consist of excavation using a front-end loader or similar equipment. A bulldozer may be used if necessary, to loosen the shale fill prior to loading into dumper trucks for off-site hauling. Loading will be done using one or two 5- cubic yard (CY) bucket front-end loaders. The production rate is estimated to be 150 CY/hr/loader (225 ton/hr/loader). A Subtitle D landfill refers to a solid waste landfill that meets the NYSDEC and USEPA Subtitle D landfill construction specifications. Monitoring would be required to assure that the treatment would continue to be effective.

3.3.6 Alternative 5 - The On-Site Disposal Alternative

Alternative 5 is the On-Site Disposal Alternative, similar to Alternative 4 and involves excavation of soils that are expected to exceed the TCLP limits and processing the soils through a mechanical mixing operation where a solidifying agent is added to solidify the soils that exceeded the TCLP limit. The solidified soils and the remainder of the contaminated soils above the 500 mg/kg RAO for lead in soil, would then be disposed of in an on-site landfill. The on-site landfill would be constructed nearby the OB Grounds. The landfill would meet the requirements of a Subtitle D landfill for the USEPA and the requirements of NYSDEC identified in 6 NYCCR Part 360 for landfill construction. Monitoring would be required to assure that the treatment would continue to be effective.

3.3.7 Alternative 6 - The Innovative Treatment Alternative

Alternative 6 is the innovative treatment alternative and involves soil washing. For this alternative, the sediments and soils will be excavated and soil washed to separate the coarse fraction of soil from the fine fraction. The coarse fraction will be backfilled as clean fill providing the requirements of the RAO are met. The fine fraction is expected to contain the majority of the target constituents of concern, i.e. lead and copper, and will be treated, either via solidification or acid leaching, to remove any characteristic that the washed soil may exhibit for toxicity in order to allow the fine fraction to be disposed of at an off-site solid waste landfill. If the fine fraction is acid extracted and successful at reducing the concentration of the soils to below the 500 mg/kg goal for lead, it may be possible to minimize the volume of soils that would require off-site disposal by backfilling the clean coarse fraction or otherwise reused as daily landfill cover while the fine fraction may be subsequently treated via technologies such as acid extraction or solidification.

Soil washing has been identified as an effective technology for soil treatment at the OB Grounds because soils that comprise the pads and the berms are made-up of a large quantity of coarse particles, i.e. crushed shale imported from a SEDA borrow pit, and a small quantity of fine particles, i.e. the portion of the glacial till that is less than the 200 micron particle size for clay. From various particle size distribution curves generated during the RI, it has been determined that the fine fraction in the glacial till at the site varies from between 30 to 70 percent with median of approximately 50%. The inorganic and organic constituents that are of interest for treatment tend to bind chemically or physically to the smaller quantity of fine-grained silt and clay particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion. Washing processes that separate the smaller fraction of fine clay and silt particles from the larger fraction of coarse sand and gravel soil particles can thus effectively separate and concentrate chemical constituents into a smaller volume of soil that can be further treated or disposed. The clean, larger fraction of coarse material can be returned to the site for continued use. Therefore, by employing a combination of physical separation techniques, the process of soil washing reduces the volume of waste material by causing constituents to be separated from the larger quantity of coarse particles and concentrated into the smaller quantity fine particles. Soil washing is expected to be done at a rate of 25 tph or about 17 CY/hr.

Once the particles have been separated the fine fraction can be treated further to remove the inorganic components using acids. A combination of flurosilcic acid (H_2SiF_6), nitric acid (H_2NO_3) and hydrochloric acid (Hcl) have been utilized as effective agents for solubilizing metal contaminants in various soil washing processes. In general, acid is slowly added to a water and soil slurry to achieve and maintain a pH of 2. Precautions are taken to avoid lowering the pH below 2 and disrupting the soil matrix. When extraction is complete, the soil is rinsed, neutralized, and dewatered. The extraction solution and rinsewater are regenerated. The regeneration process removes entrained soil, organics, and heavy metals from the extraction fluid. Heavy metals are concentrated in a form potentially suitable for recovery. Recovered acid is recycled to the extraction unit. Other metal chelating agents such as EDTA have been attempted but generally have not produced effective results. Following treatment, soil may be re-used as daily cover in a Subtitle D landfill or backfilled on-site. The U.S. Bureau of Mines has developed an acid leaching process that recovers lead from the acid leaching solution using electrochemical techniques. The outcome is an ingot of lead that can be recycled as scrap lead. This is an option that can be implemented as part of the soil washing option but will require treatability testing to determine the proper acid type and quantities.

The technology of soil washing varies from vendor to vendor but will generally consist of many unit operations including the following:

Physical Separation Unit Operations	Chemical Extraction Unit Operations
• dry screening (grizzly screen)	• washwater treatment/recycle
• dry screening (vibratory screen)	• residual treatment and disposal
• dry trommel screen	• treated water discharge
• wet sieves	• acid leaching/metals recovery

- attrition scrubber (wet)
- dense media separator (wet)
- hydrocyclone separators
- flotation separator
- gravity separators
- dewatering equipment
- clarifiers
- filter presses

3.4 SCREENING CRITERIA

3.4.1 General

Alternatives assembled in Section 3.2 and defined in Section 3.3 have been screened in this section. Six alternatives, listed on Table 3-1 have been evaluated against short-term and long-term aspects of three broad criteria: effectiveness, implementability and cost. Two screening evaluations were conducted and are presented in Table 3-2.

The purpose of screening is to reduce the number of alternatives that will undergo detailed analysis, the screening conducted in this section is of a general nature. Although this is necessarily a qualitative screening, care has been taken to ensure that screening criteria are applied consistently to each alternative and that comparisons have been made on an equal basis, at approximately the same level of detail. These criteria consist of several elements shown as follows.

TABLE 3-2
SCREENING OF ALTERNATIVES

ALT.	TECHNOL. AND PROCESS.	EFFECTIVENESS									IMPLEMENTIBILITY				COST		SCORE
		PROTECTIVENESS				REDUCTIONS			PER-MAN-ENCE	ARAR COMP-LIANCE	TECH. FEASIB.		ADM. FEASIB.				
		Human Health		Environment													
		short-term	long-term	short-term	long-term	Tox.	Mob.	Vol.			CON-STRUC.	LONG-TERM MONIT.	AGENCY APPROV.	AVAIL.	CAPIT.	O&M	
1	No Action Alternative	6	1	1	1	1	1	1	1	1	6	6	1	6	6	6	45
2	Containment Alternative Consolidate/Slurry Wall/Cap	5	2	6	2	2	2	5	4	6	4	1	4	3	5	1	52
3	In-situ Treatment Alternative Solidify soils in-place/soil cover	4	3	5	3	5	5	2	5	6	2	2	5	2	1	3	53
4	Off-site Disposal Alternative Excavation/solidification/ Off-site disposal	1	4	4	4	3	3	3	2	6	5	5	2	5	4	5	56
5	On-site Disposal Alternative Excavation/solidification/ on-site Subtitle D landfill	3	5	2	5	4	4	4	3	6	3	3	3	4	3	2	54
6	Innovative Treatment Alternative Excavation/wash/backfill coarse frac./treat fine frac./either backfill fine fract. or /residual to off-site landfill	2	6	3	6	6	6	6	6	6	1	4	6	1	2	4	65

H:\ENG\SENECA\OBFS\TBL3-2.WK3

3.4.2 Effectiveness

A key aspect of the screening evaluation is the effectiveness of each alternative in protecting human health and the environment. This screening criterion includes the evaluation of each alternative as to the protectiveness it provides and the reductions in toxicity, mobility, or volume it achieves.

- Short-term protectiveness of human health - Rating the potential for the remedial action to affect human health during remedial action. Both on- and off-site exposures are considered under this criterion. Exposure routes include inhalation, ingestion, and dermal absorption.

- Long-term protectiveness of human health - Rating the effectiveness of the remedial action to alleviate adverse human health effects after the remedial action is complete. The ability of an alternative to minimize future exposures is considered under this criterion. Exposure routes include inhalation, ingestion, and dermal absorption.

- Short-term protectiveness of the environment - Rating the effectiveness of the remedial action to prevent environmental receptors from being affected by constituents during remedial action.

- Long-term protectiveness of the environment - Rating the effectiveness of the remedial action to prevent environmental receptors from being affected by constituents after remedial action is completed.

- Reduction of mobility, toxicity, or volume of waste - Rating of effectiveness in changing one or more characteristics of the medium by treatment to decrease risks associated with chemical constituents present.

3.4.3 Implementability

Implementability is a measure of both the technical and administrative feasibility of constructing and operating a remedial action alternative.

- Technical feasibility - Rating of the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete.

That also includes monitoring of the alternative, if required, after the remedial action is complete.

- Administrative feasibility - Rating of the ability to obtain approvals from regulatory agencies and the Army; the availability of treatment, storage, and disposal services; and the requirements for, and availability of, specific equipment and technical specialists.

3.4.4 Costs

Both capital and operation and maintenance have been considered during the screening of alternatives.

- Capital costs - these were estimated based on order-of-magnitude vendor unit costs.

- Operating and maintenance (O&M) costs - O&M costs were evaluated by assigning a rating value ranging between 1 and 6 as described in the following paragraph (Section 3.4.5).

3.4.5 Numeric Rating System

The alternatives were evaluated by applying a simple numeric rating system. Each alternative was assigned a value ranging between 1 and 6 for a particular criteria. The value assignments were based on both experience and the overall characteristics of the alternatives. If a specific alternative was considered very unfavorable for a given criteria a value of 1 was assigned relative to the other alternatives within the criteria. Likewise, if a particular alternative was considered very favorable, a rating value of 6 was assigned to it relative to the other alternatives within that criteria. Rating scores of 2 through 4 were given to distinguish varying degrees of unfavorable and favorable alternatives. The individual criteria values were summed for each alternative and the totals used to screen alternatives.

3.5 ALTERNATIVES SCREENING

3.5.1 Method of Scoring

The alternatives screening process is presented in Tables 3-2 for the six alternatives listed in rows and screening criteria listed in columns. Screening was conducted by considering one column (one criteria) at a time, independent of the other columns and relative to the other alternatives, particularly the no action alternative. The first step was to review each alternative and identify the alternatives that represent the two extreme values (1 and 6), with 6 representing the most favorable score and 1 representing the worst score, for a particular evaluation factor. The values were applied consistently and unbiasedly to each alternative on this column-by-column basis. The total score for each alternative was then summed and used as the basis for proceeding to the detailed evaluation. The following sections present the qualitative rationale for each factor that were utilized to assign values to each alternative.

3.5.2 Effectiveness

3.5.2.1 Short-Term Human Health Protectiveness

All alternatives provide short term human health protectiveness. This assessment ranks the relative merits that each may provide over another one. The assessment of short-term human health protectiveness was based upon any factor that would increase exposure or increase physical hazards and the quickness and completeness that an alternative could be implemented to protect human health.

Activities that contribute to increased exposure are excavation, which is the first step in many alternatives. Excavation is considered to lower short-term worker protectiveness relative to no action, even with dust controls applied and personal protection equipment used by remediation workers. Other factors that increase short term risks are activities that increase off-site exposure such as: fugitive dust emissions due to on-site movement of construction vehicles, runoff during excavation in Reeder Creek, or from physical and/or noise hazards such as increased truck traffic through local streets. Alternatives identified as limiting these exposure scenarios were ranked higher than those that did not. Alternatives that involved excavation followed by off-site transportation were perceived as increasing the risk the most and was consequently ranked the lowest.

Alternative 1, the no-action alternative, was ranked the highest with a 6 since no excavation is conducted. Alternative 2, the containment alternative, was ranked the next highest with a 5 since this alternative did not involve a large amount of excavation, had limited off-site traffic and could be implemented quickly as it did not require specialized equipment or vendors. The only excavation of contaminated materials will involve the sediment in Reeder Creek and some uncontaminated soil for the installation of the slurry wall. The construction of the impermeable cap could involve off-site hauling of clay and possibly clean fill for the protective cover, thereby increasing truck traffic in the area, and was identified as a negative factor. However, this can be limited through the use of a geosynthetic membrane in place of clay and obtaining clean fill from other areas of the depot, instead of off-depot, thereby limiting off-depot traffic. Alternative 3, the in-situ alternative, was ranked the next highest with a 4 since it involved the same amount of excavation as Alternative 2. For both alternatives only sediment in Reeder Creek would require excavation to an area where in-situ mixing would be performed. Alternative 3 was ranked lower than Alternative 2, even though both are low excavation alternatives, because this alternative will involve hauling a large amount of solidification materials thereby increasing off-depot traffic. Further, due to the specialized nature of this process the quickness that this alternative could be implemented is less than Alternative 2 due to the limited number of vendors.

Alternative 5, the on-site disposal alternative, was ranked the next highest with a 3 since, in addition to the excavation of sediment in Reeder Creek, the remaining soil would be excavated. However, this material would not be transported off-site, therefore this alternative was ranked moderately high even though a large amount of excavation would be performed.

Alternative 6, the innovative treatment alternative, was ranked lower than Alternative 5 even though both alternatives involve a similar amount of excavation because this alternative would require a specialized vendor, thereby limiting the availability and quickness that this alternative could be implemented. This alternative also involves the storage of acids or other hazardous chemicals that could cause spills, thereby increasing exposure. Further some off-site disposal of residuals will involve off-site transportation and therefore this alterative was considered only moderately protective.

Alternative 4, the off-site disposal alternative, was ranked with a 1 since this alternative involved the off-site transport of approximately 3,800 c.y. of a RCRA characteristic hazardous waste.

3.5.2.2 Long-Term Human Health Protectiveness

All alternatives, other than the no action alternative, protect human health in the long term. This assessment ranks the relative merits that each may provide over another one. The assessment of long-term human health protectiveness is based upon factors that could cause risk due to a increase in exposure from releases of treated materials. Alternatives identified as having the least potential for causing releases over the life of an alternative were ranked the highest than those that did not. Alternatives that involved treatment, either from entrainment or metals removal and recovery, were considered more favorable than alternatives that did not involve a treatment process since treatment would be one additional step that would assure reduced potential for long term releases.

Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would actually provide the highest amount of treatment. This alternative accomplishes both volume reduction and treatment either from solidification or acid extraction of the washed soil. Even though small portion of residuals would be disposed of off-site in a landfill this alterative was considered the most protective as it provides the most treatment.

Alternative 5, the on-site disposal alternative, was ranked the next highest with a 5 since this alternative involves treatment using stabilization/solidification and construction of a new on-site landfill, designed and constructed to hold this materials. Since this landfill would be on-site, it would be easy to monitor and maintain to assure long term effectiveness. In addition, the landfill would not be subjected to other chemical wastes or be subjected to physical hazards such as increased vehicle traffic that may adversely affect the physical integrity of the liner or cap. The long term liabilities associated with off-site disposal, both financial and legal, due to releases at an off-site landfill would be eliminated.

Alternative 4, the off-site disposal alternative, was ranked moderately high with a 4 since this alternative involved some treatment and would protect long term human health as no contaminated soil would remain on-site. However, due to the uncertainties associated with off-site disposal and long term liabilities at an off-site facility it was not ranked higher.

Alternative 3, the in-situ alternative, was ranked the next highest with a 3 since it involved a large amount of treatment, albeit in-situ. This alternative was only ranked moderate since all treatment would be performed in-situ leading to uncertainties due to the effectiveness and completeness of a mixing process that cannot be fully observed.

Alternative 2, the containment alternative, was ranked the next to lowest with a 2 since this alternative does not involve any actual treatment of soils and includes some uncertainty associated with the long term effectiveness of the protective cover/cap in addition to the slurry wall.

Alternative 1, the no action alternative, was ranked with a 1 since lead and copper in soil and sediment would continue to contribute to the potential long term human health impacts.

3.5.2.3 Short-Term Environmental Protectiveness

All alternatives, other than the no action alternative, provide short term environmental protectiveness. This assessment ranks the merits that one alternative may provide over another one. The evaluation of short-term environmental protectiveness has been based upon factors that could cause exposure to environmental receptors. As with short term human health protectiveness, excavation is considered to lower short-term protectiveness as this process would increase the potential to expose contaminants to the environment and environmental receptors. Other activities that disturb the natural conditions are perceived as factors that would contribute to increased environmental risk. These activities include any other construction process such as: setup of field offices, staging areas or other support facilities, movement of heavy equipment, sediment removal in Reeder Creek and noise hazards. These activities contribute to increase short term environmental risk by either increasing fugitive dust emissions, decreasing available wildlife habitat or causing noise that will disturb environmental receptors. Alternatives that involve constructing landfills were considered as contributing to environmental risk by decreasing habitat for wildlife.

Alternative 2, the containment alternative, was ranked the highest with a 6 since this alternative involved only a small amount of excavation in Reeder Creek and no permanent elimination of wildlife habitat. This alternative can be implemented in a short period of time thereby limiting the time that environmental receptors will be impacted.

Alternative 3, the in-situ alternative, was ranked the next highest with a 5. Since although it involved the same, limited, amount of excavation as Alternative 2, it was ranked higher but due to the large soil mixing equipment that would be on-site for a longer than the equipment required for Alternative 2, thereby causing greater disturbance to wildlife.

Alternative 4, the off-site disposal alternative, was ranked with a 4 since even though this alternative involved a large amount of excavation, off-site hauling is not perceived as having a significant affect on environmental receptors as truck traffic would be limited to existing roadways. The quickness of implementing this alternative and the ability of this alternative to eliminate any pollutants from continued environmental exposure was considered a positive factor. These factors in addition to the fact that no wildlife habitat or resources would be lost caused this alternative to be rated high.

Alternative 6, the innovative treatment alternative, was ranked with a 3 since this will involve a large amount of excavation and could potentially involve storage of acids or other hazardous chemical that could be involved in spills. Further, this alternative will involve construction of a treatment facility to soil wash the excavated soil causing impacts to the environment as a result of the construction and operation of the facility.

Alternative 5, the on-site disposal alternative, was ranked slightly lower than Alternative 6 with a 2, since this alternative will also involve a large amount excavation, thereby causing disturbance to environmental receptors and would eliminate a large amount of habitat by construction of an on-site landfill.

Alternative 1, the no action alternative, was ranked the lowest with a 1. Although no excavation would be performed, the existing conditions have been identified as currently adversely impacting environmental receptors and, unlike the conditions for human health, there are no provisions to restrict exposure to environmental receptors.

3.5.2.4 Long-Term Environmental Protectiveness

All alternatives, other than the no action alternative, provide long term protection of the environment. This assessment ranks the relative merits that each may provide over another one. The assessment of long-term environmental protectiveness is based upon factors that could cause risks due to a increase in exposure for environmental receptors from releases of treated materials. Alternatives identified as having the least potential for causing releases over the life of an alternative were ranked the highest than those that did not. Alternatives that involved treatment, either from entrainment or metals removal and recovery, were considered more favorable than alternatives that did not involve a treatment process since treatment would be one additional step that would assure reduced potential for long term releases.

Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would actually provide the highest amount of treatment, from both volume reduction and treatment either from solidification or acid extraction of the remaining soil volumes.

Alternative 5, the on-site disposal alternative, was ranked the next highest with a 5 since this alternative involves treatment using stabilization/solidification in addition to the construction of a new on-site landfill, that would be designed and constructed to hold the contaminated materials for the long term. This alternative was deemed superior to an in-situ treatment or containment alternative because it would be able to provide a greater degree of assurance that materials would remain contained since the landfill would be aboveground, newly designed and would be monitored and maintained for perpetuity by the federal government. Further, because the landfill would designed and operated for remediation of this and possibly other sites within SEDA, other chemical wastes or physical hazards such as daily vehicle traffic, that would be associated with a commercial off-site landfill would be controlled and restricted. These factors may adversely affect the physical integrity of the liner or cap over the long term through either chemical attack or punctures and were considered negative factors that would make the on-site landfill alternative more attractive than an off-site alternative.

Alternative 4, the off-site disposal alternative, was ranked with a 4 since this alternative involved some treatment and eliminated the long term impacts to the environment by physically removing the risk producing constituents from the site. Although the risks are removed and will not affect the environment at the OB Grounds, the pollutants could affect the environment if released at another landfill. Due to the long term liabilities and uncertainties associated with off-site disposal, this alternative was ranked lower than the on-site alternative.

Alternative 3, the in-situ alternative, was ranked the next highest with a 3 since it involved a large amount of treatment, albeit in-situ. This alternative was only ranked moderately high since there are uncertainties due to the effectiveness of the mixing process that cannot be fully evaluated as an ex-situ alternative would allow. These uncertainties arise as a result of the variability of the layers of till at the site and the variability in the size and shapes of the debris found within the berms and pads. The non-uniform nature of the matrix that will require solidification will contribute to mixing difficulties and less effective treatment.

Alternative 2, the containment alternative, was ranked the next to lowest with a 2 since this alternative does not involve any actual treatment of soils and includes some uncertainty associated with the long term effectiveness of the slurry wall and the protective cover/cap.

Alternative 1, the no action alternative, was ranked with a 1 since lead and copper in soil and sediment would continue to contribute to continued long term environmental impacts.

3.5.2.5 Reductions In Toxicity

The assessment of toxicity reduction is based upon factors that would decrease the toxicity of the constituents of concern. Alternatives or processes that chemically or physically bind with the inorganics constituents provide the greatest reduction of toxicity as these constituents are no longer in a form that would be biologically available for uptake. The alternatives that provided the greatest reduction in toxicity by decreasing the bioavailablity through solidification or treatment were subsequently ranked the highest than those that did not. Entrainment within a solidified matrix of cement or metals removal and recovery are examples of treatment alternatives that were considered more favorable than alternatives that did not involve a treatment process.

Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would actually provide the highest amount of treatment, from both volume reduction and treatment either from solidification or acid extraction of the remaining soil volumes.

Alternative 3, the in-situ alternative, was ranked the next highest with a 5 since it involved a large amount of treatment that would reduce the toxicity by binding metals in a cementous matrix. Alternative 6 was ranked higher than Alternative 3 even though both involve a large amount of treatment because Alternative 3 has more of a potential for incomplete mixing since it is performed in-situ and therefore would have more uncertainty for reducing toxicity than Alternative 6.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked the next highest with a 4 and a 3, respectively. These alternatives are very similar and involve some treatment using stabilization/solidification but only for the soils that exceed the toxicity characteristic. Even though only a portion of the soils will be treated to reduce the toxicity of the soils some toxicity reduction will be achieved. The only difference between these two alternative involves where the soils will be landfilled. Landfilling, by itself, will not reduce the toxicity since there will be no treatment associated with the landfilling process other than what would be expected in isolating the waste in a landfill. Alternative 5, the on-site landfill alternative, was ranked slightly higher than Alternative 4 because the types of other wastes that would be placed in an on-site landfill and mixed with the soils from the OB Grounds would be limited and controlled. An off-site landfill would potentially accept other wastes that may mix with the soils from OB Grounds and adversely affect the treated waste, possibly increasing the toxicity.

Alternative 2,the containment alternative, was ranked the next to lowest with a 2 since this alternative does not involve any actual treatment of soils or reduction in toxicity.

Alternative 1, the no action alternative, was ranked with a 1 since there is no reduction in the toxicity of lead and copper in soil and sediment.

3.5.2.6 Reduction In Mobility

Mobility reduction factors are closely related to those that involve reductions in toxicity and the rankings were identical to that determined previously for toxicity. As the focus of this effort is to reduce the concentration of inorganic compounds, specifically lead and copper, this assessment ranked those alternatives that involved a chemical or physical reaction resulting in the formation of a less mobile state of the metals as preferable over those alternatives that did not involve a beneficial reaction. A beneficial reaction is a reaction that results in the formation of insoluble compounds like hydroxides. Such compounds would be produced during the stabilization/solidification process. Other beneficial reaction include the formation of the base metal that would be produced during the electrochemical process of reducing and recovering metallic ions following soil washing and acid extraction. In general, alternatives that involved treatment, either from entrainment or metals removal, reduction and/or recovery, were considered favorable in reducing mobility. Alternatives that involve containment also provide mobility reduction but these alternatives were viewed as less desirable since the mobility reduction is dependent on maintaining the integrity of the containment system. Uncertainties associated with containment systems, i.e. formation of leaks, were considered as factors that would decrease the ability of an alternative to reduce mobility and were ranked slightly below treatment alternatives.

Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would provide the highest amount of treatment.

Alternative 3, the in-situ alternative, was ranked the next highest with a 5 since it involved a large amount of treatment that would reduce the mobility by binding metals in a cementous matrix. The reason Alternative 6 was ranked higher than Alternative 3 was due to the uncertainties associated with achieving a completely mixed system in-situ. Since there more potential for this to occur with Alternative 3, the in-situ alternative, Alternative 3 was ranked lower than Alternative 6.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked the next highest with a 4 and a 3, respectively. These alternatives involve a limited amount of treatment by stabilization/solidification for soils that exceed the toxicity characteristic and this process will achieve mobility reduction as a result. However, landfilling the remaining soils will not reduce mobility other than what would be expected by physically isolating the waste in a landfill. These alternatives were ranked in the middle of the alternatives due to the uncertainties associated with potential leaks that occasionally occur in landfills. Alternative 5 was ranked slightly higher than Alternative 4 since the uncertainties associated with mixing other types of wastes with the soils from the OB Grounds would be more restricted, limited and controlled in an on-site landfill than an off-site landfill. An off-site landfill could potentially accept other wastes that may mix with the soils from OB Ground and increase the mobility through processes such as chelation with organic acids produced during decomposition of organic materials.

Alternative 2, the containment alternative, was ranked the next to lowest with a 2 since this alternative does not involve any actual treatment of soils or reduction in mobility other than the physical restrictions of migration resulting from the slurry wall and the cap.

Alternative 1, the no action alternative, was ranked the lowest with a 1 since there is no reduction in the mobility of lead and copper in soil and sediment.

3.5.2.7 Reduction in Volume

The rankings for volume reduction are different than for other reduction factors. Any alternative that caused an increase in volume was ranked lower than those alternatives that did not cause an increase. Although some volume increase would be expected due to excavation, Alternative 6, the soil washing alternative is a volume reduction alternative and is intended to initially reduce the volume of soil the most, (by up to approximately 50%), using wet separation techniques. Once the volume has been reduced the remaining fraction could be reduced even further if, following extraction with acids, the metallic ions are reduced electrochemically and recovered as the base metal. Solidification could be selected over acid extraction following wet separation, depending upon future treatability studies, and if selected would produce an increase in volume. Solidification causes an increase in the volume due to the addition of cement or another material that is used to incorporate the soil material. This volume increase varies depending upon the mixture used and the ratio of soil to admixture but can be as much as 50%. Usually this volume increase is approximately 20%.

Alternative 2, the containment alternative, was ranked next to highest with a 5 because this alternative will involve only a minimal amount of volume increase due to excavation of the sediments. It was not ranked higher than Alternative 6 because there is no volume reduction associated with this alternative as with Alternative 6.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked with a 4 and a 3, respectively. Both alternatives involve an identical, yet limited, amount volume increase due to the treatment by stabilization/solidification and excavation. However, Alternative 5 was ranked slightly higher than Alternative 4 as the uncertainties associated with the compaction process, which is considered a volume reduction process, that is used prior to placing the soils in a landfill are more controlled in an on-site landfill than an off-site landfill.

Alternative 3, the in-situ alternative, was ranked with a 2 since it involved a large volume increase since this alternative involves the most solidification.

Alternative 1, the no action alternative, was ranked the lowest with a 1 since there is no reduction in the volume of lead and copper in soil and sediment.

3.5.2.8 **Permanence**

All alternatives, with the exception of the no action alternative, will achieve a permanent solution. Alternatives that have the longest lifespan, preferably permanent, with the least amount of continued attention would be considered attractive and were ranked high. Factors that were deemed favorable in evaluating the permanence of an alternative included those that would permanently remove lead and copper from soil. Those alternatives that involved containment were not ranked as high as those alternatives that completely removed the metals from soil. This is because containment alternatives require long term care and maintenance to assure that the constructed containment structure will remain intact and permanent, whereas alternatives that involve a treatment process that will remove metals from the soil do not require continued attention, as the constituents of concern are eliminated, and are therefore more permanent and preferred.

Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would involve removing lead and copper from soil.

Alternative 3, the in-situ alternative, was ranked the next highest with a 5 since it involved a large amount of treatment that would permanently bind the metals in a cementous matrix.

Alternative 2, the containment alternative, was ranked with a 4 since this alternative involves construction of a permanent subsurface slurry wall that will require little, if any, maintenance. Only the aboveground cap, that will be placed over the slurry wall will require attention to assure permanence of this alternative.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked the next highest with a 3 and a 2, respectively. These alternatives involve a limited amount of treatment by stabilization/solidification for soils that exceed the toxicity characteristic. followed by landfilling the remaining soils. Since landfills are not considered permanent these alternatives were ranked low.

Alternative 5 was ranked slightly higher than Alternative 4 since maintaining a landfill at the OB Grounds would be more controlled and certain than an off-site landfill.

Alternative 1, the no action alternative, was ranked the lowest with a 1 since site conditions are subject to climatic change and is considered to be the least permanent alternative.

3.5.2.9 ARAR Compliance

All the alternatives comply with ARARs, with the exception of the No action alternative that did slightly exceed the GA groundwater standard for lead in 2 of 35 monitoring wells tested. The rankings for ARAR compliance was an evaluation as to the ability of an alternative to continue to comply with ARARs in the future.

Although there are no ARAR's for soil remediation which specifically provide promulgated cleanup standards, the NYSDEC TAGM HWR-94-4046 titled "Determination of Soil Cleanup Objectives and Cleanup Levels" has been identified as a TBC for soil remediation levels. Comparing the NYSDEC TAGM values with the 95th UCL of the mean of the soils concentrations indicates that the semivolatiles, benzo(a)anthracene, benzo(a)pyrene and dibenzo(a,h)anthracene and the metals barium, copper, lead, and zinc currently exceed the appropriate TAGM values. All of the alternatives do not actually reduce the concentration of the components to levels below the TAGM values.

Alternative 1, the no action alternative, was ranked the lowest with a 1 since there would be no provisions to assure that continued leaching to groundwater would cause additional exceedances of the GA groundwater standard for metals, especially lead.

3.5.3 Implementability

Implementability is a measure of both the technical and administrative ease and likelihood than an alternative could be implemented. Alternatives that are difficult to construct due to site factors, such as the need to construct a long road around a wetland in order to protect the wetland or would involve restrictions on the time of year that construction activities could be performed due to flooding or wildlife nesting activities are examples of construction difficulties that affect the implementability of an alternative. Alternatives that would require long term monitoring and continued attention are considered as negative factors in implementing an alternative. The ability of an alternative to obtain any necessary regulatory permits and the availability of vendors to implement an alternative are additional factors that could affect the ease of an alternative to be implemented.

3.5.3.1 Constructability

There are no current restrictions at the OB Grounds that would prevent the construction of an alternative. The site is located in a remote section of the depot and has easy access from several directions. Since the facility is a military reservation there are security restrictions that will need to be adhered, including restrictions on the use of open flames and spark producing devices, but these restrictions are not considered significant to affect the ability of an alternative to be constructed. Reeder Creek is adjacent to the site but is not considered to be large enough to cause difficulties in implementing an alternative. Winter conditions can occasionally be severe at times but are temporary and should not cause prolonged delays. In general, all the alternatives are constructible and therefore the rankings will focus on rating those alternatives that are the easiest to construct versus those that are not.

Alternative 1, the no action alternative, was ranked the highest with a 6 since this alternative would be the easiest to implement.

Alternative 4, the off-site disposal alternative, was ranked the next highest with a 5. Although this alternative does involve some solidification of soils that exceed the TCLP limit, this alternative involves removing soil and placing the soil in an off-site landfill and is considered the easiest, other than doing nothing, to implement since it involves simple excavation and hauling operations.

Alternative 2, the containment alternative, was ranked the next highest with a 4 since this alternative involves leaving soils inplace and constructing a slurry wall and a cap. The construction of a slurry wall and the cap would involve some specialized equipment but are considered to be relatively standard technologies and would not involve very deep excavating equipment.

Alternative 5, on-site disposal alternative, was ranked with a 3 because of the need to construct an on-site landfill. Although technically feasible to construct, the presence of shallow bedrock and Reeder Creek would limit the depth and lateral extent of the landfill. This along with the presence of on-site wetlands would provide some construction complications that cause this alternative to be ranked lower.

Alternative 3, the in-situ alternative, was ranked the next to lowest with a 2 since it involves specialized in-situ mixing equipment and is more complicated than simple excavating.

Alternative 6, the innovative treatment alternative, was ranked the lowest with a 1 since this alternative would involve construction of the most sophisticated and complicated unit operations associated with soil washing and treatment.

3.5.3.2 Long-Term Monitoring

It is technically feasible to implement a long term monitoring program for each of the alternatives. Such a plan would be most appropriate and required for alternatives that involved containment or landfilling. For these alternatives monitoring would be used to assure that the waste isolation system has remained secure. Typically, monitoring involves a network of monitoring wells that are strategically placed to intercept any release. A statistical procedure is used to compare data sets from downgradient and upgradient wells in order to determine changes that would suggest a release has occurred. If a release has been detected then an assessment and a remediation plan can be implemented to control the release. Long term monitoring would also include monitoring the condition of the cap to assure that the integrity of the cap has been maintained. If the cap monitoring detects a breach then reconstruction of the cap can be implemented to minimize the effects of the breach. For this evaluation, alternatives that involve containment or landfilling would require a similar monitoring plan for groundwater and other media and were considered to be equivalent. In this instance the ranking was made based upon the likelihood that a monitoring plan would detect a release. Those that were most likely to detect a release were ranked less favorable than those alternatives that were considered least likely to produce a "hit" in the monitoring plan.

Alternative 1, the no action alternative, was ranked the highest with a 6 since this alternative would not involve any monitoring.

Alternative 4, the off-site disposal alternative, was ranked the next highest with a 5 since this alternative would not involve monitoring as all soils will be removed and placed in an off-site landfill that would be monitored by the landfill operator but not by the federal government.

Alternative 6, the innovative treatment alternative, was ranked the next highest with a 4 since this alternative would involve only monitoring of the treated soils to assure compliance with the RAO but would not involve any long term monitoring as no contaminated materials would remain on-site.

Alternative 5, the on-site disposal alternative, was ranked with a 3 because of the need to monitor the on-site landfill. Although there is the potential for this landfill to leak, it was ranked higher than Alternative 2 that was ranked with a 1 because it included removal of all soils followed by the construction of a new engineered landfill that would have less likelihood to leak than soils left inplace.

Alternative 3, the in-situ alternative, was ranked with a 2 since it would involve a monitoring network that would monitor groundwater in order to assure the leaching to groundwater has not occurred. It was not ranked higher due to uncertainties associated with an in-situ process. Since a portion of the soils would remain in contact with the groundwater there is the possibility that leakage could occur.

Alternative 2, the containment alternative, was ranked the lowest with a 1 since this alternative involves leaving soils inplace and in contact with groundwater and would require long term monitoring for both the groundwater and the cap. It was ranked the lowest since it was perceived as the most likely alternative for a monitoring program to detect a release as the inplace soils were not treated.

3.5.3.3 Agency Approval

In general, when a remedial action is required, alternatives that meet remedial objectives, comply with ARARs, minimize off-site disposal, are permanent and reduce the toxicity, mobility and volume of pollutants will meet the goals of the NCP and are considered to be the agency preferred alternatives.

All alternatives will meet the remedial action objectives for the site with the exception of the no action alternative. Alternative 6, the innovative treatment alternative, was ranked the highest with a 6 since this alternative would minimize off-site disposal, is permanent, and reduces the toxicity of pollutants involve removing lead and copper from soil.

Alternative 3, the in-situ alternative, was ranked the next highest with a 5 since it involved a large amount of treatment that would permanently bind the metals in an on-site cementous matrix.

Alternative 2, the containment alternative, was ranked with a 4 since this alternative involves construction of a permanent subsurface slurry wall that will require little maintenance but will not reduce the toxicity, mobility or volume of the metals.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked with a 3 and a 2, respectively. These alternatives involve a limited amount of treatment by stabilization/solidification followed by landfilling the remaining soils. Since landfills are not considered permanent these alternatives were ranked low. Alternative 5 was ranked slightly higher than Alternative 4 since an on-site landfill would be preferred than an off-site landfill.

Alternative 1, the no action alternative, was ranked the lowest with a 1 since it does not meet the remedial action objectives for the site and is considered to be the least permanent alternative.

3.5.3.4 Availability

The evaluation of availability involves consideration of the availability of vendors, equipment and space for implementing an alternative. Alternatives that involve highly specialized equipment or vendors that are limited are factors that contribute to long term delays associated with implementing an alternative and are negative factors.

Alternative 1, the no action alternative, was ranked the highest with a 6 since it readily available.

Alternatives 5 and 4, the on-site and off-site disposal alternatives, are similar in nature and were ranked with a 4 and a 5, respectively. These alternatives are easily implemented and readily available since they involve excavation using standard earth moving equipment. Alternative 4 was ranked slightly higher than Alternative 5 since off-site landfills are readily available in the area to dispose of the soil. Alternative 5 was ranked lower than Alternative

4 because the installation of an impermeable cap was considered somewhat specialized and limited to a few vendors or suppliers of clay. There is sufficient land available on-site to construct an on-site landfill and the construction of the on-site landfill and, other than the construction of the cap, would not require specialized equipment, therefore, this alternative was ranked high but lower than Alternative 4, that does not involve any specialized equipment or vendors.

Alternative 2, the containment alternative, was ranked with a 3 since this alternative involves construction of a permanent subsurface slurry wall that will require specialized equipment that is less available than typical earth moving equipment although this alternative is considered more available than the very specialized in-situ mixing equipment required for Alternative 3.

Alternative 3, the in-situ alternative, was ranked the next to lowest with a 2 since it involved specialized and less available equipment.

Alternative 6, the innovative treatment alternative, was ranked the next to lowest with a 1 since this alternative would require specialized equipment and vendors. Although this alternative is specialized and limited to a few vendors, there is an adequate soil washing capacity provided by several US vendors who have licensed European technologies.

3.5.4 Costs

The costs are evaluated for both capital and operation and maintenance (O&M) costs and are based upon vendor quotes, the EPA database VISITT, the U.S. Army cost estimating database, MCASES, experience at other remedial action sites and engineering judgement. The costs are provided for feasibility analyses and are considered to be accurate to within +50% and -30%. Capital costs are the costs for materials, labor and other direct costs, such as equipment and facilities rentals, that are required to implement an alternative. Operation and maintenance costs are those that are required to maintain an alternative and include labor and analytical costs associated with groundwater monitoring or costs required to maintain and repair a cap. The total cost for each alternative is the sum of the capital cost and the present worth cost for O&M. A thirty year present worth time was used to estimate the alternative lifespan. Inflation was estimated using the Military Cost Index and was generally about 3%. The interest rate used was 5%. The total rate of cost increase used during the calculation of present worth was therefore the sum of the interest rate and the inflation rate which was 8%.

3.5.4.1 Capital Cost

Capital costs for remedial alternatives have been estimated, whenever possible, using vendor supplied information for the unit operations associated with each of the six alternatives. These unit costs are as follows :

- Off-site disposal in a Subtitle D landfill $75/CY
  (based on a per cubic yard (CY) unit disposal cost from High Acres Landfill)

- On-site In-situ solidification $400/CY
  (based on costs provided in SITE report for in-situ stabilization performed by Silicate Technologies)

- On-site Subtitle D landfill (Parsons ES project files) $180/cy

- Soil Washing, wet separation (Quote from Bergmann USA) $300/cy

- Acid Extraction (Bergmann USA) $600/cy

These are the most significant unit costs. Other costs such as excavation, material handling, on-site hauling and backfilling are not significant and are within the rounding error of the listed unit costs.

Capital costs for each alternative have been estimated based on these unit costs and are presented as follows (refer to Appendix D for cost estimate details):

Alternative	Estimated Capital Cost (+50%, -30%)	Ranking
1	$0	6
2	$4.65 million	5
3	$11.3 million	1
4	$3.7 to $4.8 million	4
5	$7.4 million	3
6	$9.4 million	2

3.5.4.2 Operation and Maintenance (O&M) Cost

Long-term operation and maintenance (O&M) costs are costs that are incurred after remedial action is completed. The estimated O&M costs for each alternative are provided below.

Alternative	Estimated Annual O&M Cost (+50%, -30%)	Ranking
1	$0	6
2	$49,100	1
3	$45,300	3
4	$45,300	5
5	$49,100	2
6	$45,300	4

Alternative 1, the no action alternative, was ranked the highest because there would be no O&M costs.

Alternatives 3, the in-situ alternative, Alternative 4, the off-site disposal alternative and Alternative 6, the innovative treatment alternative all have identical O&M costs as the costs assume an identical groundwater monitoring system. Alternative 4, the off-site disposal alternative, was ranked the highest of the three with a 5 as all the contaminated soils would be removed from the site and the likelihood of a future activities associated with a release would be the least of the three. Therefore, this alternative was ranked highest with a 5. Alternative 6 was ranked the next highest with a 4 since only treated soil would remain on-site and would have a low possibility that a release or maintenance of the site would be required. Alternative 3 was ranked the lowest of the three since it would involve monitoring and maintaining a landfill that contained contaminated materials and has the most possibility for a future maintenance activities.

Alternatives 2 and 5, the containment alternative and the on-site disposal alternative, have the most long-term O&M costs as they include both groundwater sampling and cap maintenance and are ranked the lowest with a 1 and a 2, respectively. Alternative 5 was ranked above Alternative 2, the containment alternative, because Alternative 2 could involve maintaining the slurry wall if there is a detected failure in the wall. Alternative 5 does not include a slurry wall and therefore is more simpler to maintain and was ranked higher, even though the costs are identical. There is no provision to account for repairing a slurry wall as this is assumed to be permanent and should not require maintenance.

3.5.5 Screening

The results of the screening of alternatives are provided on Table 3-2. The no action alternative scored the lowest with a total score of 45. The containment alternative, Alternative 2, and the in-situ alternative, Alternative 3 also scored low with a score of 52 and 53, respectively. The on-site disposal alternative, Alternative 5, scored the next highest with a score of 54. Alternative 4, the off-site disposal alternative, scored the next to highest with a total score of 56 and Alternative 6, the innovative treatment alternative, scored the highest with a total score of 65. Alternatives 4, 5 and 6 were retained for detailed evaluation. Alternative 1 was also retained for comparitory purposes. Alternatives 2 and 3 were screen out from further consideration as they scored low and in the case of Alternative 3 were the most costliest.

Section 4

4.0 TREATABILITY INVESTIGATIONS

4.1 INTRODUCTION

One of the important parts of most remedial actions is the treatability investigation. In general, there are two primary objectives for treatability studies:

- Provide sufficient data to allow treatment alternatives to be fully developed and evaluated and to support the remedial design of a selected alternative

- Reduce cost and performance uncertainties for treatment alternatives so that a remedy can be selected.

There are three stages in the CERCLA process in which treatability studies may be used, remedy screening, remedy selection, and remedy design. In the remedy screening phase treatability studies are designed to establish whether or not a technology can effectively treat a given waste. These studies generally provide little cost or design data. In the next stage, remedy selection, treatability studies are used to evaluate the site-specific performance of each technology in order to support selection of an alternative. Treatability studies in the remedy selection stage may yield information on 7 of the 9 technology evaluation criteria, including: (EPA, 1991b)

- Overall protection of human health and the environment
- Compliance with ARARs
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Long-term effectiveness and permanence
- Cost.

This mid-stage of the CERCLA process is implemented prior to the Record of Decision (ROD) and would be referred to as a pre-ROD treatability study.

The last stage of the CERCLA process is the remedy design stage. This stage is implemented after the ROD has been signed, and these treatability studies are often referred to as post-ROD treatability studies. Post-ROD treatability studies provide quantitative performance, cost, and design information (EPA, 1991b). This information is then used to design the remedial treatment process, refine the remedial action cost estimate, and make accurate predictions of the time required for remediation.

At the OB Grounds, there is no need for remedy screening treatability studies. Both technologies being considered for treatment, solidification/stabilization and soil washing, are demonstrated. This means that substantial treatability and remedial work has been done with these technologies on sites with similar wastes. Therefore, the only treatability work proposed for this remedial action is pre-ROD testing, since the treatability results can then be used to finalize the remedial selection, design and to develop a detailed cost estimate.

There are two technologies proposed for this remedial action which require treatability testing, solidification/stabilization, and soil washing. Section 4.2 provides a brief overview of the pre-ROD treatability study process. Sections 4.3 and 4.4 describe the detailed treatability procedures for solidification/stabilization and soil washing, respectively.

4.2 GENERAL TREATABILITY STUDIES

As described above, this discussion will focus on those treatability studies conducted prior to the ROD. The primary goals of a pre-ROD treatability study are:

- Facilitate the alternative selection process
- To select among multiple vendors and/or processes within a given technology
- To support the detailed design and the development of specifications
- To provide information supporting a detailed cost estimate.

These studies can be conducted either in the laboratory or the field, at bench or pilot scale. For these remedial actions, the treatability studies will likely be conducted in the laboratory, by either the Army, or the various vendors interested in performing the remedial activities.

Bench-scale testing is usually conducted in the laboratory, and is best used to establish treatment parameters. Bench-scale testing is useful for established technologies, such as solidification and soil washing, since it can be used to pinpoint site-specific operating parameters. Pilot-scale testing can be done either at the site or in the laboratory. In pilot-scale testing, smaller versions of the actual treatment equipment, or the actual treatment equipment may be used. Since solidification/stabilization and soil washing are demonstrated technologies, bench-scale treatability work will be appropriate.

The first step in any treatability study is establishing the Data Quality Objectives (DQOs) and preparing the study workplans. DQOs are qualitative and quantitative statements that specify the requirements for the data collected during the study. The final DQOs will be incorporated into the treatability study design, workplan, sampling and analysis plan, and chemical data acquisition plan will ensure that the data collected are of sufficient quality to support the objectives of the treatability study. For pre-ROD treatability studies, fairly rigorous Quality Assurance/Quality Control (QA/QC) will be required. Since the QA/QC required will be similar to that required for the remedial investigation, the chemical data acquisition plan developed in support of the Remedial Investigation/Feasibility Study (RI/FS) (MAIN, 1991) will be modified for use in the treatability testing.

An important part of the DQO and workplan process is identifying the treatment goals. These goals include, but are not limited to the attainment of ARARs. For example, an ARAR for the solidification/stabilization of the soils is that the treated soils are not Toxicity Characteristic (TC) hazardous waste. An additional treatment criteria which is not an ARAR, but would be important if an on-site landfill is used, will likely be that the solidified waste have sufficient structural strength to support the cap placed over the landfill. The treatability study workplan will clearly delineate all treatment criteria for this remedial action.

The subsections generally included in a treatability study workplan are:

- Project description
- Remedial technology description
- Test objectives
- Experimental design and procedures
- Equipment and materials
- Sampling and analysis
- Data management
- Data analysis and interpretation
- Health and safety
- Residuals management
- Community relations
- Reports
- Schedule
- Management and staffing
- Budget

Not every one of these items will be described in detail in each workplan, but it is important to at least consider each item. Most of the section titles are self-explanatory, and will not be described in detail, but there are several points which should be highlighted. First, health and safety merits its own section in the workplan. Health and safety is very important because the soil to be treated is a hazardous waste. Not only will the party implementing the work plan be required to follow the health and safety plan, but they must be in full compliance with all Occupational Safety and Health Administration (OSHA) and EPA regulations regarding working with hazardous wastes.

Residuals management is another important issue. Any soil which is not successfully treated is still a hazardous waste. In addition, any residuals generated during the testing may be hazardous wastes, and must be handled and disposed of accordingly. Community relations is included in the treatability work plan, but is really part of the entire CERCLA process.

Once the workplan has been completed, the next step in the process is to identify the party which will implement the study. For both solidification/stabilization and soil washing the technologies used by the various vendors are similar, and the major differences between the vendors involve proprietary materials. Therefore, it is likely that the treatability studies will be carried out by the vendors, so that the proprietary materials can be used. It will be important to clearly specify the goals of the study so that the results of the different vendors can be accurately compared and evaluated.

Once the work plans have been finalized and the vendors have been selected, the next step will be to collect a representative. In order to better compare the results of each vendor's testing, it would be best for the Army to collect sufficient volume of sample for all the studies to be conducted. A set volume of soil could be collected from each pad and berm designated for remediation in proportion to the volume of soil in the given unit. All the soil collected would be composited and apportioned to each vendor. This assures that each vendor will be testing similar material.

Once each vendor has completed their studies, the data must be reviewed and assessed prior to contractor selection and the completion of the detailed designs and specifications. The results will be reviewed to ensure that each technology meets the specified treatment criteria. All technologies that meet the treatment criteria will then be reviewed for other items, such as cost-effectiveness and ease of implementation. Once a vendor is selected, detailed design and specifications will be developed.

4.3 SOLIDIFICATION/STABILIZATION TREATABILITY STUDIES

The first step in preparing the DQOs and work plans for the solidification/stabilization treatability study is to determine the final disposition of the treated soils, in order to specify the treatment criteria. If the treated soils are to be sent to an off-site Subtitle D landfill, the primary treatment criteria are that the waste not be a RCRA hazardous waste, and that the waste not contain free liquids (i.e., pass the paint filter test requirements in 40 CFR 258.28). If the waste will be disposed of on-site, an additional treatment criterion is structural strength. Typically, the design bearing strength is that which is required to support construction equipment during installation of the final landfill cover. Another important treatment criterion which is not an ARAR is volume increase. A solidification/stabilization process which minimizes the volume increase of the treated soil is desirable because final disposal costs, either on or off-site are dependent on the volume of the material to be disposed of.

Next, as described above, a representative sample must be collected. A number of preliminary tests will be run on the soil to establish baseline conditions. These tests will include a full Toxicity Characteristic Leaching Procedure (TCLP) metals analysis, moisture content, percent solids, and density. Total metals analysis may also be run, if additional data is required.

The next step is the treatability work itself. Often, the primary admixtures used are cement, lime (or lime kiln dust), and fly ash. These are used either individually or in varying mixtures of two or three. Most vendors also use proprietary admixtures. Therefore, the admixtures to be used in this treatability study will not be specified by the Army.

The admixtures will be added to the soil in varying ratios based on the dry weight of the soil. Water will be added as necessary, and the final volume of water added will be recorded. The mixtures will then be allowed to cure. At different times in the curing process, usually at 1 day, 3 days, 1 week, 2 weeks, and 1 month, the mixtures will tested to determine if the treatment criteria are met. These tests may include TCLP metals, bearing strength, volume increase, and moisture content. The actual testing schedule and parameter list will vary, depending on the vendor and the final disposition of the treated soil. Each vendor will then prepare a final report which documents all the results of the testing. The report will demonstrate which admixtures and curing times meet the treatment criteria. The Army will then evaluate the results to determine the most cost-effective of the admixtures which meet all the treatment criteria.

The results of the treatability study will then be used to prepare the final design and specifications. It is anticipated that the design will involve performance specifications geared towards meeting the treatment criteria, as opposed to design criteria which specify he admixtures to be used and the different ratios.

4.4 SOIL WASHING TREATABILITY STUDIES

The mechanics of the soil washing treatability study are very similar to those of the solidification/stabilization treatability study. Again, a DQOs and a work plan will be developed to describe the goals of the study. Representative samples will be collected. The pre-study testing will vary slightly for the soil washing treatability study. Preliminary data will include a full TCLP metals analysis to establish baseline conditions, and a number of physical chemical properties to aid in developing the treatment process. At a minimum, the soils will be analyzed for particle size distribution (sieve and hydrometer), dry bulk density, moisture content, total organic carbon, pH, and soil mineralogy.

One important test which is run for the soil washing treatability study is a chemical analysis on each of several soil fractions separated with sieves. Often, most of the chemical constituents are associated with the fine fraction in the soil. When this is the case, wet separation unit operations can significantly reduce the quantity of soil which needs to be treated. By analyzing the different fractions prior to treatment, the distribution of the potentially hazardous constituents with respect to particle size can be determined.

The first step in the treatability study is usually a series of jar tests. Soil samples are placed in a series of jars, and an equal volume of liquid is added to each jar. Usually plain water (hot and cold) are the first liquids tested. Other liquids to test include aqueous solutions of surfactants, chelating agents, or other dispersing agents. The pH of the test water may also be varied. After the liquids are placed in the jars, the jars are shaken. Next, the soil/water mixture is poured into a 2mm sieve. The water is allowed to drain, and the remaining soil is rinsed with clean water. After the soil drys, it is analyzed to determine the percent reduction. The solutions which yield satisfactory results are carried over to the next stage of the study.

The bench-scale testing is far more involved than the jar tests. The first step is often to determine the optimal wash times, washwater to soil ratios, and rinsewater to washwater ratios (EPA, 1991b). Once these values are determined with plain water, the optimal additives determined in the jar testing stage can be used. Each of the other additives can be evaluated to determine the solution which best removes hazardous constituents from the coarse fraction. If the acid leaching process is used to treat the fine fraction to remove inorganic components, these agents will also be analyzed to determine whether they are effective for solubilizing metal contaminants and to determine if the process meets the remediation requirements established for the site. The wash water and rinse water will also be analyzed for mass balance purposes, and for determining the best treatment and disposal option for the washwater. If necessary, treatability testing will be conducted on the washwater.

The last step is evaluating the results of the treatability study. Analytical data taken before and after the washing are used to determine the removal efficiency. The particle size distributions can be used to estimate the volume reduction of the process. The effectiveness of the washwater treatment and fine soil separation must also be considered. These results will then be used to size the final unit, specify the reagents and reagent ratios, and prepare a detailed cost estimate for the process.

Section 5

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 GENERAL

The four remedial action alternatives represent a range of waste management strategies which address the human health and environmental concerns associated with the OB grounds. Although the selected alternative will be further refined as necessary during the predesign phase, the description of the alternatives and the analysis with respect to the criteria discussed below present the fundamental components of the various alternatives being considered for this site.

A technical description of each alternative is presented. After the technical description, a discussion of the alternative is presented with respect to overall protection of human health and the environment; short-term effectiveness; long-term effectiveness and permanence; compliance with ARARs; reduction of toxicity, mobility, or volume through treatment; implementability; and cost.

The analysis of each alternative with respect to overall protection of human health and the environment provides an evaluation of how the alternative reduces the risk from potential exposure pathways and meets the site-specific cleanup goals established between NYSDEC, the USEPA, and the Army through treatment, engineering, or institutional controls. These goals are presented in Table 2-2. The goals were developed for on-site soils and sediments in Reeder Creek.

The major Federal and State requirements that are applicable or relevant and appropriate to each alternative are identified. The ability of each alternative to meet all of its respective ARARs is noted for each.

Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk remaining from untreated waste or treated residuals after the remedial action is complete, and the adequacy and reliability of controls used to manage remaining waste (untreated waste and treatment residuals) over the long-term. One requirement of CERCLA is that a remedial action should involve solutions with the highest degrees of long-term effectiveness and permanence. That is, little or no waste would remain at the site such that long-term maintenance and monitoring are unnecessary and reliance on institutional controls is minimized.

The discussion of the reduction of toxicity, mobility, or volume through treatment addresses the anticipated performance of the treatment technologies involved with an alternative. This evaluation relates to one of the requirements by CERCLA that a selected remedial action employ treatment to reduce the toxicity, mobility, or volume of hazardous substances. The evaluation will determine the amount of waste treated or destroyed, the reduction in toxicity, mobility, or volume, and the type and quantity of treatment residuals that will remain.

Evaluation of alternatives with respect to short-term effectiveness takes into account protection of workers and the community during the remedial action, environmental impacts from implementing the action, and the time required to achieve cleanup goals.

The analysis of implementability deals with the technical and administrative feasibility of implementing the alternatives and the availability of necessary materials and services. This criteria includes the ability to construct and operate components of the alternatives; the availability of adequate offsite treatment, storage, and disposal services; the availability of services, equipment, and specialists; the ability to monitor the effectiveness of remedial actions; and the ability to obtain necessary approvals from agencies.

The cost estimates presented in this report are order-of-magnitude level estimates. These costs are based on a variety of information including quotes from suppliers in the area of the site, generic unit costs,vendor information, conventional cost estimating guides, and prior experience. The cost estimates presented in this feasibility report have been prepared for guidance in project evaluation. The actual costs of the project will depend on true labor and materials costs, actual site conditions, competitive market condition, final project scope, and other variables.

Capital costs include those expenditures required to implement a remedial action. Both direct and indirect costs are considered in the development of capital cost estimates. Direct costs include construction costs or expenditures for equipment, labor, and materials required to implement a remedial action. Indirect costs include those associated with engineering, permitting, construction management, and other services necessary to carry out a remedial action.

Annual O&M costs, which include labor, maintenance materials, and purchased services have also been determined.

The detailed analysis of alternatives applies to the future on-site residential exposure scenario because SEDA has been placed on the base closure list for BRAC95 and the intended future land use has not been determined. The residential exposure scenario is considered to be the potential, worst-case future land use. Furthermore, the purpose of the remedial action objectives established by NYSDEC, USEPA, and the Army is to protect human health and the environment and to allow unrestricted future use of the site. Alternatives 1, 4, 5, and 6 have been retained for analysis in this section. The primary components of each alternative are listed in Table 5-1.

5.2 ANALYSIS OF ALTERNATIVE 1: NO ACTION

5.2.1 Definition of Alternative 1

The no action alternative means that no remedial activities will be undertaken at the site. No monitoring or security measures will be undertaken. Any attenuation of the threats posed by the site to human health and the environment would be the result of natural processes. Current security measures, which include the SEDA-wide security activities that effectively eliminate public access to the area, would be eliminated or modified depending upon if the property is transferred or leased. Open burning would not be performed. Access to the OB Grounds could be limited depending upon how the Army determines the property will be used.

This alternative will be used as a baseline for comparison with all of the other alternatives developed as part of this feasibility study.

5.2.2 Protection of Human Health and the Environment

An evaluation of the protectiveness of human health and the environment includes an assessment of the short-term and long-term effectiveness as well as permanence. Analysis of short-term effectiveness is not necessary for this alternative because assessment of the short-term effectiveness addresses the effects of an alternative during construction and implementation of a remedial action. Alternative 1 is a no action alternative.

5.2.2.1 Long-Term Effectiveness and Permanence

Table 5-1
SENECA ARMY DEPOT ACTIVITY
OPEN BURNING GROUNDS
FEASIBILITY STUDY

ASSEMBLED REMEDIAL ALTERNATIVES

ALTERNATIVE	TECHNOLOGIES AND PROCESSES
1	No Action
4	Excavation/Solidification/Stabilization of soils failing TCLP/Off-site landfill - Excavation and treatment of soils above TCLP criteria - Excavation of sediments in Reeder Creek which exceed NYSDEC sediment criteria for lead and copper; - Excavation of remaining soils with lead concentrations above 500 mg/kg; - Place all excavated soils in off-site Subtitle D landfill - Long-term groundwater monitoring - Soil erosion will be controlled through proper site grading - Site Covering and Revegetation - Sediment sampling in Reeder Creek
5	Excavation/Solidification/stabilization of soils failing TCLP/On-site landfill - Excavation and treatment of soils exceeding TCLP criteria; - Excavation of sediments in Reeder Creek which exceed NYSDEC sediment criteria for lead and copper; place in on-site Subtitle D landfill - Excavation of remaining soils with lead concentrations above 500 mg/kg; - Place all excavated and treated soils in on-site Subtitle D landfill - Long-term groundwater monitoring - Soil erosion will be controlled through proper site grading - Site Covering and Revegetation - Sediment sampling in Reeder Creek
6	Excavation/Soil Washing - Excavation of all soils with lead concentrations above 500 mg/kg including soils above TCLP criteria - Excavation of sediments in Reeder Creek which exceed NYSDEC sediment criteria for lead and copper - Soil washing with coarse soil fraction backfilled and fine fraction to off-site treatment and landfill - Long-term groundwater monitoring - Soil erosion will be controlled through proper site grading - Site Covering and Revegetation - Sediment sampling in Reeder Creek

The Baseline Risk Assessment (BRA) indicates that the no action alternative is currently within the EPA target risk range for carcinogenic risk and below the target value for non-carcinogenic risk for the future on-site residential exposure scenario. The total site non-carcinogenic risk, HI, for this scenario was determined to be 0.33, which is below the EPA target value of 1.0. The total site carcinogenic risk for this scenario was calculated to be 1.0 x 10^{-5} which is within the EPA target range of 1 x 10^{-4} to 1 x 10^{-6}. Therefore this alternative is considered to be protective of human health.

However, this alternative does not protect against ingestion of and direct contact with soils having concentrations of lead above 500 mg/kg, or prevent potential leaching of lead from the soil into the groundwater above the federal action level. All of the constituents of concern remain in-place. Since the SEDA security measures prevent public access to the site, there is currently little or no risk to the public because there is not exposure. Access by site workers is infrequent and limited to demilitarization activities. SEDA personnel working at the OB Grounds have also received training which will allow them to operate safely in the areas near the site. However, since the depot is a facility scheduled to be closed under BRAC95, these security measures will eventually be eliminated and the site could be considered for alternative future land uses.

This alternative does not provide long-term protection to ecological receptors in Reeder Creek because the sediments with concentrations of lead and copper above the NYSDEC criteria would remain. While no adverse affects were observed during the RI, there is a potential for long-term chronic affects. Further contamination of the creek by runoff from the site would not be prevented.

The no action alternative does not provide a permanent solution since no treatment, engineering or institutional controls are provided to prevent exposure to constituents of concern in on-site soils and sediments in Reeder Creek.

5.2.3 Reduction of Toxicity, Mobility, and Volume

There would be little or no reduction in the toxicity, mobility, and volume of the impacted soil at the site. Some natural attenuation would be expected, through dispersal of the affected soil, and through chemical and physical changes which would reduce the mobility of the heavy metals. These decreases would be minimal, since no reduction from treatment would occur.

5.2.4 Compliance with ARARs

The no action alternative complies with all of the chemical and location-specific ARARs specified in Appendix A. If no action is taking place, there are no action-specific ARARs.

A list of the ARARs for this alternative are in Appendix C.

5.2.5 Implementability

The criteria of implementability is not applicable to the no action alternative since there are no activities occurring. There would still be monitoring and security activities, as described above, as well as some administrative requirements but these activities will be performed as part of compliance in the RCRA. These peripheral activities are already occurring. Formal RCRA closure activities may require additional remedial measures if necessary.

5.2.6 Cost

There are no costs associated with the no action alternative. The costs associated with the monitoring and security described above are covered through other mechanisms, and would not be directly attributable to this remedial action.

5.3 ALTERNATIVES 4 THROUGH 6: COMMON COMPONENTS

All of the remaining alternatives have five components in common. These components, which are in addition to the remediation criteria for soils and sediments required by NYSDEC and the USEPA, include groundwater monitoring, runoff prevention, site revegetation, periodic monitoring of the sediments in Reeder Creek, and UXO clearance. A detailed description of each component is provided below.

- Site groundwater will be monitored on a quarterly basis. There are a number of wells already installed at the site, and these may be sufficient for the continued monitoring. New wells will be installed as necessary to ensure that the monitoring program is sufficient to detect any migration from the area.

- A soil cover consisting of 9 inches of clean fill will be placed over areas of the OB Grounds with soils containing lead concentrations above 60 ppm. The area to be covered is estimated to encompass most of the OB Grounds. Slope stabilization will also be provided near Reeder Creek as necessary to prevent surface water runoff from migrating to the creek.

- A cover of native vegetation will be established as an erosion control measure. Once the cover is established, there will be no continued maintenance requirements. This will help to control dust and reduce infiltration of contaminants to groundwater.

- Recontamination of the Reeder Creek sediments will be prevented or minimized by removal of lead-bearing soils and covering of the remaining soils.

- Sediment sampling in Reeder Creek will be conducted on an annual basis at four location within the reach affected by the OB grounds. The purpose of the sampling is to ensure that Reeder Creek is not being recontaminated by lead left in the soil at the site.

- The following is a generic description of one type of UXO clearance which may potentially be used by the Army to clear areas of the OB Grounds undergoing remediation. The process is a sifting operation which would be conducted prior to any treatment process and would involve the following steps:

    1. Soils are excavated.
    2. Soils are brought to the sifter area.
    3. Soils are loaded into a sifter. Those items which do not fit through the sifter screen will fall into a conveyor and be sorted by UXO personnel.
    4. Potential live items and inert scrap are segrated and dealt with as required.
    5. The sifted soil is stockpiled and/or taken for treatment in the standard haztox sense.

The "Proposed Ordnance and Explosive Clearance Procedures" are included in Appendix G.

5.4 ANALYSIS OF ALTERNATIVE 4: EXCAVATION, TREATMENT OF SOILS FAILING TCLP , AND OFF-SITE LANDFILL

5.4.1 Definition of Alternative 4

5.4.1.1 Description

This alternative includes excavation of Case 1 through Case 5 soils, treatment of soils exceeding the TCLP limit (Case 1 soils) to remove the characteristic of toxicity, and disposal of all the excavated soils, sediments, and treated soils (Case 1 through Case 5) in an off-site, non-hazardous, solid waste, Subtitle D, industrial landfill. For this alternative, the soils with concentrations of lead exceeding TCLP limit will be treated by a solidification/stabilization process prior to disposal in a Subtitle D landfill. This treatment will be conducted either on site or off site at a TSD facility. All the soils will be transported off-site to a Subtitle D solid waste landfill for disposal. Each of the processes involved with this alternative will be described briefly in this section. A detailed analysis of how this option meets the selection criteria, and a budgetary cost estimate are provided below.

The first step in this alternative is excavation. An excavation plan will be developed using previous RI data to delineate the extent of removal. In general, the materials to be excavated are Case 1 through Case 5 soils as described in Section 2.4 and presented in Table 2-3. These volumes include soils exceeding the TCLP regulatory limits; sediments from Reeder Creek with concentrations of copper and lead above the NYSDEC criteria; and soils from the low hill, berms, pads and hotspots between the pads (grid boring locations) with lead concentrations above 500 mg/kg. The excavation will be accomplished with standard construction equipment, such as a front end loader or bulldozer.

The data indicate that the soils to be removed for solidification/stabilization are limited to berms and the soils of Pads B, F, and G. The total extent of this excavation will be approximately 3800 c.y. Pad B soils will be completely removed down to a depth of nine feet below ground surface. This is the only pad which will require excavation to this depth. At Pad F, the southeast side of the berm surrounding the pad and the whole pad down to a depth of two feet will be removed. Sections of the berm of Pad H will also be removed. The excavated soil will either be brought to an on-site pug mill where it will be stockpiled prior to stabilization on site, or immediately loaded into trucks for transport to an appropriate TSDF for off-site treatment. The TSDF will be responsible for treatment (e.g., solidification and stabilization) which is necessary for placement in the off-site solid waste landfill.

The remaining soils to be removed and disposed of in an off-site solid waste landfill are all on-site soils having concentrations of lead greater than 500mg/kg, and soils/sediments from two remote areas, the low hill and Reeder Creek. The volume of material is approximately 14,200 cy, which includes Case 2 through Case 5 soils as described in Section 2.4 and outlined in Table 2-3. The location of these areas are shown in Figures 2-1 and 2-2. The areas to be excavated on-site include sections of berms of Pads A, C, D, E, G, and J; the whole pad of Pad A; sections of pads and areas around hotspots to a depth of 2 feet at Pads C, G and J; sections of pads to a depth of 4 feet at Pads D and G; and seven locations off the pads at grid boring or sediment sampling locations.

The two remote areas (Case 2 soils) to be excavated and disposed of in an off-site landfill include (1) Reeder Creek sediments having copper and lead concentrations above the NYSDEC sediment criteria of 16 mg/kg and 31 mg/kg, respectively, and (2) soils with concentrations of lead above 500 mg/kg from the low hill area southeast of the OB grounds. These areas are shown on Figure 2-1. Sediment from two sections of the creek will be removed. One reach is located adjacent to the site and one reach is downstream of the OD grounds. The total volume of soil and sediment from the remote areas is approximately 900 cy. Reeder Creek sediment will be removed with an excavator during the dry season (August-September) when the entire flow of the creek can be diverted relatively easily.

The berms and pads will be regraded with a bulldozer in a manner which approximates the original grade of the site. If necessary, clean fill will be brought in to make up for the soils excavated at Pad B. The topsoil cover will be vegetated with indigenous grasses as an erosion control measure.

In summary, the soils and sediment to be removed for this remedial action include soils exceeding the TCLP limit (Case 1), soils/sediments from remote areas including Reeder Creek and the low hill (Case 2), and the remaining on-site soils with lead concentrations above 500 mg/kg (Case 3 through Case 5). The cumulative total volume for these soils is approximately 17,900 cy. Of this total volume, the volume of the Case 1 soils, which will be treated prior to disposal, is approximately 3,800 cy.

The next step in this alternative is the solidification/stabilization treatment step, which will be accomplished either on or off site. Solidification/stabilization is a process in which a setting agent is added to the soil to form a mixture which entraps the constituents. Solidification refers to the techniques use to encapsulate hazardous waste into a solid material, and stabilization generally refers to the techniques that treat hazardous wastes by converting them into a less soluble, mobile, or toxic state. The different setting agents used are described below. The primary goals of solidification are to:

- Improve the handling and physical characteristics of the waste
- Decrease constituent solubility and mobility
- Decrease the surface area across which the migration of constituents may occur.

The reason for stabilizing the soil is to immobilize the lead and other heavy metals in the Case 1 soils that have concentrations of constituents in excess of the TCLP regulatory limits. Once this is accomplished the material can be disposed of as a solid waste in an on-site landfill.

Solidification/stabilization is a process in which the contaminants are converted to less toxic, mobile, and/or in soluble forms. The physical properties of the soil or waste are not necessarily changed by this process (EPA 1990).

Solidification/stabilization has been used primarily for the treatment of soils containing inorganic contaminants and has been shown to be effective for heavy metals, the primary contaminant of concern at the OB Grounds. Some organics may interfere with the setting process, and others may not be bound up in the finished product. There are few organics in the soils to be stabilized at the OB Grounds, and interference by organics is not considered to be a problem. Bench scale treatability tests will be conducted to assess the adequacy of a given additive to a specific soil-waste mixture.

Four types of mixtures are generally used for solidification/stabilization. Inorganic solidification/stabilization is often achieved with cement or pozzolanic additives. Organic solidification/stabilization is often accomplished with thermo-plastic or organic polymerization additives (EPA, 1989). A combination of these processes may be used for a soil containing both organic and inorganic contaminants.

In cement-based solidification/stabilization, the soil is mixed with Portland cement. Water is added to the mixture. Inorganic materials then become bound up in the cement matrix. Pozzolanic solidification/stabilization involves mixing the waste with a siliceous material, such as fly ash, pumice, or lime kiln dust. The mixture is often combined with lime or cement and water to form a cement-like final product. The end result of inorganic solidification/stabilization can be a granular material or a cohesive solid (EPA, 1989). Cement-based stabilization is the likely choice for the OB Grounds. The berms and pads are constructed primarily of fill material, much of which consists of crushed shale. This material will be readily bound up in a cement base, and will act like the aggregate used in making concrete. Treatability testing will be conducted to determine the quantities and types of admixtures which best satisfy the treatment criteria for this site.

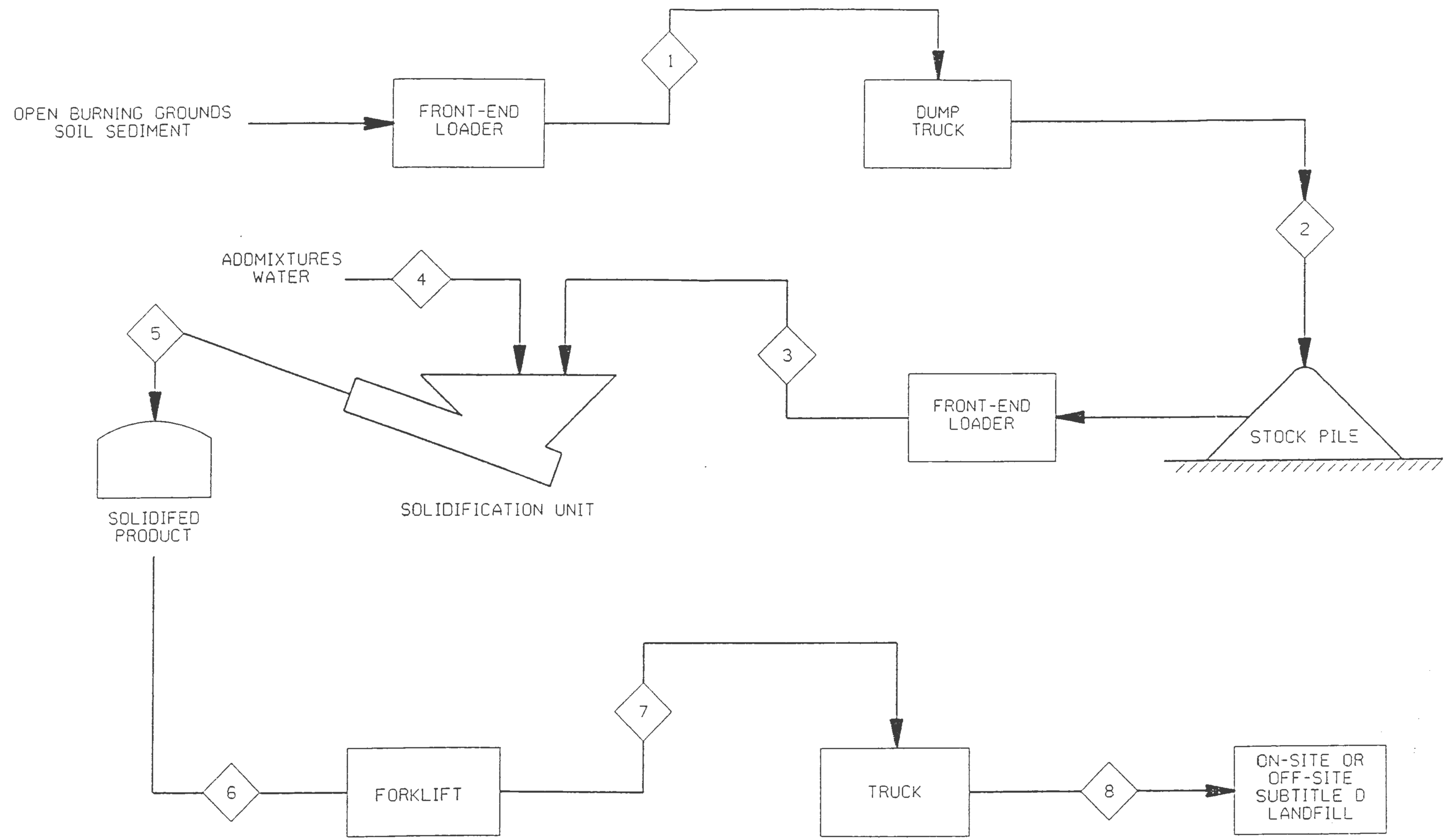
Solidification/stabilization can be conducted either in-situ or in a batch mode. For in-situ solidification/stabilization, the mixtures are injected into the soil and then mixed. Farm equipment such as tillers can be used in this process. In batch operations, the material is removed from the ground with standard earthmoving equipment and mixed in units such as standard cement trucks. The solidified material is then replaced in the ground. Batch processes require more area than in situ processes because space is necessary to store the untreated soil when it is removed from the ground. For on-site treatment at the OB Grounds, a batch operation will be used. The contaminated soil is shallow, and is easily removed. In addition, there is plenty of space available to set up a stockpile area and cement plant. The treated soil could be placed directly into trucks for removal to the offsite landfill.

The final step in this remedial action is disposal of all the soils and sediments including the treated material. The treated soils (Case 1 soils) and remaining excavated soils and sediments will not be considered a characteristic RCRA hazardous waste. It will be a solid waste, and the disposal will be subject to RCRA Subtitle D and New York State solid waste regulations. In New York, all sanitary landfills are authorized to accept industrial wastes, and therefore would be able to accept the stabilized soil. These landfills cannot accept hazardous waste, and therefore require extensive testing to assure that the waste is no a hazardous waste. The actual testing requirements vary from landfill to landfill, and the exact requirements for this remedial action will be specified once a landfill is selected.

Two landfills, which may be used for this remedial action, have been identified. The first is the Seneca Meadows landfill located in Waterloo, New York, approximately 10 to 15 miles from the site. The other landfill is the Waste Management of New York High Acres landfill in Fairport, Monroe County, approximately 40 to 50 miles from the site.

5.4.1.2 **Process Flow and Site Layout**

Figure 5-1 is a process flow diagram for Alternative 4 (and 5). The process flow for this alternative consists of three steps. First, the soil is excavated, as described above. Soils exceeding the TCLP criteria are either placed in trucks and hauled to the TSDF or brought to an on-site pug mill where it is stockpiled prior to stabilization. If the material is sent off-



TYPICAL FLOW RATES														
MATERIAL	STREAM NO.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SOIL/SEDIMENT (CY/HR)	50	50	40											
SOLIDIFIED PRODUCT (CY/HR)					60	60	60	60						
ADMIXTURES / WATER (CY/HR)				20										

PARSONS
PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No. 720446-03000

FIGURE 5-1
ALTERNATIVE 4 AND 5
SOLIDIFICATION/SUBTITLE D LANDFILL

SCALE NA | DATE MARCH 1996 | REV A

site for treatment, the soil will be treated and then disposed of in an appropriate landfill. If treatment will take place on-site, the soil will be placed in the pug mill and mixed with water and the various admixtures. The soil likely will be placed in the pug mill using a conveyor belt with a scale system in order to record the weight of the soil to be treated. Another option is a front end loader, with the volume of the treated soil recorded. the admixtures may be added in several ways, depending on the final technology selected. Dry admixtures will either be stockpiled and added via a conveyor or a front end loader, or added with a hopper system. If water is necessary to the process, either a temporary tank will be used, or depending on the location, a hook up to the Depot water supply may be possible.

The treated soil is then discharged either directly to the trucks for transport to the landfill, or to a treated soil stockpile for testing. In general, a volume increase of 50% is expected for the solidified soil. The treated soil will be analyzed by the TCLP at the rate required by the landfill accepting the waste. For the High Acres Landfill, the rate required is one TCLP analysis per 1,000 tons of treated soil.

In the final step, all the soils are transported to the off-site solid waste landfill.
This alternative does not require much area, only sufficient area for the pug mill and two small stockpile areas if treatment is conducted on site. Once the system is operational, there will only need to be room in each stockpile for 1,000 to 2,000 tons. The pug mill and stockpile area will be located near Pad J. This will provide for easy access for the excavation equipment to bring the untreated soil to the pug mill, and for the trucks which will haul the treated material to the landfill.

If treatment is conducted off-site, each truck will be loaded directly from the excavations. A small staging area and equipment decontamination area will be set up as necessary.

5.4.2 <u>Protection of Human Health and the Environment</u>

An evaluation of the protectiveness of human health and the environment includes the assessment of short- and long-term effectiveness as well as permanence. The following discussion will show how this alternative meets these criteria.

5.4.2.1 Short-term Protectiveness

This alternative will be evaluated with respect to the effect on human health and the environment during the implementation of the remediation action. Four items are included in an assessment of the short-term protectiveness of Alternative 4. The first issue is protection of the community during the remedial action. If no treatment will be accomplished on site, there will be transport of hazardous material. Care will be taken to assure that the trucks are not overloaded. The soils will be covered with a tarp during transport to ensure that no dust is released from the trucks. If all treatment will be accomplished on site, this alternative is very protective of the community. There will be transport of no hazardous materials. All waste which is sent to the offsite landfill will no longer be considered hazardous waste.

There is also a minor threat from dust released during the excavation. The site is located far from the SEDA boundary, so the likelihood of any hazardous dust migrating offsite is negligible. As discussed in Section 5 of the RI report, fugitive dust migration is not a major migration pathway. Any dust generated during excavation will be minimized by the use of water or other dust control chemicals.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during treatment are direct contact with the contaminated soil and inhalation of vapors or particulates. Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. During on-site treatment, dust generation can be minimized at the pug mill by containing all admixtures which tend to from dust (ie., cement and lime), and by containing the mixing process. The solidification/ stabilization process is very similar to normal cement construction procedures, and is therefore fairly straightforward. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. For Alternative 4, there will be little or no environmental impacts. This alternative calls for construction type activities in an active portion of the Depot. These activities will not be substantially different from what is currently occurring. In addition, since the hazardous material is primarily in the soil, there is little or no risk of a spill or release during the remedial action.

The last item to be considered is the time until treatment is accomplished. Alternative 4 should be completed in a brief period of time. If treatment is conducted on site, the initial treatability testing and vendor selection should take two to three months. Once the treatability testing is completed and a vendor is selected, the mobilization time should be less than one month, since no specialized equipment is required. All of the equipment used is standard construction equipment. Little permitting will be required, and operations should begin quickly. The remedial action would take one to two months, depending primarily on the time needed for the solidified soil to cure. Once the solidification was finished, and the treated soil landfilled off-site, the remedial action would be complete.

If treatment is conducted at an off site TSD facility, this alternative will take one to two months to complete, depending on the weather, because it would be a "dig and haul" operation. There is little mobilization, since only a loader, and maybe a scraper are necessary to accomplish the excavation. It would only take one to two days to set up a staging area and construct an equipment decontamination pad. Once the soil is removed, the remedial action would be complete.

5.4.2.2 Long-term Effectiveness and Permanence

The assessment of the long-term effectiveness of can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals and untreated soil.

The magnitude of the residual risk is easy to quantify. The removal plan for the soils will be designed such that the remaining soils demonstrate a concentration of lead below 500 mg/kg. There will be no treatment residuals left at the site, so the treatment residuals will not be included in the risk evaluation. All of the excavated soils will be hauled off-site, treated, and disposed of in an off-site Subtitle D landfill.

The controls to be used for long-term management are also easy to assess. No residuals will remain on site. The long-term management will be left to the NYSDEC-permitted Subtitle D landfill selected for receiving the treated and remaining excavated soils. It will be important to select a well run landfill in order to assure that the landfill will be managed and closed in accordance with State and Federal requirements. The treated material is not a RCRA hazardous waste, so there should be little risk associated with offsite disposal. The landfills considered for this remedial action do not accept hazardous wastes.

As described above, there will be no long-term maintenance required at the site. Any exposed areas will be regraded to minimize erosion potential. Any areas in which soil was removed below grade will be backfilled with clean soil. A cover of native vegetation will be established as an additional erosion control measure, but once the cover is established, maintenance activities will no longer be required.

The permanence of the alternative must also be assessed. Once the treated and remaining excavated soils are removed from the site, the remedial action would be considered permanent. There will no longer be soil on the site that poses an unacceptable threat to human health and the environment. There is some question about the permanence of the solidification/stabilization treatment technology. In general, the solidified soil, as with all concrete, is subject to weathering from freeze-thaw and wet-dry cycles. If the material is safely placed in a secure landfill, the material will be protected from weathering, and there would be no degradation of the concrete, which indicates that the treatment will be permanent.

Permanence is further enhanced by the use of stabilizing agents, such as lime. The lime reacts with the heavy metals to form insoluble carbonates and hydroxides. These products are far less soluble than the free metals, and are very resistant to weathering.

5.4.2.3 Conclusion

Alternative 4 would protect human health and the environment. This alternative protects against ingestion of and direct contact with surface soils having concentrations of lead above 500 mg/kg and prevents potential leaching of lead into the groundwater by removing subsurface soils with concentrations of lead above 500 mg/kg. These soils also include the Case 1 soils, which have concentrations of constituents exceeding TCLP criteria. Excluding the hazard contributed by lead which was evaluated separately, the results of the human heath baseline risk assessment determined that the total site non-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, aside from the hazards posed by lead, the conditions at the site would not require a remedial action. However, removal of Case 1 through Case 5 soils would further reduce both risks because the RI analytical data indicate that the soils in these locations also contain high concentrations of other metals and semivolatile organic compounds. The HI would be reduced from 0.33 to 0.11 and the total site carcinogenic risk would be reduced from 1×10^{-5} to 9×10^{-6}.

This alternative also meets the soil clean-up criteria established for lead in on-site soils and the sediment clean-up criteria for copper and lead in Reeder Creek. The entire 17,900 cy of soil and sediment would be removed, treated (Case 1 soils), and disposed of in a Subtitle D landfill (Cases 1 through 5 soils). As shown in Table 2-4, removal of Case 1 through Case 5 soils will result in a maximum concentration of level of 463 mg/kg. For off-site sediments, removal of Reeder Creek sediments reduces the maximum concentration of copper and lead to 9.5 mg/kg and 10.5 mg/kg, respectively, for the reach influenced by the OB grounds.

This alternative also provides long-term protection of the environment. The sediments in Reeder Creek with concentrations of lead and copper above the established criteria will be removed. As a result, the aquatic community in Reeder Creek would be protected. Furthermore, revegetation of the site and construction of a sedimentation basin will prevent recontamination of Reeder Creek by runoff from the OB grounds.

5.4.3 Reduction in Toxicity, Mobility, and Volume

Overall, Alternative 4 would be effective in reducing the toxicity and mobility of the hazardous constituents present in the soil at the site. Assessing the volume reduction is somewhat more difficult. The treated soil will have a larger volume than the untreated soil, but the treated soil will no longer be a hazardous waste. In general, a volume increase of 50% for the treated soil can be expected. Furthermore, excavation of the remaining soils and sediments would increase the volume by approximately 20% from 14,200 cy to 17,000 cy.

The decrease in toxicity and mobility can be assessed on both a small scale and site-wide basis. On the small scale, both the toxicity and mobility of the hazardous constituents in the soil are assessed with the TCLP test. The larger the leaching fraction, the greater the mobility and the greater the toxicity. Since the primary treatment criteria for solidification/stabilization is that the waste no longer be TC hazardous, the treated waste will exhibit lower toxicity and mobility than the untreated waste. The mass of the potentially hazardous constituents in the soil will remain unchanged.

There are also major decreases on a site-wide basis. By treating the soil which contains the highest concentrations of hazardous constituents, the overall site risk (toxicity) will be reduced to acceptable levels. By solidifying the soil, and then transferring all the soils and sediments to a landfill, the mobility of the hazardous constituents will be effectively reduced. A properly managed Subtitle D landfill does not allow for uncontrolled releases from the landfill. The treated soil will be the only treatment residual.

5.4.4 Compliance with ARARs

Alternative 4 will comply with all ARARs and TBCs. A list of the ARARs for this alternative is in Appendix C.

5.4.5 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

5.4.5.1 Technical Feasibility

The overall technical feasibility of Alternative 4 is very good. Solidification/stabilization is a technology which has been frequently used to treat similar soils, and it is not anticipated that problems will be encountered during construction, as long as the proper treatability work has been completed to establish the optimal admixture ratios. Since the materials and equipment used are all standard construction equipment, the process can be operated in almost all weather conditions. If treatment is conducted off site, the TSD facilities in the region have accepted similar wastes for a number of years. These facilities are fully capable of treating and disposing of the Case 1 soils.

The excavation process is also well defined. The areas demonstrating elevated concentrations of heavy metals have been delineated, and it will be straightforward to develop an excavation plan that assures all areas with high concentrations are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located above grade, and should not be adversely affected by wet conditions.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the OB Grounds. However, if additional work is required in the future, this remedial action will not interfere in any way. Once the remedial action is complete, the site will be revegetated, and will essentially remain as it is now.

Several monitoring requirements govern the solidification/stabilization process. The additives must be properly metered into the soil to assure proper treatment. The soil which has been treated must be tested to ensure that the contaminants have been stabilized. Air monitoring will likely be necessary to determine if movement of the soil is releasing constituents to the air.

5.4.5.2 Administrative Feasibility

The administrative feasibility of this alternative is also very good. Since there will only be a temporary treatment facility on site if treatment is conducted on-site, no hazardous waste permitting will be required. Construction permits necessary for the activities are readily attainable. In addition, there will be no transport of hazardous waste, greatly simplifying the manifest requirements. Since the wastes will be sent to a permitted disposal facility, no disposal permits will be necessary.

If treatment is conducted off site, the TSDFs which may be used for off-site treatment, are fully permitted. There will be some transport of hazardous waste, and proper manifests will be required. All of the contractors used for excavation and hauling will be experienced in preparing manifests.

Coordination with the various regulatory agencies is also important. As described above, the Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

5.4.5.3 Availability of Services and Materials

This technology relies primarily on standard equipment, which is readily available in the Romulus area, since the equipment consists primarily of farm and construction equipment. The excavation would be accomplished with backhoes and scrapers, and the material would be transported in standard size dumptrucks. For on-site treatment , the stabilization unit would consist of a temporary pug mill.

Startup time to implement solidification/stabilization is one to two months, depending on the level of effort necessary for treatability testing. Bench-scale tests will likely be necessary to determine the proper additives and ratios of additives to contaminated soil. These must be brought to the site along with the earthmoving and mixing equipment. Total treatment time for a site such as the OB Grounds is approximately two to four months, including the treatability studies.

The availability of permitted hazardous waste TSD facilities which could accept the soils from this site should be considered. Two regional facilities, which could be used, are EWR in Waterbury, Connecticut and the Waste Management Model City Landfill near Buffalo, New York. Both have sufficient capacity to accept the soils from this site.

The last issue to consider is the availability of Subtitle D landfills to accept the excavated and solidified soils. Both the Seneca Meadows and High Acres landfills indicated that they had sufficient capacity to accept the waste, and would be willing to accept the waste if the proper analytical results were provided.

5.4.6 Cost

5.4.6.1 Capital Costs

The total capital cost for this alternative is estimated to be $4.0 million if treatment is conducted off site and $2.4 million if treatment is conducted on-site. There is a fair amount on uncertainty associated with that estimate. The disposal cost assumes disposal at the High Acres Landfill, and a cost associated with cement blocks. If the Seneca Meadows Landfill is used, the disposal cost can be substantially reduced. The cost backup for this alternative is presented in Appendix D.

5.4.6.2 O & M Costs

O & M costs associated with Alternative 4 include costs for quarterly groundwater sampling and yearly sediment sampling of Reeder Creek. The O & M cost is estimated to be $45,300. Once the remedial action is completed, there will be no residuals remaining on site which require management. Initially, there will be some minor costs associated with the establishment of the vegetative cover, but the cost estimate for these items have been included in the capital costs.

5.4.6.3 Present Worth Costs

The present worth costs for Alternative 4 are estimated to be $2.9 to $4.5 million.

5.5 ANALYSIS OF ALTERNATIVE 5: EXCAVATION, SOLIDIFICATION/ STABILIZATION OF SOILS FAILING TCLP CRITERIA, AND ON-SITE LANDFILLING

5.5.1 Definition of Alternative 5

5.5.1.1 Description

This alternative includes excavation of Case 1 through Case 5 soils, treatment of Case 1 soils (soils with TCLP exceedences), and disposal of both the treated soils and Case 2 through Case 5 soils in an on-site solid waste (Subtitle D) landfill. For this alternative, soils with concentrations of lead exceeding the TCLP limit will be treated by a solidification/stabilization process prior to disposal. This treatment process will be conducted on-site. Each of the processes involved with this alternative will be described briefly in this section. A detailed analysis of how this option meets the selection criteria and a budgetary cost estimate are also provided below.

The first step in this option is excavation. An excavation plan will be developed using previous RI data to delineate the extent of removal. In general, the materials to be excavated are Case 1 through Case 5 soils as described in Section 2.4 and presented in Table 2-3. These volumes include soils exceeding the TCLP regulatory limits; sediments from Reeder Creek with concentrations of copper and lead above the NYSDEC criteria; and soils from the low hill, berms, pads and hotspots between the pads (grid boring locations) with lead concentrations above 500 mg/kg. The excavation will be accomplished with standard construction equipment, such as a front end loader or bulldozer.

The data indicate that the soils to be removed for on-site solidification/stabilization prior to landfilling are the berms and soils of Pads B, F, and G. Pad B soils will be completely removed down to a depth of nine feet below ground surface. This is the only pad which will require excavation to this depth. At Pad F, the southeastern side of the berm surrounding the pad and the whole pad down to a depth of two feet will be removed. Sections of the berm of Pad H near BE-H-2, 3, and 5 down to a maximum depth of seven feet will be removed. The volume of these soils is approximately 3,800 cy. The excavated soil will be brought to the pug mill where it will be stockpiled prior to stabilization. The solidification/stabilization process is described in detail in the description of Alternative 4, Section 5.4.1.1.

Soils and sediments from two remote areas (Case 2) will also be excavated and placed in an on-site landfill. They include (1) Reeder Creek sediments having copper and lead concentrations above the NYSDEC sediment criteria of 16 mg/kg and 31 mg/kg, respectively, and (2) soils with concentration of lead above 500 mg/kg from the low hill area southeast of the OB grounds. These areas are shown on Figure 2-1. Sediment from two sections of Reeder Creek were found to have concentrations of copper and lead above the criteria. One reach is adjacent to the site and a second reach is downstream of the OD grounds. The total volume of soil and sediment from the remote areas is approximately 900 cy. Reeder Creek sediment will be removed with an excavator during the dry season (August-September) when the entire flow of the creek can be diverted relatively easily.

The remaining soils to be removed and placed in an on-site landfill are all on-site soils having concentrations of lead greater than 500 mg/kg. This volume is approximately 13,300 cy, which includes Case 3 through Case 5 soils as outlined in Table 2-3. The location of these areas are shown in Figure 2-2. The areas to be excavated include sections of berms at Pads A, C, D, E, G, and J; the whole pad of Pad A; sections of pads and areas around hotspots to a depth of 2 feet at Pads C, G, H, and J; sections of pads to a depth of 4 feet at Pads D and G; and seven locations off the pads at grid boring or sediment sampling locations.

After the excavation, the berms and pads will be regraded with a bulldozer in a manner which approximates the original grade of the site. If necessary, clean fill will be brought in to make up for the soils excavated at Pad B. The topsoil cover will be vegetated with indigenous grasses as an erosion control measure.

In summary, the soils and sediment to be removed for this remedial action include soils with concentrations of constituents exceeding TCLP limits (Case 1), soils/sediments from remote areas including Reeder Creek and the low hill (Case 2), and the remaining on-site soils with lead concentrations above 500 mg/kg (Case 3 through Case 5). The cumulative total volume for these soils is approximately 17,900 cy. Of this volume, the volume to be stabilized prior to on-site landfilling (Case 1 soils) is approximately 3,800 cy.

After the solidification/stabilization process, the final step in the remedial action is disposal of the remaining soils and Reeder Creek sediments. This remaining excavated material will not be considered a characteristic RCRA hazardous waste. It will be a solid waste, and the disposal will be subject to RCRA Subtitle D and New York State solid waste regulations. There are no landfills on SEDA property which meet the current New York State Subtitle

D requirements. Therefore, a landfill meeting these requirements will need to be constructed for this remedial action.

The requirements for the construction of a Subtitle D landfill are summarized below. The following discussion will focus on several of the key design issues which are useful in evaluating the feasibility of this alternative, and which are necessary in developing a budgetary cost estimate.

The NYSDEC requirements for Subtitle D landfills are described in 6 NYCRR Part 360. These landfills are required to be constructed such that the bottom of the lowest liner is a minimum of five feet above the seasonal high water table and 10 feet above bedrock. Since the seasonal high water table at the proposed landfill location at the OB Grounds is only three to four feet below the ground surface, it would be necessary to build the landfill completely above grade. Approximately two feet of fill would be required below the base of the landfill.

In general NYSDEC requires a double composite liner system with a leak detection layer in between the two liners. As defined in 6 NYCRR 360-2.13, a composite liner consists of "two components, an upper geomembrane liner placed directly above a low permeability soil layer." The soil component of the upper liner must have a minimum compacted thickness of 18 inches. The soil component of the lower liner must have a minimum compacted thickness of 24 inches, and a maximum permeability of 1 X 10^{-7} centimeters per second (cm/s). There are also a number of compaction, construction, and slope requirements.

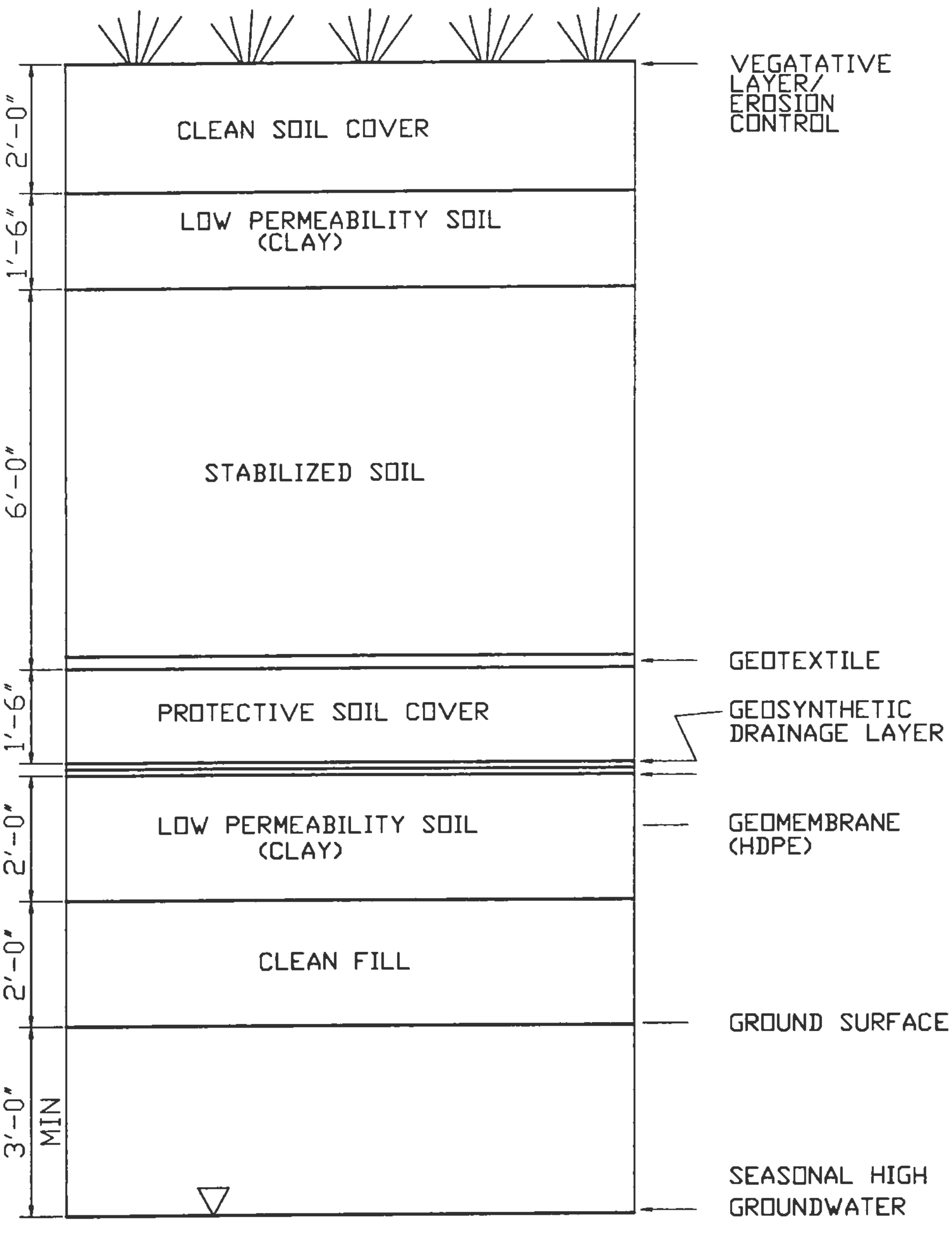
In 6 NYCRR 360-2.14, there are separate provisions for industrial landfills. In particular, this section specifies that the above requirements may be modified on a case by case basis. Specifically, the requirements for a double composite liner may be waived. One example given is the case of an ash monofill, in which only a single composite liner is required. The solidified waste at the OB Grounds is very similar to an ash monofill, and it is likely that the double liner requirement could be waived for this remedial action. As stated i 6 NYCRR 360-2.14, this alternative liner system must demonstrate its ability to adequately present a negative impact on groundwater quality and must address all the factors specified in Section 360-214(a)(1). The following discussion and cost estimate assumes that only a single composite liner will be required at the site. A full discussion of the cost impacts of the different liner requirements is provided below.

The next layer up from the liner system is the leachate collection system. The leachate collection system generally consists of one foot of high permeability soil, such as sand, with a network of pipes. The sand and pipe system may be replaced with a geosynthetic drainage layer, providing that the geosynthetic layer has a hydraulic transmissivity equivalent to one foot of sand. The leachate collection system is sloped such that any accumulated liquid collects in a sump from which it can be pumped out. Once the landfill is full and properly closed, there should be no leachate generation. At the OB Grounds, a geosynthetic layer would likely be used in order to minimize the height of the above grade landfill.

After the leachate collection system, approximately 1 foot of clean fill is placed in order to protect the leachate collection system. The waste is then placed on top of the protective soil. Once the filling is complete, which for the OB Grounds should only take one to two months, the landfill would be ready for closure. The final cover consists of a low permeability soil layer with a minimum thickness of 18 inches overlain by a protective soil layer of a minimum thickness of 24 inches. The cover is sloped to allow for drainage. It is also necessary to establish vegetation on the cover to minimize erosion. Figure 5-2 is a cross-sectional view of a landfill showing all of the different layers.

There are additional requirements for gas venting systems and groundwater monitoring. Gas venting systems may not be required at the OB Grounds since there are no putrescible wastes, and there should be no gas generated. If gas venting systems are required they should be very simple. Groundwater monitoring is accomplished by placing a number of wells around the landfill into the uppermost water bearing zone. There are wells already installed at the site as part of the RI, so it should be necessary to install only a few wells.

The regulations require that post-closure care and monitoring be conducted for a minimum of thirty years. In general, the maintenance required is for erosion control, pest control, and maintenance of the vegetative cover. The wells must also be sampled on a regular basis. Any releases from the landfill must be addressed accordingly.



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING	Dwg. No.

FIGURE 5-2
ALTERNATIVE 5 CROSS-SECTIONAL VIEW OF SUBTITLE D LANDFILL

SCALE NA	DATE MARCH 1996	REV A

ACAD\SENECA\OBRI\CROSSECT.DWG

5.5.1.2 Process Flow

The process flow for this alternative consists of three steps, excavation, stabilization, and on-site landfilling. Figure 5-1 is a process flow diagram for the solidification/stabilization process for this alternative. The process is fairly simple. The Case 1 soil is excavated, and brought to the pug mill where it is stockpiled prior to stabilization. Next, the soil is placed in the pug mill and mixed with water and the various admixtures. The soil likely will be placed in the pug mill using a conveyor belt with a scale system in order to record the weight of the soil to be treated. Another option is a front end loader, with the volume of the treated soil recorded. The admixtures may be added in several ways, depending on the final technology selected. Dry admixtures will either be stockpiled and added via a conveyor or a front end loader, or added with a hopper system. If water is necessary to the process, either a temporary tank will be used, or depending on the location, a hook up to the Depot water supply may be possible.

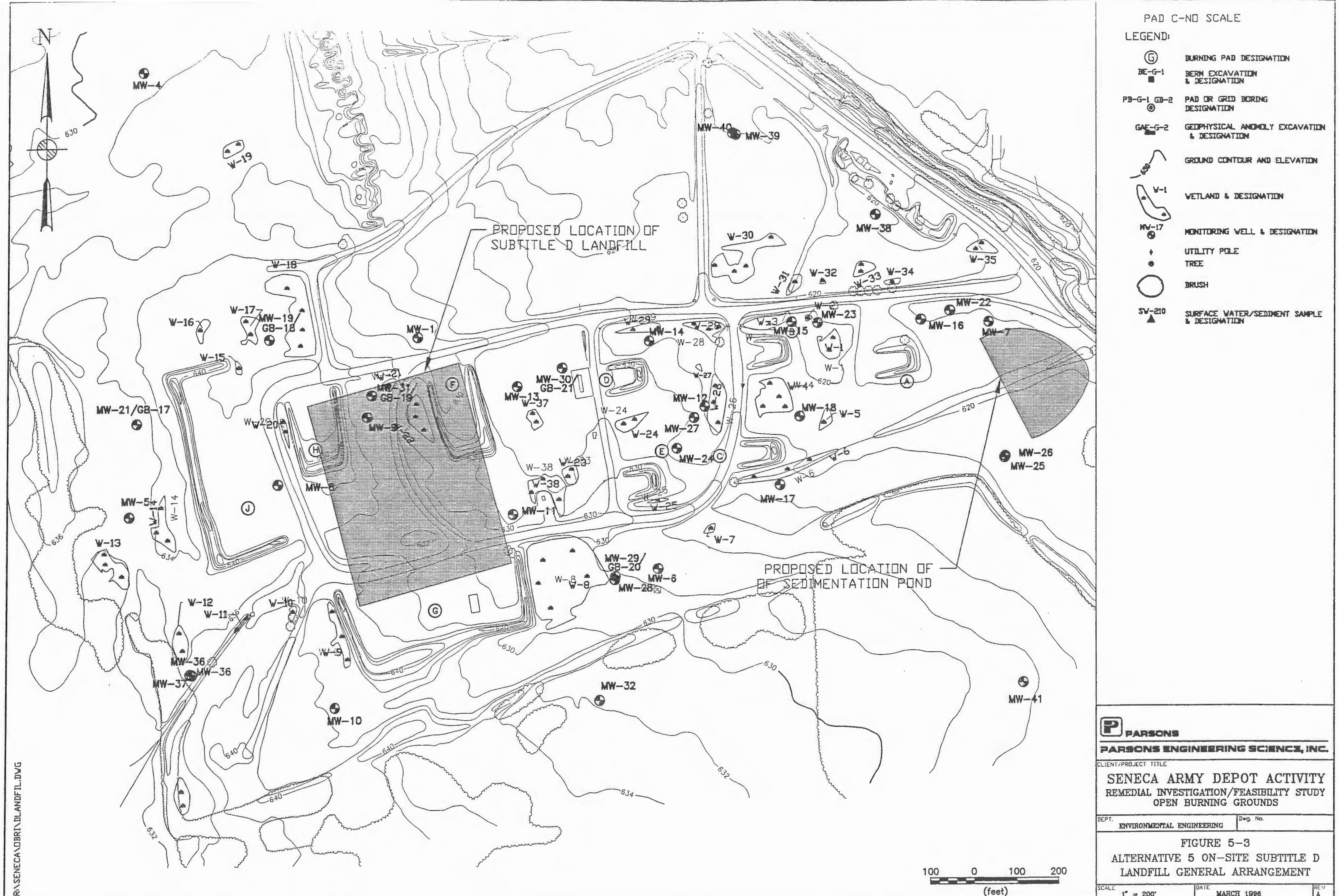
The treated soil is discharged either directly to the trucks for transport to the landfill, or to a treated soil stockpile for testing. In general, a volume increase of 50% is expected for the solidified soil. The treated soil will be analyzed by the TCLP at the rate required by NYSDEC. For existing off-site Subtitle landfills, the rate required is one TCLP analysis per 1,000 tons of treated soil.

In the final step, the treated and remaining excavated soils are placed in an on-site landfill.

5.5.1.3 Site Layout

This alternative requires approximately 6 acres for the on-site landfill in addition to sufficient area for the pug mill and two small stockpile areas. Once the system is operational, there will only need to be room in each stockpile for 1,000 to 2,000 tons. The pug mill and stockpile area will be located near the landfill. This will provide for easy access for the excavation equipment to bring the untreated soil to the pug mill, and for the trucks which will haul the treated material to the landfill.

Figure 5-3 shows the proposed location of the landfill. The landfill will be located near Pad J, since this is the highest area on the site, and allows the most separation between the landfill and the seasonal high water table. The landfill will be located completely above grade in order to satisfy the requirements that the base of the landfill be 5 feet above the seasonal high water table and 10 feet above bedrock.



PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No.

FIGURE 5-3

ALTERNATIVE 5 ON-SITE SUBTITLE D
LANDFILL GENERAL ARRANGEMENT

SCALE 1" = 200' | DATE MARCH 1996 | REV A

5.5.2 Protection of Human Health and the Environment

An evaluation of the protectiveness of human health and the environment includes the assessment of the short- and long-term effectiveness as well as permanence. The following discussion will show how this alternative meets these criteria.

5.5.2.1 Short-term Protectiveness

Several items are included in an assessment of the short-term protectiveness of Alternative 5. The first issue is protection of the community during the remedial action. This alternative is protective of the community. All treatment and disposal will be accomplished on site, so that there will be no transport of hazardous materials. There is also little threat from dust released during the excavation. The site is located far from the SEDA boundary, so the likelihood of any hazardous dust migrating offsite is negligible. As discussed in Section 5 of the RI report, fugitive dust migration is not a major migration pathway. Fugitive dust is further minimized by the makeup of the pads and berms which will be excavated. The pads and berms are constructed primarily of shale fill, a material which has a fairly large particle size, and is less subject to dust formation.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during treatment are direct contact with the contaminated soil and inhalation of vapors or particulates. Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. Dust generation can be minimized at the pug mill by containing all admixtures which tend to from dust (ie., cement and lime), and by containing the mixing process. The solidification/stabilization process is very similar to normal cement construction procedures, and is therefore fairly straightforward. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site.

Another part of the short-term protectiveness criterion is assessing the environmental impacts during the remedial action. For Alternative 5, there will be little or no environmental impacts. This alternative calls for construction type activities in an active portion of the Depot. These activities will not be substantially different from what is currently occurring.

In addition, since the hazardous material is primarily in the soil, there is little or no risk of a spill or release during the remedial action.

The last item to be considered is the time until treatment is accomplished. Initially, there will be a substantial period of time required to obtain the necessary permits and approvals for construction of the landfill. The actual remedial action (excavation and stabilization) should be completed in a brief period of time. The initial treatability testing and vendor selection should take two to three months. Once the treatability testing is completed and a vendor is selected, the mobilization time should be less than one month, since no specialized equipment is required. All of the equipment used is standard construction equipment. Little permitting will be required, and operations should begin quickly. The remedial action would take one to three months, depending primarily on the time needed for the solidified soil to cure.

There will also be time required to properly close the landfill, probably two to three months. By this time, the waste will have been treated and will no longer be hazardous, so the threats to human health and the environment will be negligible.

5.5.2.2 Long-term Protectiveness

The assessment of the long-term protectiveness of Alternative 5 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals and untreated soil.

The magnitude of the residual risk is easy to quantify. The removal plan for the soils will be designed such that the remaining soils demonstrate a lead concentration less than 500 mg/kg. There will be no treatment residuals left at the site, so the treatment residuals will not be included in the risk evaluation.

The controls to be used for long-term management are more involved. The material disposed in the landfill will not be hazardous, and there will be no long term threat to human health and the environment. However, there will be a landfill on site which will require maintenance.

The permanence of the alternative must also be assessed. Once the soil is encased in the Subtitle D landfill, the remedial action would be considered permanent. There will no longer be soil on the site that poses an unacceptable threat to human health and the environment. There is some question about the permanence of the solidification/stabilization treatment technology. In general, the solidified soil, as with all concrete, is subject to weathering from freeze-thaw and wet-dry cycles. If the material is safely placed in a secure landfill, the material will be protected from weathering, and there would be no degradation of the concrete, which indicates that the treatment will be permanent.

Permanence is further enhanced by the use of stabilizing agents, such as lime. The lime reacts with the heavy metals to form insoluble carbonates and hydroxides. These products are far less soluble than the free metals, and are very resistant to weathering.

5.5.2.3 Conclusion

Alternative 5 would protect human health and the environment. This alternative protects against ingestion of and direct contact with surface soils having concentrations of lead above 500 mg/kg and prevents potential leaching of lead into the groundwater by removing subsurface soils with concentrations of lead above 500 mg/kg. These soils also include the Case 1 soils, which have concentrations of constituents exceeding TCLP criteria. Excluding the hazard contributed by lead which was evaluated separately, the results of the human heath baseline risk assessment determined that the total site non-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, aside from the hazards posed by lead, the conditions at the site would not require a remedial action. However, removal of Case 1 through Case 5 soils would further reduce both risks because the RI analytical data indicate that the soils in these locations also contain high concentrations of other metals and semivolatile organic compounds. The HI would be reduced from 0.33 to 0.11 and the total site carcinogenic risk would be reduced from 1×10^{-5} to 9×10^{-6}.

This alternative meets the soil clean-up criteria established for lead in on-site soils and the sediment clean-up criteria for copper and lead in Reeder Creek. The entire 17,900 cy of soil and sediment would be excavated and placed in an on-site landfill. As shown in Table 2-4, removal of Case 1 through Case 5 soils will result in a maximum concentration of lead of 463 mg/kg. For off-site sediment, removal of Reeder Creek sediments reduces the maximum concentration of copper and lead to 9.5 mg/kg and 10.5 mg/kg, respectively, for the reach influenced by the OB grounds.

This alternative also provides long-term protection of the environment. The sediments in Reeder Creek with concentrations of lead and copper above the established criteria will be removed. As a result, the aquatic community in Reeder Creek would be protected.

Furthermore, revegetation of the site and construction of a sedimentation basin will prevent recontamination of Reeder Creek by runoff from the OB grounds.

5.5.3 Reduction of Toxicity, Mobility, and Volume

Overall, Alternative 5 would be effective in reducing the toxicity and mobility of the hazardous constituents present in the soil at the site. The treated soil will have a larger volume but will no longer be considered a hazardous waste or capable of leaching metals. In general, a volume increase of 50% for the treated soil can be expected. In addition, excavation of the remaining soils would increase the volume by approximately 20%.

The decrease in toxicity and mobility can be assessed on both a small scale and site-wide basis. On the small scale, both the toxicity and mobility of the hazardous constituents in the soil are assessed with the TCLP test. The larger the leaching fraction, the greater the mobility and the greater the toxicity. Since the primary treatment criteria for solidification/stabilization is that the waste no longer be TC hazardous, the treated waste will exhibit lower toxicity and mobility than the untreated waste. The mass of the potentially hazardous constituents in the soil will remain unchanged.

There are also major decreases on a site-wide basis. By treating the soil at the site which contains the highest concentrations of hazardous constituents, the overall site risk (toxicity) will be reduced. By transferring the treated soil and remaining excavated soils and sediments to a properly constructed Subtitle D landfill, the mobility of the hazardous constituents will be effectively reduced.

5.5.4 Compliance with ARARs

Alternative 5 will comply with all ARARs and TBCs. A list of the ARARs for this alternative is in Appendix C.

5.5.5 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with

NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

5.5.5.1 Technical Feasibility

The overall technical feasibility of Alternative 5 is good, but the issues involved with the construction of an onsite landfill are somewhat complicated, as described below. Solidification/stabilization is a technology which has been frequently used to treat similar soils, and it is not anticipated that problems will be encountered during construction, as long as the proper treatability work has been completed to establish the optimal admixture ratios. Since the materials and equipment used are all standard construction equipment, the process can be operated in almost all weather conditions.

The excavation process is also well defined. The areas demonstrating elevated concentrations of heavy metals have been delineated, and it will be straightforward to develop an excavation plan that assures all of the hot spots are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located above grade, and should not be adversely affected by wet conditions.

There are a number of technical issues which must be addressed in order to properly construct an onsite landfill. Landfill construction is a common practice, and the issues are not especially complicated, but the overall technical complexity of Alternative 5 is much greater than Alternative 4.

The first issue is landfill siting. In order to meet the NYSDEC requirement that the landfill be at least five feet above the seasonal high water table, the landfill will need to be located on high ground, and most likely, on several feet of clean fill. The landfill will have to be designed to allow access during construction and filling. Also, since the landfill will be completely above grade, more stringent erosion control measures will be required. The weather is an important factor. Heavy rains or other adverse weather conditions could severely impact the construction schedule.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the OB Grounds. However, if additional work is required in the future, this remedial action will not interfere in any way.

Several monitoring requirements govern the solidification/stabilization process. The monitoring requirements of the solidification/stabilization process are essentially the same as for Alternative 4. The additives must be properly metered into the soil to assure proper treatment. The soil which has been treated must be tested to ensure that the contaminants have been stabilized. Air monitoring will likely be necessary to determine if movement of the soil is releasing contaminants to the air.

There are a number of monitoring requirements for the landfill. The landfill construction requires continual supervision and testing, since there are a number of requirements for each layer. A Construction Quality Assurance (CQA) plan will be developed which describes the specific requirements for the landfill. Some of the major items to be addressed are described below.

The initial fill layer must be compacted to ensure that it will have sufficient structural strength to support the landfill. Next, the low permeability soil layer is installed in lifts, with each lift monitored for compaction and permeability. The geomembrane must be tested for holes and permeability, and the installed seams must be carefully inspected. Next, the geosynthetic drainage layer is installed, and finally the protective soil layer. There are similar monitoring requirements for the cap installation. Each layer must be carefully surveyed to ensure that the proper slopes are obtained. Problems at any point in the process may necessitate removal and reinstallation of a given layer.

5.5.5.2 Administrative Feasibility

The administrative feasibility of this alternative is described in the New York code of regulations. The unit to be constructed is a Subtitle D landfill, and a NYSDEC permit would be required. The permit application requirements, described in 6 NYCRR Part 360 are broad, and include issues such as siting, design, closure, post closure, and monitoring. It would be necessary to obtain NYSDEC concurrence on the acceptability of a single composite liner system. Obtaining the necessary permit and concurrence could take six months to a year, or more, and would require a great deal of engineering and money.

The administrative feasibility of the solidification unit would be good, as with Alternative 4. Since there will only be a temporary treatment facility on site, no hazardous waste permitting will be required. Construction permits necessary for the activities are readily attainable. In addition, there will be no transport of waste offsite.

Coordination with the various regulatory agencies is also important. As described above, the Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

5.5.5.3 Availability of Services and Materials

This technologies used for this alternative rely primarily on standard equipment, which is readily available in the Romulus area. The excavation would be accomplished with backhoes and scrapers, and the material would be transported in standard size dumptrucks. The stabilization unit would consist of a temporary pug mill, or if the volume is fairly small, the stabilization could be conducted in a cement truck.

Startup time to implement solidification/stabilization is one to two months, depending on the level of effort necessary for treatability testing. Bench-scale tests will likely be necessary to determine the proper additives and ratios of additives to contaminated soil. These must be brought to the site along with the earthmoving and mixing equipment. Total treatment time for a site such as the OB Grounds is approximately 2 to 4 months, including the treatability studies.

Obtaining the construction materials for the landfill would require a clay source to be identified, tested for quality and quantity and brought to the site. It is anticipated that a local source would be available, since the base soils in the Finger Lakes region are clays. Clean fill could be obtained on the Depot. The geomembrane and geosynthetic drainage layer are available from a number of vendors.

5.5.6 <u>Cost</u>

5.5.6.1 Capital Costs

There are two separate capital costs to consider, the cost of the soil treatment, and the cost of the landfill construction. The costs for solidification/stabilization vary depending on quantities and types of additives and the field mixing techniques used. Treatability study costs range from $10,000 to $30,000, and treatment costs, including site preparation and excavation range from $50 to $150 per ton. Additional items, including engineering, oversight, and site restoration would bring the total cost for remediation of 17,900 cubic yards to $4.0 million. Again, there is a fair amount of uncertainty in this cost. A breakdown of the costs for this alternative is presented in Appendix D.

5.5.6.2 O & M Costs

There are a number of O & M costs associated with the onsite landfill. The first of these is quarterly groundwater monitoring, which would likely cost from $30,000 to $40,000 per year, depending on the number of parameters and wells required by NYSDEC. There are also general maintenance costs for the vegetative cover, erosion control, equipment upkeep, and annual sediment sampling in Reeder Creek. These costs are estimated to be $10,000 per year. The total O & M costs are estimated to be $49,100 per year (Appendix D).

5.5.6.3 Present Worth Costs

The present worth costs for Alternative 5 are estimated to be $4.5 million.

5.6 ANALYSIS OF ALTERNATIVE 6: EXCAVATION, SOIL WASHING, BACKFILLING COARSE FRACTION, OFFSITE LANDFILL FINE FRACTION

5.6.1 Definition of Alternative 6

5.6.1.1 Description

This alternative includes excavation of Case 1 through Case 5 soils, soil washing, off-site landfilling of the fine fraction, and backfilling of the coarse fraction. Each of these processes will be described briefly in this section. A detailed analysis of how this option meets the selection criteria, and a budgetary cost estimate are provided below.

The first step in this alternative, as with the other alternatives, is excavation. An excavation plan will be developed using previous RI data to delineate the extent of removal. The data indicate that the soils to be removed are all on-site soils with lead concentrations above 500 mg/kg, which includes soils with TCLP exceedances; portions of the low hill; and Reeder Creek sediments having copper and lead concentrations above the NYSDEC sediment criteria. The extent of the excavation will be approximately 17,900 cubic yards. The location of these areas are shown in Figures 2-1 and 2-2. The volumes are outlined in Table 2-3 and include Case 1 through Case 5 soils. The areas to be excavated on-site include the entire berm of Pad B; sections of berms of Pads A, C, D, E, F, G, H, and J; the whole pads of Pads A and B (the pad of Pad B to a depth of nine feet); sections of pads and areas around hotspots to a depth of 2 feet at Pads C, G and J; sections of pads to a depth of 4 feet at Pads D, G, and H; and seven locations off the pads at grid boring and sediment sampling locations.

The two remote areas to be excavated include (1) Reeder Creek sediments having copper and lead concentrations above the NYSDEC sediment criteria of 16 mg/kg and 31 mg/kg, respectively, and (2) soils with concentration of lead above 500 mg/kg from the low hill area southeast of the OB grounds. These areas are shown on Figure 2-1. The total volume of soil and sediment from the remote areas (Case 2) is approximately 900 cy. Reeder Creek sediment will be removed with an excavator during the dry season (August-September) when the entire flow of the creek can be diverted relatively easily.

In summary, the soils and sediment to be removed for this remedial action include soils exceeding the TCLP limit (Case 1), soils/sediments from remote areas including Reeder Creek and the low hill (Case 2), and the remaining on-site on-site soils with lead concentrations above 500 mg/kg (Case 3 through Case 5). The cumulative total volume for these soils is approximately 17,900 cy.

The excavation will be accomplished with standard construction equipment, such as a front end loader or bulldozer. Pad B soils will be completely removed down to a depth of nine feet below ground surface. This is the only pad which will require excavation to this depth.

The next step is the soil washing process. The primary purpose of soil washing is to separate soil into component parts, and in the process, do some scrubbing and washing of the components. Soil washing experiments have shown that a significant portion of the hazardous constituents present in the soil are concentrated generally in the fine fraction and that the coarse fraction can be cleaned by physically separating and concentrating the fines. The soil washing process separates the fractions, and the fine fraction is then subjected to additional treatment. The coarse fraction, which no longer contains excessive levels of the hazardous constituents, is no longer a waste and can be backfilled on site. It is estimated that the fine fraction will make up 30 percent of the overall volume. The actual quantity of the fine fraction would need to be determined with a treatability study.

The following is a general description of a soil washing process which would be applicable to this site. First, the waste material is fed into a hopper which screens the oversize material (more than 1/4 inch diameter) from the finer fractions. The oversize material then goes to a rotary drum where it is tumbled washed, tested, and backfilled to the site.

The remaining soil is passed into a device with hydroclones which turns the material into a slurry and pumps it through the hydroclones. The hydroclones mechanically separate the slurry into two streams, the coarse material (sand and gravel) and the fine material (silt and clay) and water.

The coarse material may then be directed to froth flotation cells which wash it with surfactants. The flotation cells, which aerate the material, and the surfactant washing generate a heavy froth. The organic and inorganic contaminants in the soil will move with the froth. The froth is then skimmed from the top of the material and is considered a hazardous waste. The soil passing through the froth flotation units , i.e., the coarse fraction, has been shown to pass the TCLP and can then be backfilled to the site.

The fine material and water are sent to a sludge basin where the solids are settled out. The sludge is dewatered and then further treated or disposed. The water will be treated prior to discharge.

The process separates the soil into four streams: (1) oversize material, which is generally non-hazardous and can be backfilled to the site, (2) clean sand and gravel, which also can be backfilled, (3) sludge consisting of the fine fraction, which is a hazardous waste, and (4) concentrated froth from the flotation unit (if utilized) which is also considered a hazardous waste. For this alternative, the fine fraction and froth will be transported off-site to a TSDF. The TSDF will then be responsible for the solidification/stabilization, or whatever treatment is necessary for the soil prior to disposal in their landfill. Since the only criteria for landfilling is that RCRA land ban requirements be met, the TSDF may opt for an abbreviated treatment process.

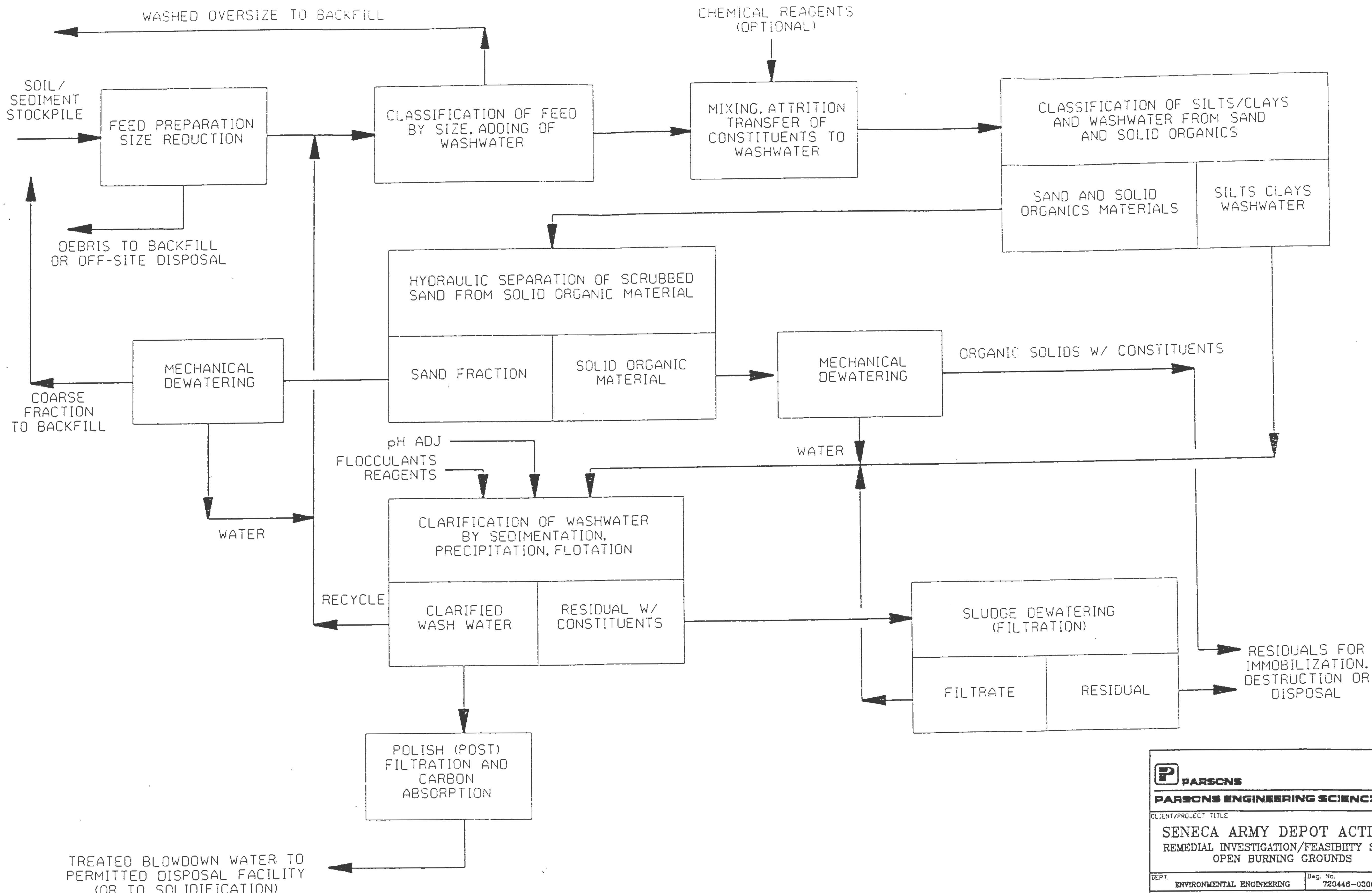
The final step in the remedial action is site restoration. After the coarse fraction has been backfilled to the site, the berms and pads will be regraded with a bulldozer in a manner which approximates the original grade of the site. If necessary, clean fill will be brought in to make up for the soils excavated at Pad B. The topsoil cover will be vegetated with indigenous grasses as an erosion control measure. Once the cover is established, there will be no continued maintenance requirements.

5.6.1.2 Process Flow and Site Layout

A detailed process flow schematic for soil washing is shown in Figure 5-4. An equipment layout is shown in Figure 5-5. A soil washing operation will consist of several or all of the following processes:

- Vibratory screen - This unit separates the feed, and removes oversized (greater than 2-inch diameter) particles.
- Feeder module and conveyor - This unit carries and weighs material fed to the soil washer.
- Trommel screen - This unit breaks up clumped feed materials.
- Attrition scrubber - This unit adds the washwater to the broken up soil. The washwater mobilizes the fine fraction of the soil.
- Hydrocyclone separators - This unit is a solids/liquid flash separation device which separates the coarse (sand and gravel) soil from the fine (silt and clay) soil.
- Dense media separation column - This unit separates materials based on density, and would be used to separate pieces of munitions, elemental metals and other debris from the soil to be treated.
- Dewatering screen - This unit removes the fine material from the process train. The coarse fraction is rinsed, and removed from the soil washer.
- Washwater treatment system - The spent washwater is treated for reuse or disposal. The type of treatment used is site-specific.
- Belt filter press - This unit dewaters the fine fraction prior to solidification.

The stockpiled soil will be loaded into the soil washing unit with front-end loader. The conveyor will likely be equipped with a scale to keep track of the quantity of soil treated. For this site, a 25-tph unit will be used. This unit is delivered on fifteen 45-foot trailers. The total size of the soil washing operation is approximately 100 feet by 200 feet. The assembled



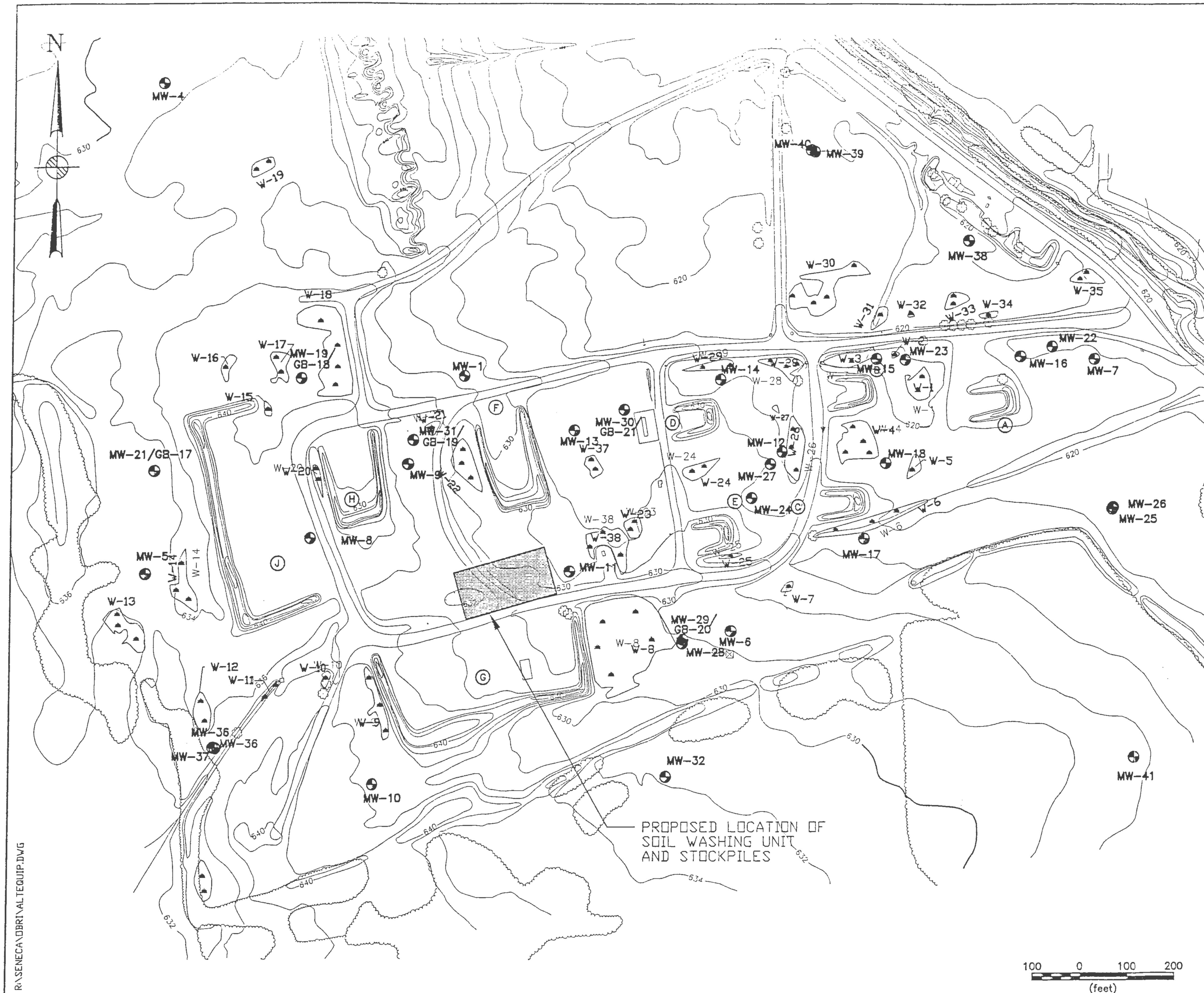
PARSONS
PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBITY STUDY
OPEN BURNING GROUNDS

DEPT. ENVIRONMENTAL ENGINEERING	Dwg. No. 720446-03000

FIGURE 5-4
ALTERNATIVE 6 SOILS WASHING
GENERALIZED PROCESS FLOW SCHEMATIC

SCALE NA	DATE MARCH 1998	REV A



PAD C-NO SCALE

LEGEND:

- BURNING PAD DESIGNATION
- BE-G-1 BERM EXCAVATION & DESIGNATION
- PB-G-1 GB-2 PAD OR GRID BORING DESIGNATION
- GAE-G-2 GEOPHYSICAL ANOMOLY EXCAVATION & DESIGNATION
- 630 GROUND CONTOUR AND ELEVATION
- W-1 WETLAND & DESIGNATION
- MW-17 MONITORING WELL & DESIGNATION
- UTILITY POLE
- TREE
- BRUSH
- SW-210 SURFACE WATER/SEDIMENT SAMPLE & DESIGNATION

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT ACTIVITY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
OPEN BURNING GROUNDS

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	

FIGURE 5-5
ALTERNATIVE 6
EQUIPMENT LAYOUT

SCALE	DATE	REV
1" = 200'	MARCH 1996	A

unit has a height of 50 feet. The unit requires a 600-kW, 440-Volt AC power supply, and a 25 gallons per minute (gpm) water source.

The coarse fraction is removed from the unit, allowed to dry, and stockpiled in a clean soil area. The material can be tested to ensure that the hazardous constituents have been removed to acceptable levels. The material will then be re-used as clean fill.

After dewatering, the fine material will be solidified and disposed of in an off-site Subtitle D landfill. The solidification will be accomplished at a TSDF as described for Alternatives 4 and 5. The water will be treated on-site or sent to the Depot Publicly Owned Treatment Works (POTW) for treatment. The cost estimate assumes that the water can be treated at the Depot POTW at minimal cost.

5.6.2 Protection of Human Health and the Environment

An evaluation of the protection of human health and the environment includes the assessment of the short- and long-term effectiveness as well as permanence. The following discussion will show how this alternative meets these criteria.

5.6.2.1 Short-term Protectiveness

This alternative will be evaluated with respect to the effect on human health and the environment during the implementation of the remediation action. Four items are included in an assessment of the short-term protectiveness of Alternative 6. The first issue is protection of the community during the remedial action. This alternative is protective of the community. Because the final treatment will be not be accomplished on site, there will be transport of hazardous materials. Care will be taken to assure that the trucks are not overloaded. The soils will be covered with a tarp during transport to ensure that no dust is released from the trucks.

There is also little threat from dust released during the excavation. The site is located far from the SEDA boundary, so the likelihood of any hazardous dust migrating offsite is negligible. As discussed in Section 5 of the RI report, fugitive dust migration is not a major migration pathway. Fugitive dust is further minimized by the makeup of the pads and berms which will be excavated. The pads and berms are constructed primarily of shale fill, a material which has a fairly large particle size, and is less subject to dust formation.

The short-term protectiveness to site workers must also be considered. The major routes of exposure during excavation are direct contact with the affected soil and inhalation of vapors or particulates. There is also potential for exposure to soils and other hazardous materials during the soil washing process. Protection from exposure can be minimized through site access controls and the use of proper protective equipment for site workers, such as dust masks and Tyvek protective clothing. Air monitoring may be used to determine if there is a significant threat from the inhalation of vapors or particulates. Dust generation at the excavation can be minimized by using water or other dust control chemicals. It should also be noted that all the site workers will be required to meet all the OSHA training and medical monitoring requirements prior to working on site. All of the contractor personnel working around the soil washing unit will be trained in the proper health and safety procedures to be used near the unit.

Another part of the short-term effectiveness criteria is assessing the environmental impacts during the remedial action. For Alternative 6, there will be few environmental impacts. There is the potential for spills during excavation, but the soil is a solid, and spills would readily be contained. There is also a potential for releases of washwater from the soil washing unit. This threat is minimized with proper controls and inspections of the units. The site workers will be trained in the proper operation of the unit operations.

The last item to be considered is the time until treatment is accomplished. Alternative 6 should take three to six months to complete. Mobilization would take two weeks. It would take an additional three weeks to fine tune the unit. Once the unit is fully operational at 25 tph, it would take one to three months to complete the soil washing step. Backfill, transport of the fines offsite, and demobilization would be expected to take another two to four weeks. Once the fines are removed and the coarse fraction is backfilled, the remedial action would be complete.

5.6.2.2 Long-term Effectiveness and Permanence

The assessment of the long-term effectiveness of Alternative 6 can be divided into two major categories, an assessment of the magnitude of the residual risk, and an evaluation of the adequacy and reliability of the controls used for the waste residuals and untreated soil.

The magnitude of the residual risk is easy to quantify. The removal plan for the soils will be designed such that the remaining soils demonstrate a concentration of lead below 500 mg/kg. The only treatment residuals remaining on site will be the coarse fraction of the soil, which will have been tested to ensure that there are no unacceptable levels of lead remaining. Initially, some maintenance will be required to reestablish a vegetative cover at the site. Once the cover is established, there will be no need for long-term maintenance.

The permanence of the alternative must also be assessed. Once the soil fines are removed from the site, the remedial action would be considered permanent. There will no longer be soil on the site that poses an unacceptable threat to human health and the environment.

5.6.2.3 Conclusion

This alternative would protect human health and the environment. This alternative protects against ingestion of and direct contact with surface soils having concentrations of lead above 500 mg/kg and prevents potential leaching of lead into the groundwater by removing subsurface soils with concentrations of lead above 500 mg/kg. These soils also include the Case 1 soils, which have concentrations of constituents exceeding TCLP criteria. Excluding the hazard contributed by lead which was evaluated separately, the results of the human heath baseline risk assessment determined that the total site non-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, aside from the hazards posed by lead, the conditions at the site would not require a remedial action. However, removal of Case 1 through 5 soils would further reduce both risks because the RI analytical data indicate that the soils in these locations also contain high concentrations of other metals and semivolatile organic compounds. The HI would be reduced from 0.33 to 0.11 and the total site carcinogenic risk would be reduced from 1×10^{-5} to 9×10^{-6}.

This alternative meets the soil clean-up criteria established for lead in on-site soils and the sediment clean-up criteria for copper and lead in Reeder Creek. The entire 17,900 cy of soil and sediment would be excavated and portions would either be treated off-site at a TSDF (i.e., the fine fraction from the soil washing process) or backfilled to the site as clean fill. As shown in Table 2-4, removal of Case 1 through Case 5 soils will result in a maximum concentration of lead of 463 mg/kg. For off-site sediment, removal of Reeder Creek sediments reduces the maximum concentration of copper and lead to 9.5 mg/kg and 10.5 mg/kg, respectively for the reach influenced by the OB Grounds.

This alternative also provides long-term protection of the environment. The sediments in Reeder Creek with concentrations of lead and copper above the established criteria will be removed. As a result, the aquatic community in Reeder Creek would be protected.

Furthermore, revegetation of the site and construction of a sedimentation basin will prevent recontamination of Reeder Creek by runoff from the OB grounds.

5.6.3 Reduction in Toxicity, Mobility, and Volume

Alternative 6 would be very effective in reducing the toxicity, mobility, and volume of the hazardous constituents present at the site. The primary goal of soil washing is volume reduction, and the process is expected to reduce the volume of contaminated soil to approximately 30 percent of the original volume. The toxicity and mobility reductions are accomplished in the solidification process. The potentially hazardous constituents are stabilized in the process, which reduces the toxicity. The solidification and subsequent landfilling of the soil fines reduces the mobility. The final mobility of the hazardous constituents is negligible.

5.6.4 Compliance with ARARs

Alternative 6 will comply with all ARARs and TBCs. A list of the ARARs for this site is in Appendix C.

5.6.5 Implementability

A discussion of implementability can be divided into three sections, technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility describes items such as construction and operation, technology reliability, and monitoring considerations. Administrative feasibility addresses issues such as permitting, interaction with NYSDEC and EPA, and community relations. Availability of services and materials describes the ease of obtaining vendors and equipment, and the availability of offsite disposal capacity.

5.6.5.1 Technical Feasibility

The technical feasibility of Alternative 6 is fairly good. Soil washing has been used for a number of years, and has been demonstrated to be effective at sites with similar contamination, but treatability studies will be necessary to confirm that the technology will be effective at the OB Grounds. The solidification/stabilization process is known to be effective for treating the soil washing residuals. The technical advantages of soil washing is to decrease the quantity of material that will require solidification. The solidification process will also be more effective because the cement matrix will solidify easier with a matrix of fines.

The excavation portion of the remediation can also be readily implemented. The areas demonstrating elevated concentrations of heavy metals have been delineated, and the excavation plan will ensure that all of the hot spots are removed. It is possible that some minor weather delays may be encountered, but most of the soil to be removed is located above grade, and should not be adversely affected by wet conditions.

Another aspect of technical feasibility is the ease with which additional work may be conducted. At this time, it is anticipated that this remedial action will preclude the necessity of any additional remedial efforts at the OB Grounds. However, if additional work is required in the future, this remedial action will not interfere in any way. Once the remedial action is complete, the site will be revegetated, and will essentially remain as it is now.

5.6.5.2 Administrative Feasibility

The administrative feasibility of this alternative is as good or better than the rest of the alternatives. This option greatly reduces the volume of material to be landfill. Construction permits necessary for the activities are readily attainable. Due to the volume reduction, there will be minimal transport of hazardous waste, and the number of manifests will be reduced. All the contractors used for excavation and hauling will be experienced in preparing manifests.

Coordination with the various regulatory agencies is also important. The Army has coordinated the entire remedial program with both EPA and NYSDEC, and will consider input from both these agencies in the final remedy selection. It is anticipated that any issues arising with the regulatory agencies will be addressed prior to remedy selection.

5.6.5.3 Availability of Services and Materials

There is good availability of the materials and services necessary to accomplish this alternative. Several companies have extensive experience in implementing soil washing, including Bergmann U.S.A., and Biotrol, Inc. These companies can rapidly assemble the necessary unit operations for the OB Grounds.

The excavation and hauling equipment and Subtitle D landfill space is readily available. The equipment to be used is fairly standard, and is available from a number of vendors.

5.6.6 Cost

5.6.6.1 Capital Costs

There are four major cost items for this alternative, excavation and backfilling, soil washing, solidification, and offsite disposal. Transportation is also a cost to consider. Soil washing costs are estimated to be $190 per cubic yard ($200 per ton). Solidification costs and offsite disposal costs (including transportation) would be $450 per cubic yard ($300 per ton). The total cost including engineering, oversight, and site restoration for remediation of 17,900 cubic yards is $9.4 million. The costs for this alternative is provided in Appendix D.

5.6.6.2 O & M Costs

There will be two O & M costs associated with Alternative 6. The first of these is quarterly groundwater monitoring, which would cost from $30,000 to $40,000 per year depending on the number of parameters and wells required by NYSDEC. The second O & M cost is yearly sampling of sediments in Reeder Creek. This would cost approximately $6600 per year depending on the number of parameters required for analysis and locations required for sampling. The total cost for O & M is estimated to be $45,300.

Once the remedial action is completed, there will be no residuals remaining on site which require management. Initially, there will be some minor costs associated with the establishment of the vegetative cover, but the cost estimate for these items have been included in the capital costs.

5.6.6.3 Present Worth Costs

The present worth costs for Alternative 6 are estimated to be $9.9 million.

5.7 COMPARATIVE ANALYSIS OF ALTERNATIVES

5.7.1 Introduction

The purpose of this section is to compare each of the four alternatives detailed above to each other with respect to the specific evaluation criteria. The following discussion will rate each of the alternatives with regard to the evaluation criteria, and identify the relative advantages and disadvantages of each. The tradeoffs among the different alternatives will be discussed.

This comparison will provide the information necessary to decide the appropriate alternative for this site.

The discussion is divided into two groups. The first group, the threshold criteria, include the overall protection of human health and the environment, and compliance with ARARs. The next group includes the remainder of the evaluation criteria: long term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment, short-term effectiveness, implementability, and cost.

5.7.2 Threshold Criteria

Each alternative must be assessed against the threshold criteria, which are overall protection of human health and the environment and compliance with ARARs, because both criteria must be met by any alternative in order to be eligible for selection.

All of the alternatives, except Alternative 1 (no-action), provide protection of human health and the environment. For Alternatives 4, 5, and 6, soils with concentrations of lead exceeding 500 mg/kg will be removed. Although the results of the human health baseline risk assessment determined that the total site non-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the on-site residential future use exposure scenario, removal of these soils (Case 1 through Case 5 soils) further reduces both risks. The indicator for noncarcinogenic risk, HI, for the future on-site residential exposure scenario is reduced from 0.33 to 0.11, which are both below the EPA target value of 1.0. The total site carcinogenic risk for the same exposure scenario is reduced from 1×10^{-5} to 9×10^{-6}.

Alternatives 4, 5, and 6 are also protective of the environment because sediments with lead and copper concentrations above the established NYSDEC criteria will be removed from Reeder Creek, and revegetation of the site and the sedimentation basin, which are required as part of the remedial action, will prevent recontamination of the creek. Furthermore, the removal of these sediments reduces the maximum concentrations of copper and lead for the reach of Reeder Creek affected by the OB grounds to 9.5 mg/kg and 10.5 mg/kg, respectively. These concentrations are considered to be protective of the aquatic life with the creek.

Alternatives 4, 5, and 6 prevent dermal contact with and ingestion of contaminated soils by removing surface soils with lead concentrations above the established clean-up goal of 500 mg/kg. These alternatives also prevent potential leaching of lead to the groundwater by removing the subsurface soils with lead concentrations above 500 mg/kg. This volume also includes soils with concentrations of constituents exceeding the TCLP criteria (Case 1). The removal of Case 1 through Case 5 soils reduces the maximum lead concentration in on-site soils to 463 mg/kg, which is below the established clean-up goal of 500 mg/kg.

All alternatives will meet all of their respective ARARs except the no action alternative.

5.7.3 Other Considerations

5.7.3.1 Long Term Effectiveness and Permanence

The criteria of long-term effectiveness addresses the long-term protectiveness to human health and the environment. Most of the detailed alternatives are highly effective in eliminating the long-term threats because they rely on treatment technologies to reduce the hazardous constituents in the soils. Alternatives 4, 5, and 6 will excavate all soils with unacceptable levels of lead and sediments from Reeder Creek with concentrations of copper and lead above the established criteria; Alternatives 4 and 5 will use a Subtitle D landfill and Alternative 6 will backfill the coarse fraction to the site. This coarse fraction will no longer contain concentrations of lead above 500 mg/kg. Alternative 6 is the most effective in eliminating the long-term threats because the soil washing process segregates the coarse and fine fractions, and all the hazardous constituents are sent off site in the fines fraction. This is a reliable technology which has been successfully utilized at similar sites. All three of the alternatives rely on some type of stabilization technology for the Case 1 soils, or fines fraction in the case of Alternative 6. This is considered to be technically feasible and when combined with landfilling, provides effective long term protection.

However, Alternatives 4 and 5 do not score as well as Alternative 6 because the long-term health risks associated with the Subtitle D landfills, which will be used for Alternatives 4 and 5, are not completely understood. Alternative 5, the on-site disposal alternative, was ranked next highest because this alternative involves treatment and construction of a new on-site landfill. Since this landfill would be on-site, it would be easy to monitor and maintain to assure long term effectiveness. The long term liabilities associated with off-site disposal, as for Alternative 4, would be eliminated. Alternative 1, the no action alternative, does not provide long-term protection of human health and the environment.

The rankings of the alternatives based on permanence are essentially the same as the rankings for long-term protectiveness. Since Alternatives 4, 5, and 6 provide treatment, they are essentially permanent. Alternatives 4 and 5 use landfills, which will require some long-term maintenance of the cap and groundwater monitoring. Alternative 1, the no action alternative is not permanent since no treatment is taking place.

5.7.3.2 Reduction of Toxicity, Mobility, or Volume

The alternatives are also compared with respect to the relative decreases in the toxicity, mobility, and volume of the hazardous constituents present at the site. Alternative 6, which uses the soil washing process, yields the greatest reduction in the toxicity by separating the fines and solidifying this smaller volume of material. The hazardous constituents are normally concentrated in the fines fraction of the soil which will be solidified. The solidification process is more effective for fines than large aggregate materials. Alternatives 4 and 5 also significantly decrease the toxicity, but only for the Case 1 soils. The solidification/stabilization process decreases the toxicity of the metals because the metals are converted to less soluble forms. Neither Alternative 4 or 5 completely treat all of the soils at the site. For both alternatives, 14,200 c.y. of untreated soils and sediments will be placed in a solid waste landfill. Alternative 1, the no action alternative, does not reduce the toxicity of the hazardous constituents.

Alternative 6 provides the best reductions in mobility. Once the fines fraction is solidified and landfilled, the hazardous constituents are essentially immobile. Alternatives 4 and 5 are similar in nature and were ranked the same. For Alternatives 4 and 5, approximately 14,200 c.y. of untreated soil are placed in a landfill, which will reduce the mobility of the hazardous constituents in the soils. Alternative 1, the no action alternative does nothing to reduce the mobility of the hazardous constituents.

Alternative 6 provides the greatest volume reduction of the contaminated soils. The hazardous constituents are concentrated in the fines fraction, which reduces the volume of the contaminated soil to approximately 30 percent of the original volume. Alternatives 4 and 5, which rely on solidification, do not score as well on volume reduction. The Case 1 soils are treated, which reduces the volume of hazardous soil, but the treatment residual (soil/cement mixture) has a greater volume than the initial untreated soil. Furthermore, the remaining soils which will be excavated and landfilled will increase in volume by approximately 20% as a result of the excavation process. In Alternative 1, the no action alternative, there is no volume decrease, but there is also no volume increase.

5.7.3.3 Short-term Effectiveness

Alternative 5 is expected to have the best short-term effectiveness because no hazardous materials are removed from the site, and only trained site workers would handle the soils. The soil washing alternative (Alternative 6) does not rate as well because of the necessity of greater handling of the contaminated soil, and because of the greater quantities of treatment residuals, such as spent wash water which must then be treated. Alternative 4 , in which the soils are not treated prior to being transported to the TSD facility also scores lower, because there is transport of approximately 3,800 c.y. of RCRA characteristic hazardous waste. Alternative 1, the no action alternative provides good short-term protection of human health because of the administrative controls currently in place, but provides no short-term protection of the environment.

5.7.3.4 Implementability

All of the alternatives score well on implementability. For technical feasibility, Alternative 1, the no action alternative, and Alternative 4, which relies on off site treatment and disposal of Case 1 soils, score the highest. Alternative 4 requires primarily standard earth moving equipment. Alternatives 4 and 5 are both easy to implement, since they require only standard construction equipment, though a large cement plant is required for these alternatives. Alternative 4 rates higher than Alternative 5 because it is easier to send the soils off site for disposal than to construct an on-site Subtitle D landfill. Alternative 6 is the most difficult to implement because of the need for specialized soil washing equipment, but there are enough soil washing vendors to ensure that this option is still viable.

The availability of the equipment, materials, and vendors is very good for all the alternatives. Alternative 4 rates the best on availability, because these materials are more available from local suppliers than the other alternatives. Alternative 6 scores the worst because there are less soil washing vendors than there are solidification vendors, but this will not preclude implementation of this alternative.

The last item to consider is agency approval. Alternative 6 is the best because of the greatest volume reduction. Alternatives 4 and 5 rate lower because of the work required to site and permit an on site landfill. Alternative 1, the no action alternative is the worst.

5.7.4 Cost

The last criteria to compare is cost. This comparison will evaluate the present worth costs of the alternatives, which are presented on Table 5-2. Alternative 4 is the least expensive with an estimated cost of $2.9 to $4.5 million. Alternative 5, which includes on-site solidification and disposal in a Subtitle D landfill, has a present cost of $4.5 million and Alternative 6 was the most costly, at an estimated cost of $9.9. A breakdown of these costs are provided in Appendix D.

5.8 CONCLUSIONS AND RECOMMENDATIONS

As described above, all of the alternatives described in the detailed analysis would be effective for the OB Grounds remedial action if the intended future use of the site were to be residential. Because SEDA was placed on the BRAC95 list, the residential exposure scenario was considered as a potential, worst-case, future land use. The baseline human health risk assessment indicates that, under the current and intended future use of the site, the risk-based carcinogenic and noncarcinogenic human health risk values are within EPA target ranges. Therefore, if risk-based health criteria are applied to the OB grounds, remedial objectives have been met with no further action.

However, the risk analysis could not consider the presence of lead in the soils. From the results of the UBK model, it was determined that the range of allowable lead in soil would be approximately 500 mg/kg to 1000 mg/kg for a residential exposure scenario. Based on the results of this study, a site specific remedial action objective for lead in soil of 500 mg/kg was established for the OB grounds as being protective of human health.

Based on the comparisons conducted for the ecological risk analysis, it was determined that a remedial action would be appropriate for copper and lead in sediments in order to protect the aquatic life and wildlife consumers of aquatic life. Remedial action objectives were established for lead and copper and were the Lowest Effect Levels presented in NYSDEC guidance document "Technical Guidance for Screening Contaminated Sediments, November, 1993."

Alternatives 4, 5, and 6 were determined to meet these site specific remedial action objectives for soil and sediments. That is, they are protective against ingestion of and dermal contact with soils having concentrations of lead above 500 mg/kg; prevent leaching of lead from the soil into the groundwater above the federal action level; and protect the ecological receptors within Reeder Creek.

Alternative 6 ranks highest for long-term protectiveness of human health and the environment, permanence, and reductions in toxicity, mobility, and volume of hazardous constituents. Alternative 4, which involves off-site disposal of the materials, ranks highest for implementability and cost. Furthermore, Alternative 4 is far less costly than Alternative 6. However, Alternative 4 ranks lowest for short-term protectiveness because all of the soils are transported off-site for disposal while Alternative 5 ranks highest for short-term protectiveness because no hazardous materials are transported from the site.

Table 5-2
Seneca Army Depot Activity
OB Feasibility Study
Cost Estimates for Alternatives

Alternative	Present Worth Cost	Capital Cost	O & M Costs
	(in millions)	(in millions)	
4	$2.9 to $4.5	$ 2.4 to $ 4.0	$45,300
5	$4.5	$4.0	$49,100
6	$ 9.9	$ 9.4	$45,300

APPENDIX A

ARARs, SCGs and TBCs

A.1 GENERAL

Pursuant to Section 300.400(g) of the NCP, the lead and support agencies shall identify applicable or relevant and appropriate requirements (ARARs) for the remedial action. ARARs are used to identify remedial action objectives, formulate remedial action alternatives, govern the implementation and operation of a selected remedial action, and evaluate the appropriate extent of site cleanup.

In New York State, the acronym ARARs is not used, but is replaced with the term New York State Standards, Criteria, and Guidelines (SCGs), as presented in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #HWR-90-4030. The removal action must be compatible with long-term remedial objectives at the site.

In 40 CFR 300.5, EPA defines applicable requirements as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are defined as those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, constituent, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Any standard, requirement, criterion, or limitation under any federal environmental or state environmental or facility siting law may be either applicable or relevant and appropriate to a specific action. The only state laws that may become ARARs are those promulgated such that they are legally enforceable and generally applicable and equivalent to or more stringent than federal laws. A determination of applicability is made for the requirements as a whole, whereas a determination of relevance and appropriateness may be made for only specific portions of a requirement. An action must comply with relevant and appropriate requirements to the same extent as an applicable requirement with regard to substantive conditions, but need not comply with the administrative conditions of the requirement.

Three categories of ARARs have been analyzed: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain chemicals or a class of chemicals and relate to concentrates of constituents allowed in various environmental media (water, soil, air). Location-specific ARARs are based on the specific setting and nature of the site. Action-specific ARARs relate to specific remedial actions proposed for a site. In addition to ARARs, advisories, criteria or guidance may be evaluated as "To Be Considered" (TBC) regulatory items. CERCLA indicates that the TBC category could include advisories, criteria or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies. These advisories, criteria or guidance that were developed by EPA, other federal agencies or states taht may be useful in developing CERCLA remedies. These advisories, criteria or guidance are not promulgated and therefore are not legally enforceable standards such as ARARs.

A.2 CHEMICAL-SPECIFIC ARARS AND TBCs

Chemical-specific ARARs are usually health or risk-based standards limiting the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing actual cleanup concentrations, or the basis for calculating such concentrations for specific media. These requirements may apply to air emissions during the removal action. A number of federal and state regulations may be used for this site. These include the following:

Air Quality

Remedial alternatives proposed for this site will not involve emissions; fugitive dust may be encountered during excavation and construction.

- NYSDEC TAGM HWR-89-4031 (TBC): Fugitive Dust Suppressino and Particulate Monitoring Program at Inactive Hazardous Waste Sites. This guidance provides a basis for developing and implementing a fugitive dust suppression and particulate monitoring program. The TAGM references the 40 CFR Par 50.6, Ambient Air Quality Standard for PM-10.

- 40 CFR Part 50.6 (applicable: Ambient Air Quality Standard for PM-10. PM-10 concentrations in the ambient air shall not exceed the following: 24-hour average, 150 micrograms per cubic meter of air; annual average, 50 micrograms per cubic meter of air.

Water Quality

There are a number of water quality standards which are potential ARARs for this remedial action, described as follows:

- 40 CFR Part 131 (applicable): Water Quality Standards. This part implements Section 101 of the Clean Water Act (CWA), which specifies the national goals of eliminating the discharge of pollutants, prohibiting the discharge of toxic pollutants in toxic amounts, and implementing programs for control of non-point sources.

- 40 CFR Part 131.12 (applicable): Anti-degradation Policy. Establishes standards to prevent a body of water which has an existing high standard from degrading to a lower standard.

- 40 CFR Part 141 (applicable): National Primary Drinking Water Regulations. This part establishes primary drinking water regulators pursuant to Section 1412 of the Public Health Service Act as amended by the Safe Drinking Water Act.

- 40 CFR Part 141.11 (applicable): Maximum Inorganic Chemical Contaminant Levels. This section establishes maximum contaminant levels (MCLs) for inorganic chemicals including the following:

Constituent	Level (mg/L)
Arsenic	0.05
Barium	2.0
Cadmium	0.005
Chromium	0.10
Lead	Treatment technique
Mercury	0.002
Selenium	0.05

- 40 CFR Part 141.12 (applicable): Maximum Organic Chemical Contaminant Levels. This section establishes MCLs for organic chemicals including the following:

Constituent	Level (mg/L)
TCE	0.005
Benzene	0.005
Total trihalomethanes	0.10

- 40 CFR Part 264 Subpart F (relevant and appropriate): Releases from Solid Waste Management Units. Standards for protection of groundwater are established under this citation.

- 40 CFR Part 403 (applicable): Pretreatment Standards for the Discharge of Treated Site Water to a Publicly Owned Treatment Works (POTW). This part establishes pretreatment standards for the discharge of wastewater to POTWs.

- 6 NYCRR Chapter X (relevant and appropriate): This chapter establishes the requirements of the State Pollutant Discharge Elimination System (SPDES).

- 6 NYCRR subparts 701 and 702 (applicable): These subparts establish surface water standards for protection of drinking water and aquatic life.

- 6 NYCRR subpart 703 (applicable): This subpart establishes groundwater standards specified to protect groundwater for drinking water purposes.

- 6 NYCRR subpart 375 (relevant and appropriate): This subpart contains the New York State rules for inactive hazardous waste disposal sites.

- 6 NYCRR subpart 373-2.6 and 373-2.11 (applicable): This regulation requires groundwater monitoring for releases from solid waste management units.

- 6 NYCRR subpart 373-2 (relevant and appropriate): This regulation establishes postclosure care and groundwater monitoring requirements.

- 10 NYCRR Part 5 (relevant and appropriate): This regulation establishes criteria for drinking water supplies.

- NYSDEC TOGS 1.1.1 (relevant and appropriate): This document compiles water quality standards and guidance values for use in NYSDEC programs.

Soil Quality

- 40 CFR parts 264.552 and 264.553: (relevant and applicable): Corrective Action for Solid Waste Management Action for Solid Waste Management Units. Allows for the consolidation of wastes, or the replacement of remediated wastes in land based units without invoking the RCRA land-disposal requirement of 40 CFR 268.

- 40 CFR Part 264, Subpart X - Miscellaneous Units: RCRA Closure and Post-Closure Requirements.

- 6 NYCRR subpart 375 (relevant and appropriate): This subpart contains the New York State rules for inactive hazardous waste disposal sites.

- NYSDEC TAGM HWR-94-4046 (TBC): Specifically, cleanup concentrations for hazardous constituents in soil have been proposed by the State of New York through Technical and Administrative Guidance Manuals (TAGMs). Any soil or sediment that is treated for re-use on-site as backfill must meet TAGM concentrations.

PCBs

- 40 Part 761 (TBC): Polychlorinated Biphenyls (PCBs) Manufacturing, processing, distribution in commerce and use prohibition. This part establish and the requirements for the storage and disposal of PCBs. No action is required in regards to this regulation.

- 40 Part 761 subpart G (TBC): PCB Spill Clean Up Policy, This regulation establishes criteria EPA will use to determine the adequacy of the clean up of spills resulting from the release of materials containing PCBs. No action is required in regards to this regulation since the concentrations of PCBs at the OB Grounds are less than 50 ppm.

A.3 LOCATION-SPECIFIC ARARS

Location-specific ARARs govern natural site features such as wetlands, floodplains, and sensitive ecosystems, and manmade features such as landfills, disposal areas, and places of historic or archaeological significance. These ARARs generally restrict the concentration of hazardous substances or the conduct of activities based solely on the particular characteristics or location of the site. Federal and State regulations which may apply to this remedial action include the following:

Endangered Species

- 40 CFR Part 257.3-2 (relevant and appropriate): Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species.

Location Standards

- 40 CFR Part 264.18 (relevant and appropriate): Location Standards for Hazardous Waste Facilities. The general requirements for locating a hazardous treatment, storage, or disposal facility are found in this section. They include provisions for seismic considerations and floodplains.

- 40 CFR Part 241.202 (applicable): Site selection shall be consistent with public health and welfare. It shall also be consistent with land-use plans and air and water quality standards.

- Wetlands Executive Order (EO1199) (applicable): Under this regulation federal agencies are required to minimize the destruction, loss, or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands. Consideration: Remedial alternative that involve construction must include all practical means of minimizing harm to wetlands.

Antiquities

- 16 USC Part 469a-1 (applicable): The Archaeological and Historic Preservation Act requires that action be taken to recover and preserve artifacts.

- 36 CFR Part 800 (relevant and appropriate): Action must be taken to preserve historic properties. Actions must be planned to minimize harm to national historic landmarks.

A.4 ACTION-SPECIFIC ARARS

Action-specific ARARs are usually technology- or activity-based limitations that control actions at hazardous waste sites. Action-specific ARARs generally set performance or design standards, controls, or restrictions on particular types of activities. To develop technically feasible alternatives, applicable performance or design standards must be considered during the development of all remedial alternatives. Action—specific ARARs are applicable to this site. The action-specific ARARs to be used will be determined by the Army based upon the technology chosen. Federal and State regulations which may apply include the following:

Solid Waste Management

- 40 part CFR 241.100 (relevant and appropriate): Guidelines for the Land Disposal of Solid Wastes. These regulations are geared specifically toward sanitary landfills; however, they are applicable to all forms of land disposal and land-based treatment.

- 40 CFR Part 241.204 (applicable): Water Quality. The location, design, construction, and operation of land disposal facilities shall protect water quality.

- 40 CFR Part 241.205 (applicable): The design, construction, and operation of land disposal facilities shall conform to air quality and source control standards.

- 40 CFR Part 257.1 (relevant and appropriate): This part establishes the scope and purpose of criteria for use in assessing the possibility of adverse effects on health or the environment from solid waste disposal operations.

- 40 CFR Part 257.3 (relevant and appropriate): This part establishes criteria to assess the impact of disposal operations, including such considerations as floodplains, endangered species, air, surface water, groundwater, and land used for food-chain crops.

- 40 CFR Part 243.202 (relevant and appropriate): This part specifies the requirements for transporting solid waste, including provisions to prevent spillage.

- 6 NYCRR Part 360 (applicable): This part specifies the requirements for solid waste management facilities in New York.

Hazardous Waste Management

- 40 CFR 261 (applicable): Standards for the Identification and Listing of Hazardous Waste are applicable to the proper characterization of solid waste generated as a result of the remedial actions.

- 40 CFR 262.11 (applicable): This regulation requires a person who generates a solid waste to determine if that waste is a hazardous waste.

- 40 CFR 262 Subparts B, C, and D (applicable): These regulations apply to off-site disposal actions for hazardous wastes.

- 40 CFR Part 263.30 and 263.31 (relevant and appropriate): These regulations set forth the standards and requirements for action in the event of a release during transport.

- 40 CFR Part 264 (relevant and appropriate): This part establishes hazardous waste management facility standards and requirements. The onsite disposal areas used for stockpiling, mixing, and extended bioremediation of wastes must meet the substantive requirements of 40 CFR subparts B (general facility standards), E (manifest system, record keeping, and reporting), F (releases from solid waste management units), G (closure and postclosure), L (waste piles), M (land treatment), N (landfills) and X (Miscellaneous Units). These regulations are applicable for hazardous wastes and are also relevant and appropriate for certain wastes which are not hazardous wastes.

- 40 CFR Part 268 (relevant and appropriate): Land Disposal Restrictions. Restricts the disposal of listed and characteristic hazardous waste which contain hazardous constituents exceeding designated concentrations. Only applies when the waste is "placed" on the land. There are indications from previous study of the site that some of the soil and sediment may be hazardous due to toxicity characteristic. Land Disposal Restrictions (LDR) mandate treatment of contaminated soils, which are removed, to eliminate this characteristic prior to any disposal.

- 40 CFR Part 270 subpart C (relevant and appropriate): This regulation establishes permit conditions, including monitoring, recordkeeping requirements, operation and maintenance requirements, sampling, and monitoring requirements. Although no permit is required for activities conducted entirely on site, the substantive requirements of these provisions are relevant and appropriate.

- 40 CFR Part 270 subpart B (relevant and appropriate): This part defines the required contents of a hazardous waste management permit application. The substantive requirements of these provisions are relevant and appropriate.

Occupational Health and Safety Administration

- 29 CFR Part 1910.50 (applicable): Occupational Noise. No worker shall be exposed to noise levels in excess of the levels specified in this regulation.

- 29 CFR Part 1910.1000 (applicable): Occupational Air Contaminants. The purpose of this rule is to establish standards for air contaminants called permissible exposure limits (PELs), which are legally enforceable, 8 hour time weighted averages of which no employees' exposure may exceed in any 8 hour shift of a 40 hour work week. Threshold Limit Values (TLVs), on the other hand, are not legally enforceable, but are considered to represent conditions under which it is believed all workers may be repeatedly exposed without adverse effect. In some instances, there may be disparity in the PELs and TLVs. It is the Army Corps of Engineers policy that the most stringent of the exposure limits should be used.

- 29 CFR Part 1910.1025 (applicable): This section applies to occupational exposure to lead.

- 29 CFR Part 1910.1200 (applicable): This part requires that each employer compile and maintain a workplace chemical list which contains the chemical name of each hazardous chemical in the workplace, cross-referenced to generally used common names. This list must indicate the work area in which each such hazardous chemical is stored or used. Employees must be provided with information and training regarding the hazardous chemicals.

- 29 CFR Part 120 (applicable): This part applies to employers and employees engaged in sites that have been designated for cleanup, and other work related to

RCRA and CERCLA. The regulation establishes proceedings for site characterization and control, and requirements for employee training and medical monitoring.

- 49 CFR Part 1926 (applicable): Construction safety standards. 49 CFR Part 1926.62 (applicable): Applies to all construction work where an employee may be occupationaly exposed to lead.

Transportation of Hazardous Waste

- 49 CFR Part 171 (applicable): General information, regulations, and definitions. This regulation prescribes the requirements of the DOT governing the transportation of hazardous material.

- 40 CFR Part 172 (applicable): Hazardous materials table, special provisions, Hazardous Materials Communications, Emergency Response Information, and Training requirements. This regulation lists and classifies those materials which the DOT has designated to be hazardous materials for the purpose of transportation and prescribes the requirements for shipping papers, package marking, labeling and transport vehicle placarding applicable to the shipment and transportation of those hazardous materials.

- 49 CFR Part 173 (applicable): General DOT requirements for shipment and packaging.

- 49 CFR Part 177 (applicable): Carriage by Public Highway. This regulation prescribes requirements that are applicable to the acceptance and transportation of hazardous materials by private, common, or contract carriers by motor vehicle.

- 6 NYCRR Chapter 364 (applicable): New York Waste Transport Permit Regulation. This regulation governs the collection, transport, and delivery of regulated waste originating on terminating within the state of New York.

- EPA/DOT Guidance Manual on hazardous waste transportation (TBC):

Incineration

- 40 CFR Part 264 Subpart O (relevant and appropriate): This regulation establishes performance standards and monitoring requirements for hazardous waste incinerators.

- 6 NYCRR Subpart 373-2.15 (relevant and appropriate): This regulation establishes performance standards and monitoring requirements for hazardous waste incinerators for New York State.

APPENDIX B

BACKUP RISK CALCULATIONS FOR SOIL EXCAVATION CASES

Baseline Risk Case

BASELINE CASE

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	208	1,300.00	300.38	283.51	147.91	0.52	NORMAL	300.38
3-Nitroaniline	ug/kg	209	2,950.00	1,269.92	1,187.99	719.99	0.61	NORMAL	1,269.92
2,4-Dinitrotoluene	ug/kg	216	33,000.00	698.13	848.61	2,572.77	3.03	LOGNORMAL	698.13
Phenanthrene	ug/kg	213	2,600.00	318.84	292.35	235.06	0.80	NORMAL	318.84
Benzo(a)anthracene	ug/kg	207	3,900.00	348.74	313.43	308.90	0.99	NORMAL	348.74
Chrysene	ug/kg	209	8,900.00	350.63	339.84	628.10	1.85	LOGNORMAL	350.63
Benzo(b)fluoranthene	ug/kg	207	11,000.00	352.57	352.59	792.72	2.25	LOGNORMAL	352.57
benzo(k)fluoranthene	ug/kg	207	4,500.00	333.52	317.58	356.60	1.12	LOGNORMAL	333.52
Benzo(a)pyrene	ug/kg	207	3,700.00	350.19	314.43	312.80	0.99	NORMAL	350.19
Indeno(1,2,3-cd)pyrene	ug/kg	206	2,300.00	327.40	304.97	195.75	0.64	NORMAL	327.40
Dibenz(a,h)anthracene	ug/kg	201	670.00	301.48	289.95	99.44	0.34	NORMAL	301.48
Benzo(g,h,i)perylene	ug/kg	202	960.00	301.77	293.60	115.13	0.39	NORMAL	301.77
Pesticides/PCBs									
Dieldrin	ug/kg	211	50.00	11.56	10.61	8.89	0.84	NORMAL	11.56
4,4'-DDE	ug/kg	214	830.00	17.97	16.55	57.77	3.49	LOGNORMAL	17.97
4,4'-DDT	ug/kg	215	2,800.00	18.66	26.41	191.56	7.25	LOGNORMAL	18.66
Explosives									
RDX	ug/kg	217	4,800.00	91.42	121.24	396.34	3.27	LOGNORMAL	91.42
1,3,5-Trinitrobenzene	ug/kg	217	7,800.00	110.19	172.72	742.91	4.30	LOGNORMAL	110.19
Tetryl	ug/kg	217	1,000.00	149.59	137.79	105.71	0.77	NORMAL	149.59
2,4,6-Trinitrotoluene	ug/kg	217	80,000.00	130.68	607.24	5,684.72	9.36	LOGNORMAL	130.68
4-amino-2,6-Dinitrotoluene	ug/kg	217	8,900.00	130.03	181.53	665.01	3.66	LOGNORMAL	130.03
2-amino-4,6-Dinitrotoluene	ug/kg	217	11,000.00	143.50	212.08	821.54	3.87	LOGNORMAL	143.50
Metals									
Barium	mg/kg	194	34,400.00	1,445.67	1,479.39	4,100.07	2.77	LOGNORMAL	1,445.67
Cadmium	mg/kg	217	28.20	5.74	3.49	4.59	1.32	LOGNORMAL	5.74
Chromium	mg/kg	198	1,430.00	31.62	35.98	101.67	2.83	LOGNORMAL	31.62
Copper	mg/kg	211	38,100.00	678.04	796.94	3,166.79	3.97	LOGNORMAL	678.04
Lead	mg/kg	208	56,700.00	2,836.27	1,888.27	5,966.04	3.16	LOGNORMAL	2,836.27
Thallium	mg/kg	214	38.00	0.32	0.46	2.58	5.62	LOGNORMAL	0.32
Zinc	mg/kg	216	127,000.00	884.31	1,317.65	8,713.76	6.61	LOGNORMAL	884.31

BASELINE CASE

**CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semi-volatiles											
Methylnaphthalene, 2-			3.00E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.27E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	2.0E-06		6.98E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.19E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.5E-07	3.49E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.5E-07	3.51E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.5E-07	3.53E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.4E-07	3.34E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.5E-07	3.50E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.3E-07	3.27E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.0E-07	3.01E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			3.02E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.3E-08	1.2E-08	1.16E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		1.8E-08	1.80E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	5.3E-08	1.9E-08	1.87E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.6E-07	9.2E-08	9.14E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	3.1E-07		1.10E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.50E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	3.7E-07	1.3E-07	1.31E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			1.30E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			1.43E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	4.1E-03		1.45E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	1.6E-05		5.74E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	8.9E-05		3.16E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	1.9E-03		6.78E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			2.84E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	9.1E-07		3.23E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.5E-03		8.84E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/yr)	150 events/year
IR = Ingestion Rate (mg soil/day)	480	ED = Exposure Duration (years)	25 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)

BASELINE CASE

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	2.9E-06		5.74E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: **Absorbed Dose (mg/kg-day) =**

$$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	2.0E-06		2.0E-03	NA	9.8E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.5E-07	NA	7.3E-01		2.6E-07
Chrysene		3.5E-07	NA	7.3E-02		2.6E-08
Benzo(b)fluoranthene		3.5E-07	NA	7.3E-01		2.6E-07
Benzo(k)fluoranthene		3.4E-07	NA	7.3E-01		2.5E-07
Benzo(a)pyrene		3.5E-07	NA	7.3E+00		2.6E-06
Indeno(1,2,3-cd)pyrene		3.3E-07	NA	7.3E-01		2.4E-07
Dibenzo(a,h)anthracene		3.0E-07	NA	7.3E+00		2.2E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.3E-08	1.2E-08	5.0E-05	1.6E+01	6.5E-04	1.9E-07
4,4'-DDE		1.8E-08	NA	3.4E-01		6.2E-09
4,4'-DDT	5.3E-08	1.9E-08	5.0E-04	3.4E-01	1.1E-04	6.4E-09
Explosives						
RDX	2.6E-07	9.2E-08	3.0E-03	1.1E-01	8.6E-05	1.0E-08
1,3,5-Trinitrobenzene	3.1E-07		5.0E-05	NA	6.2E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	3.7E-07	1.3E-07	5.0E-04	3.0E-02	7.4E-04	3.9E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	4.1E-03		7.0E-02	NA	5.8E-02	
Cadmium	1.6E-05		5.0E-04	NA	3.2E-02	
Chromium	8.9E-05		5.0E-03	NA	1.8E-02	
Copper	1.9E-03		4.0E-02	NA	4.8E-02	
Lead			NA	NA		
Thallium	9.1E-07		9.0E-05	NA	1.0E-02	
Zinc	2.5E-03		3.0E-01	NA	8.3E-03	
Totals - HQ & CR					**1.8E-01**	**6.0E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	2.9E-06		5.0E-04	NA	5.8E-03	
Totals - HQ & CR					**5.8E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING) FROM DERMAL CONTACT TO SURFACE WATER INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-08	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING) FROM DERMAL CONTACT TO SURFACE WATER RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.88E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	19400	ED = Exposure Duration (years)	30
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)	CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70
		AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	490.00	411.83	314.63	411.83
Phenanthrene	ug/kg	490.00	396.75	269.38	396.75
Benzo(a)anthracene	ug/kg	490.00	407.76	336.25	407.76
Benzo(b)fluoranthene	ug/kg	490.00	407.76	336.25	407.76
benzo(k)fluoranthene	ug/kg	490.00	407.76	336.25	407.76
Benzo(a)pyrene	ug/kg	490.00	407.76	336.25	407.76
Indeno(1,2,3-cd)pyrene	ug/kg	490.00	407.76	336.25	407.76
Explosives					
4-amino-2,6-Dinitrotoluen	ug/kg	60.00	60.00	60.00	60.00
2-amino-4,6-Dinitrotoluen	ug/kg	60.00	60.00	60.00	60.00
Metals					
Aluminum	mg/kg	15,600.00	12,202.89	10,104.50	12,202.89
Antimony	mg/kg	4.05	4.06	3.71	4.05
Arsenic	mg/kg	7.40	6.66	5.28	6.66
Barium	mg/kg	94.80	66.24	47.33	66.24
Beryllium	mg/kg	0.71	0.65	0.47	0.65
Cadmium	mg/kg	3.40	2.27	1.71	2.27
Chromium	mg/kg	24.50	22.85	18.08	22.85
Cobalt	mg/kg	11.20	10.23	8.03	10.23
Copper	mg/kg	2,380.00	1,032.68	262.51	1,032.68
Lead	mg/kg	332.00	418.55	94.17	332.00
Manganese	mg/kg	596.00	474.62	420.00	474.62
Mercury	mg/kg	0.69	1.22	0.20	0.69
Nickel	mg/kg	42.30	37.97	29.62	37.97
Selenium	mg/kg	1.40	1.02	0.62	1.02
Vanadium	mg/kg	20.10	18.02	13.90	18.02
Zinc	mg/kg	497.00	899.80	148.22	497.00

BASELINE CASE, CASE 1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	362.54	312.35	362.54
Phenanthrene	ug/kg	600.00	395.15	330.85	395.15
Benzo(a)anthracene	ug/kg	500.00	366.89	311.28	366.89
Benzo(b)fluoranthene	ug/kg	500.00	366.93	311.50	366.93
benzo(k)fluoranthene	ug/kg	500.00	366.95	311.61	366.95
Benzo(a)pyrene	ug/kg	500.00	366.78	310.72	366.78
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	366.77	310.67	366.77
Explosives					
4-amino-2,6-Dinitrotoluen	ug/kg	160.00	72.20	64.55	72.20
2-amino-4,6-Dinitrotoluen	ug/kg	180.00	75.88	66.59	75.88
Metals					
Aluminum	mg/kg	25,800.00	17,742.74	16,486.36	17,742.74
Antimony	mg/kg	28.30	10.60	7.25	10.60
Arsenic	mg/kg	9.50	5.66	4.85	5.66
Barium	mg/kg	1,780.00	366.08	271.98	366.08
Beryllium	mg/kg	1.60	1.09	0.98	1.09
Cadmium	mg/kg	9.70	3.38	2.55	3.38
Chromium	mg/kg	41.80	26.72	24.56	26.72
Cobalt	mg/kg	17.70	12.70	11.64	12.70
Copper	mg/kg	3,790.00	489.13	288.04	489.13
Lead	mg/kg	7,400.00	1,674.71	526.09	1,674.71
Manganese	mg/kg	1,520.00	597.58	502.05	597.58
Mercury	mg/kg	2.00	0.93	0.32	0.93
Nickel	mg/kg	64.40	40.25	36.55	40.25
Selenium	mg/kg	1.80	0.91	0.73	0.91
Vanadium	mg/kg	37.90	27.22	25.23	27.22
Zinc	mg/kg	1,200.00	446.43	273.22	446.43

BASELINE CASE, CASE 1

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

BASELINE CASE, CASE 1

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Semivolatiles											
Methylnaphthalene, 2-			4.12E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Phenanthrene			3.97E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(a)anthracene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(b)fluoranthene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(k)fluoranthene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(a)pyrene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Explosives											
Dinitrotoluene, 2,6-, 4-amino-			6.00E-02	100	1.0E-06	1	7	30	70	10,950	25,550
Dinitrotoluene, 4,6,- 2-amino-			6.00E-02	100	1.0E-06	1	7	30	70	10,950	25,550
Metals											
Aluminum			1.22E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Antimony	1.1E-07		4.05E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.8E-07	7.8E-08	6.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.8E-06		6.62E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	1.8E-08	7.7E-09	6.54E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	6.2E-08		2.27E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	6.3E-07		2.28E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.02E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	2.8E-05		1.03E+03	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			3.32E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.3E-05		4.75E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	1.9E-08		6.90E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.80E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	2.8E-08		1.02E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.9E-07		1.80E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	1.4E-05		4.97E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chem. Conc. in Sediment (mg/kg-soil)	**95th UCL Sediment Data**	**EF = Exposure Frequency (days/year)**	**7 events/year**
IR = Ingestion Rate (mg soil/day)	**100**	**ED = Exposure Duration (years)**	**30 years**
CF = Conversion Factor (10-6 kg/mg)	**10-6**	**BW = Bodyweight (kg)**	**70 kg**
FI = Fraction Ingested (unitless)	**1**	**AT = Averaging Time (days)**	**30 x 365 (NC) 70 x 365 (C)**

BASELINE CASE, CASE 1

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	3.3E-07		2.27E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

BASELINE CASE, CASE 1

**CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(b)fluoranthene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(k)fluoranthene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(a)pyrene		4.8E-09	NA	7.3E+00		3.5E-08
Indeno(1,2,3-cd)pyrene		4.8E-09	NA	7.3E-01		3.5E-09
Explosives						
Dinitrotoluene, 2,6-, 4-amino-			NA	NA		
Dinitrotoluene, 4,6-, 2-amino-			NA	NA		
Metals						
Aluminum			NA	NA		
Antimony	1.1E-07		4.0E-04	NA	2.8E-04	
Arsenic	1.8E-07	7.8E-08	3.0E-04	1.8E+00	6.1E-04	1.4E-07
Barium	1.8E-06		7.0E-02	NA	2.6E-05	
Beryllium	1.8E-08	7.7E-09	5.0E-03	4.3E+00	3.6E-06	3.3E-08
Cadmium	6.2E-08		5.0E-04	NA	1.2E-04	
Chromium	6.3E-07		5.0E-03	NA	1.3E-04	
Cobalt			NA	NA		
Copper	2.8E-05		4.0E-02	NA	7.1E-04	
Lead			NA	NA		
Manganese	1.3E-05		5.0E-03	NA	2.6E-03	
Mercury	1.9E-08		3.0E-04	NA	6.3E-05	
Nickel			NA	NA		
Selenium	2.8E-08		5.0E-03	NA	5.6E-06	
Vanadium	4.9E-07		7.0E-03	NA	7.1E-05	
Zinc	1.4E-05		3.0E-01	NA	4.5E-05	
Totals - HQ & CR					**4.7E-03**	**2.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	3.3E-07		5.0E-04	NA	6.7E-04	
Totals - HQ & CR					**6.7E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE CASE

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	2.22E-05	5.14E-06	4.85E-06	5.14E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.17E-05	2.03E-05	2.17E-05
Dinitrotoluene, 2,4-	ug/m3	5.65E-04	1.20E-05	1.45E-05	1.20E-05
Phenanthrene	ug/m3	4.45E-05	5.45E-06	5.00E-06	5.45E-06
Benzo(a)anthracene	ug/m3	6.67E-05	5.97E-06	5.36E-06	5.97E-06
Chrysene	ug/m3	1.52E-04	6.00E-06	5.81E-06	6.00E-06
Benzo(b)fluoranthene	ug/m3	1.88E-04	6.03E-06	6.03E-06	6.03E-06
Benzo(k)fluoranthene	ug/m3	7.70E-05	5.71E-06	5.43E-06	5.71E-06
Benzo(a)pyrene	ug/m3	6.33E-05	5.99E-06	5.38E-06	5.99E-06
Indeno(1,2,3-cd)pyrene	ug/m3	3.94E-05	5.60E-06	5.22E-06	5.60E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.16E-06	4.96E-06	5.16E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	5.16E-06	5.02E-06	5.16E-06
Pesticides/PCBs					
Dieldrin	ug/m3	8.55E-07	1.98E-07	1.82E-07	1.98E-07
4,4'-DDE	ug/m3	1.42E-05	3.08E-07	2.83E-07	3.08E-07
4,4'-DDT	ug/m3	4.79E-05	3.19E-07	4.52E-07	3.19E-07
Explosives					
RDX	ug/m3	8.21E-05	1.56E-06	2.07E-06	1.56E-06
1,3,5-Trinitrobenzene	ug/m3	1.33E-04	1.89E-06	2.96E-06	1.89E-06
Tetryl	ug/m3	1.71E-05	2.56E-06	2.36E-06	2.56E-06
2,4,6-Trinitrotoluene	ug/m3	1.37E-03	2.24E-06	1.04E-05	2.24E-06
4-amino-2,6-Dinitrotoluene	ug/m3	1.52E-04	2.22E-06	3.11E-06	2.22E-06
2-amino-4,6-Dinitrotoluene	ug/m3	1.88E-04	2.46E-06	3.63E-06	2.46E-06
Metals					
Barium	ug/m3	5.89E-01	2.47E-02	2.53E-02	2.47E-02
Cadmium	ug/m3	4.82E-04	1.20E-02	5.97E-05	4.82E-04
Chromium	ug/m3	2.45E-02	4.85E-02	6.16E-04	2.45E-02
Copper	ug/m3	6.52E-01	1.20E-02	1.36E-02	1.20E-02
Lead	ug/m3	9.70E-01	4.85E-02	3.23E-02	4.85E-02
Thallium	ug/m3	6.50E-04	5.53E-06	7.85E-06	5.53E-06
Zinc	ug/m3	2.17E+00	1.51E-02	2.25E-02	1.51E-02

BASELINE CASE

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles									
Methylnaphthalene, 2-			5.14E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.17E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			1.20E-05	20	150	25	70	9,125	25,550
Phenanthrene			5.45E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			5.97E-06	20	150	25	70	9,125	25,550
Chrysene			6.00E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			6.03E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.71E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			5.99E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.60E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.16E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			5.16E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		8.3E-12	1.98E-07	20	150	25	70	9,125	25,550
4,4'-DDE		1.3E-11	3.08E-07	20	150	25	70	9,125	25,550
4,4'-DDT		1.3E-11	3.19E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.56E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.89E-06	20	150	25	70	9,125	25,550
Tetryl			2.56E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			2.24E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			2.22E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			2.46E-06	20	150	25	70	9,125	25,550
Metals									
Barium	2.9E-06		2.47E-02	20	150	25	70	9,125	25,550
Cadmium		2.0E-08	4.82E-04	20	150	25	70	9,125	25,550
Chromium		1.0E-06	2.45E-02	20	150	25	70	9,125	25,550
Copper			1.20E-02	20	150	25	70	9,125	25,550
Lead			4.85E-02	20	150	25	70	9,125	25,550
Thallium			5.53E-06	20	150	25	70	9,125	25,550
Zinc			1.51E-02	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	**95% UCL Air Model Data**
IR = Inhalation Rate (m3/day)	**20**
EF = Exposure Frequency (days/yr)	**150**
ED = Exposure Duration (years)	**25**
BW = Bodyweight (kg)	**70**
AT = Averaging Time (days)	**25 x 365 (Nc) 70 x 365 (Car)**

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		8.3E-12	NA	1.6E+01		1.3E-10
4,4'-DDE		1.3E-11	NA	3.4E-01		4.4E-12
4,4'-DDT		1.3E-11	NA	3.4E-01		4.5E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	2.9E-06		1.4E-04	NA	2.0E-02	
Cadmium		2.0E-08	NA	6.3E+00		1.3E-07
Chromium		1.0E-06	NA	4.2E-02		4.3E-08
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**2.0E-02**	**1.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

BASELINE CASE

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	8.5E-06	2.3E-06	1.5E-05		6.8E-06	2.3E-06	5.74E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	6 Child, 24 Adult
SA = Surface Area Contact (cm2)	1510(C)/3120(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF = Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	6 x 365 (Nc)+ 24 x 365 (Nc)
ABS = Absorption Factor (unitless)	varies (1-25%)		70 x 365 (Car)

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.7E-07	NA	NA		
3-Nitroaniline	4.6E-06	2.0E-06	NA	NA		
Dinitrotoluene, 2,4-	2.6E-06	1.1E-06	2.0E-03	NA	1.3E-03	
Phenanthrene	1.2E-06	5.0E-07	NA	NA		
Benzo(a)anthracene	1.3E-06	5.5E-07	NA	7.3E-01		4.0E-07
Chrysene	1.3E-06	5.5E-07	NA	7.3E-02		4.0E-08
Benzo(b)fluoranthene	1.3E-06	5.5E-07	NA	7.3E-01		4.0E-07
Benzo(k)fluoranthene	1.2E-06	5.2E-07	NA	7.3E-01		3.8E-07
Benzo(a)pyrene	1.3E-06	5.5E-07	NA	7.3E+00		4.0E-06
Indeno(1,2,3-cd)pyrene	1.2E-06	5.1E-07	NA	7.3E-01		3.7E-07
Dibenzo(a,h)anthracene	1.1E-06	4.7E-07	NA	7.3E+00		3.4E-06
Benzo(g,h,i)perylene	1.1E-06	4.7E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	4.2E-08	1.8E-08	5.0E-05	1.6E+01	8.4E-04	2.9E-07
4,4'-DDE	6.6E-08	2.8E-08	NA	3.4E-01		9.6E-09
4,4'-DDT	6.8E-08	2.9E-08	5.0E-04	3.4E-01	1.4E-04	9.9E-09
Explosives						
RDX	3.3E-07	1.4E-07	3.0E-03	1.1E-01	1.1E-04	1.6E-08
1,3,5-Trinitrobenzene	4.0E-07	1.7E-07	5.0E-05	NA	8.1E-03	
Tetryl	5.5E-07	2.3E-07	NA	NA		
Trinitrotoluene, 2,4,6-	4.8E-07	2.0E-07	5.0E-04	3.0E-02	9.5E-04	6.1E-09
Dinitrotoluene, 2,6-, 4-ami	4.7E-07	2.0E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	5.2E-07	2.2E-07	NA	NA		
Metals						
Barium	5.3E-03	2.3E-03	7.0E-02	NA	7.5E-02	
Cadmium	2.1E-05	9.0E-06	5.0E-04	NA	4.2E-02	
Chromium	1.2E-04	5.0E-05	5.0E-03	NA	2.3E-02	
Copper	2.5E-03	1.1E-03	4.0E-02	NA	6.2E-02	
Lead	1.0E-02	4.4E-03	NA	NA		
Thallium	1.2E-06	5.1E-07	9.0E-05	NA	1.3E-02	
Zinc	3.2E-03	1.4E-03	3.0E-01	NA	1.1E-02	
Totals - HQ & CR					**2.4E-01**	**9.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE CASE

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.7E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	3.00E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.6E-06	2.0E-06	1.6E-05	1.4E-06	1.7E-06	6.0E-07	1.27E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	2.6E-06	1.1E-06	8.9E-06	7.7E-07	9.6E-07	3.3E-07	6.98E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.2E-06	5.0E-07	4.1E-06	3.5E-07	4.4E-07	1.5E-07	3.19E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.3E-06	5.5E-07	4.5E-06	3.8E-07	4.8E-07	1.6E-07	3.49E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.3E-06	5.5E-07	4.5E-06	3.8E-07	4.8E-07	1.6E-07	3.51E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.3E-06	5.5E-07	4.5E-06	3.9E-07	4.8E-07	1.7E-07	3.53E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.2E-06	5.2E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.34E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.3E-06	5.5E-07	4.5E-06	3.8E-07	4.8E-07	1.6E-07	3.50E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.27E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.7E-07	3.9E-06	3.3E-07	4.1E-07	1.4E-07	3.01E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.7E-07	3.9E-06	3.3E-07	4.1E-07	1.4E-07	3.02E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	4.2E-08	1.8E-08	1.5E-07	1.3E-08	1.6E-08	5.4E-09	1.16E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	6.6E-08	2.8E-08	2.3E-07	2.0E-08	2.5E-08	8.4E-09	1.80E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	6.8E-08	2.9E-08	2.4E-07	2.0E-08	2.6E-08	8.8E-09	1.87E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	3.3E-07	1.4E-07	1.2E-06	1.0E-07	1.3E-07	4.3E-08	9.14E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	4.0E-07	1.7E-07	1.4E-06	1.2E-07	1.5E-07	5.2E-08	1.10E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	5.5E-07	2.3E-07	1.9E-06	1.6E-07	2.0E-07	7.0E-08	1.50E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	4.8E-07	2.0E-07	1.7E-06	1.4E-07	1.8E-07	6.1E-08	1.31E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-amin	4.7E-07	2.0E-07	1.7E-06	1.4E-07	1.8E-07	6.1E-08	1.30E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-amin	5.2E-07	2.2E-07	1.8E-06	1.6E-07	2.0E-07	6.7E-08	1.43E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	5.3E-03	2.3E-03	1.8E-02	1.6E-03	2.0E-03	6.8E-04	1.45E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	2.1E-05	9.0E-06	7.3E-05	6.3E-06	7.9E-06	2.7E-06	5.74E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.2E-04	5.0E-05	4.0E-04	3.5E-05	4.3E-05	1.5E-05	3.16E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	2.5E-03	1.1E-03	8.7E-03	7.4E-04	9.3E-04	3.2E-04	6.78E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	1.0E-02	4.4E-03	3.6E-02	3.1E-03	3.9E-03	1.3E-03	2.84E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	1.2E-06	5.1E-07	4.1E-06	3.5E-07	4.4E-07	1.5E-07	3.23E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	3.2E-03	1.4E-03	1.1E-02	9.7E-04	1.2E-03	4.2E-04	8.84E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:

CS = Chemical Concentration in Soil (mg soil/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10-6 kg/mg)
FI = Fraction Ingested (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Bodyweight (kg)
AT = Averaging Time (days)

Assumptions:

95th UCL Soil Data
100 (Adult)/ 200 (Child)
10-6
1
350 events/year
30 years
70 (Adult male)/ 15 (Child 6-7)
6 x 365 child ; 24 x 365 adult (NC)
70 x 365 (C)

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	8.5E-06	2.3E-06	5.0E-04	0.0E+00	1.7E-02	0.0E+00
Totals - HQ & CR					**1.7E-02**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

BASELINE CASE

CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles									
Methylnaphthalene, 2-			5.14E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.17E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			1.20E-05	20	350	30	70	10,950	25,550
Phenanthrene			5.45E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			5.97E-06	20	350	30	70	10,950	25,550
Chrysene			6.00E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			6.03E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.71E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			5.99E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.60E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.16E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			5.16E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.3E-11	1.98E-07	20	350	30	70	10,950	25,550
4,4'-DDE		3.6E-11	3.08E-07	20	350	30	70	10,950	25,550
4,4'-DDT		3.7E-11	3.19E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.56E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.89E-06	20	350	30	70	10,950	25,550
Tetryl			2.56E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			2.24E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			2.22E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			2.46E-06	20	350	30	70	10,950	25,550
Metals									
Barium	6.8E-06		2.47E-02	20	350	30	70	10,950	25,550
Cadmium		5.7E-08	4.82E-04	20	350	30	70	10,950	25,550
Chromium		2.9E-06	2.45E-02	20	350	30	70	10,950	25,550
Copper			1.20E-02	20	350	30	70	10,950	25,550
Lead			4.85E-02	20	350	30	70	10,950	25,550
Thallium			5.53E-06	20	350	30	70	10,950	25,550
Zinc			1.51E-02	20	350	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

BASELINE CASE

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.3E-11	NA	1.6E+01		3.7E-10
4,4'-DDE		3.6E-11	NA	3.4E-01		1.2E-11
4,4'-DDT		3.7E-11	NA	3.4E-01		1.3E-11
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	6.8E-06		1.4E-04	NA	4.7E-02	
Cadmium		5.7E-08	NA	6.3E+00		3.6E-07
Chromium		2.9E-06	NA	4.2E-02		1.2E-07
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**4.7E-02**	**4.8E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING) FROM DERMAL CONTACT TO SURFACE WATER RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED\ CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

Baseline Case

ABSORPTION METHODOLOGY: Linear Absorption

AIR CONCENTRATION: 0.032 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1888.0	529.0
1-2	1888.0	529.0
2-3	1888.0	529.0
3-4	1888.0	529.0
4-5	1888.0	529.0
5-6	1888.0	529.0
6-7	1888.0	529.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	10.28	21.44	19.33
1-2:	11.85	31.43	28.98
2-3:	11.41	33.25	30.41
3-4:	11.01	34.73	31.83
4-5:	9.68	29.37	26.20
5-6:	8.41	28.11	24.62
6-7:	7.51	27.67	23.81

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
.5-1:	1.84	0.27	0.00	0.01
1-2:	1.81	0.63	0.00	0.01
2-3:	2.14	0.68	0.00	0.02

3-4:	2.15	0.73	0.00	0.02
4-5:	2.30	0.84	0.00	0.02
5-6:	2.53	0.93	0.00	0.03
6-7:	2.87	0.97	0.00	0.03

Case 1

CASE 1

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	190	1,100.00	301.89	286.89	125.64	0.44	NORMAL	301.89
3-Nitroaniline	ug/kg	192	2,950.00	1,284.59	1,198.33	726.55	0.61	NORMAL	1,284.59
2,4-Dinitrotoluene	ug/kg	197	33,000.00	563.33	700.44	2,464.42	3.52	LOGNORMAL	563.33
Phenanthrene	ug/kg	194	2,600.00	324.87	297.19	234.38	0.79	NORMAL	324.87
Benzo(a)anthracene	ug/kg	190	3,900.00	349.03	315.86	321.12	1.02	LOGNORMAL	349.03
Chrysene	ug/kg	191	8,900.00	354.91	343.26	656.09	1.91	LOGNORMAL	354.91
Benzo(b)fluoranthene	ug/kg	190	11,000.00	358.86	358.54	826.85	2.31	LOGNORMAL	358.86
benzo(k)fluoranthene	ug/kg	190	4,500.00	337.74	320.39	371.07	1.16	LOGNORMAL	337.74
Benzo(a)pyrene	ug/kg	190	3,700.00	350.60	316.95	325.19	1.03	LOGNORMAL	350.60
Indeno(1,2,3-cd)pyrene	ug/kg	189	2,300.00	330.86	306.66	202.30	0.66	NORMAL	330.86
Dibenz(a,h)anthracene	ug/kg	185	670.00	303.48	291.32	100.52	0.35	NORMAL	303.48
Benzo(g,h,i)perylene	ug/kg	186	960.00	303.81	295.28	117.25	0.40	NORMAL	303.81
Pesticides/PCBs									
Dieldrin	ug/kg	194	50.00	11.85	10.85	8.97	0.83	NORMAL	11.85
4,4'-DDE	ug/kg	197	830.00	18.89	17.28	60.13	3.48	LOGNORMAL	18.89
4,4'-DDT	ug/kg	197	320.00	17.29	13.86	25.04	1.81	LOGNORMAL	17.29
Explosives									
RDX	ug/kg	198	4,800.00	78.33	104.47	393.06	3.76	LOGNORMAL	78.33
1,3,5-Trinitrobenzene	ug/kg	198	3,900.00	84.06	96.33	278.27	2.89	LOGNORMAL	84.06
Tetryl	ug/kg	198	270.00	135.58	127.37	70.19	0.55	NORMAL	135.58
2,4,6-Trinitrotoluene	ug/kg	198	2,100.00	77.95	84.98	167.53	1.97	LOGNORMAL	77.95
4-amino-2,6-Dinitrotoluene	ug/kg	198	1,300.00	89.20	93.11	130.36	1.40	LOGNORMAL	89.20
2-amino-4,6-Dinitrotoluene	ug/kg	198	1,800.00	92.36	100.00	176.40	1.76	LOGNORMAL	92.36
Metals									
Barium	mg/kg	176	34,400.00	1,129.18	1,275.41	3,931.48	3.08	LOGNORMAL	1,129.18
Cadmium	mg/kg	198	28.20	5.65	3.38	4.61	1.36	LOGNORMAL	5.65
Chromium	mg/kg	185	1,430.00	31.74	36.41	105.17	2.89	LOGNORMAL	31.74
Copper	mg/kg	192	15,500.00	523.29	594.52	1,902.73	3.20	LOGNORMAL	523.29
Lead	mg/kg	189	56,700.00	1,689.38	1,404.61	5,170.96	3.68	LOGNORMAL	1,689.38
Thallium	mg/kg	195	38.00	0.33	0.48	2.70	5.61	LOGNORMAL	0.33
Zinc	mg/kg	197	127,000.00	814.69	1,330.27	9,117.23	6.85	LOGNORMAL	814.69

CASE 1

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Semi-volatiles											
Methylnaphthalene, 2-			3.02E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.28E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	1.6E-06		5.63E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.25E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.5E-07	3.49E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.6E-07	3.55E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.6E-07	3.59E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.4E-07	3.38E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.5E-07	3.51E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.3E-07	3.31E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.1E-07	3.03E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			3.04E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.3E-08	1.2E-08	1.19E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		1.9E-08	1.89E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	4.9E-08	1.7E-08	1.73E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.2E-07	7.9E-08	7.83E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	2.4E-07		8.41E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.36E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	2.2E-07	7.8E-08	7.80E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			8.92E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			9.24E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	3.2E-03		1.13E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	1.6E-05		5.65E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	8.9E-05		3.17E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	1.5E-03		5.23E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			1.69E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	9.4E-07		3.34E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.3E-03		8.15E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/yr)	150 events/year
IR = Ingestion Rate (mg soil/day)	480	ED = Exposure Duration (years)	25 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)

CASE 1

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	2.9E-06		5.65E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	1.6E-06		2.0E-03	NA	7.9E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.5E-07	NA	7.3E-01		2.6E-07
Chrysene		3.6E-07	NA	7.3E-02		2.6E-08
Benzo(b)fluoranthene		3.6E-07	NA	7.3E-01		2.6E-07
Benzo(k)fluoranthene		3.4E-07	NA	7.3E-01		2.5E-07
Benzo(a)pyrene		3.5E-07	NA	7.3E+00		2.6E-06
Indeno(1,2,3-cd)pyrene		3.3E-07	NA	7.3E-01		2.4E-07
Dibenzo(a,h)anthracene		3.1E-07	NA	7.3E+00		2.2E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.3E-08	1.2E-08	5.0E-05	1.6E+01	6.7E-04	1.9E-07
4,4'-DDE		1.9E-08	NA	3.4E-01		6.5E-09
4,4'-DDT	4.9E-08	1.7E-08	5.0E-04	3.4E-01	9.7E-05	5.9E-09
Explosives						
RDX	2.2E-07	7.9E-08	3.0E-03	1.1E-01	7.4E-05	8.7E-09
1,3,5-Trinitrobenzene	2.4E-07		5.0E-05	NA	4.7E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	2.2E-07	7.8E-08	5.0E-04	3.0E-02	4.4E-04	2.4E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	3.2E-03		7.0E-02	NA	4.5E-02	
Cadmium	1.6E-05		5.0E-04	NA	3.2E-02	
Chromium	8.9E-05		5.0E-03	NA	1.8E-02	
Copper	1.5E-03		4.0E-02	NA	3.7E-02	
Lead			NA	NA		
Thallium	9.4E-07		9.0E-05	NA	1.0E-02	
Zinc	2.3E-03		3.0E-01	NA	7.7E-03	
Totals - HQ & CR					**1.6E-01**	**6.1E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	2.9E-06		5.0E-04	NA	5.7E-03	
Totals - HQ & CR					**5.7E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-08	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
									Nc	Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.88E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	19400	ED = Exposure Duration (years)	30
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)	CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70
		AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	490.00	411.83	314.63	411.83
Phenanthrene	ug/kg	490.00	396.75	269.38	396.75
Benzo(a)anthracene	ug/kg	490.00	407.76	336.25	407.76
Benzo(b)fluoranthene	ug/kg	490.00	407.76	336.25	407.76
benzo(k)fluoranthene	ug/kg	490.00	407.76	336.25	407.76
Benzo(a)pyrene	ug/kg	490.00	407.76	336.25	407.76
Indeno(1,2,3-cd)pyrene	ug/kg	490.00	407.76	336.25	407.76
Explosives					
4-amino-2,6-Dinitrotoluen	ug/kg	60.00	60.00	60.00	60.00
2-amino-4,6-Dinitrotoluen	ug/kg	60.00	60.00	60.00	60.00
Metals					
Aluminum	mg/kg	15,600.00	12,202.89	10,104.50	12,202.89
Antimony	mg/kg	4.05	4.06	3.71	4.05
Arsenic	mg/kg	7.40	6.66	5.28	6.66
Barium	mg/kg	94.80	66.24	47.33	66.24
Beryllium	mg/kg	0.71	0.65	0.47	0.65
Cadmium	mg/kg	3.40	2.27	1.71	2.27
Chromium	mg/kg	24.50	22.85	18.08	22.85
Cobalt	mg/kg	11.20	10.23	8.03	10.23
Copper	mg/kg	2,380.00	1,032.68	262.51	1,032.68
Lead	mg/kg	332.00	418.55	94.17	332.00
Manganese	mg/kg	596.00	474.62	420.00	474.62
Mercury	mg/kg	0.69	1.22	0.20	0.69
Nickel	mg/kg	42.30	37.97	29.62	37.97
Selenium	mg/kg	1.40	1.02	0.62	1.02
Vanadium	mg/kg	20.10	18.02	13.90	18.02
Zinc	mg/kg	497.00	899.80	148.22	497.00

BASELINE CASE, CASE 1

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	362.54	312.35	362.54
Phenanthrene	ug/kg	600.00	395.15	330.85	395.15
Benzo(a)anthracene	ug/kg	500.00	366.89	311.28	366.89
Benzo(b)fluoranthene	ug/kg	500.00	366.93	311.50	366.93
benzo(k)fluoranthene	ug/kg	500.00	366.95	311.61	366.95
Benzo(a)pyrene	ug/kg	500.00	366.78	310.72	366.78
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	366.77	310.67	366.77
Explosives					
4-amino-2,6-Dinitrotoluen	ug/kg	160.00	72.20	64.55	72.20
2-amino-4,6-Dinitrotoluen	ug/kg	180.00	75.88	66.59	75.88
Metals					
Aluminum	mg/kg	25,800.00	17,742.74	16,486.36	17,742.74
Antimony	mg/kg	28.30	10.60	7.25	10.60
Arsenic	mg/kg	9.50	5.66	4.85	5.66
Barium	mg/kg	1,780.00	366.08	271.98	366.08
Beryllium	mg/kg	1.60	1.09	0.98	1.09
Cadmium	mg/kg	9.70	3.38	2.55	3.38
Chromium	mg/kg	41.80	26.72	24.56	26.72
Cobalt	mg/kg	17.70	12.70	11.64	12.70
Copper	mg/kg	3,790.00	489.13	288.04	489.13
Lead	mg/kg	7,400.00	1,674.71	526.09	1,674.71
Manganese	mg/kg	1,520.00	597.58	502.05	597.58
Mercury	mg/kg	2.00	0.93	0.32	0.93
Nickel	mg/kg	64.40	40.25	36.55	40.25
Selenium	mg/kg	1.80	0.91	0.73	0.91
Vanadium	mg/kg	37.90	27.22	25.23	27.22
Zinc	mg/kg	1,200.00	446.43	273.22	446.43

BASELINE CASE, CASE 1

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

BASELINE CASE, CASE 1

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles											
Methylnaphthalene, 2-			4.12E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Phenanthrene			3.97E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(a)anthracene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(b)fluoranthene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(k)fluoranthene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Benzo(a)pyrene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene		4.8E-09	4.08E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Explosives											
Dinitrotoluene, 2,6-, 4-amino-			6.00E-02	100	1.0E-06	1	7	30	70	10,950	25,550
Dinitrotoluene, 4,6,- 2-amino-			6.00E-02	100	1.0E-06	1	7	30	70	10,950	25,550
Metals											
Aluminum			1.22E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Antimony	1.1E-07		4.05E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.8E-07	7.8E-08	6.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.8E-06		6.62E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	1.8E-08	7.7E-09	6.54E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	6.2E-08		2.27E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	6.3E-07		2.28E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.02E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	2.8E-05		1.03E+03	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			3.32E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.3E-05		4.75E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	1.9E-08		6.90E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.80E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	2.8E-08		1.02E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.9E-07		1.80E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	1.4E-05		4.97E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chem. Conc. in Sediment (mg/kg-soil)	95th UCL Sediment Data	EF = Exposure Frequency (days/year)	7 events/year
IR = Ingestion Rate (mg soil/day)	100	ED = Exposure Duration (years)	30 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)

BASELINE CASE, CASE 1

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	3.3E-07		2.27E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

BASELINE CASE, CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING) INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

**CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	**CDI (Nc)** (mg/kg/day)	**CDI (Car)** (mg/kg/day)	**RfD** (mg/kg/day)	**Oral Slope Factor** (mg/kg/day)-1	**Hazard Quotient**	**Cancer Risk**
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(b)fluoranthene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(k)fluoranthene		4.8E-09	NA	7.3E-01		3.5E-09
Benzo(a)pyrene		4.8E-09	NA	7.3E+00		3.5E-08
Indeno(1,2,3-cd)pyrene		4.8E-09	NA	7.3E-01		3.5E-09
Explosives						
Dinitrotoluene, 2,6-, 4-amino-			NA	NA		
Dinitrotoluene, 4,6-, 2-amino-			NA	NA		
Metals						
Aluminum			NA	NA		
Antimony	1.1E-07		4.0E-04	NA	2.8E-04	
Arsenic	1.8E-07	7.8E-08	3.0E-04	1.8E+00	6.1E-04	1.4E-07
Barium	1.8E-06		7.0E-02	NA	2.6E-05	
Beryllium	1.8E-08	7.7E-09	5.0E-03	4.3E+00	3.6E-06	3.3E-08
Cadmium	6.2E-08		5.0E-04	NA	1.2E-04	
Chromium	6.3E-07		5.0E-03	NA	1.3E-04	
Cobalt			NA	NA		
Copper	2.8E-05		4.0E-02	NA	7.1E-04	
Lead			NA	NA		
Manganese	1.3E-05		5.0E-03	NA	2.6E-03	
Mercury	1.9E-08		3.0E-04	NA	6.3E-05	
Nickel			NA	NA		
Selenium	2.8E-08		5.0E-03	NA	5.6E-06	
Vanadium	4.9E-07		7.0E-03	NA	7.1E-05	
Zinc	1.4E-05		3.0E-01	NA	4.5E-05	
Totals - HQ & CR					**4.7E-03**	**2.2E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

BASELINE CASE, CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	3.3E-07		5.0E-04	NA	6.7E-04	
Totals - HQ & CR					**6.7E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	1.88E-05	5.16E-06	4.91E-06	5.16E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.20E-05	2.05E-05	2.20E-05
Dinitrotoluene, 2,4-	ug/m3	5.65E-04	9.64E-06	1.20E-05	9.64E-06
Phenanthrene	ug/m3	4.45E-05	5.56E-06	5.08E-06	5.56E-06
Benzo(a)anthracene	ug/m3	6.67E-05	5.97E-06	5.40E-06	5.97E-06
Chrysene	ug/m3	1.52E-04	6.07E-06	5.87E-06	6.07E-06
Benzo(b)fluoranthene	ug/m3	1.88E-04	6.14E-06	6.13E-06	6.14E-06
Benzo(k)fluoranthene	ug/m3	7.70E-05	5.78E-06	5.48E-06	5.78E-06
Benzo(a)pyrene	ug/m3	6.33E-05	6.00E-06	5.42E-06	6.00E-06
Indeno(1,2,3-cd)pyrene	ug/m3	3.94E-05	5.66E-06	5.25E-06	5.66E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.19E-06	4.98E-06	5.19E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	5.20E-06	5.05E-06	5.20E-06
Pesticides/PCBs					
Dieldrin	ug/m3	8.55E-07	2.03E-07	1.86E-07	2.03E-07
4,4'-DDE	ug/m3	1.42E-05	3.23E-07	2.96E-07	3.23E-07
4,4'-DDT	ug/m3	5.47E-06	2.96E-07	2.37E-07	2.96E-07
Explosives					
RDX	ug/m3	8.21E-05	1.34E-06	1.79E-06	1.34E-06
1,3,5-Trinitrobenzene	ug/m3	6.67E-05	1.44E-06	1.65E-06	1.44E-06
Tetryl	ug/m3	4.62E-06	2.32E-06	2.18E-06	2.32E-06
2,4,6-Trinitrotoluene	ug/m3	3.59E-05	1.33E-06	1.45E-06	1.33E-06
4-amino-2,6-Dinitrotoluene	ug/m3	2.22E-05	1.53E-06	1.59E-06	1.53E-06
2-amino-4,6-Dinitrotoluene	ug/m3	3.08E-05	1.58E-06	1.71E-06	1.58E-06
Metals					
Barium	ug/m3	5.89E-01	1.93E-02	2.18E-02	1.93E-02
Cadmium	ug/m3	4.82E-04	9.66E-05	5.78E-05	9.66E-05
Chromium	ug/m3	2.45E-02	5.43E-04	6.23E-04	5.43E-04
Copper	ug/m3	2.65E-01	8.95E-03	1.02E-02	8.95E-03
Lead	ug/m3	9.70E-01	2.89E-02	2.40E-02	2.89E-02
Thallium	ug/m3	6.50E-04	5.71E-06	8.25E-06	5.71E-06
Zinc	ug/m3	2.17E+00	1.39E-02	2.28E-02	1.39E-02

CASE 1

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles									
Methylnaphthalene, 2-			5.16E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.20E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			9.64E-06	20	150	25	70	9,125	25,550
Phenanthrene			5.56E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			5.97E-06	20	150	25	70	9,125	25,550
Chrysene			6.07E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			6.14E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.78E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			6.00E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.66E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.19E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			5.20E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		8.5E-12	2.03E-07	20	150	25	70	9,125	25,550
4,4'-DDE		1.4E-11	3.23E-07	20	150	25	70	9,125	25,550
4,4'-DDT		1.2E-11	2.96E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.34E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.44E-06	20	150	25	70	9,125	25,550
Tetryl			2.32E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			1.33E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			1.53E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			1.58E-06	20	150	25	70	9,125	25,550
Metals									
Barium	2.3E-06		1.93E-02	20	150	25	70	9,125	25,550
Cadmium		4.1E-09	9.66E-05	20	150	25	70	9,125	25,550
Chromium		2.3E-08	5.43E-04	20	150	25	70	9,125	25,550
Copper			8.95E-03	20	150	25	70	9,125	25,550
Lead			2.89E-02	20	150	25	70	9,125	25,550
Thallium			5.71E-06	20	150	25	70	9,125	25,550
Zinc			1.39E-02	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	150
ED = Exposure Duration (years)	25
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		8.5E-12	NA	1.6E+01		1.4E-10
4,4'-DDE		1.4E-11	NA	3.4E-01		4.6E-12
4,4'-DDT		1.2E-11	NA	3.4E-01		4.2E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	2.3E-06		1.4E-04	NA	1.6E-02	
Cadmium		4.1E-09	NA	6.3E+00		2.6E-08
Chromium		2.3E-08	NA	4.2E-02		9.6E-10
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**1.6E-02**	**2.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 1

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days) Child(Nc)	Averaging Time (days) Adult(Nc)	Averaging Time (days) Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.7E-07	3.9E-06	3.3E-07	4.1E-07	1.4E-07	3.02E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.7E-06	2.0E-06	1.6E-05	1.4E-06	1.8E-06	6.0E-07	1.28E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	2.1E-06	8.8E-07	7.2E-06	6.2E-07	7.7E-07	2.6E-07	5.63E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.25E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.3E-06	5.5E-07	4.5E-06	3.8E-07	4.8E-07	1.6E-07	3.49E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.3E-06	5.6E-07	4.5E-06	3.9E-07	4.9E-07	1.7E-07	3.55E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.3E-06	5.6E-07	4.6E-06	3.9E-07	4.9E-07	1.7E-07	3.59E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.2E-06	5.3E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.38E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.3E-06	5.5E-07	4.5E-06	3.8E-07	4.8E-07	1.6E-07	3.51E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06	5.2E-07	4.2E-06	3.6E-07	4.5E-07	1.6E-07	3.31E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.03E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.04E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	4.3E-08	1.9E-08	1.5E-07	1.3E-08	1.6E-08	5.6E-09	1.19E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	6.9E-08	3.0E-08	2.4E-07	2.1E-08	2.6E-08	8.9E-09	1.89E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	6.3E-08	2.7E-08	2.2E-07	1.9E-08	2.4E-08	8.1E-09	1.73E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	2.9E-07	1.2E-07	1.0E-06	8.6E-08	1.1E-07	3.7E-08	7.83E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	3.1E-07	1.3E-07	1.1E-06	9.2E-08	1.2E-07	3.9E-08	8.41E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	5.0E-07	2.1E-07	1.7E-06	1.5E-07	1.9E-07	6.4E-08	1.36E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	2.8E-07	1.2E-07	1.0E-06	8.5E-08	1.1E-07	3.7E-08	7.80E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-ami	3.3E-07	1.4E-07	1.1E-06	9.8E-08	1.2E-07	4.2E-08	8.92E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.4E-07	1.2E-06	1.0E-07	1.3E-07	4.3E-08	9.24E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	4.1E-03	1.8E-03	1.4E-02	1.2E-03	1.5E-03	5.3E-04	1.13E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	2.1E-05	8.8E-06	7.2E-05	6.2E-06	7.7E-06	2.7E-06	5.65E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.2E-04	5.0E-05	4.1E-04	3.5E-05	4.3E-05	1.5E-05	3.17E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	1.9E-03	8.2E-04	6.7E-03	5.7E-04	7.2E-04	2.5E-04	5.23E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	6.2E-03	2.6E-03	2.2E-02	1.9E-03	2.3E-03	7.9E-04	1.69E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	1.2E-06	5.2E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.34E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	3.0E-03	1.3E-03	1.0E-02	8.9E-04	1.1E-03	3.8E-04	8.15E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:

CS = Chemical Concentration in Soil (mg soil/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10-6 kg/mg)
FI = Fraction Ingested (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Bodyweight (kg)
AT = Averaging Time (days)

Assumptions:

95th UCL Soil Data
100 (Adult)/ 200 (Child)
10-6
1
350 events/year
30 years
70 (Adult male)/ 15 (Child 6-7)
6 x 365 child ; 24 x 365 adult (NC)
70 x 365 (C)

CASE 1

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	8.4E-06	2.3E-06	1.5E-05		6.7E-06	2.3E-06	5.65E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	6 Child, 24 Adult
SA = Surface Area Contact (cm2)	1510(C)/3120(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	6 x 365 (Nc)+ 24 x 365 (Nc)
ABS = Absorption Factor (unitless)	varies (1-25%)		70 x 365 (Car)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.7E-07	NA	NA		
3-Nitroaniline	4.7E-06	2.0E-06	NA	NA		
Dinitrotoluene, 2,4-	2.1E-06	8.8E-07	2.0E-03	NA	1.0E-03	
Phenanthrene	1.2E-06	5.1E-07	NA	NA		
Benzo(a)anthracene	1.3E-06	5.5E-07	NA	7.3E-01		4.0E-07
Chrysene	1.3E-06	5.6E-07	NA	7.3E-02		4.1E-08
Benzo(b)fluoranthene	1.3E-06	5.6E-07	NA	7.3E-01		4.1E-07
Benzo(k)fluoranthene	1.2E-06	5.3E-07	NA	7.3E-01		3.9E-07
Benzo(a)pyrene	1.3E-06	5.5E-07	NA	7.3E+00		4.0E-06
Indeno(1,2,3-cd)pyrene	1.2E-06	5.2E-07	NA	7.3E-01		3.8E-07
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	NA	7.3E+00		3.5E-06
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	4.3E-08	1.9E-08	5.0E-05	1.6E+01	8.7E-04	3.0E-07
4,4'-DDE	6.9E-08	3.0E-08	NA	3.4E-01		1.0E-08
4,4'-DDT	6.3E-08	2.7E-08	5.0E-04	3.4E-01	1.3E-04	9.2E-09
Explosives						
RDX	2.9E-07	1.2E-07	3.0E-03	1.1E-01	9.5E-05	1.3E-08
1,3,5-Trinitrobenzene	3.1E-07	1.3E-07	5.0E-05	NA	6.1E-03	
Tetryl	5.0E-07	2.1E-07	NA	NA		
Trinitrotoluene, 2,4,6-	2.8E-07	1.2E-07	5.0E-04	3.0E-02	5.7E-04	3.7E-09
Dinitrotoluene, 2,6-, 4-ami	3.3E-07	1.4E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.4E-07	NA	NA		
Metals						
Barium	4.1E-03	1.8E-03	7.0E-02	NA	5.9E-02	
Cadmium	2.1E-05	8.8E-06	5.0E-04	NA	4.1E-02	
Chromium	1.2E-04	5.0E-05	5.0E-03	NA	2.3E-02	
Copper	1.9E-03	8.2E-04	4.0E-02	NA	4.8E-02	
Lead	6.2E-03	2.6E-03	NA	NA		
Thallium	1.2E-06	5.2E-07	9.0E-05	NA	1.4E-02	
Zinc	3.0E-03	1.3E-03	3.0E-01	NA	9.9E-03	
Totals - HQ & CR					**2.0E-01**	**9.4E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	8.4E-06	2.3E-06	5.0E-04	0.0E+00	1.7E-02	0.0E+00
Totals - HQ & CR					**1.7E-02**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 1

CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.16E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.20E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			9.64E-06	20	350	30	70	10,950	25,550
Phenanthrene			5.56E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			5.97E-06	20	350	30	70	10,950	25,550
Chrysene			6.07E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			6.14E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.78E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			6.00E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.66E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.19E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			5.20E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.4E-11	2.03E-07	20	350	30	70	10,950	25,550
4,4'-DDE		3.8E-11	3.23E-07	20	350	30	70	10,950	25,550
4,4'-DDT		3.5E-11	2.96E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.34E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.44E-06	20	350	30	70	10,950	25,550
Tetryl			2.32E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			1.33E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			1.53E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			1.58E-06	20	350	30	70	10,950	25,550
Metals									
Barium	5.3E-06		1.93E-02	20	350	30	70	10,950	25,550
Cadmium		1.1E-08	9.66E-05	20	350	30	70	10,950	25,550
Chromium		6.4E-08	5.43E-04	20	350	30	70	10,950	25,550
Copper			8.95E-03	20	350	30	70	10,950	25,550
Lead			2.89E-02	20	350	30	70	10,950	25,550
Thallium			5.71E-06	20	350	30	70	10,950	25,550
Zinc			1.39E-02	20	350	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	**95% UCL Air Model Data**
IR = Inhalation Rate (m3/day)	**20**
EF = Exposure Frequency (days/yr)	**350**
ED = Exposure Duration (years)	**30**
BW = Bodyweight (kg)	**70**
AT = Averaging Time (days)	**30 x 365 (Nc) 70 x 365 (Car)**

CASE 1

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.4E-11	NA	1.6E+01		3.8E-10
4,4'-DDE		3.8E-11	NA	3.4E-01		1.3E-11
4,4'-DDT		3.5E-11	NA	3.4E-01		1.2E-11
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	5.3E-06		1.4E-04	NA	3.7E-02	
Cadmium		1.1E-08	NA	6.3E+00		7.1E-08
Chromium		6.4E-08	NA	4.2E-02		2.7E-09
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**3.7E-02**	**7.5E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \ CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ABSORPTION METHODOLOGY: Linear Absorption

Cases 1 & 2

AIR CONCENTRATION: 0.029 ug Pb/m3

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1405.0	470.0
1-2	1405.0	470.0
2-3	1405.0	470.0
3-4	1405.0	470.0
4-5	1405.0	470.0
5-6	1405.0	470.0
6-7	1405.0	470.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	8.86	18.34	16.09
1-2:	10.19	26.92	24.29
2-3:	9.79	28.39	25.36
3-4:	9.41	29.48	26.40
4-5:	8.22	24.74	21.43
5-6:	7.11	23.62	20.00
6-7:	6.33	23.26	19.26

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	1.96	0.28	0.00	0.01
1-2:	1.95	0.67	0.00	0.01
2-3:	2.28	0.73	0.00	0.02

3-4:	2.28	0.78	0.00	0.02
4-5:	2.41	0.88	0.00	0.02
5-6:	2.64	0.96	0.00	0.03
6-7:	2.97	1.00	0.00	0.03

Case 2

CASE 2

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	187	1,100.00	303.42	288.24	126.20	0.44	NORMAL	303.42
3-Nitroaniline	ug/kg	189	2,950.00	1,296.47	1,209.50	726.82	0.60	NORMAL	1,296.47
2,4-Dinitrotoluene	ug/kg	194	33,000.00	570.56	708.12	2,482.72	3.51	LOGNORMAL	570.56
Phenanthrene	ug/kg	191	2,600.00	326.75	298.66	235.92	0.79	NORMAL	326.75
Benzo(a)anthracene	ug/kg	187	3,900.00	352.16	317.67	323.38	1.02	LOGNORMAL	352.16
Chrysene	ug/kg	188	8,900.00	357.85	345.49	661.09	1.91	LOGNORMAL	357.85
Benzo(b)fluoranthene	ug/kg	187	11,000.00	361.94	361.03	833.26	2.31	LOGNORMAL	361.94
benzo(k)fluoranthene	ug/kg	187	4,500.00	340.26	322.27	373.75	1.16	LOGNORMAL	340.26
Benzo(a)pyrene	ug/kg	187	3,700.00	353.76	318.78	327.48	1.03	LOGNORMAL	353.76
Indeno(1,2,3-cd)pyrene	ug/kg	186	2,300.00	332.87	308.32	203.51	0.66	NORMAL	332.87
Dibenz(a,h)anthracene	ug/kg	182	670.00	305.05	292.77	100.70	0.34	NORMAL	305.05
Benzo(g,h,i)perylene	ug/kg	183	960.00	305.36	296.79	117.61	0.40	NORMAL	305.36
Pesticides/PCBs									
Dieldrin	ug/kg	192	90.00	12.60	11.40	10.61	0.93	NORMAL	12.60
4,4'-DDE	ug/kg	194	830.00	19.24	17.51	60.56	3.46	LOGNORMAL	19.24
4,4'-DDT	ug/kg	194	320.00	17.61	14.04	25.19	1.79	LOGNORMAL	17.61
Explosives									
RDX	ug/kg	195	4,800.00	78.65	105.15	396.05	3.77	LOGNORMAL	78.65
1,3,5-Trinitrobenzene	ug/kg	195	3,900.00	84.44	96.86	280.38	2.89	LOGNORMAL	84.44
Tetryl	ug/kg	195	270.00	136.68	128.41	70.23	0.55	NORMAL	136.68
2,4,6-Trinitrotoluene	ug/kg	195	2,100.00	78.26	85.37	168.79	1.98	LOGNORMAL	78.26
4-amino-2,6-Dinitrotoluene	ug/kg	195	1,300.00	89.72	93.62	131.30	1.40	LOGNORMAL	89.72
2-amino-4,6-Dinitrotoluene	ug/kg	195	1,800.00	92.94	100.62	177.69	1.77	LOGNORMAL	92.94
Metals									
Barium	mg/kg	173	34,400.00	1,146.73	1,289.86	3,964.01	3.07	LOGNORMAL	1,146.73
Cadmium	mg/kg	195	28.20	5.75	3.40	4.64	1.36	LOGNORMAL	5.75
Chromium	mg/kg	182	1,430.00	31.87	36.61	106.02	2.90	LOGNORMAL	31.87
Copper	mg/kg	189	15,500.00	521.03	598.45	1,917.57	3.20	LOGNORMAL	521.03
Lead	mg/kg	186	56,700.00	1,652.81	1,409.45	5,212.30	3.70	LOGNORMAL	1,652.81
Thallium	mg/kg	192	38.00	0.34	0.49	2.72	5.61	LOGNORMAL	0.34
Zinc	mg/kg	194	127,000.00	827.61	1,346.29	9,186.89	6.82	LOGNORMAL	827.61

CASE 2

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Semi-volatiles											
Methylnaphthalene, 2-			3.03E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.30E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	1.6E-06		5.71E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.27E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.5E-07	3.52E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.6E-07	3.58E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.6E-07	3.62E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.4E-07	3.40E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.6E-07	3.54E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.4E-07	3.33E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.1E-07	3.05E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			3.05E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.5E-08	1.3E-08	1.26E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		1.9E-08	1.92E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	5.0E-08	1.8E-08	1.76E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.2E-07	7.9E-08	7.86E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	2.4E-07		8.44E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.37E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	2.2E-07	7.9E-08	7.83E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			8.97E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			9.29E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	3.2E-03		1.15E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	1.6E-05		5.75E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	9.0E-05		3.19E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	1.5E-03		5.21E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			1.65E+03	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	9.4E-07		3.35E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	2.3E-03		8.28E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**	**EF = Exposure Frequency (days/yr)**	**150 events/year**
IR = Ingestion Rate (mg soil/day)	**480**	**ED = Exposure Duration (years)**	**25 years**
CF = Conversion Factor (10-6 kg/mg)	**10-6**	**BW = Bodyweight (kg)**	**70 kg**
FI = Fraction Ingested (unitless)	**1**	**AT = Averaging Time (days)**	**25 x 365 (NC) 70 x 365(c)**

CASE 2

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	2.9E-06		5.75E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	1.6E-06		2.0E-03	NA	8.0E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.5E-07	NA	7.3E-01		2.6E-07
Chrysene		3.6E-07	NA	7.3E-02		2.6E-08
Benzo(b)fluoranthene		3.6E-07	NA	7.3E-01		2.7E-07
Benzo(k)fluoranthene		3.4E-07	NA	7.3E-01		2.5E-07
Benzo(a)pyrene		3.6E-07	NA	7.3E+00		2.6E-06
Indeno(1,2,3-cd)pyrene		3.4E-07	NA	7.3E-01		2.4E-07
Dibenzo(a,h)anthracene		3.1E-07	NA	7.3E+00		2.2E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.5E-08	1.3E-08	5.0E-05	1.6E+01	7.1E-04	2.0E-07
4,4'-DDE		1.9E-08	NA	3.4E-01		6.6E-09
4,4'-DDT	5.0E-08	1.8E-08	5.0E-04	3.4E-01	9.9E-05	6.0E-09
Explosives						
RDX	2.2E-07	7.9E-08	3.0E-03	1.1E-01	7.4E-05	8.7E-09
1,3,5-Trinitrobenzene	2.4E-07		5.0E-05	NA	4.8E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	2.2E-07	7.9E-08	5.0E-04	3.0E-02	4.4E-04	2.4E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	3.2E-03		7.0E-02	NA	4.6E-02	
Cadmium	1.6E-05		5.0E-04	NA	3.2E-02	
Chromium	9.0E-05		5.0E-03	NA	1.8E-02	
Copper	1.5E-03		4.0E-02	NA	3.7E-02	
Lead			NA	NA		
Thallium	9.4E-07		9.0E-05	NA	1.0E-02	
Zinc	2.3E-03		3.0E-01	NA	7.8E-03	
Totals - HQ & CR					**1.6E-01**	**6.1E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	2.9E-06		5.0E-04	NA	5.8E-03	
Totals - HQ & CR					**5.8E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-08	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
									Nc	Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.88E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	19400	ED = Exposure Duration (years)	30
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)	CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70
		AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING) INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
Explosives					
Metals					
Aluminum	mg/kg	8,310.00	11,682.32	5,767.50	8,310.00
Arsenic	mg/kg	4.40	5.66	3.45	4.40
Barium	mg/kg	44.10	57.70	33.85	44.10
Beryllium	mg/kg	0.71	1.03	0.47	0.71
Cadmium	mg/kg	2.00	2.73	1.45	2.00
Chromium	mg/kg	15.20	20.51	11.20	15.20
Cobalt	mg/kg	7.50	10.32	5.38	7.50
Copper	mg/kg	22.40	31.05	15.88	22.40
Lead	mg/kg	15.40	18.65	12.95	15.40
Manganese	mg/kg	468.00	548.91	407.00	468.00
Mercury	mg/kg	0.17	0.27	0.10	0.17
Nickel	mg/kg	23.30	31.42	17.18	23.30
Selenium	mg/kg	0.19	0.20	0.17	0.19
Vanadium	mg/kg	10.90	14.68	8.05	10.90
Zinc	mg/kg	76.00	113.27	47.90	76.00

CASE 2 through CASE 4

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	362.54	312.35	362.54
Phenanthrene	ug/kg	600.00	395.15	330.85	395.15
Benzo(a)anthracene	ug/kg	500.00	366.89	311.28	366.89
Benzo(b)fluoranthene	ug/kg	500.00	366.93	311.50	366.93
benzo(k)fluoranthene	ug/kg	500.00	366.95	311.61	366.95
Benzo(a)pyrene	ug/kg	500.00	366.78	310.72	366.78
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	366.77	310.67	366.77
Explosives					
4-amino-2,6-Dinitrotoluene	ug/kg	160.00	72.20	64.55	72.20
2-amino-4,6-Dinitrotoluene	ug/kg	180.00	75.88	66.59	75.88
Metals					
Aluminum	mg/kg	25,800.00	17,742.74	16,486.36	17,742.74
Antimony	mg/kg	28.30	10.60	7.25	10.60
Arsenic	mg/kg	9.50	5.66	4.85	5.66
Barium	mg/kg	1,780.00	366.08	271.98	366.08
Beryllium	mg/kg	1.60	1.09	0.98	1.09
Cadmium	mg/kg	9.70	3.38	2.55	3.38
Chromium	mg/kg	41.80	26.72	24.56	26.72
Cobalt	mg/kg	17.70	12.70	11.64	12.70
Copper	mg/kg	3,790.00	489.13	288.04	489.13
Lead	mg/kg	7,400.00	1,674.71	526.09	1,674.71
Manganese	mg/kg	1,520.00	597.58	502.05	597.58
Mercury	mg/kg	2.00	0.93	0.32	0.93
Nickel	mg/kg	64.40	40.25	36.55	40.25
Selenium	mg/kg	1.80	0.91	0.73	0.91
Vanadium	mg/kg	37.90	27.22	25.23	27.22
Zinc	mg/kg	1,200.00	446.43	273.22	446.43

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles											
Explosives											
Metals											
Aluminum			1.17E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.6E-07	6.6E-08	5.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.6E-06		5.77E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	2.8E-08	1.2E-08	1.03E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	7.5E-08		2.73E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	5.6E-07		2.05E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.03E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	8.5E-07		3.11E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			1.86E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.5E-05		5.49E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	7.4E-09		2.69E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.14E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	5.6E-09		2.05E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.0E-07		1.47E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	3.1E-06		1.13E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chem. Conc. in Sediment (mg/kg-soil)	95th UCL Sediment Data	EF = Exposure Frequency (days/year)	7 events/year
IR = Ingestion Rate (mg soil/day)	100	ED = Exposure Duration (years)	30 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	4.0E-07		2.73E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-07	6.6E-08	3.0E-04	1.8E+00	5.2E-04	1.2E-07
Barium	1.6E-06		7.0E-02	NA	2.3E-05	
Beryllium	2.8E-08	1.2E-08	5.0E-03	4.3E+00	5.7E-06	5.2E-08
Cadmium	7.5E-08		5.0E-04	NA	1.5E-04	
Chromium	5.6E-07		5.0E-03	NA	1.1E-04	
Cobalt			NA	NA		
Copper	8.5E-07		4.0E-02	NA	2.1E-05	
Lead			NA	NA		
Manganese	1.5E-05		5.0E-03	NA	3.0E-03	
Mercury	7.4E-09		3.0E-04	NA	2.5E-05	
Nickel			NA	NA		
Selenium	5.6E-09		5.0E-03	NA	1.1E-06	
Vanadium	4.0E-07		7.0E-03	NA	5.7E-05	
Zinc	3.1E-06		3.0E-01	NA	1.0E-05	
Totals - HQ & CR					**3.9E-03**	**1.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	4.0E-07		5.0E-04	NA	8.0E-04	
Totals - HQ & CR					**8.0E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	1.88E-05	5.19E-06	4.93E-06	5.19E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.22E-05	2.07E-05	2.22E-05
Dinitrotoluene, 2,4-	ug/m3	5.65E-04	9.76E-06	1.21E-05	9.76E-06
Phenanthrene	ug/m3	4.45E-05	5.59E-06	5.11E-06	5.59E-06
Benzo(a)anthracene	ug/m3	6.67E-05	6.03E-06	5.43E-06	6.03E-06
Chrysene	ug/m3	1.52E-04	6.12E-06	5.91E-06	6.12E-06
Benzo(b)fluoranthene	ug/m3	1.88E-04	6.19E-06	6.18E-06	6.19E-06
Benzo(k)fluoranthene	ug/m3	7.70E-05	5.82E-06	5.51E-06	5.82E-06
Benzo(a)pyrene	ug/m3	6.33E-05	6.05E-06	5.45E-06	6.05E-06
Indeno(1,2,3-cd)pyrene	ug/m3	3.94E-05	5.69E-06	5.28E-06	5.69E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.22E-06	5.01E-06	5.22E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	5.22E-06	5.08E-06	5.22E-06
Pesticides/PCBs					
Dieldrin	ug/m3	1.54E-06	2.16E-07	1.95E-07	2.16E-07
4,4'-DDE	ug/m3	1.42E-05	3.29E-07	3.00E-07	3.29E-07
4,4'-DDT	ug/m3	5.47E-06	3.01E-07	2.40E-07	3.01E-07
Explosives					
RDX	ug/m3	8.21E-05	1.35E-06	1.80E-06	1.35E-06
1,3,5-Trinitrobenzene	ug/m3	6.67E-05	1.44E-06	1.66E-06	1.44E-06
Tetryl	ug/m3	4.62E-06	2.34E-06	2.20E-06	2.34E-06
2,4,6-Trinitrotoluene	ug/m3	3.59E-05	1.34E-06	1.46E-06	1.34E-06
4-amino-2,6-Dinitrotoluene	ug/m3	2.22E-05	1.53E-06	1.60E-06	1.53E-06
2-amino-4,6-Dinitrotoluene	ug/m3	3.08E-05	1.59E-06	1.72E-06	1.59E-06
Metals					
Barium	ug/m3	5.89E-04	1.96E-05	2.21E-05	1.96E-05
Cadmium	ug/m3	4.82E-07	9.85E-08	5.83E-08	9.85E-08
Chromium	ug/m3	2.45E-05	5.45E-07	6.26E-07	5.45E-07
Copper	ug/m3	2.65E-04	8.91E-06	1.02E-05	8.91E-06
Lead	ug/m3	9.70E-04	2.83E-05	2.41E-05	2.83E-05
Thallium	ug/m3	6.50E-07	5.74E-09	8.31E-09	5.74E-09
Zinc	ug/m3	2.17E-03	1.42E-05	2.30E-05	1.42E-05

CASE 2

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.19E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.22E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			9.76E-06	20	150	25	70	9,125	25,550
Phenanthrene			5.59E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			6.03E-06	20	150	25	70	9,125	25,550
Chrysene			6.12E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			6.19E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.82E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			6.05E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.69E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.22E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			5.22E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		9.0E-12	2.16E-07	20	150	25	70	9,125	25,550
4,4'-DDE		1.4E-11	3.29E-07	20	150	25	70	9,125	25,550
4,4'-DDT		1.3E-11	3.01E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.35E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.44E-06	20	150	25	70	9,125	25,550
Tetryl			2.34E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			1.34E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			1.53E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			1.59E-06	20	150	25	70	9,125	25,550
Metals									
Barium	2.3E-09		1.96E-05	20	150	25	70	9,125	25,550
Cadmium		4.1E-12	9.85E-08	20	150	25	70	9,125	25,550
Chromium		2.3E-11	5.45E-07	20	150	25	70	9,125	25,550
Copper			8.91E-06	20	150	25	70	9,125	25,550
Lead			2.83E-05	20	150	25	70	9,125	25,550
Thallium			5.74E-09	20	150	25	70	9,125	25,550
Zinc			1.42E-05	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	150
ED = Exposure Duration (years)	25
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INHALATION OF FUGITIVE DUST (WHILE WORKING) INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		9.0E-12	NA	1.6E+01		1.5E-10
4,4'-DDE		1.4E-11	NA	3.4E-01		4.7E-12
4,4'-DDT		1.3E-11	NA	3.4E-01		4.3E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	2.3E-09		1.4E-04	NA	1.6E-05	
Cadmium		4.1E-12	NA	6.3E+00		2.6E-11
Chromium		2.3E-11	NA	4.2E-02		9.6E-13
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**1.6E-05**	**1.8E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 2

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days) Child(Nc)	Adult(Nc)	Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.03E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.7E-06	2.0E-06	1.7E-05	1.4E-06	1.8E-06	6.1E-07	1.30E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	2.1E-06	8.9E-07	7.3E-06	6.3E-07	7.8E-07	2.7E-07	5.71E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.27E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.3E-06	5.5E-07	4.5E-06	3.9E-07	4.8E-07	1.7E-07	3.52E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.3E-06	5.6E-07	4.6E-06	3.9E-07	4.9E-07	1.7E-07	3.58E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.3E-06	5.7E-07	4.6E-06	4.0E-07	5.0E-07	1.7E-07	3.62E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.2E-06	5.3E-07	4.4E-06	3.7E-07	4.7E-07	1.6E-07	3.40E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.3E-06	5.5E-07	4.5E-06	3.9E-07	4.8E-07	1.7E-07	3.54E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06	5.2E-07	4.3E-06	3.6E-07	4.6E-07	1.6E-07	3.33E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.05E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.05E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	4.6E-08	2.0E-08	1.6E-07	1.4E-08	1.7E-08	5.9E-09	1.26E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	7.0E-08	3.0E-08	2.5E-07	2.1E-08	2.6E-08	9.0E-09	1.92E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	6.4E-08	2.8E-08	2.3E-07	1.9E-08	2.4E-08	8.3E-09	1.76E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	2.9E-07	1.2E-07	1.0E-06	8.6E-08	1.1E-07	3.7E-08	7.86E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	3.1E-07	1.3E-07	1.1E-06	9.3E-08	1.2E-07	4.0E-08	8.44E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	5.0E-07	2.1E-07	1.7E-06	1.5E-07	1.9E-07	6.4E-08	1.37E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	2.9E-07	1.2E-07	1.0E-06	8.6E-08	1.1E-07	3.7E-08	7.83E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-ami	3.3E-07	1.4E-07	1.1E-06	9.8E-08	1.2E-07	4.2E-08	8.97E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.5E-07	1.2E-06	1.0E-07	1.3E-07	4.4E-08	9.29E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	4.2E-03	1.8E-03	1.5E-02	1.3E-03	1.6E-03	5.4E-04	1.15E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	2.1E-05	9.0E-06	7.4E-05	6.3E-06	7.9E-06	2.7E-06	5.75E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.2E-04	5.0E-05	4.1E-04	3.5E-05	4.4E-05	1.5E-05	3.19E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	1.9E-03	8.2E-04	6.7E-03	5.7E-04	7.1E-04	2.4E-04	5.21E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	6.0E-03	2.6E-03	2.1E-02	1.8E-03	2.3E-03	7.8E-04	1.65E+03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	1.2E-06	5.2E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.35E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	3.0E-03	1.3E-03	1.1E-02	9.1E-04	1.1E-03	3.9E-04	8.28E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 child ; 24 x 365 adult (NC) 70 x 365 (C)

CASE 2

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	8.5E-06	2.3E-06	1.5E-05		6.8E-06	2.3E-06	5.75E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	6 Child, 24 Adult
SA = Surface Area Contact (cm2)	1510(C)/3120(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	6 x 365 (Nc)+ 24 x 365 (Nc)
ABS = Absorption Factor (unitless)	varies (1-25%)		70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.8E-07	NA	NA		
3-Nitroaniline	4.7E-06	2.0E-06	NA	NA		
Dinitrotoluene, 2,4-	2.1E-06	8.9E-07	2.0E-03	NA	1.0E-03	
Phenanthrene	1.2E-06	5.1E-07	NA	NA		
Benzo(a)anthracene	1.3E-06	5.5E-07	NA	7.3E-01		4.0E-07
Chrysene	1.3E-06	5.6E-07	NA	7.3E-02		4.1E-08
Benzo(b)fluoranthene	1.3E-06	5.7E-07	NA	7.3E-01		4.1E-07
Benzo(k)fluoranthene	1.2E-06	5.3E-07	NA	7.3E-01		3.9E-07
Benzo(a)pyrene	1.3E-06	5.5E-07	NA	7.3E+00		4.0E-06
Indeno(1,2,3-cd)pyrene	1.2E-06	5.2E-07	NA	7.3E-01		3.8E-07
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	NA	7.3E+00		3.5E-06
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	4.6E-08	2.0E-08	5.0E-05	1.6E+01	9.2E-04	3.2E-07
4,4'-DDE	7.0E-08	3.0E-08	NA	3.4E-01		1.0E-08
4,4'-DDT	6.4E-08	2.8E-08	5.0E-04	3.4E-01	1.3E-04	9.4E-09
Explosives						
RDX	2.9E-07	1.2E-07	3.0E-03	1.1E-01	9.6E-05	1.4E-08
1,3,5-Trinitrobenzene	3.1E-07	1.3E-07	5.0E-05	NA	6.2E-03	
Tetryl	5.0E-07	2.1E-07	NA	NA		
Trinitrotoluene, 2,4,6-	2.9E-07	1.2E-07	5.0E-04	3.0E-02	5.7E-04	3.7E-09
Dinitrotoluene, 2,6-, 4-ami	3.3E-07	1.4E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.5E-07	NA	NA		
Metals						
Barium	4.2E-03	1.8E-03	7.0E-02	NA	6.0E-02	
Cadmium	2.1E-05	9.0E-06	5.0E-04	NA	4.2E-02	
Chromium	1.2E-04	5.0E-05	5.0E-03	NA	2.3E-02	
Copper	1.9E-03	8.2E-04	4.0E-02	NA	4.8E-02	
Lead	6.0E-03	2.6E-03	NA	NA		
Thallium	1.2E-06	5.2E-07	9.0E-05	NA	1.4E-02	
Zinc	3.0E-03	1.3E-03	3.0E-01	NA	1.0E-02	
Totals - HQ & CR					**2.1E-01**	**9.5E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	8.5E-06	2.3E-06	5.0E-04	0.0E+00	1.7E-02	0.0E+00
Totals - HQ & CR					**1.7E-02**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 2

**CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.19E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.22E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			9.76E-06	20	350	30	70	10,950	25,550
Phenanthrene			5.59E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			6.03E-06	20	350	30	70	10,950	25,550
Chrysene			6.12E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			6.19E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.82E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			6.05E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.69E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.22E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			5.22E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.5E-11	2.16E-07	20	350	30	70	10,950	25,550
4,4'-DDE		3.9E-11	3.29E-07	20	350	30	70	10,950	25,550
4,4'-DDT		3.5E-11	3.01E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.35E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.44E-06	20	350	30	70	10,950	25,550
Tetryl			2.34E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			1.34E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			1.53E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			1.59E-06	20	350	30	70	10,950	25,550
Metals									
Barium	5.4E-09		1.96E-05	20	350	30	70	10,950	25,550
Cadmium		1.2E-11	9.85E-08	20	350	30	70	10,950	25,550
Chromium		6.4E-11	5.45E-07	20	350	30	70	10,950	25,550
Copper			8.91E-06	20	350	30	70	10,950	25,550
Lead			2.83E-05	20	350	30	70	10,950	25,550
Thallium			5.74E-09	20	350	30	70	10,950	25,550
Zinc			1.42E-05	20	350	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 2

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.5E-11	NA	1.6E+01		4.1E-10
4,4'-DDE		3.9E-11	NA	3.4E-01		1.3E-11
4,4'-DDT		3.5E-11	NA	3.4E-01		1.2E-11
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	5.4E-09		1.4E-04	NA	3.8E-05	
Cadmium		1.2E-11	NA	6.3E+00		7.3E-11
Chromium		6.4E-11	NA	4.2E-02		2.7E-12
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**3.8E-05**	**5.1E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	**Assumptions:**	**Variables:**	**Assumptions:**
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \;\; CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ABSORPTION METHODOLOGY: Linear Absorption

Cases 1 & 2

AIR CONCENTRATION: 0.029 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1405.0	470.0
1-2	1405.0	470.0
2-3	1405.0	470.0
3-4	1405.0	470.0
4-5	1405.0	470.0
5-6	1405.0	470.0
6-7	1405.0	470.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	8.86	18.34	16.09
1-2:	10.19	26.92	24.29
2-3:	9.79	28.39	25.36
3-4:	9.41	29.48	26.40
4-5:	8.22	24.74	21.43
5-6:	7.11	23.62	20.00
6-7:	6.33	23.26	19.26

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	1.96	0.28	0.00	0.01
1-2:	1.95	0.67	0.00	0.01
2-3:	2.28	0.73	0.00	0.02

3-4:	2.28	0.78	0.00	0.02
4-5:	2.41	0.88	0.00	0.02
5-6:	2.64	0.96	0.00	0.03
6-7:	2.97	1.00	0.00	0.03

Case 3

CASE 3

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	171	1,100.00	307.07	291.12	126.86	0.44	NORMAL	307.07
3-Nitroaniline	ug/kg	173	2,950.00	1,312.54	1,220.90	732.77	0.60	NORMAL	1,312.54
2,4-Dinitrotoluene	ug/kg	178	33,000.00	552.23	702.65	2,579.76	3.67	LOGNORMAL	552.23
Phenanthrene	ug/kg	175	1,800.00	311.63	290.74	168.01	0.58	NORMAL	311.63
Benzo(a)anthracene	ug/kg	171	2,400.00	324.64	300.20	194.29	0.65	NORMAL	324.64
Chrysene	ug/kg	172	2,700.00	305.14	305.81	212.81	0.70	NORMAL	305.14
Benzo(b)fluoranthene	ug/kg	171	3,900.00	317.44	307.92	297.87	0.97	NORMAL	317.44
benzo(k)fluoranthene	ug/kg	171	2,800.00	303.58	303.56	219.30	0.72	NORMAL	303.58
Benzo(a)pyrene	ug/kg	171	2,800.00	330.46	302.64	221.19	0.73	NORMAL	330.46
Indeno(1,2,3-cd)pyrene	ug/kg	170	1,600.00	317.55	299.28	144.79	0.48	NORMAL	317.55
Dibenz(a,h)anthracene	ug/kg	166	670.00	306.76	293.70	102.26	0.35	NORMAL	306.76
Benzo(g,h,i)perylene	ug/kg	167	960.00	303.81	295.62	112.75	0.38	NORMAL	303.81
Pesticides/PCBs									
Dieldrin	ug/kg	176	90.00	12.78	11.51	10.79	0.94	NORMAL	12.78
4,4'-DDE	ug/kg	178	830.00	19.51	17.84	63.19	3.54	LOGNORMAL	19.51
4,4'-DDT	ug/kg	178	320.00	17.39	13.75	25.57	1.86	LOGNORMAL	17.39
Explosives									
RDX	ug/kg	179	4,800.00	80.54	109.19	413.23	3.78	LOGNORMAL	80.54
1,3,5-Trinitrobenzene	ug/kg	179	350.00	71.58	72.22	42.78	0.59	NORMAL	71.58
Tetryl	ug/kg	179	270.00	137.81	129.16	70.36	0.54	NORMAL	137.81
2,4,6-Trinitrotoluene	ug/kg	179	910.00	70.84	71.13	72.88	1.02	LOGNORMAL	70.84
4-amino-2,6-Dinitrotoluene	ug/kg	179	810.00	85.75	87.16	100.69	1.16	LOGNORMAL	85.75
2-amino-4,6-Dinitrotoluene	ug/kg	179	1,300.00	88.99	92.54	133.21	1.44	LOGNORMAL	88.99
Metals									
Barium	mg/kg	157	10,300.00	722.06	731.06	1,547.15	2.12	LOGNORMAL	722.06
Cadmium	mg/kg	176	20.70	4.63	2.70	3.02	1.12	LOGNORMAL	4.63
Chromium	mg/kg	172	1,430.00	31.40	36.45	108.91	2.99	LOGNORMAL	31.40
Copper	mg/kg	170	15,500.00	339.67	444.90	1,676.25	3.77	LOGNORMAL	339.67
Lead	mg/kg	167	7,400.00	660.43	491.79	1,107.91	2.25	LOGNORMAL	660.43
Thallium	mg/kg	173	38.00	0.35	0.51	2.87	5.61	LOGNORMAL	0.35
Zinc	mg/kg	175	127,000.00	561.78	1,171.63	9,601.53	8.20	LOGNORMAL	561.78

CASE 3

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semi-volatiles											
Methylnaphthalene, 2-			3.07E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.31E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	1.6E-06		5.52E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.12E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.3E-07	3.25E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.1E-07	3.05E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.2E-07	3.17E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.1E-07	3.04E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.3E-07	3.30E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.2E-07	3.18E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.1E-07	3.07E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			3.04E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.6E-08	1.3E-08	1.28E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		2.0E-08	1.95E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	4.9E-08	1.7E-08	1.74E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.3E-07	8.1E-08	8.05E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	2.0E-07		7.16E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.38E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	2.0E-07	7.1E-08	7.08E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			8.58E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			8.90E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	2.0E-03		7.22E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	1.3E-05		4.63E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	8.8E-05		3.14E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	9.6E-04		3.40E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			6.60E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	9.7E-07		3.45E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	1.6E-03		5.62E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/yr)	150 events/year
IR = Ingestion Rate (mg soil/day)	480	ED = Exposure Duration (years)	25 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)

CASE 3

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	2.4E-06		4.63E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	1.6E-06		2.0E-03	NA	7.8E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.3E-07	NA	7.3E-01		2.4E-07
Chrysene		3.1E-07	NA	7.3E-02		2.2E-08
Benzo(b)fluoranthene		3.2E-07	NA	7.3E-01		2.3E-07
Benzo(k)fluoranthene		3.1E-07	NA	7.3E-01		2.2E-07
Benzo(a)pyrene		3.3E-07	NA	7.3E+00		2.4E-06
Indeno(1,2,3-cd)pyrene		3.2E-07	NA	7.3E-01		2.3E-07
Dibenzo(a,h)anthracene		3.1E-07	NA	7.3E+00		2.3E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.6E-08	1.3E-08	5.0E-05	1.6E+01	7.2E-04	2.1E-07
4,4'-DDE		2.0E-08	NA	3.4E-01		6.7E-09
4,4'-DDT	4.9E-08	1.7E-08	5.0E-04	3.4E-01	9.8E-05	5.9E-09
Explosives						
RDX	2.3E-07	8.1E-08	3.0E-03	1.1E-01	7.6E-05	8.9E-09
1,3,5-Trinitrobenzene	2.0E-07		5.0E-05	NA	4.0E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	2.0E-07	7.1E-08	5.0E-04	3.0E-02	4.0E-04	2.1E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	2.0E-03		7.0E-02	NA	2.9E-02	
Cadmium	1.3E-05		5.0E-04	NA	2.6E-02	
Chromium	8.8E-05		5.0E-03	NA	1.8E-02	
Copper	9.6E-04		4.0E-02	NA	2.4E-02	
Lead			NA	NA		
Thallium	9.7E-07		9.0E-05	NA	1.1E-02	
Zinc	1.6E-03		3.0E-01	NA	5.3E-03	
Totals - HQ & CR					**1.2E-01**	**5.9E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	2.4E-06		5.0E-04	NA	4.7E-03	
Totals - HQ & CR					**4.7E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

03/01/94

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-08	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE FROM INGESTION OF SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.88E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
SA = Surface Area Contact (cm2)	19400
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING) INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING) RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
Explosives					
Metals					
Aluminum	mg/kg	8,310.00	11,682.32	5,767.50	8,310.00
Arsenic	mg/kg	4.40	5.66	3.45	4.40
Barium	mg/kg	44.10	57.70	33.85	44.10
Beryllium	mg/kg	0.71	1.03	0.47	0.71
Cadmium	mg/kg	2.00	2.73	1.45	2.00
Chromium	mg/kg	15.20	20.51	11.20	15.20
Cobalt	mg/kg	7.50	10.32	5.38	7.50
Copper	mg/kg	22.40	31.05	15.88	22.40
Lead	mg/kg	15.40	18.65	12.95	15.40
Manganese	mg/kg	468.00	548.91	407.00	468.00
Mercury	mg/kg	0.17	0.27	0.10	0.17
Nickel	mg/kg	23.30	31.42	17.18	23.30
Selenium	mg/kg	0.19	0.20	0.17	0.19
Vanadium	mg/kg	10.90	14.68	8.05	10.90
Zinc	mg/kg	76.00	113.27	47.90	76.00

CASE 2 through CASE 4

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	362.54	312.35	362.54
Phenanthrene	ug/kg	600.00	395.15	330.85	395.15
Benzo(a)anthracene	ug/kg	500.00	366.89	311.28	366.89
Benzo(b)fluoranthene	ug/kg	500.00	366.93	311.50	366.93
benzo(k)fluoranthene	ug/kg	500.00	366.95	311.61	366.95
Benzo(a)pyrene	ug/kg	500.00	366.78	310.72	366.78
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	366.77	310.67	366.77
Explosives					
4-amino-2,6-Dinitrotoluene	ug/kg	160.00	72.20	64.55	72.20
2-amino-4,6-Dinitrotoluene	ug/kg	180.00	75.88	66.59	75.88
Metals					
Aluminum	mg/kg	25,800.00	17,742.74	16,486.36	17,742.74
Antimony	mg/kg	28.30	10.60	7.25	10.60
Arsenic	mg/kg	9.50	5.66	4.85	5.66
Barium	mg/kg	1,780.00	366.08	271.98	366.08
Beryllium	mg/kg	1.60	1.09	0.98	1.09
Cadmium	mg/kg	9.70	3.38	2.55	3.38
Chromium	mg/kg	41.80	26.72	24.56	26.72
Cobalt	mg/kg	17.70	12.70	11.64	12.70
Copper	mg/kg	3,790.00	489.13	288.04	489.13
Lead	mg/kg	7,400.00	1,674.71	526.09	1,674.71
Manganese	mg/kg	1,520.00	597.58	502.05	597.58
Mercury	mg/kg	2.00	0.93	0.32	0.93
Nickel	mg/kg	64.40	40.25	36.55	40.25
Selenium	mg/kg	1.80	0.91	0.73	0.91
Vanadium	mg/kg	37.90	27.22	25.23	27.22
Zinc	mg/kg	1,200.00	446.43	273.22	446.43

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles											
Explosives											
Metals											
Aluminum			1.17E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.6E-07	6.6E-08	5.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.6E-06		5.77E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	2.8E-08	1.2E-08	1.03E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	7.5E-08		2.73E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	5.6E-07		2.05E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.03E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	8.5E-07		3.11E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			1.86E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.5E-05		5.49E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	7.4E-09		2.69E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.14E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	5.6E-09		2.05E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.0E-07		1.47E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	3.1E-06		1.13E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chem. Conc. in Sediment (mg/kg-soil)	95th UCL Sediment Data	EF = Exposure Frequency (days/year)	7 events/year
IR = Ingestion Rate (mg soil/day)	100	ED = Exposure Duration (years)	30 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	4.0E-07		2.73E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-07	6.6E-08	3.0E-04	1.8E+00	5.2E-04	1.2E-07
Barium	1.6E-06		7.0E-02	NA	2.3E-05	
Beryllium	2.8E-08	1.2E-08	5.0E-03	4.3E+00	5.7E-06	5.2E-08
Cadmium	7.5E-08		5.0E-04	NA	1.5E-04	
Chromium	5.6E-07		5.0E-03	NA	1.1E-04	
Cobalt			NA	NA		
Copper	8.5E-07		4.0E-02	NA	2.1E-05	
Lead			NA	NA		
Manganese	1.5E-05		5.0E-03	NA	3.0E-03	
Mercury	7.4E-09		3.0E-04	NA	2.5E-05	
Nickel			NA	NA		
Selenium	5.6E-09		5.0E-03	NA	1.1E-06	
Vanadium	4.0E-07		7.0E-03	NA	5.7E-05	
Zinc	3.1E-06		3.0E-01	NA	1.0E-05	
Totals - HQ & CR					**3.9E-03**	**1.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	4.0E-07		5.0E-04	NA	8.0E-04	
Totals - HQ & CR					**8.0E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	1.88E-05	5.25E-06	4.98E-06	5.25E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.25E-05	2.09E-05	2.25E-05
Dinitrotoluene, 2,4-	ug/m3	5.65E-04	9.45E-06	1.20E-05	9.45E-06
Phenanthrene	ug/m3	3.08E-05	5.33E-06	4.97E-06	5.33E-06
Benzo(a)anthracene	ug/m3	4.11E-05	5.55E-06	5.14E-06	5.55E-06
Chrysene	ug/m3	4.62E-05	5.22E-06	5.23E-06	5.22E-06
Benzo(b)fluoranthene	ug/m3	6.67E-05	5.43E-06	5.27E-06	5.43E-06
Benzo(k)fluoranthene	ug/m3	4.79E-05	5.19E-06	5.19E-06	5.19E-06
Benzo(a)pyrene	ug/m3	4.79E-05	5.65E-06	5.18E-06	5.65E-06
Indeno(1,2,3-cd)pyrene	ug/m3	2.74E-05	5.43E-06	5.12E-06	5.43E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.25E-06	5.02E-06	5.25E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	5.20E-06	5.06E-06	5.20E-06
Pesticides/PCBs					
Dieldrin	ug/m3	1.54E-06	2.19E-07	1.97E-07	2.19E-07
4,4'-DDE	ug/m3	1.42E-05	3.34E-07	3.05E-07	3.34E-07
4,4'-DDT	ug/m3	5.47E-06	2.97E-07	2.35E-07	2.97E-07
Explosives					
RDX	ug/m3	8.21E-05	1.38E-06	1.87E-06	1.38E-06
1,3,5-Trinitrobenzene	ug/m3	5.99E-06	1.22E-06	1.24E-06	1.22E-06
Tetryl	ug/m3	4.62E-06	2.36E-06	2.21E-06	2.36E-06
2,4,6-Trinitrotoluene	ug/m3	1.56E-05	1.21E-06	1.22E-06	1.21E-06
4-amino-2,6-Dinitrotoluene	ug/m3	1.39E-05	1.47E-06	1.49E-06	1.47E-06
2-amino-4,6-Dinitrotoluene	ug/m3	2.22E-05	1.52E-06	1.58E-06	1.52E-06
Metals					
Barium	ug/m3	1.76E-04	1.24E-05	1.25E-05	1.24E-05
Cadmium	ug/m3	3.54E-07	7.92E-08	4.61E-08	7.92E-08
Chromium	ug/m3	2.45E-05	5.37E-07	6.24E-07	5.37E-07
Copper	ug/m3	2.65E-04	5.81E-06	7.61E-06	5.81E-06
Lead	ug/m3	1.27E-04	1.13E-05	8.41E-06	1.13E-05
Thallium	ug/m3	6.50E-07	5.91E-09	8.74E-09	5.91E-09
Zinc	ug/m3	2.17E-03	9.61E-06	2.00E-05	9.61E-06

CASE 3

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.25E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.25E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			9.45E-06	20	150	25	70	9,125	25,550
Phenanthrene			5.33E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			5.55E-06	20	150	25	70	9,125	25,550
Chrysene			5.22E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			5.43E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.19E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			5.65E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.43E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.25E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			5.20E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		9.2E-12	2.19E-07	20	150	25	70	9,125	25,550
4,4'-DDE		1.4E-11	3.34E-07	20	150	25	70	9,125	25,550
4,4'-DDT		1.2E-11	2.97E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.38E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.22E-06	20	150	25	70	9,125	25,550
Tetryl			2.36E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			1.21E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			1.47E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			1.52E-06	20	150	25	70	9,125	25,550
Metals									
Barium	1.5E-09		1.24E-05	20	150	25	70	9,125	25,550
Cadmium		3.3E-12	7.92E-08	20	150	25	70	9,125	25,550
Chromium		2.3E-11	5.37E-07	20	150	25	70	9,125	25,550
Copper			5.81E-06	20	150	25	70	9,125	25,550
Lead			1.13E-05	20	150	25	70	9,125	25,550
Thallium			5.91E-09	20	150	25	70	9,125	25,550
Zinc			9.61E-06	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	**95% UCL Air Model Data**
IR = Inhalation Rate (m3/day)	**20**
EF = Exposure Frequency (days/yr)	**150**
ED = Exposure Duration (years)	**25**
BW = Bodyweight (kg)	**70**
AT = Averaging Time (days)	**25 x 365 (Nc) 70 x 365 (Car)**

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		9.2E-12	NA	1.6E+01		1.5E-10
4,4'-DDE		1.4E-11	NA	3.4E-01		4.8E-12
4,4'-DDT		1.2E-11	NA	3.4E-01		4.2E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	1.5E-09		1.4E-04	NA	1.0E-05	
Cadmium		3.3E-12	NA	6.3E+00		2.1E-11
Chromium		2.3E-11	NA	4.2E-02		9.5E-13
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**1.0E-05**	**1.8E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.8E-07	NA	NA		
3-Nitroaniline	4.8E-06	2.1E-06	NA	NA		
Dinitrotoluene, 2,4-	2.0E-06	8.6E-07	2.0E-03	NA	1.0E-03	
Phenanthrene	1.1E-06	4.9E-07	NA	NA		
Benzo(a)anthracene	1.2E-06	5.1E-07	NA	7.3E-01		3.7E-07
Chrysene	1.1E-06	4.8E-07	NA	7.3E-02		3.5E-08
Benzo(b)fluoranthene	1.2E-06	5.0E-07	NA	7.3E-01		3.6E-07
Benzo(k)fluoranthene	1.1E-06	4.8E-07	NA	7.3E-01		3.5E-07
Benzo(a)pyrene	1.2E-06	5.2E-07	NA	7.3E+00		3.8E-06
Indeno(1,2,3-cd)pyrene	1.2E-06	5.0E-07	NA	7.3E-01		3.6E-07
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	NA	7.3E+00		3.5E-06
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	4.7E-08	2.0E-08	5.0E-05	1.6E+01	9.3E-04	3.2E-07
4,4'-DDE	7.1E-08	3.1E-08	NA	3.4E-01		1.0E-08
4,4'-DDT	6.4E-08	2.7E-08	5.0E-04	3.4E-01	1.3E-04	9.3E-09
Explosives						
RDX	2.9E-07	1.3E-07	3.0E-03	1.1E-01	9.8E-05	1.4E-08
1,3,5-Trinitrobenzene	2.6E-07	1.1E-07	5.0E-05	NA	5.2E-03	
Tetryl	5.0E-07	2.2E-07	NA	NA		
Trinitrotoluene, 2,4,6-	2.6E-07	1.1E-07	5.0E-04	3.0E-02	5.2E-04	3.3E-09
Dinitrotoluene, 2,6-, 4-ami	3.1E-07	1.3E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	3.3E-07	1.4E-07	NA	NA		
Metals						
Barium	2.6E-03	1.1E-03	7.0E-02	NA	3.8E-02	
Cadmium	1.7E-05	7.3E-06	5.0E-04	NA	3.4E-02	
Chromium	1.1E-04	4.9E-05	5.0E-03	NA	2.3E-02	
Copper	1.2E-03	5.3E-04	4.0E-02	NA	3.1E-02	
Lead	2.4E-03	1.0E-03	NA	NA		
Thallium	1.3E-06	5.4E-07	9.0E-05	NA	1.4E-02	
Zinc	2.1E-03	8.8E-04	3.0E-01	NA	6.8E-03	
Totals - HQ & CR					**1.5E-01**	**9.1E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.8E-07	3.9E-06	3.4E-07	4.2E-07	1.4E-07	3.07E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.8E-06	2.1E-06	1.7E-05	1.4E-06	1.8E-06	6.2E-07	1.31E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	2.0E-06	8.6E-07	7.1E-06	6.1E-07	7.6E-07	2.6E-07	5.52E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.1E-06	4.9E-07	4.0E-06	3.4E-07	4.3E-07	1.5E-07	3.12E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.4E-07	1.5E-07	3.25E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.05E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.2E-06	5.0E-07	4.1E-06	3.5E-07	4.3E-07	1.5E-07	3.17E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.04E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.2E-06	5.2E-07	4.2E-06	3.6E-07	4.5E-07	1.6E-07	3.30E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06	5.0E-07	4.1E-06	3.5E-07	4.3E-07	1.5E-07	3.18E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.8E-07	3.9E-06	3.4E-07	4.2E-07	1.4E-07	3.07E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.8E-07	3.9E-06	3.3E-07	4.2E-07	1.4E-07	3.04E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	4.7E-08	2.0E-08	1.6E-07	1.4E-08	1.8E-08	6.0E-09	1.28E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	7.1E-08	3.1E-08	2.5E-07	2.1E-08	2.7E-08	9.2E-09	1.95E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	6.4E-08	2.7E-08	2.2E-07	1.9E-08	2.4E-08	8.2E-09	1.74E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	2.9E-07	1.3E-07	1.0E-06	8.8E-08	1.1E-07	3.8E-08	8.05E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	2.6E-07	1.1E-07	9.2E-07	7.8E-08	9.8E-08	3.4E-08	7.16E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	5.0E-07	2.2E-07	1.8E-06	1.5E-07	1.9E-07	6.5E-08	1.38E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	2.6E-07	1.1E-07	9.1E-07	7.8E-08	9.7E-08	3.3E-08	7.08E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-ami	3.1E-07	1.3E-07	1.1E-06	9.4E-08	1.2E-07	4.0E-08	8.58E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-ami	3.3E-07	1.4E-07	1.1E-06	9.8E-08	1.2E-07	4.2E-08	8.90E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	2.6E-03	1.1E-03	9.2E-03	7.9E-04	9.9E-04	3.4E-04	7.22E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	1.7E-05	7.3E-06	5.9E-05	5.1E-06	6.3E-06	2.2E-06	4.63E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.1E-04	4.9E-05	4.0E-04	3.4E-05	4.3E-05	1.5E-05	3.14E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	1.2E-03	5.3E-04	4.3E-03	3.7E-04	4.7E-04	1.6E-04	3.40E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	2.4E-03	1.0E-03	8.4E-03	7.2E-04	9.0E-04	3.1E-04	6.60E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	1.3E-06	5.4E-07	4.4E-06	3.8E-07	4.7E-07	1.6E-07	3.45E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	2.1E-03	8.8E-04	7.2E-03	6.2E-04	7.7E-04	2.6E-04	5.62E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 child ; 24 x 365 adult (NC) 70 x 365 (C)

CASE 3

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	6.9E-06	1.9E-06	1.2E-05		5.5E-06	1.9E-06	4.63E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables: / **Assumptions:**

CS = Chemical Concentration in Soil (mg soil/kg) — 95th UCL Soil Data
CF = Conversion Factor (10-6 kg/mg) — 10-6
SA = Surface Area Contact (cm2) — 1510(C)/3120(A)
AF =Soil to Skin Adherence Factor (mg/cm2) — 2.77
ABS = Absorption Factor (unitless) — varies (1-25%)

Variables: / **Assumptions:**

EF = Exposure Frequency (days/year) — 350 events/year
ED = Exposure Duration (years) — 6 Child, 24 Adult
BW = Bodyweight (kg) — 15 kg (child) 70 kg (adult)
AT = Averaging Time (days) — 6 x 365 (Nc)+ 24 x 365 (Nc)
70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	6.9E-06	1.9E-06	5.0E-04	0.0E+00	1.4E-02	0.0E+00
Totals - HQ & CR					**1.4E-02**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 3

CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.25E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.25E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			9.45E-06	20	350	30	70	10,950	25,550
Phenanthrene			5.33E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			5.55E-06	20	350	30	70	10,950	25,550
Chrysene			5.22E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			5.43E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.19E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			5.65E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.43E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.25E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			5.20E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.6E-11	2.19E-07	20	350	30	70	10,950	25,550
4,4'-DDE		3.9E-11	3.34E-07	20	350	30	70	10,950	25,550
4,4'-DDT		3.5E-11	2.97E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.38E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.22E-06	20	350	30	70	10,950	25,550
Tetryl			2.36E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			1.21E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			1.47E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			1.52E-06	20	350	30	70	10,950	25,550
Metals									
Barium	3.4E-09		1.24E-05	20	350	30	70	10,950	25,550
Cadmium		9.3E-12	7.92E-08	20	350	30	70	10,950	25,550
Chromium		6.3E-11	5.37E-07	20	350	30	70	10,950	25,550
Copper			5.81E-06	20	350	30	70	10,950	25,550
Lead			1.13E-05	20	350	30	70	10,950	25,550
Thallium			5.91E-09	20	350	30	70	10,950	25,550
Zinc			9.61E-06	20	350	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 3

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.6E-11	NA	1.6E+01		4.1E-10
4,4'-DDE		3.9E-11	NA	3.4E-01		1.3E-11
4,4'-DDT		3.5E-11	NA	3.4E-01		1.2E-11
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	3.4E-09		1.4E-04	NA	2.4E-05	
Cadmium		9.3E-12	NA	6.3E+00		5.9E-11
Chromium		6.3E-11	NA	4.2E-02		2.6E-12
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**2.4E-05**	**5.0E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \; CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ABSORPTION METHODOLOGY: Linear Absorption Case 3

AIR CONCENTRATION: 0.029 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	492.0	470.0
1-2	492.0	470.0
2-3	492.0	470.0
3-4	492.0	470.0
4-5	492.0	470.0
5-6	492.0	470.0
6-7	492.0	470.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	6.08	12.35	9.81
1-2:	6.91	18.09	15.06
2-3:	6.60	18.96	15.52
3-4:	6.28	19.43	15.97
4-5:	5.43	16.16	12.56
5-6:	4.68	15.45	11.56
6-7:	4.17	15.30	11.05

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.22	0.32	0.00	0.01
1-2:	2.24	0.77	0.00	0.01
2-3:	2.59	0.83	0.00	0.02

3-4:	2.56	0.87	0.00	0.02
4-5:	2.62	0.96	0.00	0.02
5-6:	2.83	1.03	0.00	0.03
6-7:	3.16	1.07	0.00	0.03

Case 4

CASE 4

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	134	1,100.00	302.36	283.99	129.29	0.46	NORMAL	302.36
3-Nitroaniline	ug/kg	136	2,950.00	1,207.45	1,102.68	742.70	0.67	NORMAL	1,207.45
2,4-Dinitrotoluene	ug/kg	138	7,000.00	493.32	515.33	917.17	1.78	LOGNORMAL	493.32
Phenanthrene	ug/kg	137	1,800.00	317.16	292.57	174.95	0.60	NORMAL	317.16
Benzo(a)anthracene	ug/kg	134	2,400.00	325.73	295.71	211.28	0.71	NORMAL	325.73
Chrysene	ug/kg	135	2,700.00	298.88	300.70	234.40	0.78	NORMAL	298.88
Benzo(b)fluoranthene	ug/kg	134	3,900.00	333.82	304.21	331.60	1.09	LOGNORMAL	333.82
benzo(k)fluoranthene	ug/kg	134	2,800.00	297.73	298.67	241.83	0.81	NORMAL	297.73
Benzo(a)pyrene	ug/kg	134	2,800.00	330.44	295.75	244.17	0.83	NORMAL	330.44
Indeno(1,2,3-cd)pyrene	ug/kg	133	1,600.00	313.05	291.18	153.29	0.53	NORMAL	313.05
Dibenz(a,h)anthracene	ug/kg	129	670.00	295.29	280.43	102.61	0.37	NORMAL	295.29
Benzo(g,h,i)perylene	ug/kg	130	960.00	291.08	281.75	116.91	0.41	NORMAL	291.08
Pesticides/PCBs									
Dieldrin	ug/kg	137	28.50	10.72	9.58	8.68	0.91	NORMAL	10.72
4,4'-DDE	ug/kg	138	32.00	10.07	10.25	9.15	0.89	NORMAL	10.07
4,4'-DDT	ug/kg	138	29.50	9.88	10.10	9.02	0.89	NORMAL	9.88
Explosives									
RDX	ug/kg	139	4,800.00	77.67	101.20	403.62	3.99	LOGNORMAL	77.67
1,3,5-Trinitrobenzene	ug/kg	139	350.00	70.35	71.92	42.70	0.59	NORMAL	70.35
Tetryl	ug/kg	139	270.00	126.49	116.83	69.22	0.59	NORMAL	126.49
2,4,6-Trinitrotoluene	ug/kg	139	910.00	71.95	71.96	77.97	1.08	LOGNORMAL	71.95
4-amino-2,6-Dinitrotoluene	ug/kg	139	810.00	86.36	86.20	95.04	1.10	LOGNORMAL	86.36
2-amino-4,6-Dinitrotoluene	ug/kg	139	1,300.00	92.20	95.58	144.47	1.51	LOGNORMAL	92.20
Metals									
Barium	mg/kg	123	4,520.00	334.14	326.17	593.29	1.82	LOGNORMAL	334.14
Cadmium	mg/kg	136	9.70	3.05	1.90	2.09	1.10	LOGNORMAL	3.05
Chromium	mg/kg	132	263.00	27.98	27.35	23.25	0.85	NORMAL	27.98
Copper	mg/kg	133	3,790.00	158.41	165.43	410.86	2.48	LOGNORMAL	158.41
Lead	mg/kg	131	7,400.00	476.13	431.81	1,156.24	2.68	LOGNORMAL	476.13
Thallium	mg/kg	133	0.80	0.14	0.28	0.10	0.35	NORMAL	0.14
Zinc	mg/kg	135	1,200.00	239.50	213.94	234.33	1.10	LOGNORMAL	239.50

CASE 4

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Semi-volatiles											
Methylnaphthalene, 2-			3.02E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.21E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	1.4E-06		4.93E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.17E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.3E-07	3.26E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.0E-07	2.99E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.4E-07	3.34E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.0E-07	2.98E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.3E-07	3.30E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.2E-07	3.13E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.0E-07	2.95E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			2.91E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.0E-08	1.1E-08	1.07E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		1.0E-08	1.01E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	2.8E-08	9.9E-09	9.88E-03	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.2E-07	7.8E-08	7.77E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	2.0E-07		7.04E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.26E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	2.0E-07	7.2E-08	7.20E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			8.64E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			9.22E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	9.4E-04		3.34E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	8.6E-06		3.05E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	7.9E-05		2.80E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	4.5E-04		1.58E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			4.76E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	4.0E-07		1.43E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	6.7E-04		2.39E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/yr)	150 events/year
IR = Ingestion Rate (mg soil/day)	480	ED = Exposure Duration (years)	25 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)

CASE 4

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	1.5E-06		3.05E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	1.4E-06		2.0E-03	NA	7.0E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.3E-07	NA	7.3E-01		2.4E-07
Chrysene		3.0E-07	NA	7.3E-02		2.2E-08
Benzo(b)fluoranthene		3.4E-07	NA	7.3E-01		2.5E-07
Benzo(k)fluoranthene		3.0E-07	NA	7.3E-01		2.2E-07
Benzo(a)pyrene		3.3E-07	NA	7.3E+00		2.4E-06
Indeno(1,2,3-cd)pyrene		3.2E-07	NA	7.3E-01		2.3E-07
Dibenzo(a,h)anthracene		3.0E-07	NA	7.3E+00		2.2E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.0E-08	1.1E-08	5.0E-05	1.6E+01	6.0E-04	1.7E-07
4,4'-DDE		1.0E-08	NA	3.4E-01		3.4E-09
4,4'-DDT	2.8E-08	9.9E-09	5.0E-04	3.4E-01	5.6E-05	3.4E-09
Explosives						
RDX	2.2E-07	7.8E-08	3.0E-03	1.1E-01	7.3E-05	8.6E-09
1,3,5-Trinitrobenzene	2.0E-07		5.0E-05	NA	4.0E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	2.0E-07	7.2E-08	5.0E-04	3.0E-02	4.1E-04	2.2E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	9.4E-04		7.0E-02	NA	1.3E-02	
Cadmium	8.6E-06		5.0E-04	NA	1.7E-02	
Chromium	7.9E-05		5.0E-03	NA	1.6E-02	
Copper	4.5E-04		4.0E-02	NA	1.1E-02	
Lead			NA	NA		
Thallium	4.0E-07		9.0E-05	NA	4.5E-03	
Zinc	6.7E-04		3.0E-01	NA	2.2E-03	
Totals - HQ & CR					**7.0E-02**	**5.7E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	1.5E-06		5.0E-04	NA	3.1E-03	
Totals - HQ & CR					**3.1E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING) FROM DERMAL CONTACT TO SURFACE WATER INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-06	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
									Nc	Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.68E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	19400	ED = Exposure Duration (years)	30
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)	CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70
		AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
Explosives					
Metals					
Aluminum	mg/kg	8,310.00	11,682.32	5,767.50	8,310.00
Arsenic	mg/kg	4.40	5.66	3.45	4.40
Barium	mg/kg	44.10	57.70	33.85	44.10
Beryllium	mg/kg	0.71	1.03	0.47	0.71
Cadmium	mg/kg	2.00	2.73	1.45	2.00
Chromium	mg/kg	15.20	20.51	11.20	15.20
Cobalt	mg/kg	7.50	10.32	5.38	7.50
Copper	mg/kg	22.40	31.05	15.88	22.40
Lead	mg/kg	15.40	18.65	12.95	15.40
Manganese	mg/kg	468.00	548.91	407.00	468.00
Mercury	mg/kg	0.17	0.27	0.10	0.17
Nickel	mg/kg	23.30	31.42	17.18	23.30
Selenium	mg/kg	0.19	0.20	0.17	0.19
Vanadium	mg/kg	10.90	14.68	8.05	10.90
Zinc	mg/kg	76.00	113.27	47.90	76.00

CASE 2 through CASE 4

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	362.54	312.35	362.54
Phenanthrene	ug/kg	600.00	395.15	330.85	395.15
Benzo(a)anthracene	ug/kg	500.00	366.89	311.28	366.89
Benzo(b)fluoranthene	ug/kg	500.00	366.93	311.50	366.93
benzo(k)fluoranthene	ug/kg	500.00	366.95	311.61	366.95
Benzo(a)pyrene	ug/kg	500.00	366.78	310.72	366.78
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	366.77	310.67	366.77
Explosives					
4-amino-2,6-Dinitrotoluene	ug/kg	160.00	72.20	64.55	72.20
2-amino-4,6-Dinitrotoluene	ug/kg	180.00	75.88	66.59	75.88
Metals					
Aluminum	mg/kg	25,800.00	17,742.74	16,486.36	17,742.74
Antimony	mg/kg	28.30	10.60	7.25	10.60
Arsenic	mg/kg	9.50	5.66	4.85	5.66
Barium	mg/kg	1,780.00	366.08	271.98	366.08
Beryllium	mg/kg	1.60	1.09	0.98	1.09
Cadmium	mg/kg	9.70	3.38	2.55	3.38
Chromium	mg/kg	41.80	26.72	24.56	26.72
Cobalt	mg/kg	17.70	12.70	11.64	12.70
Copper	mg/kg	3,790.00	489.13	288.04	489.13
Lead	mg/kg	7,400.00	1,674.71	526.09	1,674.71
Manganese	mg/kg	1,520.00	597.58	502.05	597.58
Mercury	mg/kg	2.00	0.93	0.32	0.93
Nickel	mg/kg	64.40	40.25	36.55	40.25
Selenium	mg/kg	1.80	0.91	0.73	0.91
Vanadium	mg/kg	37.90	27.22	25.23	27.22
Zinc	mg/kg	1,200.00	446.43	273.22	446.43

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles											
Explosives											
Metals											
Aluminum			1.17E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.6E-07	6.6E-08	5.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.6E-06		5.77E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	2.8E-08	1.2E-08	1.03E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	7.5E-08		2.73E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	5.6E-07		2.05E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.03E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	8.5E-07		3.11E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			1.86E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.5E-05		5.49E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	7.4E-09		2.69E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.14E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	5.6E-09		2.05E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.0E-07		1.47E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	3.1E-06		1.13E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) =

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chem. Conc. in Sediment (mg/kg-soil)	95th UCL Sediment Data	EF = Exposure Frequency (days/year)	7 events/year
IR = Ingestion Rate (mg soil/day)	100	ED = Exposure Duration (years)	30 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	4.0E-07		2.73E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-07	6.6E-08	3.0E-04	1.8E+00	5.2E-04	1.2E-07
Barium	1.6E-06		7.0E-02	NA	2.3E-05	
Beryllium	2.8E-08	1.2E-08	5.0E-03	4.3E+00	5.7E-06	5.2E-08
Cadmium	7.5E-08		5.0E-04	NA	1.5E-04	
Chromium	5.6E-07		5.0E-03	NA	1.1E-04	
Cobalt			NA	NA		
Copper	8.5E-07		4.0E-02	NA	2.1E-05	
Lead			NA	NA		
Manganese	1.5E-05		5.0E-03	NA	3.0E-03	
Mercury	7.4E-09		3.0E-04	NA	2.5E-05	
Nickel			NA	NA		
Selenium	5.6E-09		5.0E-03	NA	1.1E-06	
Vanadium	4.0E-07		7.0E-03	NA	5.7E-05	
Zinc	3.1E-06		3.0E-01	NA	1.0E-05	
Totals - HQ & CR					**3.9E-03**	**1.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	4.0E-07		5.0E-04	NA	8.0E-04	
Totals - HQ & CR					**8.0E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	1.88E-05	5.17E-06	4.86E-06	5.17E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.07E-05	1.89E-05	2.07E-05
Dinitrotoluene, 2,4-	ug/m3	1.20E-04	8.44E-06	8.82E-06	8.44E-06
Phenanthrene	ug/m3	3.08E-05	5.43E-06	5.01E-06	5.43E-06
Benzo(a)anthracene	ug/m3	4.11E-05	5.57E-06	5.06E-06	5.57E-06
Chrysene	ug/m3	4.62E-05	5.11E-06	5.14E-06	5.11E-06
Benzo(b)fluoranthene	ug/m3	6.67E-05	5.71E-06	5.20E-06	5.71E-06
Benzo(k)fluoranthene	ug/m3	4.79E-05	5.09E-06	5.11E-06	5.09E-06
Benzo(a)pyrene	ug/m3	4.79E-05	5.65E-06	5.06E-06	5.65E-06
Indeno(1,2,3-cd)pyrene	ug/m3	2.74E-05	5.36E-06	4.98E-06	5.36E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.05E-06	4.80E-06	5.05E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	4.98E-06	4.82E-06	4.98E-06
Pesticides/PCBs					
Dieldrin	ug/m3	4.88E-07	1.83E-07	1.64E-07	1.83E-07
4,4'-DDE	ug/m3	5.47E-07	1.72E-07	1.75E-07	1.72E-07
4,4'-DDT	ug/m3	5.05E-07	1.69E-07	1.73E-07	1.69E-07
Explosives					
RDX	ug/m3	8.21E-05	1.33E-06	1.73E-06	1.33E-06
1,3,5-Trinitrobenzene	ug/m3	5.99E-06	1.20E-06	1.23E-06	1.20E-06
Tetryl	ug/m3	4.62E-06	2.16E-06	2.00E-06	2.16E-06
2,4,6-Trinitrotoluene	ug/m3	1.56E-05	1.23E-06	1.23E-06	1.23E-06
4-amino-2,6-Dinitrotoluene	ug/m3	1.39E-05	1.48E-06	1.47E-06	1.48E-06
2-amino-4,6-Dinitrotoluene	ug/m3	2.22E-05	1.58E-06	1.64E-06	1.58E-06
Metals					
Barium	ug/m3	7.73E-05	5.72E-06	5.58E-06	5.72E-06
Cadmium	ug/m3	1.66E-07	5.22E-08	3.25E-08	5.22E-08
Chromium	ug/m3	4.50E-06	4.79E-07	4.68E-07	4.79E-07
Copper	ug/m3	6.48E-05	2.71E-06	2.83E-06	2.71E-06
Lead	ug/m3	1.27E-04	8.15E-06	7.39E-06	8.15E-06
Thallium	ug/m3	1.37E-08	2.45E-09	4.73E-09	2.45E-09
Zinc	ug/m3	2.05E-05	4.10E-06	3.66E-06	4.10E-06

CASE 4

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.17E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.07E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			8.44E-06	20	150	25	70	9,125	25,550
Phenanthrene			5.43E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			5.57E-06	20	150	25	70	9,125	25,550
Chrysene			5.11E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			5.71E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.09E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			5.65E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.36E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.05E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.98E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		7.7E-12	1.83E-07	20	150	25	70	9,125	25,550
4,4'-DDE		7.2E-12	1.72E-07	20	150	25	70	9,125	25,550
4,4'-DDT		7.1E-12	1.69E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.33E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.20E-06	20	150	25	70	9,125	25,550
Tetryl			2.16E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			1.23E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			1.48E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			1.58E-06	20	150	25	70	9,125	25,550
Metals									
Barium	6.7E-10		5.72E-06	20	150	25	70	9,125	25,550
Cadmium		2.2E-12	5.22E-08	20	150	25	70	9,125	25,550
Chromium		2.0E-11	4.79E-07	20	150	25	70	9,125	25,550
Copper			2.71E-06	20	150	25	70	9,125	25,550
Lead			8.15E-06	20	150	25	70	9,125	25,550
Thallium			2.45E-09	20	150	25	70	9,125	25,550
Zinc			4.10E-06	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	150
ED = Exposure Duration (years)	25
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	25 x 365 (Nc) 70 x 365 (Car)

CASE 4

**CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		7.7E-12	NA	1.6E+01		1.2E-10
4,4'-DDE		7.2E-12	NA	3.4E-01		2.5E-12
4,4'-DDT		7.1E-12	NA	3.4E-01		2.4E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	6.7E-10		1.4E-04	NA	4.7E-06	
Cadmium		2.2E-12	NA	6.3E+00		1.4E-11
Chromium		2.0E-11	NA	4.2E-02		8.4E-13
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**4.7E-06**	**1.4E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 4

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.7E-07	3.9E-06	3.3E-07	4.1E-07	1.4E-07	3.02E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.4E-06	1.9E-06	1.5E-05	1.3E-06	1.7E-06	5.7E-07	1.21E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	1.8E-06	7.7E-07	6.3E-06	5.4E-07	6.8E-07	2.3E-07	4.93E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.2E-06	5.0E-07	4.1E-06	3.5E-07	4.3E-07	1.5E-07	3.17E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.26E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.1E-06	4.7E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	2.99E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.2E-06	5.2E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.34E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.1E-06	4.7E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	2.98E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.2E-06	5.2E-07	4.2E-06	3.6E-07	4.5E-07	1.6E-07	3.30E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.1E-06	4.9E-07	4.0E-06	3.4E-07	4.3E-07	1.5E-07	3.13E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.6E-07	3.8E-06	3.2E-07	4.0E-07	1.4E-07	2.95E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.6E-07	3.7E-06	3.2E-07	4.0E-07	1.4E-07	2.91E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	3.9E-08	1.7E-08	1.4E-07	1.2E-08	1.5E-08	5.0E-09	1.07E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	3.7E-08	1.6E-08	1.3E-07	1.1E-08	1.4E-08	4.7E-09	1.01E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	3.6E-08	1.5E-08	1.3E-07	1.1E-08	1.4E-08	4.6E-09	9.88E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	2.8E-07	1.2E-07	9.9E-07	8.5E-08	1.1E-07	3.6E-08	7.77E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	2.6E-07	1.1E-07	9.0E-07	7.7E-08	9.6E-08	3.3E-08	7.04E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	4.6E-07	2.0E-07	1.6E-06	1.4E-07	1.7E-07	5.9E-08	1.26E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	2.6E-07	1.1E-07	9.2E-07	7.9E-08	9.9E-08	3.4E-08	7.20E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-ami	3.2E-07	1.4E-07	1.1E-06	9.5E-08	1.2E-07	4.1E-08	8.64E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.4E-07	1.2E-06	1.0E-07	1.3E-07	4.3E-08	9.22E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	1.2E-03	5.2E-04	4.3E-03	3.7E-04	4.6E-04	1.6E-04	3.34E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	1.1E-05	4.8E-06	3.9E-05	3.3E-06	4.2E-06	1.4E-06	3.05E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.0E-04	4.4E-05	3.6E-04	3.1E-05	3.8E-05	1.3E-05	2.80E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	5.8E-04	2.5E-04	2.0E-03	1.7E-04	2.2E-04	7.4E-05	1.58E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	1.7E-03	7.5E-04	6.1E-03	5.2E-04	6.5E-04	2.2E-04	4.76E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	5.2E-07	2.2E-07	1.8E-06	1.6E-07	2.0E-07	6.7E-08	1.43E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	8.7E-04	3.7E-04	3.1E-03	2.6E-04	3.3E-04	1.1E-04	2.39E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 child ; 24 x 365 adult (NC) 70 x 365 (C)

CASE 4

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	4.5E-06	1.2E-06	8.2E-06		3.6E-06	1.2E-06	3.05E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	6 Child, 24 Adult
SA = Surface Area Contact (cm2)	1510(C)/3120(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	6 x 365 (Nc)+ 24 x 365 (Nc)
ABS = Absorption Factor (unitless)	varies (1-25%)		70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.7E-07	NA	NA		
3-Nitroaniline	4.4E-06	1.9E-06	NA	NA		
Dinitrotoluene, 2,4-	1.8E-06	7.7E-07	2.0E-03	NA	9.0E-04	
Phenanthrene	1.2E-06	5.0E-07	NA	NA		
Benzo(a)anthracene	1.2E-06	5.1E-07	NA	7.3E-01		3.7E-07
Chrysene	1.1E-06	4.7E-07	NA	7.3E-02		3.4E-08
Benzo(b)fluoranthene	1.2E-06	5.2E-07	NA	7.3E-01		3.8E-07
Benzo(k)fluoranthene	1.1E-06	4.7E-07	NA	7.3E-01		3.4E-07
Benzo(a)pyrene	1.2E-06	5.2E-07	NA	7.3E+00		3.8E-06
Indeno(1,2,3-cd)pyrene	1.1E-06	4.9E-07	NA	7.3E-01		3.6E-07
Dibenzo(a,h)anthracene	1.1E-06	4.6E-07	NA	7.3E+00		3.4E-06
Benzo(g,h,i)perylene	1.1E-06	4.6E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	3.9E-08	1.7E-08	5.0E-05	1.6E+01	7.8E-04	2.7E-07
4,4'-DDE	3.7E-08	1.6E-08	NA	3.4E-01		5.4E-09
4,4'-DDT	3.6E-08	1.5E-08	5.0E-04	3.4E-01	7.2E-05	5.3E-09
Explosives						
RDX	2.8E-07	1.2E-07	3.0E-03	1.1E-01	9.5E-05	1.3E-08
1,3,5-Trinitrobenzene	2.6E-07	1.1E-07	5.0E-05	NA	5.1E-03	
Tetryl	4.6E-07	2.0E-07	NA	NA		
Trinitrotoluene, 2,4,6-	2.6E-07	1.1E-07	5.0E-04	3.0E-02	5.3E-04	3.4E-09
Dinitrotoluene, 2,6-, 4-ami	3.2E-07	1.4E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	3.4E-07	1.4E-07	NA	NA		
Metals						
Barium	1.2E-03	5.2E-04	7.0E-02	NA	1.7E-02	
Cadmium	1.1E-05	4.8E-06	5.0E-04	NA	2.2E-02	
Chromium	1.0E-04	4.4E-05	5.0E-03	NA	2.0E-02	
Copper	5.8E-04	2.5E-04	4.0E-02	NA	1.4E-02	
Lead	1.7E-03	7.5E-04	NA	NA		
Thallium	5.2E-07	2.2E-07	9.0E-05	NA	5.8E-03	
Zinc	8.7E-04	3.7E-04	3.0E-01	NA	2.9E-03	
Totals - HQ & CR					**9.1E-02**	**8.9E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	4.5E-06	1.2E-06	5.0E-04	0.0E+00	9.0E-03	0.0E+00
Totals - HQ & CR					**9.0E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 4

CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.17E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.07E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			8.44E-06	20	350	30	70	10,950	25,550
Phenanthrene			5.43E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			5.57E-06	20	350	30	70	10,950	25,550
Chrysene			5.11E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			5.71E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.09E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			5.65E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.36E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.05E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			4.98E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.2E-11	1.83E-07	20	350	30	70	10,950	25,550
4,4'-DDE		2.0E-11	1.72E-07	20	350	30	70	10,950	25,550
4,4'-DDT		2.0E-11	1.69E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.33E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.20E-06	20	350	30	70	10,950	25,550
Tetryl			2.16E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			1.23E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			1.48E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			1.58E-06	20	350	30	70	10,950	25,550
Metals									
Barium	1.6E-09		5.72E-06	20	350	30	70	10,950	25,550
Cadmium		6.1E-12	5.22E-08	20	350	30	70	10,950	25,550
Chromium		5.6E-11	4.79E-07	20	350	30	70	10,950	25,550
Copper			2.71E-06	20	350	30	70	10,950	25,550
Lead			8.15E-06	20	350	30	70	10,950	25,550
Thallium			2.45E-09	20	350	30	70	10,950	25,550
Zinc			4.10E-06	20	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CA = Chemical Concentration in Air (mg/m3)	95% UCL Air Model Data
IR = Inhalation Rate (m3/day)	20
EF = Exposure Frequency (days/yr)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

CASE 4

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.2E-11	NA	1.6E+01		3.5E-10
4,4'-DDE		2.0E-11	NA	3.4E-01		6.9E-12
4,4'-DDT		2.0E-11	NA	3.4E-01		6.7E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	1.6E-09		1.4E-04	NA	1.1E-05	
Cadmium		6.1E-12	NA	6.3E+00		3.9E-11
Chromium		5.6E-11	NA	4.2E-02		2.4E-12
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**1.1E-05**	**4.0E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

03/08/94

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

03/08/94

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \ CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

03/08/94

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM DERMAL CONTACT TO GROUNDWATER (DAILY) RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ABSORPTION METHODOLOGY: Linear Absorption

Case 4

AIR CONCENTRATION: 0.029 ug Pb/m3
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	165.0	470.0
1-2	165.0	470.0
2-3	165.0	470.0
3-4	165.0	470.0
4-5	165.0	470.0
5-6	165.0	470.0
6-7	165.0	470.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.89	9.84	7.16
1-2:	5.49	14.30	11.09
2-3:	5.23	14.98	11.35
3-4:	4.96	15.24	11.61
4-5:	4.28	12.72	9.00
5-6:	3.70	12.23	8.24
6-7:	3.32	12.20	7.85

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.33	0.34	0.00	0.01
1-2:	2.38	0.82	0.00	0.01
2-3:	2.73	0.88	0.00	0.02

3-4:	2.69	0.91	0.00	0.02
4-5:	2.71	0.99	0.00	0.02
5-6:	2.91	1.06	0.00	0.03
6-7:	3.24	1.09	0.00	0.03

Case 5

CASE 5

SURFACE SOIL/SEDIMENT SAMPLES
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	COUNT	MAXIMUM	95th UCL of the mean	MEAN	STD. DEV.	COEF. OF VARIANCE	NORMAL/ LOGNORMAL	EXPOSURE POINT CONC.
Semivolatiles									
2-Methylnaphthalene	ug/kg	120	1,100.00	299.93	280.37	130.26	0.46	NORMAL	299.93
3-Nitroaniline	ug/kg	123	2,950.00	1,208.47	1,098.98	738.16	0.67	NORMAL	1,208.47
2,4-Dinitrotoluene	ug/kg	124	7,000.00	476.11	502.71	941.85	1.87	LOGNORMAL	476.11
Phenanthrene	ug/kg	123	1,800.00	320.69	294.56	176.15	0.60	NORMAL	320.69
Benzo(a)anthracene	ug/kg	120	2,400.00	327.84	295.02	218.58	0.74	NORMAL	327.84
Chrysene	ug/kg	121	2,700.00	301.64	300.47	243.55	0.81	NORMAL	301.64
Benzo(b)fluoranthene	ug/kg	120	3,900.00	326.57	306.03	346.67	1.13	LOGNORMAL	326.57
benzo(k)fluoranthene	ug/kg	120	2,800.00	300.40	298.28	251.54	0.84	NORMAL	300.40
Benzo(a)pyrene	ug/kg	120	2,800.00	333.27	295.14	253.92	0.86	NORMAL	333.27
Indeno(1,2,3-cd)pyrene	ug/kg	120	1,600.00	315.18	291.79	155.76	0.53	NORMAL	315.18
Dibenz(a,h)anthracene	ug/kg	118	670.00	296.59	280.97	103.14	0.37	NORMAL	296.59
Benzo(g,h,i)perylene	ug/kg	118	960.00	290.73	281.08	118.21	0.42	NORMAL	290.73
Pesticides/PCBs									
Dieldrin	ug/kg	124	28.50	10.85	9.58	8.62	0.90	NORMAL	10.85
4,4'-DDE	ug/kg	124	32.00	9.82	10.02	9.16	0.91	NORMAL	9.82
4,4'-DDT	ug/kg	124	29.50	9.66	9.89	8.98	0.91	NORMAL	9.66
Explosives									
RDX	ug/kg	125	4,800.00	79.61	105.58	425.56	4.03	LOGNORMAL	79.61
1,3,5-Trinitrobenzene	ug/kg	125	350.00	69.13	70.36	39.94	0.57	NORMAL	69.13
Tetryl	ug/kg	125	270.00	126.66	116.48	69.21	0.59	NORMAL	126.66
2,4,6-Trinitrotoluene	ug/kg	125	910.00	73.04	73.00	82.11	1.12	LOGNORMAL	73.04
4-amino-2,6-Dinitrotoluene	ug/kg	125	810.00	85.86	85.27	94.09	1.10	LOGNORMAL	85.86
2-amino-4,6-Dinitrotoluene	ug/kg	125	1,300.00	91.34	95.11	149.61	1.57	LOGNORMAL	91.34
Metals									
Barium	mg/kg	112	1,810.00	213.21	196.49	251.78	1.28	LOGNORMAL	213.21
Cadmium	mg/kg	122	9.70	2.85	1.80	2.12	1.18	LOGNORMAL	2.85
Chromium	mg/kg	118	263.00	28.77	27.46	24.69	0.90	NORMAL	28.77
Copper	mg/kg	119	730.00	74.89	68.81	101.04	1.47	LOGNORMAL	74.89
Lead	mg/kg	116	463.00	134.43	96.20	101.66	1.06	LOGNORMAL	134.43
Thallium	mg/kg	119	0.67	0.16	0.28	0.09	0.32	NORMAL	0.16
Zinc	mg/kg	121	1,060.00	199.41	180.07	191.27	1.06	LOGNORMAL	199.41

CASE 5

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL WHILE WORKING
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
										Nc	Car
Semi-volatiles											
Methylnaphthalene, 2-			3.00E-01	480	1.0E-06	1	150	25	70	9,125	25,550
3-Nitroaniline			1.21E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-	1.3E-06		4.76E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Phenanthrene			3.21E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)anthracene		3.3E-07	3.28E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Chrysene		3.0E-07	3.02E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(b)fluoranthene		3.3E-07	3.27E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(k)fluoranthene		3.0E-07	3.00E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(a)pyrene		3.4E-07	3.33E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene		3.2E-07	3.15E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene		3.0E-07	2.97E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			2.91E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Pesticides/PCB's											
Dieldrin	3.1E-08	1.1E-08	1.09E-02	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDE		9.9E-09	9.82E-03	480	1.0E-06	1	150	25	70	9,125	25,550
4,4'-DDT	2.7E-08	9.7E-09	9.66E-03	480	1.0E-06	1	150	25	70	9,125	25,550
Explosives											
RDX	2.2E-07	8.0E-08	7.96E-02	480	1.0E-06	1	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene	1.9E-07		6.91E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Tetryl			1.27E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Trinitrotoluene, 2,4,6-	2.1E-07	7.4E-08	7.30E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 2,6-, 4-amino			8.59E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Dinitrotoluene, 4,6-, 2-amino			9.13E-02	480	1.0E-06	1	150	25	70	9,125	25,550
Metals											
Barium	6.0E-04		2.13E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Cadmium	8.0E-06		2.85E+00	480	1.0E-06	1	150	25	70	9,125	25,550
Chromium	8.1E-05		2.88E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Copper	2.1E-04		7.49E+01	480	1.0E-06	1	150	25	70	9,125	25,550
Lead			1.34E+02	480	1.0E-06	1	150	25	70	9,125	25,550
Thallium	4.5E-07		1.60E-01	480	1.0E-06	1	150	25	70	9,125	25,550
Zinc	5.6E-04		1.99E+02	480	1.0E-06	1	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	**95th UCL Soil Data**	**EF = Exposure Frequency (days/yr)**	**150 events/year**
IR = Ingestion Rate (mg soil/day)	**480**	**ED = Exposure Duration (years)**	**25 years**
CF = Conversion Factor (10-6 kg/mg)	**10-6**	**BW = Bodyweight (kg)**	**70 kg**
FI = Fraction Ingested (unitless)	**1**	**AT = Averaging Time (days)**	**25 x 365 (NC) 70 x 365(c)**

CASE 5

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Conv. Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles												
Pesticides/PCBs												
Explosives												
Metals												
Cadmium	1.4E-06		2.85E+00	1.0E-06	3,120	2.77	0.01	150	25	70	9,125	25,550

EQUATION: **Absorbed Dose (mg/kg-day) =** $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL soil data	EF = Exposure Frequency (dy/yr)	150 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	3,120	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365(c)
ABS = Absorption Factor (unitless)	varies (1-25%)		

CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS FROM INGESTION OF SOIL (ONSITE) INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
3-Nitroaniline			NA	NA		
Dinitrotoluene, 2,4-	1.3E-06		2.0E-03	NA	6.7E-04	
Phenanthrene			NA	NA		
Benzo(a)anthracene		3.3E-07	NA	7.3E-01		2.4E-07
Chrysene		3.0E-07	NA	7.3E-02		2.2E-08
Benzo(b)fluoranthene		3.3E-07	NA	7.3E-01		2.4E-07
Benzo(k)fluoranthene		3.0E-07	NA	7.3E-01		2.2E-07
Benzo(a)pyrene		3.4E-07	NA	7.3E+00		2.4E-06
Indeno(1,2,3-cd)pyrene		3.2E-07	NA	7.3E-01		2.3E-07
Dibenzo(a,h)anthracene		3.0E-07	NA	7.3E+00		2.2E-06
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin	3.1E-08	1.1E-08	5.0E-05	1.6E+01	6.1E-04	1.7E-07
4,4'-DDE		9.9E-09	NA	3.4E-01		3.4E-09
4,4'-DDT	2.7E-08	9.7E-09	5.0E-04	3.4E-01	5.4E-05	3.3E-09
Explosives						
RDX	2.2E-07	8.0E-08	3.0E-03	1.1E-01	7.5E-05	8.8E-09
1,3,5-Trinitrobenzene	1.9E-07		5.0E-05	NA	3.9E-03	
Tetryl			NA	NA		
Trinitrotoluene, 2,4,6-	2.1E-07	7.4E-08	5.0E-04	3.0E-02	4.1E-04	2.2E-09
Dinitrotoluene, 2,6-, 4-amino			NA	NA		
Dinitrotoluene, 4,6-, 2-amino			NA	NA		
Metals						
Barium	6.0E-04		7.0E-02	NA	8.6E-03	
Cadmium	8.0E-06		5.0E-04	NA	1.6E-02	
Chromium	8.1E-05		5.0E-03	NA	1.6E-02	
Copper	2.1E-04		4.0E-02	NA	5.3E-03	
Lead			NA	NA		
Thallium	4.5E-07		9.0E-05	NA	5.0E-03	
Zinc	5.6E-04		3.0E-01	NA	1.9E-03	
Totals - HQ & CR					**5.9E-02**	**5.8E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (ONSITE)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	1.4E-06		5.0E-04	NA	2.9E-03	
Totals - HQ & CR					**2.9E-03**	

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

ALL CASES

SURFACE WATER DATA FOR REEDER CREEK
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	3.73	3.14	3.73
Trichloroethene	ug/L	5.00	3.76	3.18	3.76
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	10.50	6.44	5.67	6.44
Explosives					
RDX	ug/L	0.67	0.17	0.12	0.17
Tetryl	ug/L	0.20	0.13	0.10	0.13
Metals					
Aluminum	ug/L	300.00	139.41	93.23	139.41
Arsenic	ug/L	1.85	1.44	1.23	1.44
Barium	ug/L	66.60	57.50	52.15	57.50
Beryllium	ug/L	1.40	6.71	0.49	1.40
Chromium	ug/L	4.80	4.27	3.43	4.27
Copper	ug/L	9.85	8.90	6.93	8.90
Lead	ug/L	2.20	0.99	0.70	0.99
Manganese	ug/L	236.00	130.42	88.02	130.42
Nickel	ug/L	17.60	15.10	11.49	15.10
Vanadium	ug/L	39.20	18.95	13.63	18.95

ALL CASES

SURFACE WATER DATA FOR ON-SITE WETLANDS
SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Volatile Organics					
1,2-Dichloroethane	ug/L	5.00	4.30	3.82	4.30
Trichloroethene	ug/L	17.00	5.69	4.45	5.69
Semivolatiles					
bis(2-Ethylhexyl)phthalate	ug/L	71.00	9.37	8.50	9.37
Explosives					
RDX	ug/L	9.40	1.93	0.93	1.93
Tetryl	ug/L	0.52	0.18	0.14	0.18
Metals					
Aluminum	ug/L	5,220.00	18,766.22	882.22	5,220.00
Arsenic	ug/L	4.40	1.97	1.50	1.97
Barium	ug/L	523.00	190.85	141.61	190.85
Beryllium	ug/L	1.30	0.56	0.41	0.56
Chromium	ug/L	8.60	3.10	2.37	3.10
Copper	ug/L	59.80	70.79	15.33	59.80
Lead	ug/L	74.20	53.03	10.70	53.03
Manganese	ug/L	1,080.00	1,090.08	198.79	1,080.00
Nickel	ug/L	17.50	6.83	5.27	6.83
Vanadium	ug/L	37.20	32.41	9.10	32.41

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.0E-07	4.30E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Trichloroethene		1.4E-07	5.69E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	9.37E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Explosives												
RDX	1.3E-07	4.7E-08	1.93E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Tetryl			1.79E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Arsenic	1.3E-07	4.8E-08	1.97E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Barium	1.3E-05		1.91E-01	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Beryllium	3.7E-08	1.3E-08	5.55E-04	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Chromium	2.1E-07		3.10E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Copper	4.0E-06		5.98E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Lead			5.30E-02	8,620	4.0E-06	4	50	25	1.0E-03	70	9,125	25,550
Manganese	7.3E-05		1.08E+00	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Nickel			6.83E-03	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550
Vanadium	2.2E-06		3.24E-02	8,620	1.0E-03	4	50	25	1.0E-03	70	9,125	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	50
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	25
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	4	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL (mg/l)	Contact Rate (liters/hour)	Exposure Time (hours/event)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
									Nc	Car
Volatile Organics										
1,2-Dichloroethane		5.7E-08	3.73E-03	0.05	2.6	7	30	70	10,950	25,550
Trichloroethene		5.7E-08	3.76E-03	0.05	2.6	7	30	70	10,950	25,550
Semivolatiles										
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	6.44E-03	0.05	2.6	7	30	70	10,950	25,550
Explosives										
RDX	5.9E-09	2.5E-09	1.67E-04	0.05	2.6	7	30	70	10,950	25,550
Tetryl			1.25E-04	0.05	2.6	7	30	70	10,950	25,550
Metals										
Aluminum			1.39E-01	0.05	2.6	7	30	70	10,950	25,550
Arsenic	5.1E-08	2.2E-08	1.44E-03	0.05	2.6	7	30	70	10,950	25,550
Barium	2.0E-06		5.75E-02	0.05	2.6	7	30	70	10,950	25,550
Beryllium	5.0E-08	2.1E-08	1.40E-03	0.05	2.6	7	30	70	10,950	25,550
Chromium	1.5E-07		4.27E-03	0.05	2.6	7	30	70	10,950	25,550
Copper	3.2E-07		8.90E-03	0.05	2.6	7	30	70	10,950	25,550
Lead			9.88E-04	0.05	2.6	7	30	70	10,950	25,550
Manganese	4.6E-06		1.30E-01	0.05	2.6	7	30	70	10,950	25,550
Nickel			1.51E-02	0.05	2.6	7	30	70	10,950	25,550
Vanadium	6.7E-07		1.89E-02	0.05	2.6	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data
CR = Contact Rate (liters/hour)	0.05
ET = Exposure Time (hours/day)	2.6
EF = Exposure Frequency (days/year)	7
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(NC) 70 x 365(C)

ALL CASES

CALCULATION OF ABSORBED DOSE (SWIMMING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL (mg/kg)	Skin Surface Area Contact	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.8E-08	3.73E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.8E-08	3.76E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Semi-volatiles												
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	6.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.8E-09	7.9E-10	1.67E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.25E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			1.39E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.6E-08	6.8E-09	1.44E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	6.4E-07		5.75E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	1.5E-08	6.6E-09	1.40E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	4.7E-08		4.27E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	9.8E-08		8.90E-03	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			9.88E-04	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	1.4E-06		1.30E-01	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			1.51E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.1E-07		1.89E-02	19,400	8.0E-04	2.6	7	30	1.0E-03	70	10,950	25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surface Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	19400	ED = Exposure Duration (years)	30
PC = Permeability Constant (cm/hour)	0.0008 (Pc for water)	CF = Vol. Conv. Factor (1 liter/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70
		AT = Averaging Time (days)	30 x 365(Nc), 70 x 365 (C)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.0E-07	NA	9.1E-02		9.4E-09
Trichloroethene		1.4E-07	NA	1.1E-02		1.5E-09
Semivolatiles						
bis(2-Ethylhexyl)phthalate	6.3E-07	2.3E-07	2.0E-02	1.4E-02	3.2E-05	3.2E-09
Explosives						
RDX	1.3E-07	4.7E-08	3.0E-03	1.1E-01	4.3E-05	5.1E-09
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.3E-07	4.8E-08	3.0E-04	1.8E+00	4.4E-04	8.3E-08
Barium	1.3E-05		7.0E-02	NA	1.8E-04	
Beryllium	3.7E-08	1.3E-08	5.0E-03	4.3E+00	7.5E-06	5.8E-08
Chromium	2.1E-07		5.0E-03	NA	4.2E-05	
Copper	4.0E-06		4.0E-02	NA	1.0E-04	
Lead			NA	NA		
Manganese	7.3E-05		5.0E-03	NA	1.5E-02	
Nickel			NA	NA		
Vanadium	2.2E-06		7.0E-03	NA	3.1E-04	
Totals - HQ & CR					**1.6E-02**	**1.6E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		5.7E-08	NA	9.1E-02		5.2E-09
Trichloroethene		5.7E-08	NA	1.1E-02		6.3E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	2.3E-07	9.8E-08	2.0E-02	1.4E-02	1.1E-05	1.4E-09
Explosives						
RDX	5.9E-09	2.5E-09	3.0E-03	1.1E-01	2.0E-06	2.8E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	5.1E-08	2.2E-08	3.0E-04	1.8E+00	1.7E-04	3.8E-08
Barium	2.0E-06		7.0E-02	NA	2.9E-05	
Beryllium	5.0E-08	2.1E-08	5.0E-03	4.3E+00	1.0E-05	9.2E-08
Chromium	1.5E-07		5.0E-03	NA	3.0E-05	
Copper	3.2E-07		4.0E-02	NA	7.9E-06	
Lead			NA	NA		
Manganese	4.6E-06		5.0E-03	NA	9.3E-04	
Nickel			NA	NA		
Vanadium	6.7E-07		7.0E-03	NA	9.6E-05	
Totals - HQ & CR					**1.3E-03**	**1.3E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.8E-08	NA	9.1E-02		1.6E-09
Trichloroethene		1.8E-08	NA	1.1E-02		2.0E-10
Semi-volatiles						
bis(2-Ethylhexyl)phthalate	7.1E-08	3.1E-08	2.0E-02	1.4E-02	3.6E-06	4.3E-10
Explosives						
RDX	1.8E-09	7.9E-10	3.0E-03	1.1E-01	6.1E-07	8.7E-11
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-08	6.8E-09	3.0E-04	1.8E+00	5.3E-05	1.2E-08
Barium	6.4E-07		7.0E-02	NA	9.1E-06	
Beryllium	1.5E-08	6.6E-09	5.0E-03	4.3E+00	3.1E-06	2.9E-08
Chromium	4.7E-08		5.0E-03	NA	9.5E-06	
Copper	9.8E-08		4.0E-02	NA	2.5E-06	
Lead			NA	NA		
Manganese	1.4E-06		5.0E-03	NA	2.9E-04	
Nickel			NA	NA		
Vanadium	2.1E-07		7.0E-03	NA	3.0E-05	
Totals - HQ & CR					**4.0E-04**	**4.1E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR REEDER CREEK

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
Explosives					
Metals					
Aluminum	mg/kg	8,310.00	11,682.32	5,767.50	8,310.00
Arsenic	mg/kg	4.40	5.66	3.45	4.40
Barium	mg/kg	44.10	57.70	33.85	44.10
Beryllium	mg/kg	0.71	1.03	0.47	0.71
Cadmium	mg/kg	2.00	2.73	1.45	2.00
Chromium	mg/kg	15.20	20.51	11.20	15.20
Cobalt	mg/kg	7.50	10.32	5.38	7.50
Copper	mg/kg	22.40	31.05	15.88	22.40
Lead	mg/kg	15.40	18.65	12.95	15.40
Manganese	mg/kg	468.00	548.91	407.00	468.00
Mercury	mg/kg	0.17	0.27	0.10	0.17
Nickel	mg/kg	23.30	31.42	17.18	23.30
Selenium	mg/kg	0.19	0.20	0.17	0.19
Vanadium	mg/kg	10.90	14.68	8.05	10.90
Zinc	mg/kg	76.00	113.27	47.90	76.00

CASE 5

SUMMARY OF VALIDATED RESULTS (PHASE I and II)
CHEMICALS OF CONCERN
SEDIMENT DATA FOR ON-SITE WETLANDS

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatiles					
2-Methylnaphthalene	ug/kg	500.00	388.22	329.64	388.22
Phenanthrene	ug/kg	600.00	431.55	370.29	431.55
Benzo(a)anthracene	ug/kg	500.00	396.68	339.67	396.68
Benzo(b)fluoranthene	ug/kg	500.00	396.68	339.67	396.68
benzo(k)fluoranthene	ug/kg	500.00	396.68	339.67	396.68
Benzo(a)pyrene	ug/kg	500.00	396.68	339.67	396.68
Indeno(1,2,3-cd)pyrene	ug/kg	500.00	396.68	339.67	396.68
Explosives					
4-amino-2,6-Dinitrotoluene	ug/kg	160.00	74.16	65.26	74.16
2-amino-4,6-Dinitrotoluene	ug/kg	180.00	78.41	67.63	78.41
Metals					
Aluminum	mg/kg	25,800.00	17,910.92	16,468.42	17,910.92
Antimony	mg/kg	8.30	6.32	5.48	6.32
Arsenic	mg/kg	9.50	5.83	4.87	5.83
Barium	mg/kg	313.00	174.43	148.61	174.43
Beryllium	mg/kg	1.60	1.08	0.96	1.08
Cadmium	mg/kg	9.70	3.54	2.58	3.54
Chromium	mg/kg	41.80	26.36	23.91	26.36
Cobalt	mg/kg	17.70	12.41	11.22	12.41
Copper	mg/kg	416.00	183.08	94.78	183.08
Lead	mg/kg	463.00	385.37	117.10	385.37
Manganese	mg/kg	1,520.00	599.82	489.37	599.82
Mercury	mg/kg	2.00	1.39	0.36	1.39
Nickel	mg/kg	64.40	39.50	35.29	39.50
Selenium	mg/kg	1.80	0.87	0.68	0.87
Vanadium	mg/kg	37.90	27.29	24.97	27.29
Zinc	mg/kg	655.00	258.66	194.70	258.66

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (events/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	1.6E-06		3.38E+00	1.0E-06	8,620	2.77	0.01	50	25	70	9,125	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	50 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	25 years
SA = Surface Area Contact (cm2)	8,620	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	25 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF INTAKE
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles											
Explosives											
Metals											
Aluminum			1.17E+04	100	1.0E-06	1	7	30	70	10,950	25,550
Arsenic	1.6E-07	6.6E-08	5.66E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Barium	1.6E-06		5.77E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Beryllium	2.8E-08	1.2E-08	1.03E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Cadmium	7.5E-08		2.73E+00	100	1.0E-06	1	7	30	70	10,950	25,550
Chromium	5.6E-07		2.05E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Cobalt			1.03E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Copper	8.5E-07		3.11E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Lead			1.86E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Manganese	1.5E-05		5.49E+02	100	1.0E-06	1	7	30	70	10,950	25,550
Mercury	7.4E-09		2.69E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Nickel			3.14E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Selenium	5.6E-09		2.05E-01	100	1.0E-06	1	7	30	70	10,950	25,550
Vanadium	4.0E-07		1.47E+01	100	1.0E-06	1	7	30	70	10,950	25,550
Zinc	3.1E-06		1.13E+02	100	1.0E-06	1	7	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chem. Conc. in Sediment (mg/kg-soil)	95th UCL Sediment Data	EF = Exposure Frequency (days/year)	7 events/year
IR = Ingestion Rate (mg soil/day)	100	ED = Exposure Duration (years)	30 years
CF = Conversion Factor (10-6 kg/mg)	10-6	BW = Bodyweight (kg)	70 kg
FI = Fraction Ingested (unitless)	1	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)

CASE 2 through CASE 5

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Sediment (mg/kg)	Conversion Factor (kg/mg)	Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2)	Adsorption Factor (unitless)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Semivolatiles												
Explosives												
Metals												
Cadmium	4.0E-07		2.73E+00	1.0E-06	19,400	2.77	0.01	7	30	70	10,950	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg/kg-sediment)	95th UCL Sed. Data	EF = Exposure Frequency (events/year)	7 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	30 years
SA = Surface Area Contact (cm2)	19,400	BW = Bodyweight (kg)	70 kg
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	30 x 365 (NC) 70 x 365 (C)
ABS = Absorption Factor (unitless)	1.0 %		

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SEDIMENT (WHILE WADING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	1.6E-06		5.0E-04	NA	3.2E-03	
Totals - HQ & CR					**3.2E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM INGESTION OF SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg/day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Aluminum			NA	NA		
Arsenic	1.6E-07	6.6E-08	3.0E-04	1.8E+00	5.2E-04	1.2E-07
Barium	1.6E-06		7.0E-02	NA	2.3E-05	
Beryllium	2.8E-08	1.2E-08	5.0E-03	4.3E+00	5.7E-06	5.2E-08
Cadmium	7.5E-08		5.0E-04	NA	1.5E-04	
Chromium	5.6E-07		5.0E-03	NA	1.1E-04	
Cobalt			NA	NA		
Copper	8.5E-07		4.0E-02	NA	2.1E-05	
Lead			NA	NA		
Manganese	1.5E-05		5.0E-03	NA	3.0E-03	
Mercury	7.4E-09		3.0E-04	NA	2.5E-05	
Nickel			NA	NA		
Selenium	5.6E-09		5.0E-03	NA	1.1E-06	
Vanadium	4.0E-07		7.0E-03	NA	5.7E-05	
Zinc	3.1E-06		3.0E-01	NA	1.0E-05	
Totals - HQ & CR					**3.9E-03**	**1.7E-07**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

CASE 2 through CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISK
FROM DERMAL CONTACT TO SEDIMENT (WHILE SWIMMING)
RESIDENTIAL EXPOSURE (CURRENT AND FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Explosives						
Metals						
Cadmium	4.0E-07		5.0E-04	NA	8.0E-04	
Totals - HQ & CR					**8.0E-04**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 5

SUMMARY OF MODELING RESULTS
CHEMICALS OF CONCERN
AMBIENT AIR DATA

SENECA ARMY DEPOT
OB GROUNDS

COMPOUND	UNITS	MAXIMUM	95th UCL of the mean	MEAN	EXPOSURE POINT CONC.
Semivolatile Organics					
2-Methylnaphthalene	ug/m3	1.88E-05	5.13E-06	4.80E-06	5.13E-06
Nitroaniline, 3-	ug/m3	5.05E-05	2.07E-05	1.88E-05	2.07E-05
Dinitrotoluene, 2,4-	ug/m3	1.20E-04	8.15E-06	8.60E-06	8.15E-06
Phenanthrene	ug/m3	3.08E-05	5.49E-06	5.04E-06	5.49E-06
Benzo(a)anthracene	ug/m3	4.11E-05	5.61E-06	5.05E-06	5.61E-06
Chrysene	ug/m3	4.62E-05	5.16E-06	5.14E-06	5.16E-06
Benzo(b)fluoranthene	ug/m3	6.67E-05	5.59E-06	5.24E-06	5.59E-06
Benzo(k)fluoranthene	ug/m3	4.79E-05	5.14E-06	5.10E-06	5.14E-06
Benzo(a)pyrene	ug/m3	4.79E-05	5.70E-06	5.05E-06	5.70E-06
Indeno(1,2,3-cd)pyrene	ug/m3	2.74E-05	5.39E-06	4.99E-06	5.39E-06
Dibenz(a,h)anthracene	ug/m3	1.15E-05	5.07E-06	4.81E-06	5.07E-06
Benzo(g,h,i)perylene	ug/m3	1.64E-05	4.97E-06	4.81E-06	4.97E-06
Pesticides/PCBs					
Dieldrin	ug/m3	4.88E-07	1.86E-07	1.64E-07	1.86E-07
4,4'-DDE	ug/m3	5.47E-07	1.68E-07	1.71E-07	1.68E-07
4,4'-DDT	ug/m3	5.05E-07	1.65E-07	1.69E-07	1.65E-07
Explosives					
RDX	ug/m3	8.21E-05	1.36E-06	1.81E-06	1.36E-06
1,3,5-Trinitrobenzene	ug/m3	5.99E-06	1.18E-06	1.20E-06	1.18E-06
Tetryl	ug/m3	4.62E-06	2.17E-06	1.99E-06	2.17E-06
2,4,6-Trinitrotoluene	ug/m3	1.56E-05	1.25E-06	1.25E-06	1.25E-06
4-amino-2,6-Dinitrotoluene	ug/m3	1.39E-05	1.47E-06	1.46E-06	1.47E-06
2-amino-4,6-Dinitrotoluene	ug/m3	2.22E-05	1.56E-06	1.63E-06	1.56E-06
Metals					
Barium	ug/m3	3.10E-05	3.65E-06	3.36E-06	3.65E-06
Cadmium	ug/m3	1.66E-07	4.88E-08	3.08E-08	4.88E-08
Chromium	ug/m3	4.50E-06	4.92E-07	4.70E-07	4.92E-07
Copper	ug/m3	1.25E-05	1.28E-06	1.18E-06	1.28E-06
Lead	ug/m3	7.92E-06	2.30E-06	1.65E-06	2.30E-06
Thallium	ug/m3	1.15E-08	2.74E-09	4.71E-09	2.74E-09
Zinc	ug/m3	1.81E-05	3.41E-06	3.08E-06	3.41E-06

CASE 5

CALCULATION OF INTAKE (ONSITE)
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days) Nc	Averaging Time (days) Car
Semivolatiles									
Methylnaphthalene, 2-			5.13E-06	20	150	25	70	9,125	25,550
Nitroaniline, 3-			2.07E-05	20	150	25	70	9,125	25,550
Dinitrotoluene, 2,4-			8.15E-06	20	150	25	70	9,125	25,550
Phenanthrene			5.49E-06	20	150	25	70	9,125	25,550
Benzo(a)anthracene			5.61E-06	20	150	25	70	9,125	25,550
Chrysene			5.16E-06	20	150	25	70	9,125	25,550
Benzo(b)fluoranthene			5.59E-06	20	150	25	70	9,125	25,550
Benzo(k)fluoranthene			5.14E-06	20	150	25	70	9,125	25,550
Benzo(a)pyrene			5.70E-06	20	150	25	70	9,125	25,550
Indeno(1,2,3-cd)pyrene			5.39E-06	20	150	25	70	9,125	25,550
Dibenzo(a,h)anthracene			5.07E-06	20	150	25	70	9,125	25,550
Benzo(g,h,i)perylene			4.97E-06	20	150	25	70	9,125	25,550
Pesticides/PCBs									
Dieldrin		7.8E-12	1.86E-07	20	150	25	70	9,125	25,550
4,4'-DDE		7.0E-12	1.68E-07	20	150	25	70	9,125	25,550
4,4'-DDT		6.9E-12	1.65E-07	20	150	25	70	9,125	25,550
Explosives									
RDX			1.36E-06	20	150	25	70	9,125	25,550
1,3,5-Trinitrobenzene			1.18E-06	20	150	25	70	9,125	25,550
Tetryl			2.17E-06	20	150	25	70	9,125	25,550
2,4,6-Trinitrotoluene			1.25E-06	20	150	25	70	9,125	25,550
4-amino-2,6-Dinitrotoluene			1.47E-06	20	150	25	70	9,125	25,550
2-amino-4,6-Dinitrotoluene			1.56E-06	20	150	25	70	9,125	25,550
Metals									
Barium	4.3E-10		3.65E-06	20	150	25	70	9,125	25,550
Cadmium		2.0E-12	4.88E-08	20	150	25	70	9,125	25,550
Chromium		2.1E-11	4.92E-07	20	150	25	70	9,125	25,550
Copper			1.28E-06	20	150	25	70	9,125	25,550
Lead			2.30E-06	20	150	25	70	9,125	25,550
Thallium			2.74E-09	20	150	25	70	9,125	25,550
Zinc			3.41E-06	20	150	25	70	9,125	25,550

EQUATION: **Intake (mg/kg-day) =** $\frac{CA \times IR \times EF \times ED}{BW \times AT}$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	**95% UCL Air Model Data**
IR = Inhalation Rate (m3/day)	**20**
EF = Exposure Frequency (days/yr)	**150**
ED = Exposure Duration (years)	**25**
BW = Bodyweight (kg)	**70**
AT = Averaging Time (days)	**25 x 365 (Nc) 70 x 365 (Car)**

CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (WHILE WORKING)
INDUSTRIAL EXPOSURE (CURRENT LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		7.8E-12	NA	1.6E+01		1.3E-10
4,4'-DDE		7.0E-12	NA	3.4E-01		2.4E-12
4,4'-DDT		6.9E-12	NA	3.4E-01		2.4E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	4.3E-10		1.4E-04	NA	3.0E-06	
Cadmium		2.0E-12	NA	6.3E+00		1.3E-11
Chromium		2.1E-11	NA	4.2E-02		8.7E-13
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**3.0E-06**	**1.4E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

CASE 5

CALCULATION OF INTAKE (ONSITE)
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Intake (Nc) (mg/kg-day)	30 Year Intake (Car) (mg/kg-day)	Child Intake (Nc) (mg/kg-day)	Child Intake (Car) (mg/kg-day)	Adult Intake (Nc) (mg/kg-day)	Adult Intake (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Child Ingestion Rate (mg soil/day)	Adult Ingestion Rate (mg soil/day)	Conv. Factor (kg/mg)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																	Child(Nc)	Adult(Nc)	Car
Semivolatiles																			
Methylnaphthalene, 2-	1.1E-06	4.7E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	3.00E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
3-Nitroaniline	4.4E-06	1.9E-06	1.5E-05	1.3E-06	1.7E-06	5.7E-07	1.21E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,4-	1.7E-06	7.5E-07	6.1E-06	5.2E-07	6.5E-07	2.2E-07	4.76E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Phenanthrene	1.2E-06	5.0E-07	4.1E-06	3.5E-07	4.4E-07	1.5E-07	3.21E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)anthracene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.28E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chrysene	1.1E-06	4.7E-07	3.9E-06	3.3E-07	4.1E-07	1.4E-07	3.02E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(b)fluoranthene	1.2E-06	5.1E-07	4.2E-06	3.6E-07	4.5E-07	1.5E-07	3.27E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(k)fluoranthene	1.1E-06	4.7E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	3.00E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(a)pyrene	1.2E-06	5.2E-07	4.3E-06	3.7E-07	4.6E-07	1.6E-07	3.33E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Indeno(1,2,3-cd)pyrene	1.2E-06	4.9E-07	4.0E-06	3.5E-07	4.3E-07	1.5E-07	3.15E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dibenzo(a,h)anthracene	1.1E-06	4.6E-07	3.8E-06	3.3E-07	4.1E-07	1.4E-07	2.97E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Benzo(g,h,i)perylene	1.1E-06	4.6E-07	3.7E-06	3.2E-07	4.0E-07	1.4E-07	2.91E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Pesticides/PCBs																			
Dieldrin	4.0E-08	1.7E-08	1.4E-07	1.2E-08	1.5E-08	5.1E-09	1.09E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDE	3.6E-08	1.5E-08	1.3E-07	1.1E-08	1.3E-08	4.6E-09	9.82E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
4,4'-DDT	3.5E-08	1.5E-08	1.2E-07	1.1E-08	1.3E-08	4.5E-09	9.66E-03	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Explosives																			
RDX	2.9E-07	1.2E-07	1.0E-06	8.7E-08	1.1E-07	3.7E-08	7.96E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
1,3,5-Trinitrobenzene	2.5E-07	1.1E-07	8.8E-07	7.6E-08	9.5E-08	3.2E-08	6.91E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Tetryl	4.6E-07	2.0E-07	1.6E-06	1.4E-07	1.7E-07	5.9E-08	1.27E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Trinitrotoluene, 2,4,6-	2.7E-07	1.1E-07	9.3E-07	8.0E-08	1.0E-07	3.4E-08	7.30E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 2,6-, 4-ami	3.1E-07	1.3E-07	1.1E-06	9.4E-08	1.2E-07	4.0E-08	8.59E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Dinitrotoluene, 4,6-, 2-ami	3.3E-07	1.4E-07	1.2E-06	1.0E-07	1.3E-07	4.3E-08	9.13E-02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Metals																			
Barium	7.8E-04	3.3E-04	2.7E-03	2.3E-04	2.9E-04	1.0E-04	2.13E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Cadmium	1.0E-05	4.5E-06	3.6E-05	3.1E-06	3.9E-06	1.3E-06	2.85E+00	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Chromium	1.1E-04	4.5E-05	3.7E-04	3.2E-05	3.9E-05	1.4E-05	2.88E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Copper	2.7E-04	1.2E-04	9.6E-04	8.2E-05	1.0E-04	3.5E-05	7.49E+01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Lead	4.9E-04	2.1E-04	1.7E-03	1.5E-04	1.8E-04	6.3E-05	1.34E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Thallium	5.9E-07	2.5E-07	2.0E-06	1.8E-07	2.2E-07	7.5E-08	1.60E-01	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550
Zinc	7.3E-04	3.1E-04	2.5E-03	2.2E-04	2.7E-04	9.4E-05	1.99E+02	200	100	1.0E-06	1	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data
IR = Ingestion Rate (mg soil/day)	100 (Adult)/ 200 (Child)
CF = Conversion Factor (10-6 kg/mg)	10-6
FI = Fraction Ingested (unitless)	1
EF = Exposure Frequency (days/years)	350 events/year
ED = Exposure Duration (years)	30 years
BW = Bodyweight (kg)	70 (Adult male)/ 15 (Child 6-7)
AT = Averaging Time (days)	6 x 365 child ; 24 x 365 adult (NC) 70 x 365 (C)

CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-	1.1E-06	4.7E-07	NA	NA		
3-Nitroaniline	4.4E-06	1.9E-06	NA	NA		
Dinitrotoluene, 2,4-	1.7E-06	7.5E-07	2.0E-03	NA	8.7E-04	
Phenanthrene	1.2E-06	5.0E-07	NA	NA		
Benzo(a)anthracene	1.2E-06	5.1E-07	NA	7.3E-01		3.7E-07
Chrysene	1.1E-06	4.7E-07	NA	7.3E-02		3.4E-08
Benzo(b)fluoranthene	1.2E-06	5.1E-07	NA	7.3E-01		3.7E-07
Benzo(k)fluoranthene	1.1E-06	4.7E-07	NA	7.3E-01		3.4E-07
Benzo(a)pyrene	1.2E-06	5.2E-07	NA	7.3E+00		3.8E-06
Indeno(1,2,3-cd)pyrene	1.2E-06	4.9E-07	NA	7.3E-01		3.6E-07
Dibenzo(a,h)anthracene	1.1E-06	4.6E-07	NA	7.3E+00		3.4E-06
Benzo(g,h,i)perylene	1.1E-06	4.6E-07	NA	NA		
Pesticides/PCBs						
Dieldrin	4.0E-08	1.7E-08	5.0E-05	1.6E+01	7.9E-04	2.7E-07
4,4'-DDE	3.6E-08	1.5E-08	NA	3.4E-01		5.2E-09
4,4'-DDT	3.5E-08	1.5E-08	5.0E-04	3.4E-01	7.1E-05	5.1E-09
Explosives						
RDX	2.9E-07	1.2E-07	3.0E-03	1.1E-01	9.7E-05	1.4E-08
1,3,5-Trinitrobenzene	2.5E-07	1.1E-07	5.0E-05	NA	5.1E-03	
Tetryl	4.6E-07	2.0E-07	NA	NA		
Trinitrotoluene, 2,4,6-	2.7E-07	1.1E-07	5.0E-04	3.0E-02	5.3E-04	3.4E-09
Dinitrotoluene, 2,6-, 4-ami	3.1E-07	1.3E-07	NA	NA		
Dinitrotoluene, 4,6-, 2-ami	3.3E-07	1.4E-07	NA	NA		
Metals						
Barium	7.8E-04	3.3E-04	7.0E-02	NA	1.1E-02	
Cadmium	1.0E-05	4.5E-06	5.0E-04	NA	2.1E-02	
Chromium	1.1E-04	4.5E-05	5.0E-03	NA	2.1E-02	
Copper	2.7E-04	1.2E-04	4.0E-02	NA	6.8E-03	
Lead	4.9E-04	2.1E-04	NA	NA		
Thallium	5.9E-07	2.5E-07	9.0E-05	NA	6.5E-03	
Zinc	7.3E-04	3.1E-04	3.0E-01	NA	2.4E-03	
Totals - HQ & CR					**7.6E-02**	**9.0E-06**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 5

CALCULATION OF ABSORBED DOSE (ONSITE)
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	30 Year Dose (Nc) (mg/kg-day)	30 Year Dose (Car) (mg/kg-day)	Child Absorbed Dose (Nc) (mg/kg-day)	Child Absorbed Dose (Car) (mg/kg-day)	Adult Absorbed Dose (Nc) (mg/kg-day)	Adult Absorbed Dose (Car) (mg/kg-day)	95th UCL Soil (mg/kg)	Conv. Factor (kg/mg)	Child Skin Surface Area Contact (cm2/event)	Adult Skin Surface Area Contact (cm2/event)	Adherence Factor (mg soil/cm2	Absorption Factor (unitless)	Exposure Frequency (days/year)	Child Exposure Duration (years)	Adult Exposure Duration (years)	Child Body Weight (kg)	Adult Body Weight (kg)	Averaging Time (days)		
																		Child(Nc)	Adult(Nc)	Car
Semivolatiles																				
Pesticides/PCBs																				
Explosives																				
Metals																				
Cadmium	4.2E-06	1.2E-06	7.6E-06		3.4E-06	1.2E-06	2.85E+00	1.0E-06	1,510	3,120	2.77	0.01	350	6	24	15	70	2,190	8,760	25,550

EQUATION: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CS = Chemical Concentration in Soil (mg soil/kg)	95th UCL Soil Data	EF = Exposure Frequency (days/year)	350 events/year
CF = Conversion Factor (10-6 kg/mg)	10-6	ED = Exposure Duration (years)	6 Child, 24 Adult
SA = Surface Area Contact (cm2)	1510(C)/3120(A)	BW = Bodyweight (kg)	15 kg (child) 70 kg (adult)
AF =Soil to Skin Adherence Factor (mg/cm2)	2.77	AT = Averaging Time (days)	6 x 365 (Nc)+ 24 x 365 (Nc)
ABS = Absorption Factor (unitless)	varies (1-25%)		70 x 365 (Car)

CASE 5

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SOIL (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Pesticides/PCBs						
Explosives						
Metals						
Cadmium	4.2E-06	1.2E-06	5.0E-04	0.0E+00	8.5E-03	0.0E+00
Totals - HQ & CR					**8.5E-03**	**0.0E+00**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/ Reference Dose (Oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (Oral)

CASE 5

CALCULATION OF INTAKE
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95% UCL Air (ug/m3)	Inhalation Rate (m3/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Semivolatiles									
Methylnaphthalene, 2-			5.13E-06	20	350	30	70	10,950	25,550
Nitroaniline, 3-			2.07E-05	20	350	30	70	10,950	25,550
Dinitrotoluene, 2,4-			8.15E-06	20	350	30	70	10,950	25,550
Phenanthrene			5.49E-06	20	350	30	70	10,950	25,550
Benzo(a)anthracene			5.61E-06	20	350	30	70	10,950	25,550
Chrysene			5.16E-06	20	350	30	70	10,950	25,550
Benzo(b)fluoranthene			5.59E-06	20	350	30	70	10,950	25,550
Benzo(k)fluoranthene			5.14E-06	20	350	30	70	10,950	25,550
Benzo(a)pyrene			5.70E-06	20	350	30	70	10,950	25,550
Indeno(1,2,3-cd)pyrene			5.39E-06	20	350	30	70	10,950	25,550
Dibenzo(a,h)anthracene			5.07E-06	20	350	30	70	10,950	25,550
Benzo(g,h,i)perylene			4.97E-06	20	350	30	70	10,950	25,550
Pesticides/PCBs									
Dieldrin		2.2E-11	1.86E-07	20	350	30	70	10,950	25,550
4,4'-DDE		2.0E-11	1.68E-07	20	350	30	70	10,950	25,550
4,4'-DDT		1.9E-11	1.65E-07	20	350	30	70	10,950	25,550
Explosives									
RDX			1.36E-06	20	350	30	70	10,950	25,550
1,3,5-Trinitrobenzene			1.18E-06	20	350	30	70	10,950	25,550
Tetryl			2.17E-06	20	350	30	70	10,950	25,550
2,4,6-Trinitrotoluene			1.25E-06	20	350	30	70	10,950	25,550
4-amino-2,6-Dinitrotoluene			1.47E-06	20	350	30	70	10,950	25,550
2-amino-4,6-Dinitrotoluene			1.56E-06	20	350	30	70	10,950	25,550
Metals									
Barium	1.0E-09		3.65E-06	20	350	30	70	10,950	25,550
Cadmium		5.7E-12	4.88E-08	20	350	30	70	10,950	25,550
Chromium		5.8E-11	4.92E-07	20	350	30	70	10,950	25,550
Copper			1.28E-06	20	350	30	70	10,950	25,550
Lead			2.30E-06	20	350	30	70	10,950	25,550
Thallium			2.74E-09	20	350	30	70	10,950	25,550
Zinc			3.41E-06	20	350	30	70	10,950	25,550

EQUATION: **Intake (mg/kg-day) =**

$$\frac{CA \times IR \times EF \times ED}{BW \times AT}$$

Variables:	**Assumptions:**
CA = Chemical Concentration in Air (mg/m3)	**95% UCL Air Model Data**
IR = Inhalation Rate (m3/day)	**20**
EF = Exposure Frequency (days/yr)	**350**
ED = Exposure Duration (years)	**30**
BW = Bodyweight (kg)	**70**
AT = Averaging Time (days)	**30 x 365 (Nc) 70 x 365 (Car)**

CASE 5

**CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INHALATION OF FUGITIVE DUST (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)**

**SENECA ARMY DEPOT
OB GROUNDS**

Analyte	CDI (Nc) (mg/kg-day)	CDI (Car) (mg/kg-day)	RfC (mg/kg-day)	Carc. Slope Inhalation (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Semivolatiles						
Methylnaphthalene, 2-			NA	NA		
Nitroaniline, 3-			NA	NA		
Dinitrotoluene, 2,4-			NA	NA		
Phenanthrene			NA	NA		
Benzo(a)anthracene			NA	NA		
Chrysene			NA	NA		
Benzo(b)fluoranthene			NA	NA		
Benzo(k)fluoranthene			NA	NA		
Benzo(a)pyrene			NA	NA		
Indeno(1,2,3-cd)pyrene			NA	NA		
Dibenzo(a,h)anthracene			NA	NA		
Benzo(g,h,i)perylene			NA	NA		
Pesticides/PCBs						
Dieldrin		2.2E-11	NA	1.6E+01		3.5E-10
4,4'-DDE		2.0E-11	NA	3.4E-01		6.7E-12
4,4'-DDT		1.9E-11	NA	3.4E-01		6.6E-12
Explosives						
RDX			NA	NA		
1,3,5-Trinitrobenzene			NA	NA		
Tetryl			NA	NA		
2,4,6-Trinitrotoluene			NA	NA		
4-amino-2,6-Dinitrotoluene			NA	NA		
2-amino-4,6-Dinitrotoluene			NA	NA		
Metals						
Barium	1.0E-09		1.4E-04	NA	7.0E-06	
Cadmium		5.7E-12	NA	6.3E+00		3.6E-11
Chromium		5.8E-11	NA	4.2E-02		2.4E-12
Copper			NA	NA		
Lead			NA	NA		
Thallium			NA	NA		
Zinc			NA	NA		
Totals - HQ & CR					**7.0E-06**	**4.0E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) / Reference Concentration
Cancer Risk = Chronic Daily Intake (Cancinogenic) x Inhalation Slope Factor

ALL CASES

CALCULATION OF ABSORBED DOSE (WADING)
FROM DERMAL CONTACT TO SURFACE WATER
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Surface Water (mg/kg)	Skin Surface Area Contact (cm2)	Permeability Coefficient (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 cm3)	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
1,2-Dichloroethane		1.1E-08	4.30E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Trichloroethene		1.5E-08	5.69E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Semivolatiles												
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	9.37E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Explosives												
RDX	1.2E-08	5.1E-09	1.93E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Tetryl			1.79E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Metals												
Aluminum			5.22E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Arsenic	1.2E-08	5.2E-09	1.97E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Barium	1.2E-06		1.91E-01	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Beryllium	3.4E-09	1.5E-09	5.55E-04	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Chromium	1.9E-08		3.10E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Copper	3.7E-07		5.98E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Lead			5.30E-02	8,620	4.0E-06	2.6	7	30	1.0E-03	70	10,950	25,550
Manganese	6.6E-06		1.08E+00	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Nickel			6.83E-03	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
Vanadium	2.0E-07		3.24E-02	8,620	1.0E-03	2.6	7	30	1.0E-03	70	10,950	25,550
											0	25,550

Absorbed Dose (mg/kg-day) = $\frac{CW \times SA \times Kp \times ET \times EF \times ED \times CF}{BW \times AT}$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Surf. Water Data	EF = Exposure Frequency (days/year)	7
SA = Surface Area Contact (cm2)	8,620	ED = Exposure Duration (years)	30
Kp = Permeability Coefficient (cm/hour)	Compound Specific	CF = Vol. Conv. Factor (1 L/1000 cm3)	0.001
ET = Exposure Time (hours/day)	2.6	BW = Bodyweight (kg)	70

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO SURFACE WATER (WHILE WADING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg)	CDI (Car) (mg/kg)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
1,2-Dichloroethane		1.1E-08	NA	9.1E-02		1.0E-09
Trichloroethene		1.5E-08	NA	1.1E-02		1.6E-10
Semivolatiles						
bis(2-Ethylhexyl)phthalate	5.8E-08	2.5E-08	2.0E-02	1.4E-02	2.9E-06	3.5E-10
Explosives						
RDX	1.2E-08	5.1E-09	3.0E-03	1.1E-01	4.0E-06	5.6E-10
Tetryl			NA	NA		
Metals						
Aluminum			NA	NA		
Arsenic	1.2E-08	5.2E-09	3.0E-04	1.8E+00	4.0E-05	9.1E-09
Barium	1.2E-06		7.0E-02	NA	1.7E-05	
Beryllium	3.4E-09	1.5E-09	5.0E-03	4.3E+00	6.8E-07	6.3E-09
Chromium	1.9E-08		5.0E-03	NA	3.8E-06	
Copper	3.7E-07		4.0E-02	NA	9.2E-06	
Lead			NA	NA		
Manganese	6.6E-06		5.0E-03	NA	1.3E-03	
Nickel			NA	NA		
Vanadium	2.0E-07		7.0E-03	NA	2.8E-05	
Totals - HQ & CR					**1.4E-03**	**1.7E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic)/Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

03/08/94

ALL CASES

CALCULATION OF INTAKE
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Intake (Nc) (mg/kg-day)	Intake (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Ingestion Rate (liters/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	
								Nc	Car
Volatile Organics									
Acetone	1.0E-04		3.68E-03	2	350	30	70	10,950	25,550
Semi-volatiles									
Di-n-butylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Di-n-octylphthalate	1.4E-04		5.00E-03	2	350	30	70	10,950	25,550
Explosives									
RDX	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	6.00E-05	2	350	30	70	10,950	25,550
Dinitrotoluene, 2,6-	1.6E-06		6.00E-05	2	350	30	70	10,950	25,550

EQUATION: Intake (mg/kg-day) = $\frac{CW \times IR \times EF \times ED}{BW \times AT}$

Variables:	Assumptions:
CW = Chemical Concentration in Water (mg/liter)	95th UCL Groundwater Data
IR = Ingestion Rate (liters/day)	2
EF = Exposure Frequency (days/year)	350
ED = Exposure Duration (years)	30
BW = Bodyweight (kg)	70
AT = Averaging Time (days)	30 x 365(Nc) 70 x 365(C)

03/08/94

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM INGESTION OF GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.0E-04		1.0E-01	NA	1.0E-03	
Semi-volatiles						
Di-n-butylphthalate	1.4E-04		1.0E-01	NA	1.4E-03	
Di-n-octylphthalate	1.4E-04		2.0E-02	NA	6.8E-03	
Explosives						
RDX	1.6E-06	7.0E-07	3.0E-03	1.1E-01	5.5E-04	7.7E-08
Trinitrotoluene, 2,4,6-	1.6E-06	7.0E-07	5.0E-04	3.0E-02	3.3E-03	2.1E-08
Dinitrotoluene, 2,6-	1.6E-06		1.0E-03	NA	1.6E-03	
Totals - HQ & CR					**1.5E-02**	**9.9E-08**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

ALL CASES

CALCULATION OF ABSORBED DOSE
FROM DERMAL CONTACT TO GROUNDWATER (WHILE SHOWERING/BATHING)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	Absorbed Dose (Nc) (mg/kg-day)	Absorbed Dose (Car) (mg/kg-day)	95th UCL Groundwater (mg/l)	Skin Surface Area Contact (cm2)	Permeability Constant (cm/hr)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Volumetric Conv. Factor (1 liter/1000 c	Body Weight (kg)	Averaging Time (days)	
											Nc	Car
Volatile Organics												
Acetone	1.6E-07		3.68E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Semivolatiles												
Di-n-butylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Di-n-octylphthalate	2.1E-07		5.00E-03	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Explosives												
RDX	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
Dinitrotoluene, 2,6-	2.6E-09		6.00E-05	19,400	8E-04	0.2	350	30	1E-03	70	10,950	25,550
										70		25,550

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \ CF}{BW \times AT}$$

Variables:	Assumptions:	Variables:	Assumptions:
CW = Chemical Conc. in Water (mg/liter)	95th UCL Groundwater Data	ED = Exposure Duration (years)	30
SA = Surface Area Contact (cm2)	19400	ET = Exposure Time (hours/day)	0.2
PC = Permeability Constant (cm/hr)	0.0008 (Pc for water)	BW = Body Weight (kg)	70
EF = Exposure Frequency (days/year)	350	CF = Volumetric Conv. Factor	0.001
		AT = Averaging Time (days)	30 x 365 (Nc) 70 x 365 (Car)

ALL CASES

CALCULATION OF NONCARCINOGENIC AND CARCINOGENIC RISKS
FROM DERMAL CONTACT TO GROUNDWATER (DAILY)
RESIDENTIAL EXPOSURE (FUTURE LAND USE)

SENECA ARMY DEPOT
OB GROUNDS

Analyte	CDI (Nc) (mg/kg/day)	CDI (Car) (mg/kg/day)	RfD (mg/kg/day)	Oral Slope Factor (mg/kg-day)-1	Hazard Quotient	Cancer Risk
Volatile Organics						
Acetone	1.6E-07		1.0E-01	NA	1.6E-06	
Semivolatiles						
Di-n-butylphthalate	2.1E-07		1.0E-01	NA	2.1E-06	
Di-n-octylphthalate	2.1E-07		2.0E-02	NA	1.1E-05	
Explosives						
RDX	2.6E-09	1.1E-09	3.0E-03	1.1E-01	8.5E-07	1.2E-10
Trinitrotoluene, 2,4,6-	2.6E-09	1.1E-09	5.0E-04	3.0E-02	5.1E-06	3.3E-11
Dinitrotoluene, 2,6-	2.6E-09		1.0E-03	NA	2.6E-06	
Totals - HQ & CR					**2.3E-05**	**1.5E-10**

Hazard Quotient = Chronic Daily Intake (Noncarcinogenic) /Reference Dose (oral)
Cancer Risk = Chronic Daily Intake (Carcinogenic) x Slope Factor (oral)

Case 5

ABSORPTION METHODOLOGY: Linear Absorption

AIR CONCENTRATION: 0.029 ug Pb/m3
  Indoor AIR Pb Conc: 30.0 percent of outdoor.
  Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L   DEFAULT
   WATER Consumption: DEFAULT

SOIL & DUST:
   Soil: constant conc.
   Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	96.0	470.0
1-2	96.0	470.0
2-3	96.0	470.0
3-4	96.0	470.0
4-5	96.0	470.0
5-6	96.0	470.0
6-7	96.0	470.0

   Additional Dust Sources: None   DEFAULT

PAINT Intake: 0.00 ug Pb/day   DEFAULT

MATERNAL CONTRIBUTION: Infant Model
   Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.62	9.27	6.57
1-2:	5.17	13.45	10.19
2-3:	4.93	14.09	10.42
3-4:	4.66	14.30	10.64
4-5:	4.03	11.97	8.22
5-6:	3.48	11.53	7.51
6-7:	3.13	11.53	7.15

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.36	0.34	0.00	0.01
1-2:	2.41	0.83	0.00	0.01
2-3:	2.77	0.89	0.00	0.02

3-4:	2.72	0.92	0.00	0.02
4-5:	2.73	1.00	0.00	0.02
5-6:	2.92	1.07	0.00	0.03
6-7:	3.25	1.10	0.00	0.03

APPENDIX C

Table C-1
ARARs Summary for Remedial Action Alternatives
Seneca Army Depot Activity - OB Grounds

ARARs	Alternative 1	Alternative 4	Alternative 5	Alternative 6
CHEMICAL-SPECIFIC ARARS				
Air Quality				
40 CFR Part 50.6: Ambient Air Quality Standard for PM-10.	Not Applicable	Will Comply	Will Comply	Will Comply
Water Quality				
40 CFR Part 131: Water Quality Standards.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 131.12: Antidegradation Policy.	Will Not Comply	Will Comply	Will Comply	Will Comply
40 CFR Part 141: National Primary Drinking Water Regulations.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 141.11: Maximum Inorganic Chemical Contaminant Levels.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 264 Subpart F: Releases from Solid Waste Management Units.	Will Not Comply	Will Comply	Will Comply	Will Comply
40 CFR Part 403: Pretreatment Standards	Not Applicable	Not Applicable	Not Applicable	Will Comply
6 NYCRR Chapter X: SPDES	Not Applicable	Not Applicable	Not Applicable	Will Comply
6 NYCRR subparts 701 and 702: Water quality standards	Will Not Comply	Will Comply	Will Comply	Will Comply
6 NYCRR subpart 703: Groundwater standards	Will Not Comply	Will Comply	Will Comply	Will Comply
6 NYCRR subpart 375: Inactive hazardous waste disposal sites.	Will Not Comply	Will Comply	Will Comply	Will Comply

ARARs	Alternative 1	Alternative 4	Alternative 5	Alternative 6
6 NYCRR subpart 373-2.6 and 373-2.11: Groundwater monitoring for releases from SWMUs	Will Comply	Will Comply	Will Comply	Will Comply
6 NYCRR subpart 373-2: Postclosure care and groundwater monitoring	Not Applicable	Not Applicable	Will Comply	Not Applicable
10 NYCRR Part 5: Drinking water supplies.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
NYSDEC TOGS 1.1.1: Water quality standards and guidance	Will Not Comply	Will Comply	Will Comply	Will Comply
Soil Quality				
40 CFR Parts 264.552 and 264.533: Corrective Action	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 264, Subpart X: Misc. Units	Will Comply	Will Comply	Will Comply	Will Comply
6 NYCRR subpart 375: Inactive hazardous waste disposal sites.	Will Not Comply	Will Comply	Will Comply	Will Comply
LOCATION-SPECIFIC ARARS				
40 CFR Part 257.3-2: Endangered species	Will Comply	Will Comply	Will Comply	Will Comply
40 CFR Part 264.18: Location Standards for Hazardous Waste Facilities.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 241.202: Site selection	Not Applicable	Not Applicable	Will Comply	Not Applicable
16 USC Part 469a-1: The Archaeological and Historic Preservation Act	Will Comply	Will Comply	Will Comply	Will Comply
36 CFR Part 800: Historic properties	Will Comply	Will Comply	Will Comply	Will Comply

ARARs	Alternative 1	Alternative 4	Alternative 5	Alternative 6
ACTION-SPECIFIC ARARS				
Solid Waste Management				
40 part CFR 241.100: Land Disposal of Solid Wastes.	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR Part 241.204: Water Quality.	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 CFR Part 241.205: Air quality	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR Part 243.202: Transport	Not Applicable	Will Comply	Will Comply	Will Comply
6 NYCRR Part 360: Subtitle D solid waste landfills	Not Applicable	Will Comply	Will Comply	Will Comply
Hazardous Waste Management				
40 CFR 260:	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR 262.11: Generators	Not Applicable	Will Comply	Not Applicable	Will Comply
40 CFR 261: Identification of Hazardous Waste	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR 262 Subparts B, C, D: Offsite Disposal of Hazardous Wastes	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR Part 263.30 and 263.31: Release during transport.	Not Applicable	Will Comply	Not Applicable	Will Comply
40 CFR Part 264: Hazardous waste management facility standards	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR Part 268: Land Disposal Restrictions	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR Part 270 subpart C: Permit conditions	Not Applicable	Not Applicable	Not Applicable	Not Applicable

ARARs	Alternative 1	Alternative 4	Alternative 5	Alternative 6
40 CFR Part 270 subpart B: Permit applications	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Occupational Health and Safety Administration				
29 CFR Part 1910.50: Occupational Noise	Not Applicable	Will Comply	Will Comply	Will Comply
29 CFR Part 1910.1000: Occupational Air Contaminants	Not Applicable	Will Comply	Will Comply	Will Comply
29 CFR 1910.1025: Occupational Exposure to Lead	Not Applicable	Will Comply	Will Comply	Will Comply
29 CFR Part 1910.1200: Hazard communication	Not Applicable	Will Comply	Will Comply	Will Comply
29 CFR Part 120: Employee training and medical monitoring.	Not Applicable	Will Comply	Will Comply	Will Comply
40 CFR part 1926.62 Constructoin Work Where Exposure to Lead	Not Applicable	Will Comply	Will Comply	Will Comply
Transportation of Hazardous Waste				
49 CFR Part 171: Transport of hazardous material.	Not Applicable	Will Comply	Not Applicable	Will Comply
40 CFR Part 172: Hazardous materials table, special provisions, Hazardous Materials Communications, Emergency Response Information, and Training requirements.	Not Applicable	Will Comply	Not Applicable	Will Comply
40 CFR 173: General DOT Requirements for Shipment & Packaging	Not Applicable	Will Comply	Will Comply	Will Comply
49 CFR Part 177: Carriage by Public Highway.	Not Applicable	Will Comply	Not Applicable	Will Comply

ARARs	Alternative 1	Alternative 4	Alternative 5	Alternative 6
6 NYCRR Chapter 364: New York Waste Transport Permit Regulation.	Not Applicable	Will Comply	Not Applicable	Will Comply
EPA/DOT Guidance Manual on hazardous waste transportation	Not Applicable	Will Comply	Not Applicable	Will Comply

APPENDIX D

COST ESTIMATES

APPENDIX D-1

COST BACKUP

Vendor Quotes

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

NAME / **COMPANY**	
WITH: Richard Traver / Jan Limaye, Bergmann USA	JOB NO.: 720466-01023
	FILE NO.:
CLIENT: U.S. Army Engineer Div.	DATE: 11-9-93
PROJECT: OBFS	TIME: 9AM
SUBJECT OF CONVERSATION: WASH \$/cy ACID EXTRACT. \$/cy	INITIATED BY: REM
	TEL. NO.: (615) 452-5500

DISCUSSION Basis

20,000 cy removal

Bergmann USA quotes a ~~general~~ price of \$300/cy wash total ✓ 150TPD

\$600/cy acid extract total 150TPD

→ 70% coarse, 30% fines in wash (wet separation)

→ 70% clean, 30% residual in acid extract

Response Requested __ Yes __ No
Date Requested

Richard E. [signature]

PARSONS

(\$/cy) Price of NY Clay

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:	Jim Kyles	Engineering-Science Buffalo	JOB NO.: 720466
			FILE NO.:
CLIENT:	U.S. Army Engineer Division		DATE: 11-30-93
PROJECT:	OBFS		TIME: 2:30PM
SUBJECT OF CONVERSATION:	Price of clay in NY state		INITIATED BY: REM
			TEL. NO.: (716) 854-0528

DISCUSSION

He said that ES-Buffalo is receiving bids on a landfill project in the range of \$9 to \$13 /cy for clay in NY State.

Response Requested __ Yes ✓ No
Date Requested

[signature]

PARSONS

PARSONS ENGINEERING SCIENCE, INC.

TELEPHONE CONVERSATION MEMORANDUM

CALL TO: Scott Larson **OF:** Silicate Technology

DATE: July 16, 1996 **TIME:**

TELEPHONE NUMBER: 602-948-7100

INITIATED BY: Eliza Schacht **COPIES:**

SUBJECT: OB Grounds FS
Solidification of Contaminated Soils

Silicate Technology was called in 1993 for a quote to solidifiy soils contaminated with heavy metals. I called to get a more updated cost estimate. The cost for treatment, manpower, and equipment involved in stabilizing lead contaminated soil was $35 to $65/ton. Stabilization means that the final product may be a high strength monolith or a low strength material . Both final products would have the metals immobilized and below the TCLP.

ρ = 1.5 ton/cy
$ 52.50/cy to $ 97.50/cy.
use average $ 75.00/cy.

Off-site Subtitle D Landfill

Corporate Offices:

3527 Harlem Road
Buffalo, NY 14225

Phone: (716) 833-3286
Fax: (716) 833-5670

Earthwatch
WASTE SYSTEMS, INC.

Regional Offices:

Cherry Hill, NJ
East Stroudsburg, PA
Louisville, KY
Rochester, NY
Burlington, Ontario

We Offer You a World of Solutions

SERVICES QUOTATION

DATE: 7/12/96

TO: ELISA
PARSONS ENG SCIENCE

F 617-859-2043

GENERATOR OR PROJECT LOCATION:

SENECA ARMY DEPOT
22,000 CUBIC YARDS
NON HAZARDOUS SOIL

EARTHWATCH WASTE SYSTEMS, INC. is pleased to offer the following quotation to provide you with our transportation, disposal, and waste management services as described below:

BUDGETARY PRICING ONLY
DISPOSAL $14.50 / TON
ONTARIO COUNTY LANDFILL, FLINT NY
TRANSPORTATION $14.00 TO 18.00 / TON
END DUMP TRAILERS, LOAD + GO
FULL TCLP ANALYSIS REQUIRED TO RECEIVE APPROVAL
ANALYTICAL INFO (FULL TCLP) REQUIRED FOR EVERY
6000 TONS
TRANSPORTATION RATES CHEAPER DURING SLOWER SEASONS,
(IE: WINTER MONTHS) AND IF MORE RUNS CAN BE
MADE DURING A DAY,

All work described herein will be performed in strict compliance with all federal, state, and local rules and regulations.

This quotation is valid for thirty (30) days from the above date and is subject to verification thereafter. All applicable taxes are separate items. EARTHWATCH requires completion of our Credit Application in order to establish credit line and payment terms, as well as execution of our formal Waste Disposal Services Agreement between our firms.

Thank you for your interest in EARTHWATCH WASTE SYSTEMS, INC. We look forward to your positive response to our quotation, and to to serving you on this and future projects.

IF YOU HAVE ANY QUESTIONS, PLEASE CALL.

Sincerely,
LuAnn Popham
Earthwatch Waste Systems, Inc.

Use $14.50 + 18.00 = $32.50/ton

Yes, I accept this proposal:

ρ_{fill} = 1.5 ton/cy

Contact me at: 716 544-6102

By: use; → $49./cy Title: ______ Date: ______

Rev 4/10/96

FROM : EARTHWATCH PHONE NO. : 216 497 8455 Jul. 15 1996 03:17PM P01

PARSONS ENGINEERING SCIENCE, INC.

TELEPHONE CONVERSATION MEMORANDUM

CALL TO: Rocky LaRoka **OF:** Seneca Meadows Landfill

DATE: July 11, 1996 **TIME:**

TELEPHONE NUMBER: 315-539-5624

INITIATED BY: Eliza Schacht **COPIES:**

SUBJECT: OB Grounds FS
Cost of Landfilling

I called Seneca Meadows to get a quote for transporting and disposing of the contaminated soil in the OB grounds. Transportation and disposal costs are approximately \$40/ton. The landfilling cost only is \$28 to \$30/ton.

EWR (\$/ton) Load, Haul, Treat, Disposal
(\$/cy)

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

NAME	COMPANY	
WITH: Doug Howe	Environmental Waste Resources Inc. (EWR)	JOB NO.: 720466-01023
Waterbury CT		FILE NO.:
CLIENT: U.S. Army Engineers		DATE: 11-23-93
PROJECT: OBFS		TIME: 2PM
SUBJECT OF CONVERSATION: Price to load haul, treat, disposal of soil		INITIATED BY: REM
		TEL. NO.: (203)755-2283

DISCUSSION

EWR is currently taking the drill-cuttings from the OB Grounds (drummed). He quoted a bulk rate for loading, hauling, solidification and disposal (CT-regulated subtitle D landfill) of \$220/ton with a transportation rate of \$1,600/load and 23 ton/load or \$70/ton.

Total off-site treat/dispose = \$290/ton

$\rho_{SHALE\ FILL}$ = 1.5 ton/cy (\$290/ton)(1.5) = \$435/cy

Say \$450/cy

Richard E. [signature]

Response Requested __ Yes __ No
Date Requested

PARSONS

ES

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY
WITH:		Gundle

JOB NO.: 720446

FILE NO.:

CLIENT: USACE

DATE: 12/30/93

PROJECT: SEDA OB RI

TIME: 1430

SUBJECT OF CONVERSATION: Cost of HDPE Liner

INITIATED BY: D. Kelman

TEL. NO.: 1-800/435-2008

DISCUSSION

ACTION BY AND DATE

I called to get a rough price for Gundle 40-mil HDPE Liner. They said that for upstate New York, with a quantity of 125,000 ft², a good budgetary cost is $0.36/ft² - installed.

Daniel Kelman

Response Requested __ Yes __ No

Date Requested

ES

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY		
WITH:		Polyfelt	JOB NO.:	720446
			FILE NO.:	
CLIENT:	USACE		DATE:	11/30/93
PROJECT:	SEDA OB RI		TIME:	1500
SUBJECT OF CONVERSATION:			INITIATED BY:	D. Kelmar
Cost of Geotextile			TEL. NO.:	1-800/458-3567

DISCUSSION

ACTION BY AND DATE

I called to get a rough price for geotextile. They said that for New York, the material cost would be approximately \$1.00/yd² or \$0.10 to 0.15/ft².

Daniel Kelman

Response Requested __ Yes __ No
Date Requested

Cost of On-Site Landfill

PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT: USACE | JOB. NO. ____ | SHEET 1 OF 5

SUBJECT: SEDA OBFS | BY ____ | DATE ____

On-site Landfill | CKD. ____ | REVISION ____

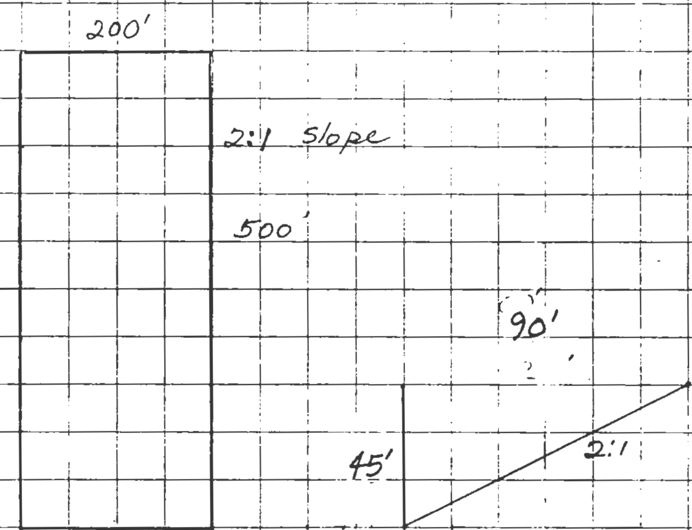
Parsons ES letter of Feb. 8, 1996 : 233,000 cy of soil landfilled.

Volume includes OB grounds.

233,000 cy material to landfill = 500′ × 200′ × height

6,291,000 cf = 100,000 ft² × height

height = 62.91 ft ⇒ 63 ft.



Real Volume 1. 200 × 500 × 60′ = 6,000,000 cf = 222,222 cy.

2. ½ × 500 × 60 × 120′ = 1,800,000 sf = 66,666 cy

3. 66,666 cy

4. ½ × 200 × 60 × 120 = 720000 sf = 26,666 cy

5. 26,666 cy

Total = 408,886 cy. volume.

PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT: USACE
JOB. NO.
SHEET 2 OF 5
SUBJECT: SEDA OBFS
On-site Landfill
BY
DATE
CKD.
REVISION

Revised estimate of height:

try h = 35'

1. 200' × 500' × 35' = 3,500,000 cf = 129,630 cy
2. ½ × 500' × 35' × 70' = 612,500 cf = 22,685 cy.
3. 22,685 cy.
4. ½ × 200 × 35 × 70 = 245,000 cf = 9075 cy
5. 9075 cy.

Total = 193,150 cy.

try h = 40'

1. 200' × 500' × 40' = 4,000,000 cf = 148,150 cy
2. ½ × 500' × 40' × 80' = 800,000 cf = 29,630 cy.
3. 29,630 cy.
4. ½ × 200' × 40' × 80' = 320,000 cf = 11,850 cy
5. 11,850 cy.

Total = 231,110 cy.

PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT USACE JOB. NO. SHEET 3 OF 5

SUBJECT SEDA OBFS BY DATE

On-site Landfill CKD. REVISION

try h=45'

1. 200' x 500' x 45' = 4,500,000 cf = 166,670 cy.

2. 1/2 x 500' x 45' x 90' = 1,012,500 cf = 37,500 cy.

3. 37,500 cy

4. 1/2 x 200' x 45' x 90' = 405,000 cf = 15,000 cy.

5. 15,000 cy.

→ Total = 271,670 cy.

PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT USACE JOB. NO. ____ SHEET 3 OF 5

SUBJECT SEDA OBFS BY ____ DATE ____

On-site Landfill CKD. ____ REVISION ____

try h = 45'

1. 200' × 500' × 45' = 4,500,000 cf = 166,670 cy.

2. 1/2 × 500' × 45' × 90' = 1,012,500 cf = 37,500 cy.

3. 37,500 cy

4. 1/2 × 200' × 45' × 90' = 405,000 cf = 15,000 cy.

5. 15,000 cy.

→ Total = 271,670 cy.

PARSONS ENGINEERING SCIENCE, INC.

PARSONS

CLIENT USACE | JOB. NO. | SHEET 4 OF ~~2~~5
SUBJECT SEDA OBFS | BY EDS | DATE 6/12/96
On-Site Landfill | CKD. | REVISION

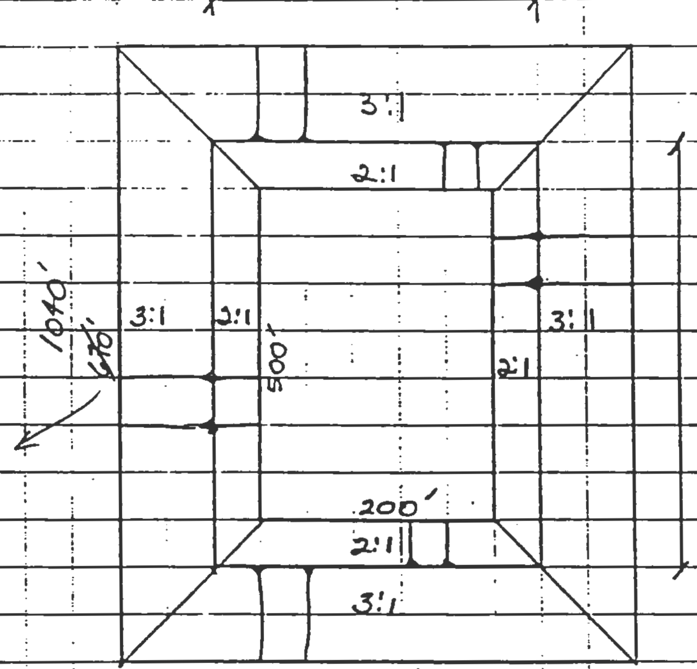
Estimate material quantities for construction of on-site Subtitle D landfill

Assume: 1 composite liner

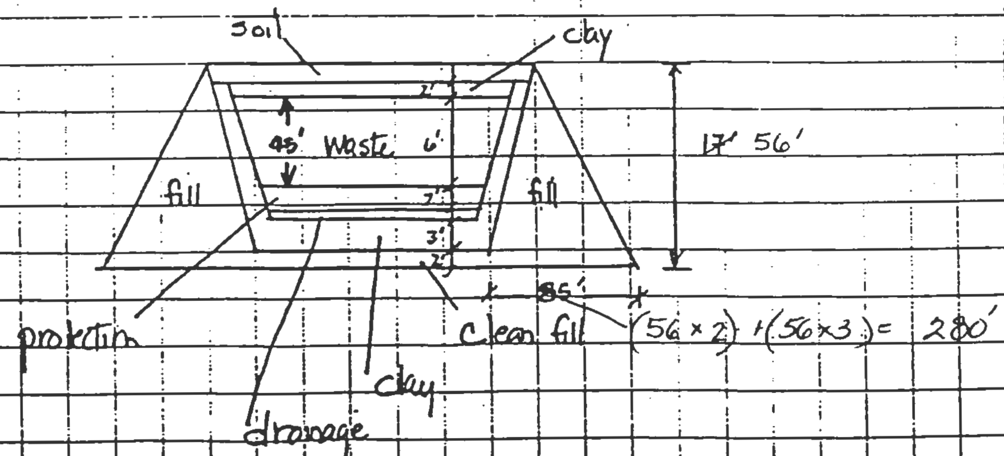
22,590 cy capacity = 6 ft (2 yd) fill height x 11,295 yd² (101,655 ft²)

2:1 side slope 404'

~~268'~~ = 200 + (51 x 2) + (51 x 2) = 404'



740' ~~370'~~ = (51 x 2) + (51 x 2) + 200 + (56' x 3) + (56 x 3)



PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT ______ JOB. NO. ______ SHEET 5 OF 5

SUBJECT ______ BY ______ DATE ______

Landfill ______ CKD. ______ REVISION ______

Estimate of Materials — height of waste material = 45'

Clean Fill:

Bottom: 740' x 1040' x 2' = 1539200 cf

Cover: 404' x 704 x 2 = 568832 cf

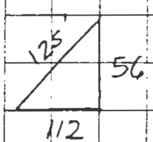
Sides: 2 [1/2 (280 x 56)] 572' = 8,968,960 cf

2 [1/2 (280 x 56)] 872' = 13,672,960 cf

Protection: 200' x 500 x 2 = 200,000 cf

Total 2 4949952 cf = 924,072 cy

Clay Liner:



Bottom: 200' x 500' x 3' = 300,000 cf

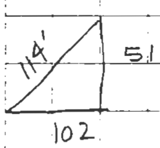
Cover: 404' x 704' x 2 = 568832 cf

Sides: 2 x [125' x 3' x 302'] = 226,500 cf

2 x [125' x 3' x 872'] = 654,000 cf

Total 1749332 cf = 64,790 cy

HDPE Liner and Geosynthetic drainage layer and geotextile



Bottom: 200' x 500' = 100,000 sf

Sides 2 x 114' x 302' 68,856 sf

2 x 114' x 872' = 198816 sf

Total 367,672 sf

Feasibility Study for
Open Burning Grounds
Seneca Army Depot Activity

Cost Estimate for an On-Site Landfill

Item	Units	Quantity	Unit Cost*	Amount
Materials				
Clean Fill	cy	924072	$15	$13,861,080
Clay (k<1x 10-7)	cy	64790	$32	$2,073,280
HDPE liner	sf	367672	$0.70	$257,370
Geosynthetic Drainage Layer	sf	367672	$0.06	$22,060
Sum (including pump and piping	each	1	$20,000	$20,000
Geotextile	sf	367672	$0.70	$257,370
Construction				
Mobilization	each	1	$10,000	$10,000
Clear Site	acre	8	$500	$4,000
Revegetation	acre	10	$2,000	$20,000
Dewatering	job	1	$10,000	$10,000
Demobilization	each	1	$5,000	$5,000
Subtotal				$16,540,161
Contingencies (20%)				$3,308,032
Engineering and Permitting (20%)				$3,308,032
Total				$23,156,226
Unit Cost per cy of waste material	quantity of waste is 233,000 cy			$99 /cy

* The unit costs are derived from Appendix A, Regulatory Impact Statement, 6 NYCRR Part 360. The unit costs include the material, installation, and CQA/CQC costs associated with current landfill construction.

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME COMPANY	
WITH:	Richard Traver / Jan Limaye Bergmann USA	JOB NO.: 720466-01023
		FILE NO.:
CLIENT:	U.S. Army Engineer Div.	DATE: 11-9-93
PROJECT:	OBFS	TIME: 9AM
SUBJECT OF CONVERSATION:	WASH $/cy ACID EXTRACT. $/cy	INITIATED BY: REM
		TEL. NO.: (615) 452-5500

DISCUSSION Basis

20,000 cy removal

Bergmann USA quotes a ~~general~~ price of $300/cy wash total ✓ 150TPD

$600/cy acid extract total 150TPD

→ 70% coarse, 30% fines in wash (wet separation)

→ 70% clean, 30% residual in acid extract

Richard E. McCaskill

Response Requested __ Yes __ No
Date Requested

PARSONS

OFF-SITE SUBTITLE D LANDFILL $/ton
Transport / Dispose

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:	Rita Frost	Waste Management of NY High Acres Land fill 425 Perinton Parkway Fairport NY 14450	JOB NO.: 720466-01023
			FILE NO.:
CLIENT:	U.S. Army Engineers		DATE: 11-29-93
PROJECT:	OBFS		TIME: 10AM
SUBJECT OF CONVERSATION:			INITIATED BY: REM
	Haul / dispose of soil		TEL. NO.: (716) 223-6132

DISCUSSION

Subtitle D landfill charges: soil $28/ton
solidif. soil $65/ton

Need one TCLP / 1,000 cy

Assumes 50% void space for solidif. product: $22/ton to transport

Total to trans./dispose of solidif. product
= 22 + 65 = $87/ton ≈ $90/ton

$\gamma_{SHALE FILL}$ = 1.5 ton/cy $135/~~ton~~ cy

Say $150/cy

[signature]

Response Requested __ Yes __ No
Date Requested

PARSONS

EWR (#/ton) Load, Haul, Treat, Disposal
($/cy)

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:	Doug Howe Waterbury CT	Environmental Waste Resources Inc. (EWR)	JOB NO.: 720466-01023
			FILE NO.:
CLIENT:	U.S. Army Engineers		DATE: 11-23-93
PROJECT:	OBFS		TIME: 2PM
SUBJECT OF CONVERSATION:	Price to load haul, treat, disposal of soil		INITIATED BY: REM
			TEL. NO.: (203) 755-2283

DISCUSSION

EWR is currently taking the drill cuttings from the OB Grounds (drummed). He quoted a bulk rate for loading, hauling, solidification and disposal (CT-regulated Subtitle D landfill) of #220/ton with a transportation rate of $1,600/load and 23 ton/load or $70/ton.

Total off-site treat/dispose = $290/ton

$\rho_{SHALE\ FILL} = 1.5$ ton/cy ($290/ton)(1.5) = $435/cy

Say $450/cy

Richard E. McGarry [signature]

Response Requested __ Yes __ No
Date Requested

PARSONS

(\$/ton) Price of Solidification

ES

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:	Lynn Cummings	Silicate Technology	JOB NO.: 720447
			FILE NO.:
CLIENT:	SEDA		DATE: 11/24/93
PROJECT:	OB Grounds FS		TIME: 1100
SUBJECT OF CONVERSATION:	Solidification		INITIATED BY: O. Kelman
			TEL. NO.: 602/948-7100

DISCUSSION | **ACTION BY AND DATE**

We discussed Silicate Technologies experience in solidification of soils contaminated with heavy metals. Their capacity is approximately 400 - 500 yards per day. The cost is approximately \$70 to \$130 per ton. They can make cement and put the cement directly into bulk bags, which are loaded in flat beds for transport to a landfill. A recent site had 13,000 yds, and was completed in 5 weeks.

→ 450 cy/day
675 tpd
100 tph

$\rho_{SHALE} = 1.5$ ton/cy

Dan Kelman

Response Requested __ Yes __ No
Date Requested

$(70+130)/2 = \$100/\text{ton}$

$(100)(1.5) = \$150/\text{cy}$

(\$/cy) Price of NY Clay

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:	Jim Kyles	Engineering-Science Buffalo	JOB NO.: 720466
			FILE NO.:

CLIENT: U.S. Army Engineer Division — DATE: 11-30-93

PROJECT: OBFS — TIME: 2:30PM

SUBJECT OF CONVERSATION: Price of clay in NY state — INITIATED BY: REM

TEL. NO.: (716) 854-0528

DISCUSSION

He said that ES-Buffalo is receiving bids on a landfill project in the range of \$9 to \$13 /cy for clay in NY State.

Response Requested __ Yes ✓ No
Date Requested

Richard [signature]

PARSONS

PARSONS ENGINEERING SCIENCE, INC. PARSONS

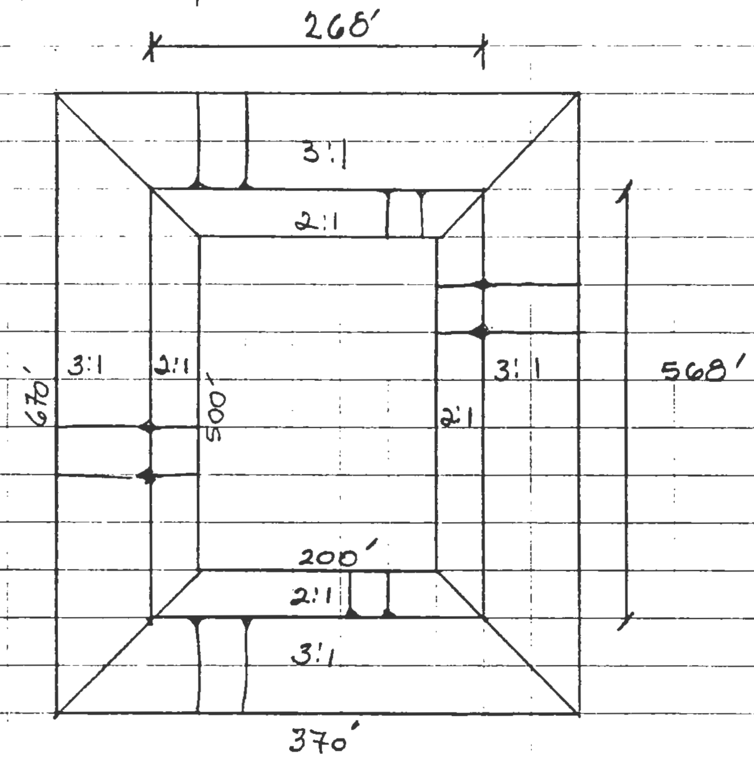
CLIENT: USACE | JOB. NO.: | SHEET 1 OF 2
SUBJECT: SEDA OBFS On-Site Landfill | BY: EDS | DATE: 6/12/96
CKD.: | REVISION:

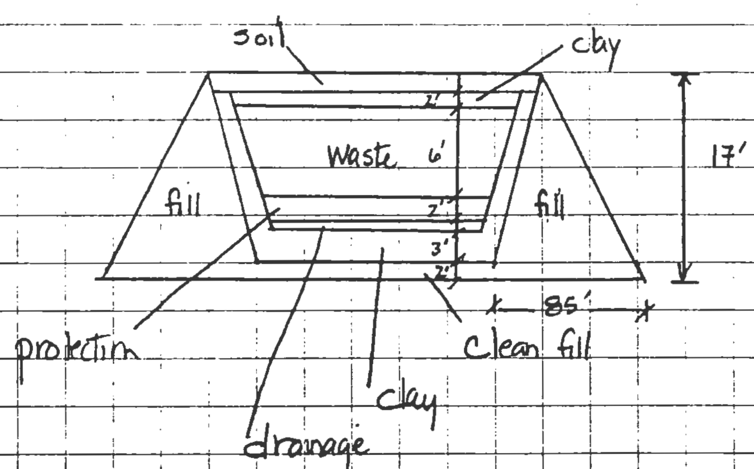
Estimate material quantities for construction of on-site Subtitle D landfill

Assume: 1 composite liner

22,590 cy capacity = 6 ft (2 yd) fill height x 11,295 yd^2 (101,655 ft^2)

2:1 side slope





PARSONS ENGINEERING SCIENCE, INC. PARSONS

CLIENT USACE | JOB. NO. | SHEET 2 OF 2
SUBJECT SEDA OBFS On-Site Landfill | BY EDS | DATE 6/12/96
CKD. | REVISION

Estimate Material Quantities

Clean Fill

Bottom: 370' × 670' × 2' = 495,800 ft^3
Cover: 268' × 568' × 2' = 304,448 ft^3
Sides: 2 [½ (85×17) 319' = 460,955 ft^3
2 [½ (85×17) 517'] = 747,065 ft^3
Protection: 200' × 500' × 2 = 200,000 ft^3

2,208,268 ft^3 = 81,790 cy.

Clay Liner

Bottom: 200' × 500' × 3' = 300,000 ft^3
Cover: 268' × 568' × 2' = 304,448 ft^3
Sides 2 × [38' × 3' × 234'] = 53,352 ft^3
2 × [38' × 3' × 534'] = 121,752 ft^3

779,552 ft^3 = 28,870 cy

HDPE liner and Geosynthetic drainage layer and Geotextile

Bottom: 200' × 500' = 100,000 ft^2
Sides 2 × [25' × 234'] 11,700 ft^2
2 × [25' × 534'] 26,700 ft^2

138,400 ft^2

Feasibility Study for
Open Burning Grounds
Seneca Army Depot Activity

Cost Estimate for an On-Site Landfill

Item	Units	Quantity	Unit Cost*	Amount
Materials				
Clean Fill	cy	81790	$15	$1,226,850
Clay (k<1x 10-7)	cy	28870	$32	$923,840
HDPE liner	sf	138400	$0.70	$96,880
Geosynthetic Drainage Layer	sf	138400	$0.06	$8,304
Sum (including pump and piping	each	1	$20,000	$20,000
Geotextile	sf	138400	$0.70	$96,880
Construction				
Mobilization	each	1	$10,000	$10,000
Clear Site	acre	8	$500	$4,000
Revegetation	acre	10	$2,000	$20,000
Dewatering	job	1	$10,000	$10,000
Demobilization	each	1	$5,000	$5,000
Subtotal				$2,421,754
Contingencies (20%)				$484,351
Engineering and Permitting (20%)				$484,351
Total				$3,390,456
Unit Cost per cy of waste material		$3,390,456/22590 cy		$150 /cy

* The unit costs are derived from Appendix A, Regulatory Impact Statement, 6 NYCRR Part 360 regulatio The unit costs include the material, installation, and CQA/CQC costs associated with current landfill construction.

h:\eng\seneca\obfs\landcos.wk4

ES

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY	
WITH:		Gundle	JOB NO.: 720446
			FILE NO.:

CLIENT: USACE — DATE: 12/30/93

PROJECT: SEDA OB RI — TIME: 1430

SUBJECT OF CONVERSATION: Cost of HDPE Liner — INITIATED BY: D. Kelman

TEL. NO.: 1-800/435-2008

DISCUSSION — **ACTION BY AND DATE**

I called to get a rough price for Gundle 40-mil HDPE Liner. They said that for upstate New York, with a quantity of 125,000 ft^2, a good budgetary cost is \$0.36/ft^2 - installed.

Daniel Kelman

Response Requested __ Yes __ No
Date Requested

ES

ENGINEERING-SCIENCE, INC.

MEMORANDUM OF TELEPHONE CONVERSATION

	NAME	COMPANY		
WITH:		Polyfelt	JOB NO.:	720446
			FILE NO.:	
CLIENT:	USACE		DATE:	11/30/93
PROJECT:	SEDA OB RI		TIME:	1500
SUBJECT OF CONVERSATION:			INITIATED BY:	D Kelmar
Cost of Geotextile			TEL. NO.:	1-800/458-3567

DISCUSSION

ACTION BY AND DATE

I called to get a rough price for geotextile. They said that for New York, the material cost would be approximately $1.00/yd² or $0.10 to 0.15/ft².

Daniel Kelmar

Response Requested __ Yes __ No
Date Requested

APPENDIX D-2

ALTERNATIVES 2 THROUGH 6
COST ESTIMATES

APPENDIX D-2

ALTERNATIVES 2 THROUGH 6
COST ESTIMATES

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 2
March 14, 1996

Alternative 2: Consolidation of sediment/ slurry wall/cap/ sedimentation pond/groundwater monitoring

				NOTES
Basis:	Excavation of sediment	$30.00	/cy	
	Slurry wall	$8.00	/sf	Parsons ES estimate
	Clay Cost	$13.00	/cy	
	Clean Fill	$10.00	/cy	
	HDPE liner	$0.50	/sf	
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Sediments	900	cy	
	Cap area	1435500	sf	at 1 ft. height
	Volume of clean fill	106333	cy	Cap area x 2 ft/27
	Volume of clay	79750	cy	Cap area x 1.5/27
	Slurry wall length	6070	lf	around entire site
	Slurry wall depth	20	ft	
	Slurry wall area	91050	sf	
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation of sediment	$30.00	cy	900	$27,000
2	Slurry Wall	$8.00	sf	91050	$728,400
2	Clean Fill	$10.00	cy	106333	$1,063,333
	Clay *	$13.00	cy	79750	$1,036,750
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
6	Engineering/				
	Permits/oversight	10%			$302,548
7	Site Prep/Mob	5%			$151,274
8	Contingency	20%			$605,097
9	Supervision and Admin	6%			$181,529
	Subtotal				**$4,265,932**

Account for inflation from 1993 to 1996	3% per year	$383,934
Total		**$4,649,865**

Notes: Slurry wall unit price from "The First EPA Superfund Cutoff Wall: Design and Specificiations" (publication date approx. 1982)
Bids received in 1982 for construction of a slurry wall was $4.65/SF
Accounting for a 3% inflation rate, this unit price is $ 8.00/SF in 1996 dollars.

Area of site is approximately 33 acres, or 1,435,500 sf.
Approximate length of boundary is 6070 lf.

* Cost of HDPE liner	$0.50	sf	1435500	$717,750

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 3
March 14, 1996

Alternative 3: Consolidation of sediment/ in-situ solidification of soils/ sedimentation pond/groundwater monitoring

				NOTES
Basis:	Excavation of sediment	$30.00	/cy	
	In-situ solidification	$400.00	/cy	See footnote
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	

Volumes:	Sediments	900	cy
	Volume of soil to solid.	17900	cy
	Area of revegetation	15	acres

Items		**Unit Cost**	**Units**	**Volume**	**Total**
1	Excavation	$20.00	cy	900	$18,000
2	In-situ solidification	$400.00	cy	17900	$7,160,000
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
6	Engineering/				
	Permits/oversight	10%			$734,800
7	Site Prep/Mob	5%			$367,400
8	Contingency	20%			$1,469,600
9	Supervision and Admin	6%			$440,880
	Subtotal				**$10,360,680**

Account for inflation from 1993 to 1996	3% per year	$932,461
Total		**$11,293,141**

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 4a
July 16, 1996

Alternative 4:	Excavation, off-site treatment and landfill of TCLP soils, off-site Subtitle D landfill of remaining soils Sedimentation pond/groundwater monitoring Treatment is solidification/stabilizaton			
Basis:	EWR Unit Cost	$450.00	/cy	Transport, treat, dispose TCLP soils
	Off-site landfill	$49.00	/cy	See note below
	Excavation	$30.00	/cy	
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Soil to EWR	3700	cy	Soils above TCLP criteria
	Soil to landfill	14200	cy	Soils above 500 mg/kg; sediments
	20% volume inc.	2840	cy	Volume inc. for landfilled soil
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation	$30.00	cy	17900	$537,000
2	EWR Cost	$450.00	cy	3700	$1,665,000
3	Off-site Landfill	$49.00	cy	17040	$834,960
4	Install Mon. wells	$5,000.00	each	8	$40,000
5	Sedimentation pond	$100,000.00	each	1	$100,000
6	Revegetation	$2,000.00	acre	15	$30,000
7	Engineering/				
	Permits/oversight	10%			$320,696
8	Site Prep/Mob	5%			$160,348
9	Contingency	20%			$641,392
10	Supervision and Admin.	6%			$192,418
	Subtotal				**$3,984,814**

Account for inflation from 1993 to 1996	3% per year	$0
Total		**$3,984,814**

Notes: Seneca Landfill costs are $40/ton for transport and disposal.
Ontario County Landfill/Earthwatch Waste Systems costs are
$14.50/ton for disposal
and $14.00 to $18.00/ton for transport; use $32.50/ton
Quotes obtained on 7/12/96
For cost estimate, assume 1.5 ton/cy; $32.50/ton x 1.5 ton/cy = $49/cy

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 4b
July 16, 1996

Alternative 4: Excavation,
On-site treatment of TCLP soils,
off-site Subtitle D landfill of treated and remaining soils
Sedimentation pond/groundwater monitoring
Treatment is solidification/stabilizaton

Basis:	Silicate technology	$75.00 /cy	Stabilize
	Excavation	$30.00 /cy	
	Off-site landfill	$49.00 /cy	Seneca Meadows
	Install Monitoring wells	$5,000.00 /well	
	Sedimentation Pond	$100,000.00	
	Revegetation	$2,000.00 /acre	
Volumes:	Soils to be treated	3700 cy	Soils above TCLP criteria
	Inc. in volume	1850 cy	Solid. increases volume
	Remaining soils	14200 cy	Soils above 500 mg/kg; sediments
	20% volume inc.	2840 cy	Volume inc. for landfilled soil
	Area of revegetation	15 acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation	$30.00	cy	17900	$537,000
2	Silicate tech. costs	$75.00	cy	3700	$277,500
3	Off-site landfill	$49.00	cy	22590	$1,106,910
4	Install. Mon. Wells	$5,000.00	each	8	$40,000
5	Sedimentation pond	$100,000.00	each	1	$100,000
6	Revegetation	$2,000.00	acre	15	$30,000
7	Engineering/				
	Permits/oversight	10%			$205,141
8	Site Prep/Mob	5%			$102,571
9	Contingency	20%			$410,282
10	Supervision and Admin.	6%			$123,085
	Subtotal				**$2,395,488**

Account for inflation from 1993 to 1996	3% per year	$0
Total		**$2,395,488**

Notes: Seneca Landfill costs are $40/ton for transport and disposal.
Ontario County Landfill/Earthwatch Waste Systems costs are $14.50/ton for disposal
and $14.00 to $18.00/ton for transport; use $32.50/ton
Quotes obtained on 7/12/96
For cost estimate, assume 1.5 ton/cy; $32.50/ton x 1.5 ton/cy = $49/cy

h:\eng\seneca\obfs\alt4bcs.wk4

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 5
July 16, 1996

Alternative 5: Excavation, on-site treatment, and on-site Subtitle D landfill
Sedimentation pond/groundwater monitoring

Basis:	Silicate technology	$75.00	/cy	Stabilize
	On-site landfill	$99.00	/cy	Parsons ES estimate
	Install mon. wells	$5,000.00	/well	8 wells; see note
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
	Excavation	$30.00	/cy	
Volumes:	Soil to stabilize	3700	cy	Soils above TCLP criteria
	Inc.volume after stabl.	1850	cy	50% inc. in volume
	Remaining soils	14200	cy	Soils above 500 mg/kg; sediment
	20% volume inc.	2840	cy	Volume inc. for landfilled soil
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation	$30.00	cy	17900	$537,000
2	Silicate tech. costs	$75.00	cy	3700	$277,500
3	On-site Landfill	$99.00	cy	22590	$2,236,410
4	Install Mon. wells	$5,000.00	each	8	$40,000
5	Sedimentation pond	$100,000.00	each	1	$100,000
6	Revegetation	$2,000.00	acre	15	$30,000
7	Engineering/				
	Permits/oversight	10%			$322,091
8	Site Prep/Mob	5%			$161,046
9	Contingency	20%			$644,182
10	Supervision and Admin	6%			$193,255
	Subtotal				**$4,004,483**

Account for inflation	3% per year	$0
from 1993 to 1996		
Total		**$4,004,483**

Note: Installation of wells is approximately $35/linear foot.

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 6
March 14, 1996

Alternative 6:	Excavate/wash and backfill coarse fraction		
	Fine fraction to offsite treatment and disposal		
	Sedimentation pond/groundwater monitoring		
Basis:	Bergmann USA *	$200.00 /cy	Excavate,wash, backfill
	EWR	$450.00 /cy	Transport, treat, dispose
	Sedimentation Pond	$100,000.00	
	Revegetation	$2,000.00 /acre	
Volumes:	Soil/sediment	17900 cy	
	70/30 volume split	12530/5370 cy	Coarse/fine split at each stage
	Washwater	cy	To SEDA POTW; no cost
	Area of Revegetation	15 acre	

Items		**Unit Cost**	**Unit**	**Volume**	**Total**
1	Wash/excavate	$200.00	cy	17900	$3,580,000
2	Fines offsite (30%)	$450.00	cy	5370	$2,416,500
3	Sedimentation Pond	$100,000.00	each	1	$100,000
4	Revegetation	$2,000.00	acre	15	$30,000
5	Engineering/				.
	Permits/oversight	10%			$612,650
6	Site Prep/Mob	5%			$306,325
7	Contingency	20%			$1,225,300
8	Supervision and Admin.	6%			$367,590
	Subtotal				**$8,638,365**

Account for inflation from 1993 (3% per year	3% per year	$777,453
Total		**$9,415,818**

Notes: Unit cost of soil washing from Bergman from EPA VISITT, on 3/14/96. This price does not include such items as excavati permits, and treatment of residuals.

APPENDIX D-3

ALTERNATIVE 2 THROUGH 5
O&M COST ESTIMATE

Seneca Army Depot Activity
OB Feasibility Study
Quarterly Monitoring Costs
March 14, 1996

1. Estimate of Quarterly Monitoring and Long-term Maintenance Costs of Monitoring Wells

Capital Costs: Installation of 8 wells at 10-15 feet depths

	Labor		$3,000.00	/per well	1 day x 4 people x 10 hrs. x $75/hr.
	Well install.		$1,100.00	/per well	
	Development		$700.00	/per well	0.5 day x 2 people x 10 hrs. x $70/hr
	Miscellaneous		$200.00	/per well	
	Total		$5,000.00	/per well	
Subtotal	For 8 wells		$40,000		
Installation:					
For inflation		9.00%	$3,600		
Total	For 8 wells		$43,600		

O & M Costs: Quarterly Sampling

	Labor		$5,000	/per quarter	4 days x 2 people x 10 hrs. x $65/hr
	Subsistence		$720	/per quarter	4 days x 2 people x $90/day
	Travel		$500	/per quarter	2 plane tickets at $250/each
	Van		$250	/per quarter	weekly rate
	Materials and Supplies		$200	/per quarter	ES experience
	Equipment Rental		$200	/per quarter	ES experience
	Miscellaneous		$200	/per quarter	ES experience
	Analytical		$800	/per quarter	ES experience
	Reporting		$1,000	/per quarter	ES experience
	Total		$8,870	/per quarter	
Subtotal	4 x $8870		$35,480		
For inflation		9.00%	$3,193		
Total for Year			$38,673		

2. O & M Cost Annual sampling of Reeder Creek sediment

	Labor	$2,600	/per year	2 days x 2 people x 10 hrs. x $65/hr
	Subsistence	$360	/per year	2 days x 2 people x $90/day
	Travel	$500	/per year	2 plane tickets at $250/each
	Van	$250	/per year	weekly rate
	Materials and Supplies	$200	/per year	ES experience
	Miscellaneous	$200	/per year	ES experience
	Analytical	$800	/per year	4 samples @ $200/each
	Reporting	$250	/per year	ES experience
	Subtotal	$5,160	/per year	
For inflation	9.00%	$464		
	Subtotal	$5,624		
	Administration	$500		
	Total	$6,589		

3. O & M for Cap Maintenance

Inspection	$1,500	
CLay Cap Repair	$300	
Misc. Repairs	$300	
Administration	$1,000	
Subtotal	$3,100	/per year
For inflation (3% per yr	$279	
Subtotal	$3,379	
Administration	$500	
Total	$3,879	

O & M Costs	Quarterly Monitoring	$38,670
	Sediment sampling	$6,590
	Cap Maintenance	$3,879
	Total	$49,139

Present Worth Analysis

Total PW = Capital Cost + PW

PW = R [A/B]

where R = annual cost

$A = (1 + C)^n - 1$

$B = C (1 + C)^n$

n = number of years = 30

C = int + inf + (int x inf)

where interest = 5 % and inflation = 3 %

$C = .05 + .03 + (.05 \times .03) = .0815$

$A = (1 + .0815)^{30} - 1 = 9.49$

$B = .0815 (1 + .0815)^{30} = .055$

PW = R (9.49/.855) = R (11.099)

Total PW = Capital Cost + PW = Capital Cost + R(11.099)

<u>Alternative 4</u>

Capital Cost = $2.4 to $4.0 million

O & M Cost = $45,300

PW = $502,800

Total PW = $2.4 million + $502,800 = $2.9 million

Total PW = $4.0 million + $502,800 = $4.5 million

<u>Alternative 5</u>

Capital Cost = $4.0 million

O & M Cost = $49,100

PW = $544,980

Total PW = $4.0 million + $544,980 = $4.5 million

<u>Alternative 6</u>

Capital Cost = $9.4 million

O & M Cost = $45,300

PW = $ 502,800

Total PW = $9.4 million + $502,800 = $9.9 million

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 2
March 14, 1996

Alternative 2: Consolidation of sediment/ slurry wall/cap/ sedimentation pond/groundwater monitoring

				NOTES
Basis:	Excavation of sediment	$30.00	/cy	
	Slurry wall	$8.00	/sf	Parsons ES estimate
	Clay Cost	$13.00	/cy	
	Clean Fill	$10.00	/cy	
	HDPE liner	$0.50	/sf	
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Sediments	900	cy	
	Cap area	1435500	sf	at 1 ft. height
	Volume of clean fill	106333	cy	Cap area x 2 ft/27
	Volume of clay	79750	cy	Cap area x 1.5/27
	Slurry wall length	6070	lf	around entire site
	Slurry wall depth	20	ft	
	Slurry wall area	91050	sf	
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation of sediment	$30.00	cy	900	$27,000
2	Slurry Wall	$8.00	sf	91050	$728,400
2	Clean Fill	$10.00	cy	106333	$1,063,333
	Clay *	$13.00	cy	79750	$1,036,750
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
6	Engineering/				
	Permits/oversight	10%			$302,548
7	Site Prep/Mob	5%			$151,274
8	Contingency	20%			$605,097
9	Supervision and Admin	6%			$181,529
	Subtotal				**$4,265,932**

Account for inflation from 1993 to 1996	3% per year	$383,934
Total		**$4,649,865**

Notes: Slurry wall unit price from "The First EPA Superfund Cutoff Wall: Design and Specificiations" (publication date approx. 1982)
Bids received in 1982 for construction of a slurry wall was $4.65/SF
Accounting for a 3% inflation rate, this unit price is $ 8.00/SF in 1996 dollars.

Area of site is approximately 33 acres, or 1,435,500 sf.
Approximate length of boundary is 6070 lf.

* Cost of HDPE liner	$0.50	sf	1435500	$717,750

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 3
March 14, 1996

Alternative 3: Consolidation of sediment/ in-situ solidification of soils/ sedimentation pond/groundwater monitoring

				NOTES
Basis:	Excavation of sediment	$30.00	/cy	
	In-situ solidification	$400.00	/cy	See footnote
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Sediments	900	cy	
	Volume of soil to solid.	17900	cy	
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Excavation	$20.00	cy	900	$18,000
2	In-situ solidification	$400.00	cy	17900	$7,160,000
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
6	Engineering/				
	Permits/oversight	10%			$734,800
7	Site Prep/Mob	5%			$367,400
8	Contingency	20%			$1,469,600
9	Supervision and Admin	6%			$440,880
	Subtotal				**$10,360,680**

Account for inflation from 1993 to 1996	3% per year	$932,461
Total		**$11,293,141**

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 4a
March 14, 1996

Alternative 4: Excavation,
off-site treatment and landfill of TCLP soils,
off-site Subtitle D landfill of remaining soils
Sedimentation pond/groundwater monitoring
Treatment is solidification/stabilizaton

Basis:	EWR Unit Cost	$450.00 /cy	Transport, treat, dispose TCLP soil
	Off-site landfill	$75.00 /cy	High Acres Landfill;transp.&dispo
	Install mon. wells	$5,000.00 /well	8 wells
	Sedimentation Pond	$100,000.00	
	Revegetation	$2,000.00 /acre	
Volumes:	Soil to EWR	3700 cy	Soils above TCLP criteria
	Soil to landfill	14200 cy	Soils above 500 mg/kg; sediments
	20% volume inc.	2840 cy	Volume inc. for landfilled soil
	Area of revegetation	15 acres	

Items		**Unit Cost**	**Units**	**Volume**	**Total**
1	EWR Cost	$450.00	cy	3700	$1,665,000
2	Landfill	$75.00	cy	17040	$1,278,000
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
6	Engineering/				
	Permits/oversight	10%			$311,300
7	Site Prep/Mob	5%			$155,650
8	Contingency	20%			$622,600
9	Supervision and Admin	6%			$186,780
	Subtotal				**$4,389,330**

Account for inflation from 1993 to 1996	3% per year	$395,040
Total		**$4,784,370**

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 4b
June 18, 1996

Alternative 4: Excavation,
On-site treatment of TCLP soils,
off-site Subtitle D landfill of treated and remaining soils
Sedimentation pond/groundwater monitoring
Treatment is solidification/stabilizaton

Basis:	Silicate technology	$150.00	/cy	Excavate , solidify
	Off-site landfill	$75.00	/cy	High Acres Landfill;transp.&disp.
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Soils to be treated	3700	cy	Soils above TCLP criteria
	Inc. in volume	1850	cy	Solid. increases volume
	Remaining soils	14200	cy	Soils above 500 mg/kg; sediments
	20% volume inc.	2840	cy	Volume inc. for landfilled soil
	Area of revegetation	15	acres	

Items		**Unit Cost**	**Units**	**Volume**	**Total**
1	Silicate tech. costs	$150.00	cy	3700	$555,000
2	Off-site landfill	$75.00	cy	22590	$1,694,250
3	Sedimentation pond	$100,000.00	each	1	$100,000
4	Revegetation	$2,000.00	acre	15	$30,000
5	Engineering/				
	Permits/oversight	10%			$237,925
6	Site Prep/Mob	5%			$118,963
7	Contingency	20%			$475,850
8	Supervision and Admin	6%			$142,755
	Subtotal				**$3,354,743**

Account for inflation from 1993 to 1996	3% per year	$301,927
Total		**$3,656,669**

h:\eng\seneca\obfs\alt4bcst.wk4

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 5
March 14, 1996

Alternative 5: Excavation, on-site treatment, and on-site Subtitle D landfill
Sedimentation pond/groundwater monitoring

Basis:	Silicate technology	$150.00	/cy	excavate, solidify
	On-site landfill	$180.00	/cy	Parsons ES estimate
	Install mon. wells	$5,000.00	/well	8 wells
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Soil to stabilize	3700	cy	Soils above TCLP criteria
	Inc.volume after stabl.	1850	cy	50% inc. in volume
	Remaining soils	14200	cy	Soils above 500 mg/kg; sediment
	20% volume inc.	2840	cy	Volume inc. for landfilled soil
	Area of revegetation	15	acres	

Items		Unit Cost	Units	Volume	Total
1	Silicate tech. costs	$150.00	cy	3700	$555,000
2	Landfill	$180.00	cy	22590	$4,066,200
3	Install Mon. wells	$5,000.00	each	8	$40,000
4	Sedimentation pond	$100,000.00	each	1	$100,000
5	Revegetation	$2,000.00	acre	15	$30,000
5	Engineering/				
	Permits/oversight	10%			$479,120
6	Site Prep/Mob	5%			$239,560
7	Contingency	20%			$958,240
8	Supervision and Admin	6%			$287,472
	Subtotal				**$6,755,592**

Account for inflation from 1993 to 1996	3% per year	$608,003
Total		**$7,363,595**

Seneca Army Depot Activity
OB Feasibility Study
Cost Estimate: Alternative 6
March 14, 1996

Alternative 6:	Excavate/wash and backfill coarse fraction			
	Fine fraction to offsite treatment and disposal			
	Sedimentation pond/groundwater monitoring			
Basis:	Bergmann USA *	$200.00	/cy	Excavate,wash, backfill
	EWR	$450.00	/cy	Transport, treat, dispose
	Sedimentation Pond	$100,000.00		
	Revegetation	$2,000.00	/acre	
Volumes:	Soil/sediment	17900	cy	
	70/30 volume split	12530/5370	cy	Coarse/fine split at each stage
	Washwater		cy	To SEDA POTW; no cost
	Area of Revegetation	15	acre	

Items		Unit Cost	Unit	Volume	Total
1	Wash/excavate	$200.00	cy	17900	$3,580,000
2	Fines offsite (30%)	$450.00	cy	5370	$2,416,500
3	Sedimentation Pond	$100,000.00	each	1	$100,000
4	Revegetation	$2,000.00	acre	15	$30,000
5	Engineering/				
	Permits/oversight	10%			$612,650
6	Site Prep/Mob	5%			$306,325
7	Contingency	20%			$1,225,300
8	Supervision and Admin.	6%			$367,590
	Subtotal				**$8,638,365**

Account for inflation from 1993 (3% per year	3% per year	$777,453
Total		**$9,415,818**

Notes: Unit cost of soil washing from Bergman from EPA VISITT, on 3/14/96. This price does not include such items as excavati permits, and treatment of residuals.

APPENDIX D-3

ALTERNATIVE 2 THROUGH 5
O&M COST ESTIMATE

Seneca Army Depot Activity
OB Feasibility Study
Quarterly Monitoring Costs
March 14, 1996

1. Estimate of Quarterly Monitoring and Long-term Maintenance Costs of Monitoring Wells

Capital Costs: Installation of 8 wells at 10-15 feet depths

Labor		$3,000.00	/per well	1 day x 4 people x 10 hrs. x $75/hr.
Well install.		$1,100.00	/per well	
Development		$700.00	/per well	0.5 day x 2 people x 10 hrs. x $70/hr
Miscellaneous		$200.00	/per well	
Total		$5,000.00	/per well	

Subtotal Installation:	For 8 wells		$40,000
For inflation		9.00%	$3,600
Total	For 8 wells		$43,600

O & M Costs: Quarterly Sampling

Labor	$5,000	/per quarter	4 days x 2 people x 10 hrs. x $65/hr
Subsistence	$720	/per quarter	4 days x 2 people x $90/day
Travel	$500	/per quarter	2 plane tickets at $250/each
Van	$250	/per quarter	weekly rate
Materials and Supplies	$200	/per quarter	ES experience
Equipment Rental	$200	/per quarter	ES experience
Miscellaneous	$200	/per quarter	ES experience
Analytical	$800	/per quarter	ES experience
Reporting	$1,000	/per quarter	ES experience
Total	$8,870	/per quarter	

Subtotal	4 x $8870		$35,480
For inflation		9.00%	$3,193
Total for Year			$38,673

h:\eng\seneca\obfs\omcost.wk4

2. O & M Cost Annual sampling of Reeder Creek sediment

	Labor		$2,600	/per year	2 days x 2 people x 10 hrs. x $65/hr
	Subsistence		$360	/per year	2 days x 2 people x $90/day
	Travel		$500	/per year	2 plane tickets at $250/each
	Van		$250	/per year	weekly rate
	Materials and Supplies		$200	/per year	ES experience
	Miscellaneous		$200	/per year	ES experience
	Analytical		$800	/per year	4 samples @ $200/each
	Reporting		$250	/per year	ES experience
	Subtotal		$5,160	/per year	
For inflation		9.00%	$464		
	Subtotal		$5,624		
	Administration		$500		
	Total		$6,589		

3. O & M for Cap Maintenance

	Inspection	$1,500	
	CLay Cap Repair	$300	
	Misc. Repairs	$300	
	Administration	$1,000	
	Subtotal	$3,100	/per year
	For inflation (3% per yr	$279	
	Subtotal	$3,379	
	Administration	$500	
	Total	$3,879	
O & M Costs	Quarterly Monitoring	$38,670	
	Sediment sampling	$6,590	
	Cap Maintenance	$3,879	
	Total	$49,139	

Present Worth Analysis

Total PW = Capital Cost + PW

PW = R [A/B]

where R = annual cost

$A = (1 + C)^{n} - 1$

$B = C (1 + C)^{n}$

n = number of years = 30

C = int + inf + (int x inf)

where interest = 5 % and inflation = 3 %

$C = .05 + .03 + (.05 \times .03) = .0815$

$A = (1 + .0815)^{30} - 1 = 9.49$

$B = .0815 (1 + .0815)^{30} = .055$

PW = R (9.49/.855) = R (11.099)

Total PW = Capital Cost + PW = Capital Cost + R(11.099)

<u>Alternative 4</u>

Capital Cost = $3.7 to $4.8 million

O & M Cost = $45,300

PW = $502,800

Total PW = $3.7 million + $502,800 = $4.2 million

Total PW = $4.8 million + $502,800 = $5.3 million

<u>Alternative 5</u>

Capital Cost = $7.4 million

O & M Cost = $49,100

PW = $544,980

Total PW = $7.4 million + $544,980 = $7.9 million

<u>Alternative 6</u>

Capital Cost = $9.4 million

O & M Cost = $45,300

PW = $ 502,800

Total PW = $9.4 million + $502,800 = $9.9 million

Appendix E

Response to Comments
by
USEPA
for Final Feasibility Study at the OB Grounds
Seneca Army Depot Activity
Romulus, New York
Comment Date: June 6, 1997

Comment #1 A review of Table 5-1 indicates that Parsons ES does not specifically state that a riprapped swale will be installed as a part of the remedial alternatives listed in the table. Also, it could be misleading to state in Table 5-1 that "Runoff prevention" is part of the alternatives. Runoff will still occur but the intent is to limit the amount of lead-bearing soil in the runoff.

Response #1 Agreed, Table 5-1 has been revised to change "Runoff prevention" to "Soil Erosion will be controlled through proper site grading". A revised Table 5-1 has been included with this response to comments letter. The reference to a riprapped drainage swale has not been added as it was felt that the need for a drainage swale should be left to the final grading plan that would be developed as part of the final remedial design. Stating that a drainage swale would be part of this final plan may be inconsistent with the final plan, if the final design determined that a drainage swale was not necessary.

<u>The following comments pertain to new text included in this submittal:</u>

Comment #1 **Page 5-7** in Insert 5, first bullet item: "to present surface water runoff" should read "to prevent surface water runoff"

Response #1 Agreed, the typo was changed.

Comment #2 **Page 5-7** in Insert 5, second bullet item: Applying nine inches of soil and vegetating it may reduce infiltration of contaminants to groundwater but it will not "minimize infiltration of contaminants to groundwater".

Response #2 Agreed, the second bullet was changed from minimize to reduce.

Comment #3 **Page 5-1** in Insert 5, third bullet item: It is unclear from the text where the riprapped channel will discharge. Unless it discharges outside of the Reeder Creek watershed, the riprapped channel will not prevent recontamination of Reeder Creek. It is the removal of lead-bearing soils and the covering of the remaining soils which will prevent or minimize the potential for recontamination of Reeder Creek.

Response #3 Agreed, the third bullet was changed to state that recontamination of Reeder Creek sediments will be prevented or minimized by removal of lead-bearing soils and covering of the remaining soils.

Present Worth Analysis

Total PW = Capital Cost + PW

PW = R [A/B]

where R = annual cost

$A = (1 + C)^n - 1$

$B = C (1 + C)^n$

n = number of years = 30

C = int + inf + (int x inf)

where interest = 5 % and inflation = 3 %

C = .05 + .03 + (.05 x .03) = .0815

$A = (1 + .0815)^{30} - 1 = 9.49$

$B = .0815 (1 + .0815)^{30} = .055$

PW = R (9.49/.855) = R (11.099)

Total PW = Capital Cost + PW = Capital Cost + R(11.099)

Alternative 4

Capital Cost = $3.7 to $4.8 million

O & M Cost = $45,300

PW = $502,800

Total PW = $3.7 million + $502,800 = $4.2 million

Total PW = $4.8 million + $502,800 = $5.3 million

Alternative 5

Capital Cost = $7.4 million

O & M Cost = $49,100

PW = $544,980

Total PW = $7.4 million + $544,980 = $7.9 million

Alternative 6

Capital Cost = $9.4 million

O & M Cost = $45,300

PW = $ 502,800

Total PW = $9.4 million + $502,800 = $9.9 million

RESPONSE TO COMMENTS
By
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
(USEPA)
REVISED DRAFT FEASIBILITY STUDY (FS) REPORT
AT THE OPEN BURNING GROUND SITE
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
JULY 30, 1996

Comment #1 Comment #4

The original comment requested that the EPA action objective, for lead in groundwater of 15 ug/l, be used as an ARAR. The response to this comment indicates that Parsons ES disagreed with this comment and states that the action objective is a TBC. The federal "action level" of 15 ug/l for lead in drinking water is Relevant and Appropriate (as in ARAR).

Response #1 Disagree. The NYSDEC GA criteria of 25 ug/L, which was used in the FS report, is a promulgated standard and is therefore legally enforceable. The federal action level of 15 ug/L for lead in drinking water is not a promulgated criteria, and therefore not an ARAR.

Comment #2 Comment #5

Regarding Table 2-5: The U.B.K. Model generates a distribution of blood lead levels for currently/potentially exposed child/children. Table 2-5 lists only the maximum predicted blood lead level. It would be beneficial to include the following information as well: geometric mean blood lead concentration; percentage of distribution that exceeds 10 ug/dl.

Response #2 Agreed. Table 2-5 has been revised and includes the geometric mean blood lead concentration and percentage of distribution exceeding 10 ug/dl.

Comment #3 Comment #6

Parsons ES response states "Agreed" for both parts of this EPA comment, but the subsequent responses indicate that they do not have an accurate understanding of how the cleanup level of 500 ppm was agreed to. EPA summarized the process in our original comment. In addition, the revised pages to the FS shows no changes to address EPA's comment. As our original comment stated, "...all references to this study (EPA's modeling study) should be deleted from the text." The text in the document should be further clarified to clearly state that the clean-up goal for lead in soils is based on discussions between the USEPA, NYSDEC and the Army.

Response #3	Agreed. All references to the EPA modeling study have been deleted from the text in Section 2 and Section 5 of the FS report. Section 2.2.5, Summary of Remedial Action Objectives and Site Specific Clean-up Goals, states that site-specific goals were established between the NYSDEC, USEPA, and Army.
Comment #4	Comment #8 It is unclear, based on a review of this response, why the requested document prepared in 1984 cannot be provided.
Response #4	Agreed. The referenced document has been included as an attachment to these comments.
Comment #5	Comment #16 The comment has not been addressed. See comment 6 above.
Response #5	Agreed. All references to the EPA modeling study have been deleted from the text in Section 2 of the FS report.
Comment #6	Comment #20 The revision to the text on page 5-7 which addresses the UXO clearance procedure is too brief and generic for the purposes of the FS. It is unclear for example, how the depth of excavation and sifting is determined. Stating that the potential live items will be dealt with as required, does not tell us much. The Army should have Standard Operating Procedures for UXO detection and removal which could be included in the FS. The text indicates that there are other methods of UXO clearance. These should be also be identified in a general way.
Response #6	Agreed. The document "Proposed Ordnance and Explosives Clearance Procedures" , which describes the procedure for UXO detection and removal, has been added to Appendix G.
Comment #7	Additional Comment Section 3.5.2.9, Page 3-24: The text states "...the TAGM HWR-92-4046...", this is an incorrect reference, this TAGM was updated in 1994 therefore the correct reference is NYSDEC TAGM HWR-94-4046, the text should be corrected to reflect this change. This comment has been made on numerous other SEDA documents.
Response #7	Agreed. The text in Section 3.5.2.9 has been revised. In addition, the footnote in Table 2-4 has been revised, and the reference to the TAGM in Appendix A has been revised.

RESPONSE TO COMMENTS
BY
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION (NYSDEC)
FOR DRAFT FINAL FEASIBILITY STUDY
OPEN BURNING GROUND SITE
BY SENECA ARMY DEPOT ACTIVITY
ROMULUS, NEW YORK
JULY 12, 1996

Comment #1 We have reviewed your response to our comments on the draft final version and find that our comment No. 2 has not been fully addressed. Your response that the estimate has been changed based on a revised unit cost of $150/cy of waste has not been followed through; calculations in Appendix D still uses a unit cost of $180/cy. In regards to your response to comment 2(b), it is our opinion that the landfill could be constructed more economically.

Response #1 Agreed. A revised Appendix D is enclosed with these comments. The cost estimate for construction of an on-site Subtitle D landfill has been revised. The revised cost estimate determined a unit cost of $99/cy of waste material. This revised cost estimate assumed a larger capacity landfill with 233,000/cy of waste material, which is the total volume of soil which could potentially be landfilled as part of the remediation process at other sites within SEDA.

The cost estimate for Alternative 5 was also revised to incorporate (1) the revised unit cost of the on-site landfill and (2) the updated unit cost of solidification by Silicate Technology.

Again, the unit cost for building an on-site landfill which was determined in this report, includes the cost of mobilization and site clearance, which are not included in the unit costs provided by NYSDEC.

RESPONSE TO COMMENTS
BY
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION (NYSDEC)
FOR
DRAFT FINAL FEASIBILITY STUDY
OPEN BURNING GROUND SITE
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
MAY 1996

Comment #1 Section 5.4.6.1 Capital Costs and Appendix D.

It appears that the capital cost for alternative 4b, on-site treatment and off-site disposal, has been incorrectly calculated. The cost for excavation and on-site solidification is stated to be $150.00 per cubic yard, but has been incorrectly used in calculations as $450.00 per cubic yard.

Response #1 Agreed. The calculation for the cost of Alternative 4b has been revised. The unit cost for on-site solidification has been corrected to $150 per cubic yard.

Comment #2 Section 5.5.6.1 Capital Costs and Appendix D.

a) Attached is a copy of Appendix A, Regulatory Impact Statement of the Final Environmental Impact Statement for Revisions/Enhancements to 6 NYCRR Part 360 Solid Waste Management Facilities May 1993. This Appendix includes generic cost estimates for a municipal landfill 20 acres (subpart 360-2), and b) construction and demolition debris landfill less than 3 acres and greater than 3 acres (subpart 360-7). These estimates indicate that the cost per cubic yard of waste ranges from $6.60 to $10.57 per ton or approximately $10 to $16 per cubic yard. The Parsons Engineering Science, Inc. has calculated the cost of $180.00 per cubic yard of waste based on a landfill capacity of only 6,000 cubic yards which is well outside of the range. The waste materials at the OB ground itself is approximately 22,500 cubic yard and if the Army plans to consolidate wastes from other onsite areas in this landfill, the total waste quantity would be well in excess of the 22,500 cubic yards. Therefore, it appears that the cost estimate for an on-site landfill would be more realistic if the cost estimate is based on at least 22,500 cubic yards capacity of landfill instead of 6,000 cubic yard.

b) In addition, further cost saving can be achieved by a judicious design of landfill. It appears that a landfill should not require an earthen dam construction around it to support the waste inside it (see Appendix D).

Response #2 a) Acknowledged. After reviewing Appendix A which was attached to these comments, we revised our cost estimate for the on-site Subtitle D landfill. The unit costs provided in Appendix A were incorporated into the cost estimate, and the revised cost estimate has been included in Appendix D. The revised cost estimate determined a unit cost of approximately $150/cy of waste material. This unit cost is approximately 10 times the unit costs stated in the above comment.

We subsequently discussed the unit costs provided in Appendix A with a representative from the NYSDEC Bureau of Solid Waste Disposal. The unit costs per cubic yard of waste material, which was provided in NYSDEC's Appendix A, were based on a landfill design which is 100 feet high. The landfill which will be constructed at the OB Grounds will have only a 6-foot thickness of waste material. Therefore, the difference in unit costs is a result of the difference in the quantity of waste material in each landfill. Furthermore, the unit costs provided by NYSDEC do not include the costs for mobilization and site clearance. These costs are included in the cost estimate for this FS report.

The cost estimate for this landfill is included in Appendix D of this report and provides a breakdown of the various materials based on a preliminary cross section of the landfill. If NYSDEC believes that the unit cost is incorrect, they should review the cost estimate provided in this report and determine any discrepencies.

b) As described in Section 5.5.1.1, the landfill must be built completely above ground in order to keep the bottom of the lowest liner a minimum of five feet above the seasonally high water table. This design requires fill material around the sides of the landfill. These are not earthen dams. The sketch in Appendix D is not an appropriate cross sectional drawing of the landfill because it is not to scale and was used only for estimating the cost of the on-site landfill alternative.

h:\eng\seneca\obfs\nysdec.doc

RESPONSE TO COMMENTS
BY
UNITED STATE ENVIRONMENTAL PROTECTION AGENCY
(USEPA)
FOR
DRAFT FINAL FEASIBILITY STUDY
OPEN BURNING GROUND SITE
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
MAY 1996

Comment #1 General Comment.

The intended future use of the site has not been definitively determined by the BRAC process. Elements of the Risk Assessment and the development and screening of remedial alternatives, including provisions of the above agreements regarding the remedial objectives may require reevaluation should the site be considered for residential use. For example, the 150 day annual exposure frequency, which was included in the Baseline Risk Case and questioned by a reviewer for the USEPA, may require further review under alternate future site uses.

Response #1 Agreed. The intended future land use of the site has not been finalized and will be determined by the Local Redevelopment Authority in conjunction with the Army. If it is determined that the intended future use of the site will be residential, certain assumptions in this FS will have to be re-evaluated. The 150 day annual exposure frequency was included in the Baseline Risk Case for the current land use which is industrial. The risk associated with the future on-site residential use scenario was also evaluated as a worst case alternative.

Comment #2 Section 1.6.1, Page 1-7 and 1-8.

The Baseline Human Health Risk Assessment should have an explanation about lead similar to that stated in paragraph 2 of section 2.2.3 Risk Based Remedial Action Objectives.

Response #2 Agreed. A brief explanation about lead in relation to the risk assessment has been added to Section 1.6.1.

Comment #3 Section 2.2.3, Page 2-16: paragraph 2.

The text should be revised to reflect that the U.B.K. model generates a distribution of blood levels in children and that current EPA policy is to set soil cleanup levels to ensure that 95 percent of the distribution falls below 10 ug/dL.

Response #3 Agreed. The information in the comment has been added to the referenced paragraph.

Comment #4 Table 2-2.

a) One of the remedial action objectives is to prevent leaching to groundwater causing lead in groundwater to exceed 15ug/L not 25 ug/L as is stated in the text. The Federal Action Level of 15ug/L of lead in groundwater is an ARAR. The text should be corrected where ever 25 ug/L is given as the ARAR or remedial action objective.

b) Setting cleanup goals for groundwater is misleading because there is no groundwater remedy proposed in this FS. During Phase II groundwater sampling 2 wells showed lead exceeding ARARs. By remediating the soil, the Army is trying to prevent further leaching of lead, not attempting to cleanup existing contaminated groundwater. Therefore, the environmental medium of "On-site Groundwater" with it's remedial action objectives, clean-up goals and basis should be deleted from Table 2-2.

Response #4

a) Disagree. The NYSDEC GA criteria of 25 ug/L was used in Table 2-2 because the value is a promulgated standard for the protection of groundwater. According to 40 CFR 300.430 (e)(5), if an MCLG for a contaminant has been set at a level of zero, the MCL promulgated for that contaminant under the SDWA shall be attained by remedial actions. The MCLG for lead is 0 mg/L, and the MCL for lead is not listed. The value of 15 ug/L is an action level, and not a promulgated criteria. Therefore, it is not an ARAR but will be considered as a TBC. Unless a standard is promulgated, it is not legally enforceable. The table was not revised.

b) Agreed. The remedial action objective for groundwater has been removed from Table 2-2.

Comment #5

Table 2-5.

The values in Column 3 entitled "Maximum Lead in Blood" appear to represent the geometric mean blood lead concentrations rather than the maximum. Please review the UBK model application and make any necessary correction to this table.

Response #5

Disagree. Review of the UBK model outputs indicates that although the maximum total uptake is reached for a child aged 3 to 4 years, the maximum lead in blood is reached by a child aged 1 to 2 years and this value was reported in Table 2-5.

Comment #6

Section 2.2.5, Page 2-18, last paragraph.

a) The cleanup goal of 500 mg/kg was not based on the results of EPA's modeling study and all references to this study should be deleted from the text. The cleanup goal was based on the results of conference calls between the Army, EPA and NYSDEC. When the Army proposed a lead cleanup number of 1000 mg/kg in soil, NYSDEC then proposed 500 mg/kg in order to meet RCRA closure and post-closure requirements for the OB grounds. Stephen Absolom summarized this in his June 30, 1995 letter regarding our May 31, 1995 conference call.

b) Since September 1994, EPA has been requesting that the Army perform extensive fate and transport modeling of lead in soils to determine what specific concentration of residual lead remaining in soil would still be protective of groundwater and ensure ARARs would not be exceeded in the future as a result of lead leaching from soil in groundwater. The Army did not cooperate with EPA's request and EPA utilized the VLEACH model along with broad assumptions concerning existing site information in order to develop a screening level. In EPA's April 14, 1995 letter to Stephen Absolom, we attached the results of the modeling effort along with a work plan for the Army to perform their own study in order to propose a site cleanup level for metals at the OB Grounds which would be protective of groundwater. EPA efforts had been preliminary due to a lack of site specific data which we requested the Army collect and utilize in their own modeling effort. To date, the Army has not performed such modeling. The reason EPA is requiring the Army to perform appropriate post-remediation groundwater monitoring at the OB Grounds is because there is currently no guarantee that the 500 mg/kg of lead remaining in the soil will be protective of groundwater.

Response #6

a) Agreed. Determination of the cleanup goal for soils at the site was not based solely on the results of the EPA's modeling study. The study provided information which was used as one of the factors in establishing 500 mg/kg as the site-specific cleanup goal for lead in soil. The text in Section 2.2.5 clearly states that the site-specific cleanup goal was established between NYSDEC, the USEPA, and the Army, and that the concentration for soils was based on several factors. The text in Section 2.2.5 has not been changed.

b) Agreed. It was the intention of the Army to perform a fate and transport modeling of lead in the soils. However, the cleanup goal of 500 mg/kg was established based on the results of EPA's modeling study using VLEACH, which is discussed in the comment. The Army felt that it would not be effective to conduct another modeling effort because the EPA study provided satisfactory information to determine the cleanup level for the site and because it would not be cost effective to conduct another modeling study. Post-remediation groundwater monitoring will be conducted at the OB Grounds to ensure that the 500 mg/kg concentration of lead in soil is protective of the groundwater.

Comment #7

Section 2.2.5, Page 2-21.

The phrase ".. which would be protective of groundwater and ensure that ARARs will not be exceeded;" should be deleted from the first bulleted paragraph. The purpose of the post remediation groundwater monitoring is to determine if that will have actually been accomplished.

Response #7

Agreed. The phrase has been removed.

Comment #8

Section 2.4, Page 2-34.

The first paragraph cites the "Hazardous Waste Study No. 37-26-0479-85, Phase 4 of AMC Open Burning/Open Detonation Grounds Evaluation Investigation of Soil Contamination at the Open Burning Grounds; Seneca Army Depot, Romulus, New York; 13-19 August 1984" as a document summarizing TCLP exceedances at these areas. EPA should be provided with a copy of this report.

Response #8

Agreed. However, the referenced report is an Army document and cannot be released without authorization of the Army. This report may be provided at a later date pending the approval by the Army.

Comment #9 Section 3.5.2.9.

As with the Ash Landfill FS, alternatives are ranked according to their compliance with ARARs. Alternatives either comply with ARARs or they do not. It would be useful in this section to discuss the compliance of the alternatives with To Be Considered (TBCs) requirements.

Response #9 Agreed. All of the alternatives except Alternative 1, the no action alternative, were ranked equally in regard to compliance to ARARs. Table 3-2 has also been revised. A brief discussion of the TBCs has been added to the section.

Comment #10 Section 5.4.2.1, Page 5-13. The facts cited to conclude that fugitive dust migration is not a major migration pathway are not convincing. Shale is a fine-grained rock and fine-grained particles can be released when it is crushed or disturbed. A cursory review of the Open Burning Grounds RI Report did not identify any grain-size curves for this soil to resolve this question. However, in any case, actions such as the use of water trucks can be used to minimize fugitive dust.

Response #10 Agreed. The text was revised to state that actions will be utilized to minimize any fugitive dust. Text stating that shale fill consists of large particles which are less subject to dust formation has been removed.

Comment #11 Section 5.4.2.3, Page 5-16, Conclusion.

Sentences 4 and 5 of paragraph 1 should be revised to reflect that, <u>excluding the hazard contributed by lead which was evaluated separately</u>, the results of the human health baseline risk assessment determined that the total site con-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, <u>aside from the hazards posed by lead</u> the conditions at the site would not require a remedial action.

Response #11 Agreed. The two underlined phrases in the comment have been added to sentences 4 and 5 in the text.

Comment #12 Section 5.5.1.1, Page 5-22.

The text indicates that 6 NYCRR Part 360 requires a five foot separation between the lowest inner and seasonally high groundwater and that therefore two feet of fill will be required at the site. This is a conservative assumption as the NYSDEC can modify this requirement; it does not even require a formal variance procedure.

Response #12 Agreed. For this Feasibility Study, a minimum five-foot separation was assumed for design of the on-site landfill in order to calculate volumes of materials and costs of the alternative. If the alternative is selected, the design will be refined.

Comment #13 Section 5.5.1.1, Page 5-23, second paragraph.

The report states that the double liner requirement could be waived for the proposed on-site landfill. This alternative liner system must demonstrate its ability to adequately prevent a negative impact on groundwater quality and must address all factors specified in the New York State Solid Waste Regulations (6 NYCRR 360-2.14).

Response #13 Agreed. The text has been revised to indicate that an alternative liner system must demonstrate its ability to adequately prevent a negative impact on groundwater quality and must address all factors specified in the New York State Solid Waste Regulations (6 NYCRR 360-2.14).

Comment #14 Section 5.5.2.3, Page 5-29, Conclusion.

Sentences 4 and 5 of paragraph 1 should be revised to reflect that, excluding the hazard contributed by lead which was evaluated separately, the results of the human health baseline risk assessment determined that the total site con-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, aside from the hazards posed by lead the conditions at the site would not require a remedial action.

Response #14 Agreed. The two underlined phrases in the comment have been added to sentences 4 and 5 in the text.

Comment #15 Section 5.6.2.3, Page 5-42, Conclusion.

Sentences 4 and 5 of paragraph 1 should be revised to reflect that, excluding the hazard contributed by lead which was evaluated separately, the results of the human health baseline risk assessment determined that the total site con-carcinogenic and carcinogenic risks are within the acceptable range of EPA target values for the future on-site residential exposure scenario. That is, aside from the hazards posed by lead the conditions at the site would not require a remedial action.

Response #15 Agreed. The two underlined phrases in the comment have been added to sentences 4 and 5 in the text.

Comment #16 Section 5,8, Page 5-50, last paragraph.

There has never been any modeling performed regarding the OB Grounds which determined "... an allowable concentration of lead in soil that would not produce a concentration of lead in groundwater above the federal action level of 15 ug/L...". All references to EPA's leaching model and results should be deleted from the text. See comments regarding Section 2.2.5, page 2-18, last paragraph.

Response #16 Acknowledged. Please refer to the Response to Comment #6.

Comment #17 Section 5.8, Page 5-51.

The text indicates that under Alternative 5, no hazardous materials are transported from the site. This is also the case for Alternative 4, since the soils will be solidified and no longer be TCLP hazardous prior to off-site disposal, but the text omits this information.

Response #17 Disagree. For Alternative 4, soils with TCLP exceedences will either be treated and disposed of at an off-site TSDF or treated at an on-site pug mill. If the off-site TSDF is selected, hazardous materials will be transported from the site.

Comment #18 Appendix A, Page A-7.

The second bulleted paragraph discusses PCBs at the Ash Landfill. The text should pertain to the OB Grounds.

Response #18 Agreed. The text has been revised accordingly.

Comment #19 Appendices A&C, ARARs.

a) Soil Quality ARARs: "40 CFR Subpart S Part 264.552 and 264.553" - the correct citations for standards applicable to Corrective Action Memorandum Units and Temporary Units are 40 CFR 264.552 and 40 CFR 264.553, respectively.

b) Standards for the Identification and Listing of Hazardous Waste (40 CFR part 261) are applicable to the proper characterization of solid waste generated as a result of the proposed remedial actions. Appendices A and C should list this standard as an action-specific ARAR.

c) Since contaminated soils and groundwater are present at the OB grounds, RCRA closure and post-closure requirements (40 CFR 264, Subpart X - Miscellaneous Units), are applicable and should be listed in Appendix A.

Response #19 a) Agreed. The citations have been revised.

b) Agreed. The regulation has been added as an ARAR in Appendices A and C.

c) Agreed. The ARAR has been added to the hazardous waste management section of the action-specific ARARs.

Comment #20 Finally, at the January 24, 1996 project manager's meeting, the Army agreed to incorporate a general summary of the scope and protocol for an unexploded ordinance (UXO) survey. The intent was to indicate the work which would be conducted if land use and access to the Open Burning Grounds was unrestricted in the future. This UXO summary is not included in the Revised Draft FS.

Response #20 Agreed. The Army agreed to incorporate a general summary of the scope and protocol for a UXO survey. This scope would be generic in order to provide an example of the type of operations used by the Army for UXO clearance. A general summary of UXO clearance has been added to the description of each of the alternatives in Section 5.

h:\eng\seneca\obfs\USEPA3.Doc

RESPONSE TO COMMENTS FOR
U.S. ARMY FOR
DRAFT FINAL FEASIBILITY STUDY
OPEN BURNING GROUNDS
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
APRIL 1996

Comments by L.L. TATE

Comment #1 Page 1 of 6, Table 2-1.

It is difficult to understand a NY DWQS of 5 micrograms per liter for acetone. There is no mcl or mclg for the chemical, which exhibits high flammability in the integral percentage ranges.

Response #1 Agreed. While there is no Federal MCL or MCLG for acetone, the NYS DWQS and AWQS guidance value for acetone in groundwater are both 50 ug/L. The value for acetone in Table 2-1 has been revised to 50 ug/L.

Comment #2 Page 3 of 6, Table 2-1.

It is difficult to understand why there is no NY AWQC for Barium.

Response #2 Acknowledged. Review of the NY AWQC indicates that Class A surface water and groundwater have criteria values for barium, however, there is no criteria value for Class C surface water.

Comment #3 Page 4 of 6, Table 2-1.

It is difficult to understand why there is no NYSDEC Sediment Criteria for Barium

Response #3 Acknowledged. The 1994 revision of the NYSDEC Sediment Criteria, which incorporated the 1992 Ministry of Ontario Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario for metals concentrations in sediment, does not have a criteria value for barium.

Comment #4 Page 2-11, 2nd Parag.

Justify the acceleration of this operable unit when the risk analysis does not provide the basis for action. It appears that deceleration until the basis for action is clarified would be more appropriate.

Response #4 Although the risk analysis does not provide the basis for action, remediation of the site was based on several factors which include (1) preventing leaching of lead from the soil into the groundwater above the NYSDEC GA criteria, (2) protecting the ecological receptors near the site, (3) protecting the surface water and aquatic biota in Reeder Creek, (4) and preventing ingestion of lead contaminated soils in the potential residential future land use. It should be noted that lead was not considered part of the risk analysis.

Comment #5 Page 2-16, 2.2.3.

Justify the acceleration of this operable unit when the risk analysis does not provide the basis for action. It appears that deceleration until the basis for action is clarified would be more appropriate.

Response #5 Although the risk analysis does not provide the basis for action, remediation of the site was based on several factors which include (1) preventing leaching of lead from the soil into the groundwater above the NYSDEC GA criteria, (2) protecting the ecological receptors near the site, (3) protecting the surface water and aquatic biota in Reeder Creek, (4) and preventing ingestion of lead contaminated soils in the potential residential future land use. It should be noted that lead was not considered part of the risk analysis.

Comment #6 Page 2-19, Human Health.

Include copies of the letters to and from NYSDEC in future project documents.

Response #6 Agreed. The two letters referenced in the text have been included in the report as Appendix F.

Comment #7 Page 2-19, Ecological.

Include copies of the letters to and from EPA in future project documents.

Response #7 Agreed. The two letters referenced in the text have been included in the report as Appendix F.

Comment #8 Page 2-21, Future Land Use.

Removal of UXOs should be the first step in remediation.

Response #8 Agreed. The text in Section 2.2.5, Future Land Use, has been revised to state that UXO clearance will be an initial step in the remediation process for areas of the site which will undergo remediation. However, UXO clearance will not be conducted on a sitewide basis. In the event of a property transfer, a qualifier will be added to the deed stating that the Army has conducted UXO clearance, however, there will always be a risk involved and the Army cannot certify that the site is free of all UXOs.

Comment #9 Page 2-23, No Action.

Removal of UXOs is required for the no action and all other alternatives.

Response #9 Disagree. The text has been revised in Section 2.3 to state that the removal of UXOs will be conducted for those alternatives which involve remediation. Therefore, UXO clearance will not be conducted for the no-action alternative.

Comment #10 Page 2-63, 2.5.2.3.

Soil caps have been proven to be effective in inhibiting leaching. Therefore, a cap would protect the groundwater to a lesser level.

Response #10 Agreed. Soil caps have been proven to be effective in inhibiting infiltration. However, the leaching from the subsurface soil at the OB Grounds into the groundwater would not be prevented by a soil cap. To prevent leaching, the soil cap would have to be used in combination with a vertical barrier such as a slurry wall. The text in Section 2.5.2.3 has been revised to clarify this point.

Comment #11 Page 2-67, 2.5.2.6.

Biological technologies should not have been included here. They are not effective in prevention of lead from leaching from soil into groundwater. They were not included in Table 2-6.

Response #11 Agreed. The text was incorrect. Biological technologies were considered as options but were screened out. The list on page 2-67 merely provides the options that were considered and the following paragraph discusses the reasons why the biological technologies were screened out. The text has been revised to clarify this point.

Comment #12 Page 3-3, Last Blt.

Innovative technology was not previously listed in the alternative selection criteria, though it should have been.

Response #12 Agreed. A sentence has been added to the first paragraph in Section 3.2 stating that an innovative technology has been selected in order to comply with the SARA (1986) requirement that alternative solutions be used to the maximum extent possible.

Comment #13 Page 3-2, Table 3-1.

No groundwater monitoring is not a valid assumption for the no action alternative. The cost of groundwater monitoring should be included in assessment of the no action alternative as well as the on-site alternatives.

Response #13 Acknowledged. According to the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, the limited action alternative may include some type of environmental monitoring. The no action alternative is defined for this FS to mean that no remedial activities will be undertaken.

Comment #14 Page 3-5, 3.3.2.

No groundwater monitoring is not a valid assumption for the no action alternative. The cost of groundwater monitoring should be included in assessment of the no action alternative as well as the on-site alternatives. Also no action does not preclude later reassessment based on new standards, such as the development of an effective standard for lead.

Response #14 Acknowledged. According to the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, the limited action alternative may include some type of environmental monitoring. The no action alternative is defined for this FS to mean that no remedial activities will be undertaken.

Comment #15 Pages 3-8 to 3-10, 3.3.7.

The additional treatment/disposal of the fines containing the concentrated lead does not appear to have been developed for costing. Approximately 30% of the soil will have to be hauled to a RCRA landfill or treated by the Bureau of mines process, the implementability of which does not appear to have been considered on the same basis as the simpler processes.

Response #15 Disagree. Transportation, treatment, and disposal of approximately 30% of the soil was included in the calculation of the cost for this alternative. The cost estimates are presented in Appendix D.

Comment #16 Page 3-15, 3.5.2.1.

Alternative 6 involves as much excavation, and much more potential exposure than alternative 4.

Response #16 Agreed. Alternative 6 involves excavation of an equal volume of soil as Alternative 4. However, Alternative 4 involves off-site transport of a RCRA characteristic hazardous waste material and for this reason Alternative 4 was ranked lower than Alternative 6.

Comment #17 Page 3-15, 3.5.2.1.

Alternative 1, no action has no excavation and minimal short term exposure. It is the most protective in the short-term, not the least.

Response #17 Agreed. The no action alternative has been ranked as most protective of short-term human health.

Comment #18 Page 3-19, 3.5.2.5.

Alternative 4 provides the greatest reduction of toxicity at this site, since only excavation and minimal handling are involved.

Response #18 Disagree. Alternative 6 provides the greatest reduction of toxicity by separating the fines and stabilizing this volume of material. The hazardous constituents are normally concentrated in the fines. For Alternative 4, only the soils with TCLP exceedences will be stabilized. The remaining soils will not be treated, but placed in a Subtitle D solid waste landfill.

Comment #19 Page 3-21, 3.5.2.6.

Alternative 4 provides the greatest reduction of mobility at this site, since only excavation and minimal handling are involved.

Response #19 Disagree. The alternative which provides the greatest reduction of mobility is that remedial alternative which involves reduction or treatment. Alternatives involving containment are considered less desirable because mobility reduction is dependent on maintaining the integrity of the containment system, in this case, the solid waste landfill. Excavation and handling are not considered to be factors in evaluating reduction in mobility. Alternative 6 ranks highest for reduction of mobility because the alternative provides the greatest amount of treatment. Alternative 4 involves stabilization of only a portion of the soils and their landfilling. Potential leaks in the landfill make this alternative less certain in reducing mobility.

Comment #20 Page 3-27.

No groundwater monitoring is not a valid assumption for the no action alternative.

Response #20 Acknowledged. According to the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, the limited action alternative may include some type of environmental monitoring. The no action alternative is defined for this FS to mean that no remedial activities will be undertaken.

Comment #21 Page 3-29, 3.5.3.

The equipment for alternative 3 is more readily obtained than the Bureau of Mines process.

Response #21 Agreed. The text has been revised and the ranking has been changed.

Comment #22 Page 3-31, 3.5.4.1.

There appears to be a calculation error for Alternative 3. It cost 1/3 as much per cubic yard as Alternative 4, yet the total cost is over twice as much. There cannot be a factor of 6 difference in volume to be treated versus excavated.

Response #22 Agreed. The unit costs which are presented in Section 3.5.4.` are incorrect for Alternatives 3 and 4. The unit cost for on-site in-situ solidification which is used in Alternative 3 should be $400 and for off-site disposal, which is used in Alternative 4, $75. For Alternative 4, approximately 17,000 to 22,000 c.y. of material will be disposed of in an off-site Subtitle D landfill. In addition, approximately 3700 c.y. of TCLP material will be treated and disposed of at a unit cost of $450. Therefore, although the unit cost for Alternative 3 is more than 5 times that for Alternative 4, the additional cost of treating TCLP material brings the total cost of Alternative 4 to almost half of Alternative 3. For Alternative 3, approximately 17,000 c.y. of material will be solidified at a unit cost of $400 per c.y.

Comment #23 Page 4-2, 4-2.

The treatment subsequent to soil washing should be studied.

Response #23 Agreed. The fine fraction will be treated subsequent to soil washing and this would involve either acid extraction, which would be part of the soil washing process, or solidification, which is a demonstrated technique. A sentence has been added to the fourth paragraph of Section 4.4 stating that if the acid extraction process is used on the fines, a treatability study will be conducted.

Comment #24 Page 4-4, Last paragraph.

Selection of vendors requires a non-competitive bid.

Response #24 According to the Code of Federal Laws, selection of vendors must be conducted by competitive bid. Is this comment in error?

Comments by J. PETERSON

Comment #1 Section D.

Was the cost estimate coordinated with and/or reviewed by the Huntsville Design Center (HNC) Cost Engineering office? If not, they should review the costs.

Response #1 This document was submitted to those departments which were included in the Scope of Work for this project. It is beyond the scope of work for us to determine whether or not the HNC has reviewed the cost estimate.

Comment #2 Section D.

The cost estimate for the final recommended plan must be structured in the HTRW Remedial Action Work Breakdown Structure format, and prepared using MCACES cost estimating system as required by ER 1110-3-1301.

Response #2 Agreed. The cost estimate for the final recommended remedial action alternative will be developed using ER1100-1-1300, Cost Engineering Policy and General Requirements - 26 Mar 93, ER 1110-3-1301, Cost Engineering Policy and General Requirements for HTRW Remedial Action Cost Estimates - 15 Apr 94. MCASES Gold software will be used to estimate the cost for the selected plan.

Comment #3 Section D.

Escalation should also be included in the final recommended alternative from present to the anticipated mid-point of construction to account for future inflation.

Response #3 Agreed. Escalation for the selected alternative will be calculated as stated in the comment.

Comments by FRYE

Comment #1 Page 1-1.

In the second paragraph, the reference should be Subpart X for RCRA miscellaneous units, not Subpart S.

Response #1 Agreed. The text on page 1-1 has been revised.

Comment #2 Page 2-21, Bullets.

The bullets listed cover several issues that will have to be addressed during RCRA closure of the site under the RCRA closure plan. Has adequate consideration been given to postponing some of the bulleted items until such time as RCRA (i.e., final) closure of the OB grounds occurs? For example, is it really necessary to remove all UXO at this time? The remedial action objective is to prevent groundwater contamination...removal of UXO could wait until final closure of the site. (Obviously, this would not include clearing areas to be excavated of UXO).

Prevention of surface water runoff and groundwater/sediment monitoring should already be required in the RCRA permit. At a minimum, activities done to meet these bulleted requirements should be executed in such a fashion as to also meet the requirements set forth in the permit.

Response #2 Acknowledged. The issues listed on page 2-21 were established in discussions between the EPA, the Army, and NYSDEC. According to Comment #8 by L.L. Tate, UXO clearance should be the first step in remediation of the site and the report has been revised to include UXO clearance as a first step.

Groundwater monitoring is currently being conducted as part of the Interim Status Permit for the OB Grounds. No sediment monitoring is required as part of this Interim Permit.

Comment #3 Page A-3, Section A.

Many of the air quality ARARs are incorrect and/or incomplete. The list really needs to be re-thought and re-written with special focus placed upon the State requirements. For example:

Ambient Air Quality Standards given in 40 CFR Part 50 are not applicable to this project. NAAQS are for use in determining attainment/non-attainment areas for criteria pollutants and are not applicable at a specific site ("at the stack"). Some of the State air quality standards are also incorrectly identified as ARARs.

40 CFR Parts 61 and 63 (NESHAPS) are not applicable at the site. No activity proposed as part of the alternatives evaluated will trigger a currently promulgated NESHAP.

40 CFR 58 applies to monitoring requirements for NAAQS, and the establishment of a national air monitoring network. The standard is not applicable to the OB site.

40 CFR 52 sets requirements for State's to follow in developing implementation plans and is not applicable to remedial activities at the site. However, the State Implementation Plan generated as required in Paragraph 52 would be an ARAR and should be listed as such.

Response #3 Agreed. The Federal air quality standards referenced in the comment have been removed. The state requirements were also reviewed and it was determined that the remedial processes which may potentially be used at the site will not have emissions. Fugitive dust may be created during excavation and construction. The only state requirement which would apply to the remediation work at this site, is the NYSDEC TAGM for Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites. This TAGM refers to the Federal Ambient Air Quality Standard for PM-10. This TAGM is a TBC and has been listed in Appendix A as a TBC. The Federal standard for PM-10 has been listed as an ARAR. There are no other NY State requirements for fugitive dust emissions.

Comment #4 Page A-3, Section A.

a) It is not clear why 40 CFR 268 regarding land disposal restrictions is listed as a chemical-specific ARAR. Part 268 only applies when wastes have been generated and require disposal. As such, Part 268 would be more correctly listed as an action-specific ARAR.

b) Also, the text states that LDRs mandate removal and treatment prior to any disposal. This is not exactly correct. LDRs do not mandate REMOVAL of contaminated soils, only that once removed, if hazardous, the soil must be treated to specified levels prior to land disposal.

Response #4 a) Agreed. The ARAR 40 CFR 268 has been moved to the action-specific listings.

b) Agreed. The description of the ARAR has been revised accordingly.

Comment #5 Page A-9, Section A.

The hazardous waste management ARARs are not correct/complete. The list needs to be rewritten to include significant omissions/corrections. For example:

The only section of 40 CFR 262 designated at applicable is 262.11. Most all other sections of 262 would be applicable as well (at least for any off-site disposal actions for hazardous wastes generated during the soil washing or other alternatives. It is assumed there will be some as ARARs are given for transportation of hazardous wastes...). At a minimum, Subparts B, C, and D for Manifesting, Pre-transportation requirements, and Recordkeeping and Reporting would be applicable.

Other applicable RCRA requirements for alternatives involving off-site disposal of soil washing fluids and other wastes would include, at a minimum, 40 CFR Parts 260, 261, and 268.

If the excavated waste is treated within 90 days of excavation, 40 CFR 264 is not going to apply. Generators can treat characteristically hazardous waste without obtaining a permit.

Response #5 Agreed. 40 CFR 262 Subparts B, C, and D and 40 CFR Parts 260 and 261 have been added as action-specific ARARs. 40 CFR 268 was already listed.

40 CFR 264.552, 40 CFR 264.553, and 40 CFR 264 Subpart X have been retained as ARARs as required by the USEPA in their Comments.

Comment #6 Page A-10, Section A.

The OSHA Applicable Standards listed should, at a minimum, include all applicable construction safety standards in 29 CFR 1926, as well as those in 1926.62 and 1910.1025 for lead exposure.

Response #6 Agreed. The 29 CFR 1926, 29 CFR 1926.62, and 29 CFR 1910.1025 have been added to the list.

Comment #7 Page A-11, Section A.

DOT requirements for transportation of hazardous waste should also include at a minimum, requirements in 49 CFR 173.

Response #7 Agreed. 49 CFR 173 has been added as a DOT requirement.

Comment #8 Page 5-20, Section 5.

Building an on-site RCRA Subtitle D landfill for the disposal of treated D008 soils is ludicrous. The expense involved with constructing a state of the art facility as well as the monitoring, closure, and post-closure care costs (for 30 years!) is not correctly reflected in the costs as shown. As far as meeting objectives of reduction in mobility, toxicity, and volume goes, capping in place is a much more cost effective remedy with the same reduction in risk benefits. Since Section 5.8 (Conclusions and Recommendations) did not recommend which of the 3 alternatives should be implemented, it is assumed that Alternative 5 will not be selected.

Response #8 Acknowledged. It may not be clear to the reader that a Subtitle D solid waste landfill will be constructed and therefore the materials which will be placed in the landfill will be Case 2 through Case 5 soils, which are not considered to be RCRA hazardous wastes, and Case 1 soils, which will be treated by solidification/stabilization prior to being placed in the landfill. After treatment the Case 1 soils will not be considered to be a RCRA hazardous waste.

The cost estimate provided in Appendix D includes O & M costs for cap maintenance and annual groundwater monitoring.

A cap was originally proposed for this site, however, review by the USEPA indicated that although a cap would prevent infiltration, it would not prevent leaching from the soil to the groundwater without the use of another technological option such as a slurry wall. The soil cap/slurry wall alternative was eliminated as an alternative in Section 3 of this FS report because it was determined that the cap/slurry wall was less effective in reducing toxicity and mobility than the on-site landfill alternative.

Comment by ZEBROWSKI/FRYE

Comment #1 SIGNIFICANT ISSUE: The selection of Alternative 5 (on-site treatment and disposal in a constructed subtitle D facility) for the lead contaminated soils over alternative 4 (off-site treatment and disposal) is neither warranted nor justified by this proposed plan. The evaluation of the two options shows alternative 4 to rank higher in the areas of long-term maintenance (none for 4, 30 years for alternative 5), implementability, and cost ($4.8 million for alternative 4 verses $7.4 million for alternative 5). Both alternatives are equally protective of human health and the environments, therefore alternative 4 should be selected.

The only rationale given in the text for the selection of alternative 5 is on page 33, wherein it is stated that alternative 5 ..."is the only alternative which meets the CERCLA requirements that a remedial action avoid off-site transportation and disposal of untreated hazardous substances". This IS NOT a requirement but rather one of the many evaluation criteria to be considered in selecting the final remedy.

Given the information in this proposed plan and the more favorable ranking of alternative 4 over 5, and the $2.6 million cost difference, it appears that alternative 4 should have been selected as the preferred alternative. Remedy selection should be revisited.

Response #1 Acknowledged. However, Section 5.8, Conclusions and Recommendations, does not select one of the alternatives, but provides conclusions of the comparison between the alternatives. As per the recommendation of NYSDEC, no alternative was selected as part of the FS Report. According to Section 6.3 of the EPA Guidance the preferred alternative is selected after finalization of the RI/FS. The rationale for selecting an alternative are the results of the detailed analyses and risk management judgements made by the decisionmakers. The purpose of the FS report is to present different alternatives, evaluate each alternative for the different criteria, and provide a comparative analysis of the alternatives.

Comments by FORGET

Comment # 1 General

Based on the responses to comments, it is described that subsurface soil remedial action objectives are based on ARARs, so I will not comment on those. However, the surface soil RAOs for lead are stated to be risk based. There are two major categories of problems with the 500 ppm RAO. First, it is based on residential future land use. I have commented on this issue on many other SEADs at Seneca. The responses have said the future residential will just be used for comparison, but not risk management decisions. This SEAD is basing all risk management decisions on future residential use. Unless this can be specifically justified as a reasonable future land use, it should not be considered in developing RAOs. (reference EPA's future land use directive 9355.7-04)

Response #1 Agreed. The comments made by Ms. Forget regarding the use of the residential future land use scenario have certainly been responded to by us. However, the cleanup goal of 500 mg/kg for soils was a negotiated value based on consideration of several factors and not simply the residential future land use scenario. These factors in clude (1) preventing leaching of lead from the soil into the groundwater above the NYSDEC GA criteria, (2) protecting the ecological receptors near the site, (3) protecting the surface water and aquatic biota in Reeder Creek, (4) and preventing ingestion of lead contaminated soils in the potential residential future land use.

Initially the future intended land use which was used for this study was the residential scenario. The Army reluctantly agreed to the residential scenario based on regulatory steadfastness, although they had no intention of cleaning up the site to this level. Since SEDA has been placed on the BRAC95 list, the future land use has become unclear and could potentially be as a residential future land use.

Comment #2 Secondly, there appears to be problems interpreting or running the IEUBK model. The EPA guidance (OSWER directive 93565.4-12) where the 400 ppm concentration level is derived and explained includes some important text apparently ignored at this SEAD.

It is true that the document recommends a SCREENING level of 400 ppm. However, in the definition of SCREENING level, the directive states the following, "Screening levels ARE NOT CLEANUP GOALS. Rather, these screening levels may be used as a tool to determine which sites or portions of "At some Superfund sites, using the IEUBK model with site-specific soil and dust characteristics, PRGs of more than twice the screening level have been identified. However, it is important to note that the model alone does not determine the cleanup levels required at a site. After considering other factors such as costs of remedial options, reliability of institutional controls, technical feasibility and/ or community acceptance, still higher cleanup levels may be selected." considering other factors such as costs of remedial options, reliability of institutional controls, technical feasibility, and/or community acceptance, still higher cleanup levels may be selected.

Response #2 The determination of 500 mg/kg for the site-specific cleanup goal for soils at the OB Grounds was based on several factors as listed in the Response to your Comment #1.

Comment #3 ALSO, the IEUBK model not only accounts for childhood exposure to lead contaminated soil, but also includes default parameters assuming the children are also exposed to lead contaminated water, lead paint, and household lead dust. Since this is not a current residential area, lead exposure from these other pathways can be assumed to be zero since household lead piping, and lead paint is no longer permitted in new construction.

These parameters should be adjusted, and the model rerun to determine more realistic RAOs!

Response #3 Disagree. To model a realistic residential scenario, the exposure to lead contaminated drinking water and dust were included as pathways and lead paint exposure was not included. According to the USEPA Guidance Manual for IEUBK Model for Lead in Children (USEPA, 1994), the default value of 4 ug/L for lead in water is a typical exposure concentration based on a 1990 census. This default value was used because no site specific data was available for potential drinking water sources. One potential source of drinking water is groundwater wells which are typically deep wells drilled into the bedrock aquifer. No site-specific data is available on the groundwater from the bedrock aquifer at the site. Water from Seneca Lake is another potential source of drinking water for the site and no data on the lead concentrations in the lake water is available for this source.

Comments by K. HEALY

Comment #1 Section 1.1, Paragraph 2.

The statement " if the control of this facility.. health and the environment." suggests that the Army is currently not doing so. To my knowledge, cleanup to the levels agreed upon will result in conditions that are protective of health and the environment and the cleanup will be appropriate for all potential future uses. Please clarify.

Response #1 Agreed. The sentence has been revised to read "...as control of this facility is transferred and the use changes, the Army will perform..." The original sentence took into account the alternative to transferring property, which would be for the Army to retain ownership of certain parcels which were determined to be more efficient to keep control over.

Comment #2 Section 2.2.5, Page 2-21.

In the second paragraph under the discussion on Future Land Use, the statement "..NYSDEC also requires.. for unrestricted land use." is incorrect. The Army performs ordnance remediation projects based on risks, not absolute certainties. The Army cannot and will not certify what is suggested here. This needs to be clarified significantly. The same comment hold for bullet no. 5 on this same page.

Response #2 Agreed. We understand that the Army will conduct UXO clearance of the site in support of the remediation activities. UXO clearance will not be conducted on a site-wide basis, nor will it be conducted for the no-action alternative. In the event of a property transfer, a qualifer will be inserted in the deed which states that there will always be a risk and the Army cannot certify that the site is certain to be free of all

UXO. The text in Section 2.2.5 as well as bullet no. 5 have been revised to state the above.

Comment #3 Page 2-36.

In line 7 of this page, correct "above" to "below". 5.49 is less than the target value of 10.

Response #3 Agreed. The text has been revised as recommended.

Comment #4 Page 2-60.

In line 6 of this page, an incomplete thought is present as "on-site disposal as clean.. to be". Please correct.

Response #4 Agreed. The sentence has been completed to state that on-site disposal as clean-fill has been retained as a technology to be considered.

Comment #5 Section 3.5.3.

Please finish the incomplete thought ".. feasibility of ...action alternative."

Response #5 Agreed. The incomplete sentence has been removed from the text.

Comments by S. BRADLEY

Comment #1 General.

Previous comments adequately addressed.

Response #1 No response is required.

/h:\eng\seneca\obfs\OBFS\ARMY.DOC

RESPONSE TO COMMENTS
U.S. EPA
DRAFT FEASIBILITY STUDY REPORT
AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
SEPTEMBER, 1995

LETTER

EPA has reviewed Draft Feasibility Study ("FS") for the Open Burning Grounds ("OB Grounds") and finds it to be inadequate. The FS does not comply with Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), nor the National Oil and Hazardous Substance Contingency Plan ("NCP"), CERCLA's implementing regulations.

Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), and the NCP (see 40 CFR Part 300.430(f)) establish as threshold criteria for remedy selection the protection of human health and the environment and the attainment of cleanup levels consistent with legally applicable or relevant and appropriate standards ("ARARs"). The FS's failure to adequately consider addressing contamination of groundwater as well as soils at the OB Grounds is among our main concern.

Lead has been detected in 20 groundwater samples at levels up to 275 part per billion ("ppb") which exceeds the state and federal action level of 15ppb, and cadmium also exceeds ARARs in the groundwater. For this reason groundwater response is considered necessary. None of the alternatives in the FS address protection of groundwater at the OB Grounds. For groundwater response the NCP requires such an evaluation, as set forth at 40 CFR Part 300.430(e)(4):

> "For ground-water response actions, the lead agency shall develop a limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies."

SEDA has not considered groundwater remedial alternatives based on the NYSDEC classification for groundwater at SEDA which is Class GA - protection for source of drinking water. The NCP states that groundwater that is not currently a drinking water source, but is a potential drinking water source in the future, should be protected to levels appropriate to its use as a drinking water source.

Furthermore, according to 40 CFR Part 264 Subpart X and related applicable requirements, Resource Conservation and Recovery Act ("RCRA") closure and post closure requirements should be implemented at the OB Grounds. These RCRA requirements are ARARs, and under RCRA, a determination to remediate a site would not be postponed based on the current risk pose to human health and the environment but on the present exceedance of the applicable standards, including the potential for contaminants to impact human health and the environment. Delaying groundwater remediation (as proposed by the Army) until the OB Grounds property is transferred will only increase the cost of an eventual remediation and the magnitude of the exposure to risk into the future. With respect to Department of Defense facilities, while determining what future land use will be can be difficult, it is likely that the current use will inevitably change.

As noted above, the FS fails to adequately address the high lead levels in soil. Analysis with EPA's UBK model has indicated that average blood lead levels (greater than 50% of population) are above 10 ug/dl in age groups 1-4 years. EPA attempts to limit exposure to lead levels in soils such that a typical group of similarly exposed children would have no more than an estimated 5% risk of exceeding a 10 ug/dl blood lead level. Based on the application of the UBK model, EPA has developed a policy setting 400 parts per million of lead in soil as a screening level for remediation. Clearly, with lead in soil detected at the OB Grounds at concentrations more than 100 times that limit, with detections as high as 56,700 ppm, 52,000 ppm, and 41,200 ppm, soil cleanup would be imperative if the site were to be designated for residential land use.

As required by the Federal Facilities Agreement between our agencies, EPA anticipates that the Army will response and revise the Draft FS for the OB Grounds to address the concerns expressed in this comment letter and attachment. It is required that Army response include extensive fate and transport modeling of lead in soils to determine what specific concentration of residual lead remaining in soil is still protective of groundwater and ensures ARARs will not be exceeded in the future as a result of lead leaching from soil to groundwater. The result of this groundwater modeling effort should be presented in the revised FS. Groundwater remediation must be included in the alternatives described in the revised OB FS if the Army is unable present such assurance.

RESPONSE TO COMMENTS PRESENTED IN THE ABOVE LETTER

The comments raised in the above letter generally fall into the two categories shown below. Responses to these comments are presented below.

Comment #1 None of the alternatives in the FS address protection of groundwater and soil at the OB Grounds. In particular, lead has been detected in groundwater and soil samples at concentrations above criteria values.

Response #1 After review of this Draft FS and discussions between NYSDEC, the EPA (Region II), the Army, and Parsons ES, the remedial action objective for soils at the OB Grounds has been established. The purpose of this objective is to protect groundwater and soil at the site. For on-site soils, the goal is to remediate soils with concentrations of lead greater than 500 mg/kg. This cleanup level is based on the results of two recent studies. For subsurface soils, a recent transport modeling study (using VLEACH) was conducted by the EPA to determine what specific concentration of residual lead remaining in soil is protective of groundwater and thereby ensures GA groundwater ARARs will not be exceeded in the future. The results of this study indicate that a lead soil level between 16 mg/kg and 483 mg/kg would be protective of groundwater. For surface soils, the output of the UBK model performed by Parsons ES indicated that 500 mg/kg would be protective of human health in a residential exposure scenario. Given the uncertainty of analyses performed and the ability to accurately measure environmental concentrations, it was agreed that a 500 mg/kg maximum value of lead in soil would be the remedial action objective for this site. Both NYSDEC and EPA have confirmed that the cleanup level of 500 mg/kg for lead in soils would be protective of human health and allow for residential and industrial future use of the site. Post remediation groundwater monitoring will be required to prove that no risks to human health exist.

Concerning lead contamination of groundwater, we disagree with the EPA comment that the FS does not adequately comply with Applicable or Relevant and Appropriate (ARARs) standards for groundwater. EPA states that "lead was detected in 20 groundwater samples at levels up to 275 parts per billion (ppb) which exceeds the state and federal action level of 15 ppb, and cadmium also exceeds ARARs in the groundwater". We believe that the EPA is incorrectly relying on the unfiltered groundwater data collected as part of the Phase 1 Remedial Investigation (RI) program and should be only considering the groundwater data collected during the Phase 2. Recall that during Phase 1 both unfiltered and filtered groundwater data were collected. This data clearly indicated the contribution that turbidity played in the metal concentration of the water. Following the first round of data collection, it was agreed that only unfiltered groundwater data would be collected and a new low flow sampling procedure was negotiated that provided a more representative, lower turbidity sample. Therefore, we believe that the Phase 1 groundwater data should not be used to determine ARAR compliance since it is not based on the agreed upon sampling procedure and is not representative of true metal concentrations in the groundwater.

A review of the Phase 2 data indicates that only two wells, MW-14 at 85 ppb and MW-19 at 36 ppb, exceed the 25 ppb NYSDEC GA groundwater standard and the federal action level of 15 ppb for lead. Due to the high clay content of the soils at the site, both wells produced samples with NTU values higher than the 50 target value even with the low flow sampling techniques. MW-14 yielded a turbidity of 155 NTU and MW-19 yielded a turbidity >200 NTU. These exceedences in the lead concentrations could be the result of these elevated turbidities. Furthermore, since these two wells are located more than 800 feet apart, there is no indication of any clearly discernible plume. For these reasons, groundwater has not been considered to be a media of concern.

Comment #2 RCRA closure and post closure requirements should be implemented at the OB Grounds. These RCRA requirements are ARARs.

Response #2 Agreed. RCRA Part 373 closure requirements (and post-closure requirements, when applicable) legally apply to all hazardous waste management units that have interim status or a permit pursuant to Part 373. Both the old and new OB units and the existing OD unit have Part 373 interim status. The new OB unit consists of steel trays near Pad D for open burning. SEDA is pursuing a Part 373 Permit for the new OB unit and the OD unit, which is currently under review by the RCRA branch of NYSDEC. The old OB unit is no longer in use, and therefore, it is subject to the Part 373 closure and post-closure requirements at this time. The closure of the OB grounds has nt been performed since the facility is being remediated under CERCLA. The closure requirements for RCRA have been considered as an ARAR.

ATTACHMENT TO LETTER

Hazardous Waste Facilities Branch (RCRA)

The "no action" alternative does not appear to be environmentally acceptable for the following reasons:

Comment #1

a) During the RI at the OB Grounds, elevated levels of metals, such as chromium, barium and lead were detected in soils ranging from 2-4ft. in depth. Chromium was detected up to 1,430 mg/kg, barium up to 19,600 mg/kg, and lead was detected at several concentrations (56,700 mg/kg, 52,000 mg/kg, 41,200 mg/kg). The NYS soil standards indicated in the FS report for the above metals are 26.6 mg/kg, 300 mg/kg, and 30 mg/kg respectively. Due to the extremely high concentrations of these metals in the soils, in particular lead, there is a potential for the metals to leach from the soils and to further contaminate the groundwater beneath the OB grounds.

b) In addition, it is likely that the contaminated soils exhibit the RCRA hazardous waste characteristic of toxicity.

c) Furthermore, the RI report specifies that contaminants have been detected in the groundwater above the New York State and EPA standards. Lead was detected in 20 samples (up to 275 ppb) above the New York State standard of 15 ppb.

Response #1

a) Agreed. Under the no-action alternative, there is potential for these metals to leach from the soils to the groundwater. The Army has agreed not to select the no-action alternative, but will conduct the soil remedation as agreed upon between the EPA, NYSDEC, and the Army. For this remediation, the clean-up level for lead in soils (500 mg/kg) at the OB Grounds was based on the EPA transport modeling study which determined the concentration of residual lead in soil which would not adversely affect the groundwater. The no-action alternative will be carried through the feasibility analysis as a baseline to compare benefits from other alternatives.

b) Agreed. Some of the soils at the site contain concentrations of contaminants above the TCLP toxicity levels and therefore, would be considered RCRA hazardous wastes when excavated. This will be considered during development of remedial action alternatives.

c) Please refer to Response to Comment # 1 on page 2 regarding groundwater contamination.

Comment #2

Since contaminated soils and groundwater are present at the OB grounds, RCRA closure and post closure requirements are applicable and should be addressed. See 40 C.F.R. Part 264 Subpart X, and related applicable requirements.

Response #2 Refer to the response to Comment # 2 on page 2.

Comment #3 The following statements describing Alternative 1 - "No Action" are included in Section 5.2 of the FS report:

"No remedial activities will be undertaken at the site. No monitoring or security measures will be undertaken. Any attenuation of threats to human health and the environment will be the result of natural process. Current RCRA groundwater monitoring of approximately 35 wells in place at the site would continue, unless the site was clean closed."

a) The above statement regarding groundwater monitoring under RCRA is not accurate. The RCRA permitting of the 4X10 steel trays does not require groundwater monitoring for the tray or for any of the OB grounds. EPA RCRA has been informed that, based on discussion between the NYSDEC Division of Hazardous Substances Regulation and the Division of Hazardous Waste Remediation, the Superfund/Remedial Program will address all historical releases to the environment at the Seneca Army Depot under the FFA, including the OB grounds. Any future releases of hazardous constituents from the steel tray at the OB grounds, and from other RCRA regulated units in other portions of the Seneca Army facility undergoing RCRA permitting, will be addressed under the RCRA Corrective Action Program.

b) Also, the "no action" alternative appears to be a postponement of a remedial decision for the OB grounds until the future use of the OB land is decided. The FS states that future remediation of the OB grounds will only be determined when the OB grounds ownership is transferred or the property is leased. Under RCRA, a determination to remediate a site is not postponed based on the possible future intended use of the area, but based on the present exceedance of the applicable standards and the potential for contaminants to impact human health and the environment. In this case, the elevated levels of metals detected in the soil could continue to leach out and impact the groundwater beneath the OB grounds.

Response #3 a) Agreed. The statement regarding groundwater monitoring under RCRA has been removed from the no-action alternative discussion. However, under the Interim RCRA permit, four monitoring wells, which are located near the steel trays, are currently being sampled semi-annually for indicator parameters and annually for metals.

b) Agreed. The no-action alternative appears to be a postponement of a remedial decision, however, the rationale for including this alternative is that the Guidance requires it to be one of the alternatives. This alternative will be carried through the feasibility analysis as a baseline to compare benefits from other alternatives. The Army has agreed not to select the no-action alternative but will conduct soil remediation and a groundwater monitoring program.

PRE-REMEDIAL & TECHNICAL SUPPORT SECTION

Comment #1 **Section 1.4 ¶ 3** - In describing the amount of contamination that is impacting Reeder Creek please include the specific chemicals of concern, their concentrations and exact location of any impact.

Response #1 Agreed. Text has been added to Section 1.4 (new paragraph 4) describing the constituents of concern, their maximum concentrations, and locations of impact in sediments in Reeder Creek.

Comment #2 **Section 1.5 ¶ 3** - Paragraph three states that the form of these chemical constituents precludes migration via water, assuming that the chemical constituents mentioned are the heavy metals described in the preceding paragraph. In light of the test results from EP and TCLP test methods, which are designed to determine the mobility of both organic and inorganic analytes present in liquid, solid and multi phasic wastes, it becomes evident that certain chemical constituents detected on site do have the potential of migrating into groundwater and/or surface water. Therefore, the EP test results show that there is an increased probability of heavy metals leaching to groundwater, through time, from the contaminated sediments in the OB grounds and associated areas. To exclude this pathway from further evaluations of fate and transport mechanisms, especially with the EP data, may result in making the wrong decision regarding remedial alternatives.

Response #2 As described in the Response to Comment #1 on page 2, the purpose of the revised cleanup level for lead in surface and subsurface soils on the OB Grounds is to reduce the maximum lead level in the soils to 500 mg/kg. This level is based on the results of the EPA transport model study of the site which determined that this concentration would not adversely affect groundwater. Furthermore, there is presently no discernible groundwater plume at the site and Phase 2 groundwater data indicated that only two wells had concentrations of lead above the criteria. Therefore, groundwater is not considered a migration pathway. As part of the remedial action objectives agreed upon by the EPA, NYSDEC, and the Army, post remediation groundwater monitoring will be conducted.

Comment #3 **Section 2.4 ¶ 4** - The maximum concentration of lead allowed by the EP toxicity characteristic is 5 mg/L and not 50 mg/L as stated in the document. The EP and TCLP test methods were designed to determine if a generators waste stream is a regulated hazardous waste as part of a general waste analysis. The tests were not designed to be used as either a criteria to determine if a specific media, such as soil, is contaminated, or as an action level for soil removal.

Response #3 Agreed. The concentration for lead has been changed to 5 mg/L. If the soils and sediments on the OB Grounds are removed as part of a remedial action, portions would be considered a regulated hazardous waste based on comparison of constituents to EP toxicity and TCLP criteria. These EP toxicity and TCLP criteria are not being used as action levels for soil removal or as a determination of contamination. Rather they will be used during remediation activities to determine the proper disposal method of those excavated soils which produce concentrations of constituents in excess of TCLP criteria.

Comment #4 <u>**Section 3.5.2.2 ¶ 1**</u> - The risk assessment does not evaluate the groundwater route of contaminant transport, therefore, any conclusions drawn regarding long term effects on human health and the environment do not reflect all eventualities. The no action scenario may even act to compound the problems that will be faced initiating the future residential exposure scenario due to contaminant migration into areas, on or off site, not as yet affected.

Response #4 For the reasons discussed in the Response to Comment #1 on page 2, groundwater is not considered a route of contaminant transport. As a remediation requirement of the EPA and NYSDEC, the groundwater will be monitored after remediation is complete to determine long term effects on human health and the environment.

Comment #5 <u>**Section 3.5.3.2 ¶ 1**</u> - The heavy metal constituents have been shown to be leachable in the EP TOX tests performed in the past. Therefore, to indicate that they are immobile and are expected to remain that way for the long term is not accurately representing the data.

Response #5 Agreed. The statement has been removed from the text.

Comment #6 <u>**Section 3.5.4.1 ¶ 3**</u> - Setting the Estimated Capital Cost for Alternative 1 is misleading. In evaluating the no action scenario added costs can be envisioned for inflationary considerations, the increased contaminated media due to contaminant migration and the additional costs of maintaining a Post-Closure detection monitoring system until clean closure is achieved.

Response #6 Disagree. Alternative 1 is the no action alternative. By definition, no remedial actions will be conducted. If remediation is conducted in the future, it would not be considered to be part of the no action alternative. Furthermore, future potential remediation requirements cannot be anticipated or a cost estimate developed at the present time.

Comment #7 <u>**Section 5.2.1 ¶ 1**</u> - Under what vehicle, (e.g., Post-Closure Permit, 3008h Order, Closure Plan, etc.) are RCRA monitoring activities taking place. Also, in order to evaluate the validity of such a detection monitoring system much more detailed information is needed. Please provide information on the analytical parameters which are being monitored for, the test methods being used, CME & O&M inspection schedules and the approved Closure and/or Post-Closure Plans.

Response #7 The OB/OD grounds are operating under interim status. The Part B Subpart X permit application was submitted on January 13, 1992. This permit is still being finalized based upon the "New Draft Strategy Policy" issued by Carol Browner. As part of the requirements under the interim status, the Army has been performing groundwater monitoring since 1980. The original monitoring program involved monitoring the entire OB/OD facility as one unit. The monitoring program was modified in February 1995 when the burning tray and the OD mound were identified as the permitted units.

The program involves collecting four independent samples from one upgradient and three downgradient monitoring wells. The samples are analyzed for TOC, TOX, pH, and specific conductivity. A statistical test for significance is performed on the data to determine if a release has occurred. This process is performed quarterly andincludes sampling for total metals.

The methods used are EPA approved methods from SW-846. Closure of the units have not been performed since the facility is being remediated under CERCLA. The closure requirements for RCRA have been considered as an ARAR and will be met as part of the CERCLA clean-up process.

Comment #8 — **Section 5.2.5 ¶ 1** - As mentioned above information is needed concerning the Interim Status classification of the units in the OB area and if immediate clean closure is required by RCRA regulations.

Response #8 — Clean closure is not required by the NYSDEC permit administrators, and the facility will be closed and monitored as a landfill. This will include a long term monitoring program. The clean-up goals established for this project have been accepted by the RCRA permit administrators as sufficient to meet the requirements for closure. No further clean-up will be required to meet the RCRA closure requirements.

Comment #9 — **Page 1-8, 1st ¶** - 'BKU' should be 'UBK'.

Response #9 — Agreed. The text should read UBK. However, the paragraph in which this appeared, has been removed as part of the revision process of the Draft FS Report.

Comment #10 — **Page 2-11, 1st ¶** - it's not clear if this discussion of AWQS is an ecological risk or human health risk matter.

Response #10 — Agreed. According to the NYSDEC Ambient Water Quality Standards and Guidance Values (1993), the standards and guidance values were developed for specific classes of fresh and saline surface waters and fresh groundwaters for protection of the best usages assigned to each class. The NY AWQC values for surface waters, which are listed in Table 2-1 and are discussed on page 2-11, are for protection of aquatic life and for wildlife consumers of fish. This information has been added to the paragraph which discusses off-site surface water data in the new Section 2.2.2.4.

Comment #11 **Baseline Risk Case, 2nd page:** - for the industrial exposure (current land use), the exposure frequency should be 250 days/year, not 150.

Response #11 The conservative maximum number of days that is allowed under the Interim Permit for the OB grounds is 150 days. This is the current land use.

ENVIRONMENTAL IMPACTS BRANCH

Comment #1 In addition to the listing of ARARs in Appendix C, we recommend that the FS include all the appropriate analyses used to support its conclusions that each of the various alternatives "will comply" with all pertinent ARARs. The present FS document only cites the ARARs and indicates that all alternatives will comply, without demonstrating how and providing the necessary supporting discussion and/or documentation.

Response #1 The current FS report lists the ARARs with brief descriptions of their content in Appendix A. This list of ARARs is extensive . Assessment of compliance with chemical and action specific ARARs is included as part of the description and analysis of the alternatives in Section 5.

GROUNDWATER MANAGEMENT SECTION

Comment #1 Note the following updated MCLs for selected constituents in Appendix A of the FS:

Constituent	MCL (mg/L)
Barium	2.0
Cadmium	0.005
Chromium	0.1
Lead	TT*
Selenium	0.05

TT = Treatment Technique
*Lead has an Action level of 0.015 mg/L.

Response #1 Agreed. Appendix A has been revised to include these updated Federal MCLs.

D#obfs

RESPONSE TO COMMENTS
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION (NYSDEC)
DRAFT FEASIBILITY STUDY REPORT
AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT ACTIVITY
ROMULUS, NY
MAY, 1994

LETTER

Comment #1

Remedial Action Objectives: The Open Burning Ground (OBG) site is approximately 30 acres in size and incineration of propellants, explosives and pyrotechnics (PEPs) was done on the unprotected ground. This practice was discontinued in 1987, and since then munitions have been burned in a steel tray near Burn Pad D, as regulated under subpart X of the Resource Conservation and Recovery Act (RCRA). Currently, an Army permit application is under review by the regulating agencies, and it is expected that the approved permit would require: a) regular sampling of surface soil surrounding the steel tray (to ensure than contaminants are not migrating in the environment), b) no munition burning in high wind condition and c) no munition burning on the ground.

This will no doubt control the migration of contaminants into the environment, particularly to the soil, surface water and groundwater media significantly from any future incineration of ammunition. Because of the past open burning practices, the soil is contaminated with explosives and heavy metals. Groundwater and surface water, which drains into Reeder Creek, are contaminated above New York State Water Quality Criteria (NYSWQC) (NYSCC Part 700-705) for metals. Constituents of concern are barium, copper, lead and zinc (Ba, Cu, Pb and Zn), which are persistent in the soil and sediments; secondary constituents of concern are explosives, PAHs and phthalates. Lead and copper concentrations in on-site soils were recorded up to 56,700 ppm and 38,100 ppm, in on-site wetlands up to 7400 ppm and 3790 ppm and in Reeder Creek sediments up to 332 ppm and 2380 respectively. These values are high enough to be of biological concern yet the feasibility study does not address them adequately in terms of threat, remedial action objectives and alternatives.

Since there are exceedances of New York State Water Quality Criteria (6 NYCRR Part 700-705), which is an Applicable or Relevant and Appropriate Requirement (ARAR) and significant ecological risk exist, a remedial action is required to alleviate the ecological risks and to attain the ARARs as per the NCP section 300.430(e)(9)(111) B.

The remedial action should be such that it addresses the source of contamination, i.e., on-site soils including soils from on-site wetlands and sediments from Reeder Creek. The NYSDEC Technical and Administrative Guidance Memorandum

(TAGM) HWR-4046 for soils and NYSDEC's sediment criteria for Reeder Creek sediments should be used for determining volume of soil and sediment in need of remediation. The emphasis should be on:

(i) isolation of surface soils from biota. We are particularly concerned about the impact of lead and copper on birds in their consumption of grit.

(ii) Preventing migration of contaminants to the groundwater and to Reeder Creek. The sediment data for Reeder Creek clearly indicates that lead and copper from the burn pits and surrounding soils are reaching the creek in amounts that exceed NYSDEC DFW sediment criteria. The document's dismissal of the sediment criteria because it is not promulgated regulation, and therefore is not a required remedial action objective is incorrect. The criteria are risk based.

Response #1

After review of this Draft FS and discussions between NYSDEC, the EPA (Region II), the Army, and Parsons ES, the remedial action objective for soils at the OB Grounds has been established. The purpose of this objective is to protect groundwater and soil at the site. For on-site soils, the goal is to remediate soils with concentrations of lead greater than 500 mg/kg. This cleanup level is based on the results of two recent studies. For subsurface soils, a recent transport modeling study (using VLEACH) was conducted by the EPA to determine what specific concentration of residual lead remaining in soil is protective of groundwater and thereby ensures GA groundwater ARARs will not be exceeded in the future. The results of this study indicate that a lead soil level between 16 mg/kg and 483 mg/kg would be protective of groundwater. For surface soils, the output of the UBK model performed by Parsons ES indicated that 500 mg/kg would be protective of human health in a residential exposure scenario. Given the uncertainty of analyses performed and the ability to accurately measure environmental concentratios, it was agreed that a 500 mg/kg maximum value of lead in soil would be the remedial action objective for this site. Both NYSDEC and EPA have confirmed that the cleanup level of 500 mg/kg for lead in soils would be protective of human health and allow for residential and industrial future use of the site. Post remediation groundwater monitoring will be required to prove that no risks to human health exist.

Sediments in Reeder Creek will be remediated until the maximum concentrations of lead are less than 31 mg/kg and copper, 16 mg/kg. These remedial action goals for sediments were established based on the NYSDEC "Technical Guidance for Screening of Contaminated Sediments". NYSDEC and the EPA have confirmed that this clean-up goal for sediment in Reeder Creek would be protective of ecological receptors within the creek.

Furthermore, as part of the remedial action a sedimentation pond will be constructed to prevent migration of contaminants from the site to Reeder Creek by means of surface water runoff.

Comment #2 1.6.1 Baseline Human Health Risk Assessment:

(i) The NYSDOH does not recognize the USEPAs acceptable range of carcinogenic risk of 10^{-4} to 10^{-7}. The establishment of "acceptable risk levels" is only appropriate after a remedial program is agreed to and which will minimize or eliminate, to the extent practical, all potential exposure pathways.

(ii) The USEPA Uptake/Biokinetic Model for lead is currently being re-evaluated by the USEPA, and is not, at this time, considered appropriate by the NYSDOH. The model pharmaco-kinetics, as well as the default soil/dust exposure assumptions used in the model, give uncertain predictions of blood lead in children; therefore, the use of this model to suggest soil cleanup goals is inappropriate. A soil cleanup level of 500 milligrams per kilogram (mg/kg) is considered protective of public health by the NYSDOH, although it may not be protective of the environment.

Response #2 i) This risk range is a promulgated standard under CERCLA regulations -40 CFR 300.430(e)(2)(i)(9A)(2). We are unaware that New York has any more stringent promulgated values. Therefore, in the absence of any such values, it is our policy to comply with the federal standards.

ii) The clean up level for on-site soils is based on the results of both the UBK model and a transport modeling study (VLEACH). This transport model was conducted by the EPA and the results indicate that a lead soil level between 16 mg/kg and 483 mg/kg would be protective of groundwater. NYSDEC and EPA agreed that the clean up level of 500 mg/kg would be protective of human health in a residential exposure scenario.

Comment #3 2.2.3 Risk Based Remedial Action Objectives:

This section only discusses risk based remedial action associated with human health which is not sufficient. The site poses significant ecological and, therefore, this section should develop a remedial action objective for both human health and ecological risks (please also see draft FS section 1.6.2 and comment 1).

Response #3 Agreed. The discussion has been expanded to state that the remedial action objective will be developed to protect both human health and the environment.

Comment #4 2.2.4 ARAR-Based Remedial Action Objectives:

This section lists ARARs, but it does not develop remedial actions which would, at a minimum, be required to meet the ARAR-based remedial action objectives. CERCLA requires that all remedial action must be assessed to determine whether they attain applicable or relevant and appropriate requirements. A No Action alternative would not meet this requirement because groundwater and surface water, which drains into Reeder Creek, are already contaminated above NYS Water Quality Criteria (6 NYCRR Part 700-705) and would continue to remain contaminated unless migration of contaminants to these water resources is inhibited significantly. This section should outline a minimum remedial action objective, which would attain all ARARs (see comment 1 also).

Response #4

Agreed. The section has been expanded to discuss the criteria for the development of an ARAR-based remedial action objective. Although the No-Action alternative will not meet the ARAR Remedial Action Objectives, this alternative will be carried through the feasibility analysis a a baseline to compare benefit from other alternatives. A new section, Section 2.2.5, has been added to summarize the Remedial Action Objectives as well as the site-specific goals outlined by EPA and NYSDEC.

Comment #5

<u>2.4 Estimate of Quantities to be Remediated:</u>

All three scenarios, which are subject to this feasibility study do not fully address the ecological risks and would not attain the ARARs and therefore are unacceptable to the NYSDEC.

a) Case 1 includes soils which failed the EP Toxicity Test conducted in 1982-1984. Though we do not accept this criteria, the soil quantity proposed does not include all soils which would most likely fail the current TCLP test (or old EP Toxicity test), if conducted on soils which have shown high levels of metal concentrations in the recent investigation. Additionally, besides Pad B soils, Pad F & H soils have also failed the EP Toxicity test and are not included in this case. Please note that the EP Toxicity limit for lead is 5 milligram per liter not 50 milligram per liter.

b) Cases 2 and 3 do not fully address the ecological risks and the remaining metal contamination (lead up to 56,700 ppm-Case 2 and 13,100 ppm-Case 3) would continue contaminating water resources (see comment 1 above).

Response #5

a) Agreed. The EP toxicity criteria are not considered soil cleanup levels. These criteria will be used to determine proper disposal of excavated soils which produce concentrations of constituents in excess of the TCLP criteria.

The soils from the pads and berms of Pads F and H have been included in Case 1.

The EP toxicity limit has been revised to 5 mg/L.

b) Agreed. Additional sediments have been proposed to be removed from sections of Reeder Creek near sediment sample locations SW140 and SW150 for Case 2. As a result, the maximum lead and copper concentrations for the reach affected by the OB grounds fall below the sediment criteria of 16 mg/kg for copper and 31 mg/kg for lead, which were determined to be protective of the environment.

Metals concentrations would continue to be high for Cases 1 through 3. Cases 4 and 5 have been added to these scenarios to lower the maximum lead concentrations in the on-site soils and to meet the site-specific requirements for clean-up. Case 1 through Case 5 cumulatively meet the soil clean-up requirement of 500 mg/kg for lead which was agreed upon by the EPA, NYSDEC, and the Army for this site.

Comment #6 2.5.2 Screening of Technologies; Table 2-6:

This section altogether ignores the ecological risks and attainment of ARARs. The screening comments column of Table 2-6 should be expanded to include comments whether or not each response action would attain the ARARs and alleviate the ecological risks.

Response #6 Disagree. According to the EPA Guidance document, this screening of technologies in Section 2.5.2 should involve screening of potentially applicable technology types and process options with respect to technical implementability. This is accomplished by using site specific information on contaminant types and concentrations and on-site characteristics to screen out technologies and process options that cannot be effectively implemented on this site. The screening of assembled remedial action alternatives in Section 3 includes an evaluation of short-term and long-term protectiveness of the environment. The detalied analysis of alternatives in Section 5 also includes an evaluation of protectiveness of the environment and compliance with ARARs.

Comment #7 Table 3-2 and 3-3:

The "no action remedial alternative", Alternative number 1, will result in no change in the volume of contaminants in the soil at the OBG. However, the tables indicate that Alternatives 3 and 4, both involving excavation of and off-site disposal, are less favorable with regard to a reduction in volume. It is a non-sequitur that a remedial alternative involving the removal and off-site disposal of contaminated soil can be deemed less favorable than an alternative that leaves all the contaminated soils in place. Please clarify.

Response #7 Disagree. If a specific alternative was considered to be very unfavorable with regard to volume reduction, a value of 1 was assigned; likewise, if an alternative was considered very favorable with regard to volume reduction, it was assigned a value of 5. For Case 6, which involved excavation, treatment, and backfilling of the coarse fraction of material, a value of 5 was assigned because the volume of contaminated soil would be decreased. A value of 1 was assigned to Cases 3 and 4, which involved excavation and treatment alternatives, because the volume of soil would increase upon excavation. Therefore, Case 1, which was the no-action alternative, was assigned a value of 2 because the volume of contaminated soil would remain unchanged. That is, in terms of volume reduction, this alternative would be considered neither favorable nor unfavorable.

Comment #8

5.2 No Action Alternatives; 5.25. Compliance with ARARs:

It should be stated that a no-action alternative would not attain the 6 NYCRR Parts 700-705 Water Quality Regulations for Surface Water and Groundwater.

Response #8

Disagree. As disucssed in Section 2.2.2.3 of the revised text, results from the second round of groundwater sampling indicated that groundwater from two monitoring wells at the site contained concentrations of lead above the NYSDEC GA criteria. Both samples had turbidities above the target level of 50 NTUs, and the exceedences in the lead concentrations could be the result of the elevated turbidities.

In addition, because of the nature of the on-site surface water, it was determined in the revised FS report (Section 2.2.2.4) that the NY AWQC do not apply to the on-site surface water because this surface water consists of essentially small intermittent pools and has not been classified by NYSDEC as a surface water body.

Comment #9

5.3 Alternative 2:

Excavation, off-site treatment and landfilling followed by capping the remaining soils on site:

(i) The excavation criteria should be established. Soils outside of Pad B are also contaminated with high levels of metals. Therefore, please provide how the excavation limits will be established; also see comments no. 5 above.

(ii) A low permeability soil (clay or HDPE) is proposed for a small area that would cover the excavated Pad B and unexcavated Pad D. Please provide the rationale for the partial cover of the contaminated area, since most of the site contaminated with high levels of metals would be uncovered.

(iii) 5.3.2.2. Long Term Protectiveness: It is incorrect to state that this alternative would preclude contact with the affected soil and provide long term protection, because this alternative does not address all surface contaminated soil.

(iv) 5.3.4. Permanence: It is incorrect to state that soil on the site will not contribute to an unacceptable threat to human health and the environment because they will be immobile, since it addresses only the Pad B soils, Reeder Creek sediments and soils from the low hill areas. The remainder of the site also contains high levels of metals, explosives, PAHs and these will continually migrate to Reeder Creek through surface drainage and a threat to human health and environment will remain.

(v) 5.3.5. Compliance with ARARs: It is incorrect to state that this alternative would comply with all ARARs and TBCs. This alternative is not complying with 6 NYCRR subpart 700-705 Water Quality Regulations for Surface Waters and Groundwater and New York State TBCs - TAGM 4046 and Sediment Criteria. The groundwater and surface water are contaminated above these standards and unless all the contaminated soil and sediment are addressed by a remedial action, the source will continue contaminating the surface and groundwater.

Response #9 Alternative 2 has been removed as a remedial action alternative. The alternatives that have been developed will treat all soils with lead concentrations greater than 500 mg/kg and Reeder Creek sediments with lead concentrations above 31 mg/kg and copper concentrations above 16 mg/kg. A total volume of approximately 18,000 c.y. of soil will be treated.

Comment #10 5.4. Analysis of Alternative 3 Excavation, Off-site:

(i) 5.4.1.1 Description: The text states "the pads and berms will be completely removed until the clay fill or native soil is uncovered." If excavation is carried out according to this statement, the quantity would be much more than described in case 3 as 6000 cubic yards. Please clarify.

(ii) 5.4.2.2. Long-Term Protectiveness: The long-term protectiveness depends on excavation criteria. As only 6000 cubic yards of contaminated soil will be excavated, that would leave on-site soils with high levels of metals, explosives and PAHs, and therefore, this remedy will not be protective to the environment. As stated under the no-action alternative, it should be stated here that this alternative also leaves on site a major portion of contamination and therefore, this alternative would also not provide long term protectiveness of the environment.

(iii) 5.4.4. Permanence: Since contamination will be left on site and would continue migrating to the environment, the remedy is not protective to the environment.

(iv) Compliance with ARARs: See comment no. v under Alternative 2. This comment also applies to this remedy.

Comment #11 5.5. Alternative 4. Excavation, Solidification and Off-Site Landfilling: All the comments made on Alternative 3 are also applicable to Alternative 4.

Comment #12 5.6. Alternative 5. Excavation, Solidification and Off-Site Landfilling: All the comments made on Alternative 3 are also applicable to Alternative 5.

Response # 10, 11, and 12

(i) The quantity of soils to be removed has been revised according to the remedial action objective of removing soils with concentrations of lead exceeding 500 mg/kg. The calculated quantity of excavated material including sediments in Reeder Creek is approximately 18,000 c.y.

(ii) As per the revised remedial action objective for on-site soils, all soils with lead in excess of 500 mg/kg will be excavated. These soils will include approximately 18,000 c.y. of soils from the berms, pads, and hotspots on the site. As now state in the revised text, constituents of concern including PAHs and other metals, are located on the pads and berms. These areas will be removed as part of the remedial action and as shown in Table 2-4, the maximum concentrations of other metals are reduced as these soils are removed. Furthermore, as shown in Table 2-5, the noncarcinogenic and carcinogenic risk values are reduced as each group of soils are excavated. Therefore, the removal of these soils not only reduces the exposure to soils with high concentrations of lead but also reduces the risks caused by the presence of other constituents of concern.

(iii) The volume of the soils with concentrations of lead exceeding 500 mg/kg also includes soils with concentrations of constituents exceeding TCLP criteria. Removal of all these soils will eliminate potential migration of contaminants to groundwater and to Reeder Creek.

(iv) Please refer to the Reponse to Comment #8. The purpose of the clean-up objectives established by the EPA and NYSDEC for soils and sediments associated with the site was to prevent contamination of groundwater and surface water.

Comment #13 5.6.6.2. Administrative Feasibility: Since the proposed location of the landfill is on site, no permit is required as per CERCLA Section 121(e)1, 42 USC §9621(e)1. However, it is required that the remedial action will meet all substantive requirements of permits, had they been in place.

Response #13 Agreed. The remedial action will meet all requirements of permits.

Comment #14 5.7. Alternative 7. Excavation, Soil Washing, Backfill Coarse Fraction, Solidify Fine Fraction, Off-site Landfill: All comments made on Alternative 3 are also applicable to Alternative 7.

Response #14 Refer to Response to Comments #9, 10, 11, and 12.

Comment #15 Miscellaneous:

(i) **Section 5.1.** The second sentence of this paragraph beginning with "The remedial action for the future...". Please correct.

(ii) **Section 5.2.5.** This section states that chemical and location specific ARARs are found in Appendix B. However, appendix B contains backup risk calculations for soil excavation cases. Please correct.

(iii) **Section 5.2.6**. The fourth sentence of the paragraph beginning with "Land will continued...". Please correct.

Response #15 i) The sentence has been removed.

ii) The reference has been changed to Appendix A, which lists the ARARs.

iii) The sentence has been removed.

D#14

APPENDIX F

CORRESPONDENCES FROM THE USEPA AND NYDEC

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 Wolf Road, Albany, New York 12233

EARTH DAY 25 1995 ENVIRONMENTAL PARTNERS

Michael D. Zagata
Commissioner

November 7, 1995

RECEIVED
NOV 15 1995
E.S. - BOSTON

Mr. Stephen M. Absolom
Program Manager
Directorate of Engineering and Housing
Seneca Army Depot Activity (SEDA)
Romulus, NY 14541-5001

Re: Open Burning Ground Site

Dear Mr. Absolom:

The New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH) have reviewed your letters of October 10 and 19, 1995 regarding cleanup levels for the Open Burning Ground (OBG) site. We reaffirm our proposal that cleanup levels for lead in soil should be 500 mg/Kg and lead and copper in Reeder Creek sediments should be 30 mg/Kg and 16 mg/Kg, respectively.

You have requested us to confirm that these cleanup levels will satisfy all ecological and human health concerns, meet RCRA requirements and will be protective of groundwater. The 31 mg/Kg lead and 16 mg/Kg copper cleanup levels for sediments in Reeder Creek will be protective of aquatic life; the 500 mg/Kg lead cleanup level for soils was proposed to the Army based both on an EPA transport model study which indicates that a lead level between 16 mg/Kg and 483 mg/Kg would be protective of groundwater, and on the RI finding that there is only limited, sporadic groundwater contamination.

The proposal of the 500 mg/Kg lead cleanup level for soils was not based on biological concerns, which would have required about 60 mg/Kg. Please note that the final remedy must include vegetative stabilization of remaining contaminated soil (up to 500 mg/Kg) to minimize erosion and possible recontamination of Reeder Creek; additionally, periodic monitoring of Reeder Creek sediments should be done to ensure that it is not being recontaminated by the lead left on site. In addition, the revised feasibility study should contain a discussion regarding the effect the lead cleanup will have on residual semi-volatile organic compounds and metals at the OBG for each alternative considered.

The proposal satisfies human health concerns and allows unrestricted future use of the site from the view point of remaining lead concentration. However, before releasing this piece of land for unrestricted use, the Army must remove all unexploded ordnances (UXOs) and must certify in writing that the land is free of all UXOs.

The proposal also meets RCRA requirements for cleanup levels.

If you have any questions, please call Kamal Gupta, of my staff, at (518) 457-3976.

Sincerely,

Salvatore Ervolina
Director, Bureau of Eastern Remedial Action
Division of Hazardous Waste Remediation

cc: C. Struble, USEPA-Region II
K. Healy, USACOE, HD
R. Battaglia, USACOE, SEAD
K. Hoddinott, USAEHA
M. Duchesneau, Eng. Sci.
D. Geraghty, NYSDOH

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

DEC 2 1995
EXPRESS MAIL

RECEIVED
JAN 9 1996
E.S.-BOSTON

Stephen M. Absolom
Program Manager
Directorate of Engineering and Housing
Seneca Army Depot Activity (SEDA)
Romulus, New York 14541-5001

Re: Open Burning Grounds

Dear Mr. Absolom:

This is regarding your October 10, 1995 and October 19, 1995 letters regarding soil and sediment cleanup levels at the Open Burning (OB) Grounds. During subsequent discussions, you informed me that the Army would agree to remediate lead contaminated surface and subsurface soils at the OB Grounds to 500 parts per million (ppm) throughout the area, not limit the excavated soils to the berms and pads specified in the Draft OB Grounds Feasibilty Study (FS). Reeder Creek sediments would be cleaned up to 31 ppm for lead and 16 ppm for copper.

EPA finds these cleanup levels acceptable for surface, subsurface soils and sediment at the SEDA OB Grounds, but we do not agree with all of the assumptions (below in bold) made by the Army in your October 10, 1995 correspondence regarding these proposed cleanup levels.

a. Meet all the RCRA requirements considered ARARs under CERCLA for this site;

EPA does not agree with this statement. There are no chemical-specific RCRA ARARs for lead in soil. However, there are numerous action-specific ARARs that exist for the various remedial alternatives proposed in the Feasibility Study if the soil is considered to contain RCRA hazardous waste. Depending on which alternative is chosen, the following RCRA ARARs may be applicable:

40 CFR 261 -	Subpart C - Characteristics of Hazardous Waste
40 CFR 262 -	Standards Applicable to Generators of Hazardous Waste
40 CFR 263 -	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264 -	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

Subpart F:	Releases From Solid Waste Management Units
Subpart G:	Closure and Post-Closure
Subpart I:	Use and Management of Containers
Subpart J:	Tank Systems

Subpart L: Surface Impoundments
Subpart N: Landfills

40 CFR 268- Land Disposal Restrictions

b. Satisfy all ecological and human health risk concerns;

Human Health

The 500ppm lead soil cleanup level would satisfy human health risk concerns for lead in soils only. Regarding the groundwater, EPA cannot agree that human health risk concerns would be addressed until appropriate post remediation groundwater monitoring prove this to be true.

Ecological

The 500 ppm lead soil cleanup level proposed by the Army for the SEDA OB Grounds would be considered acceptable for the protection of ecological receptors if future land use at the OB Grounds is limited to industrial, commercial, or residential. These land use scenarios would probably involve paving large areas of the OB Grounds which would make it unattractive to wildlife, therefore, limiting habitat for hunting, feeding, and nesting.

The 500 ppm lead soil cleanup level would not be protective of ecological receptors if the OB Grounds remains undeveloped after remediation is complete. The ecological receptors would be more likely to come into contact with the soils in this situation.

The 31 ppm lead and 16 ppm copper sediment remediation goals for Reeder Creek represent levels that are protective of ecological receptors in Reeder Creek. It must be understood that once these sediment cleanup levels are achieved, the potential for soil with 500 ppm lead to enter into the creek through surface water runoff must be prevented.

c. Satisfy all requirements for protection of the groundwater quality standards;
EPA cannot agree with this statement until the remediation is complete and appropriate groundwater monitoring prove this to be true.

d. **<u>Future land use would not be restricted</u> at the OB Grounds.**

Future use of the groundwater would be restricted until post remediation monitoring prove that there will be no risks to human health.

Future use of the soils would be restricted until the issue of unexploded ordnance (UXO) at the OB Grounds is adequately addressed. SEDA's October 10 and 19, 1995 correspondences made no mention of the UXO discovered at the OB Grounds during the UXO survey prior to the Remedial Investigation (RI). The area of the OB Grounds is 30 acres. The information contained in Section 2.3.1 and Appendix B of the OB Grounds RI Report notes that 211,000 square feet (approximately five acres) of work area and access routes were surveyed by explosive ordnance specialty companies to provide access to specified points for C.T. Main to collect environmental data. The text states that no attempt was made to remove the ordnance related materials. They were simply relocated to an area of the OB Grounds clear of the work areas. The 4,037 subsurface objects located, included but were not limited to three (3) U.S. 20 lb fragmentation bombs, one (1) U.S. bomb fuse, one (1) U.S. 75mm recoilless projectile, one (1) U.S. 37mm projectile, rocket heads, mortars, small arms ammo and various other projectiles.

A facsimile of this letter will be sent to you today. If you have any questions, do not hesitate to call me at 212-637-4322.

Sincerely yours,

C. Struble

Carla M. Struble, P.E.
Federal Facilities Section

cc: K. Gupta, NYSDEC
R. Battaglia, USACOE-NY
K. Healy, USACOE-HD
M. Duchesneau, ES ✓

APPENDIX G

Proposed Ordnance and Explosive Clearance Procedure

Proposed Ordnance and Explosive Clearance Procedures

Although this Proposed Plan focuses on the remediation of what is typically referred to as hazardous and toxic contamination, additional concern is warranted due to the presence of another type of contamination, Ordnance and Explosives (OE). The Department of Defense (DoD) treats both forms separately, with both being funded under two different programs, through two different bureaucracies. OE will eventually be investigated and remediated (as required) at the OB grounds.

Ultimately, the remediation of OE at this site will involve two different efforts. The first will involve an evasive action to be performed as part of the soil remediation that is proposed herein. This will require the separation of any OE present (within the soils to be disposed) to be separated out and removed to protect workers from explosive incidents and to provide assurance, that no OE contamination is also being landfilled if that alternative is selected. This will accomplished by a "sifting" operation, whereby all soils are first run through a shaker unit. After moving up a conveyor belt, soils are run onto a shaker screen and fall through, leaving any OE laying on the screen. Trained Explosive Ordnance Disposal technicians remove all metal that remains on the screen and separate it out depending upon whether it is inert metal scrap, OE or OE-related scrap. All scrap is inspected and certified as being nonexplosive by two authorities prior to being disposed of to either a local Defense Reutilization and Marketing Office (DRMO) or to a local scrap dealer. All potentially live OE is disposed of by detonation which will be performed at the Open Detonation Grounds, nearby.

The second OE remediation effort will focus on the remainder of the site. This effort will involve a surface clearance, whereby EOD technicians walk in defined lanes to identify inert metal scrap, OE and OE-related scrap. What is found is dealt within the same manner as what was described as part of the sifting operation. Following the surface clearance, a subsurface clearance will be performed. This will involve the location of all subsurface anomalies (technicians walking lanes with magnetometers and marking all "hits"), the intrusive identification of all anomalies and the disposal of what is found according tot he procedure already described. This subsurface search will normally be performed to a certain depth which depends upon the future use planned. A typical minimum clearance might be performed to a depth of 2-4 feet.

The actual performance of the initial, evasive effort is described here and will be considered a as part of the haz/tox remediation effort. The performance of the second effort will be designed, carried out, reported and presented for public review and approval in a separate, future effort. Both facets of the OB Grounds remediation will eventually be completed so that the site may be disposed of, as appropriate.

Search Guidelines

Surface UXO investigations require a detailed search of designated areas. This is accomplished by utilizing an equipped UXO team and following the guidelines listed:

- The CEHND Project Manager will coordinate with UXO on -site Project Manager in locating at the correct area boundaries to ensure that the removal actions are conducted at their proper locations. A 30 foot safety zone will be provided around the limits of soil remediation incorporated into each of the areas.

- Once the area boundaries are established, each will be divided into visual search lanes. UXO Assistants and/or Specialist will assemble in line formation and advance in a slow, continuous pace, visually inspecting the surface of the lane for UXO while simultaneously conducting a geophysical search. This process will continue until the assigned search lane is completed. Once a lane is completed, the team will move to the next search lane (or grid) and continue the search as described until all lanes are completely scanned.
- The team will locate, positively identify, and dispose of all suspect UXO.
- Manual excavation will only be performed by qualified UXO personnel.
- Suspect UXO will be classified as either safe to move or unsafe to move by the UXO Supervisor. UXO determined safe to move will be transported to the demolition range and disposed of by detonation on a daily basis by UXO personnel. UXO determined unsafe will be marked (with a red painted stake with a description card and pink ribbon) for in-place destruction at the end of each day.

  Each contact will be evaluated by a UXO Specialist to determine if the contact is ordnance or scrap. The detection and identification of UXO is accomplished in accordance with CEHND's "Safety Concepts and Basic Considerations for UXO Operations".

Mechanical Excavation and Soil Sifting Operations

UXO personnel will utilize an 8A subcontractor for completion of the excavation, transport, and soil sifting operations. Mechanical excavation and soil sifting procedures are as follows:

- Exclusion zones will be established for other UXO intrusive and demolition operations near or around the mechanical excavation and soil sifting operations. The limits of each exclusion zone shall be computed using a Fragmentation Table and the explosive weight of the largest UXO items found, or anticipated to be found, in each of the UXO operational areas not involving excavation and soil sifting.
- A visual inspection of the surface of each area will be conducted and any apparent UXO will be removed or blown in place in accordance with standard practices.
- All excavations will include a three (3) foot over dig beyond the "Limits of Soil Excavation".
- After completion of the visual inspection, mechanical excavation of the first six inch of soil using a scraper (Cat 621 or equal) will commence.
- The excavated soil will be transported to an area near the soil sifter and unloaded in a uniform layer not exceeding a depth of 18".
- The excavation site and the unloaded material will be visually inspected by a team of UXO specialists and all apparent UXO removed or blown in place in accordance with standard practices.
- The excavated material will then be loaded into a mechanical sifter (shaker style) using a rubber tired all-purpose loader with a bucket capacity of no more than 3 cubic yards.
- The mechanical sifter will be equipped with a remote control and a series of three (3) screens minimum, each being of a smaller operating size then the previous. The final screen will be set at no greater than 3/8" to meet the objective of removing OEW such as primers and propellant grains.

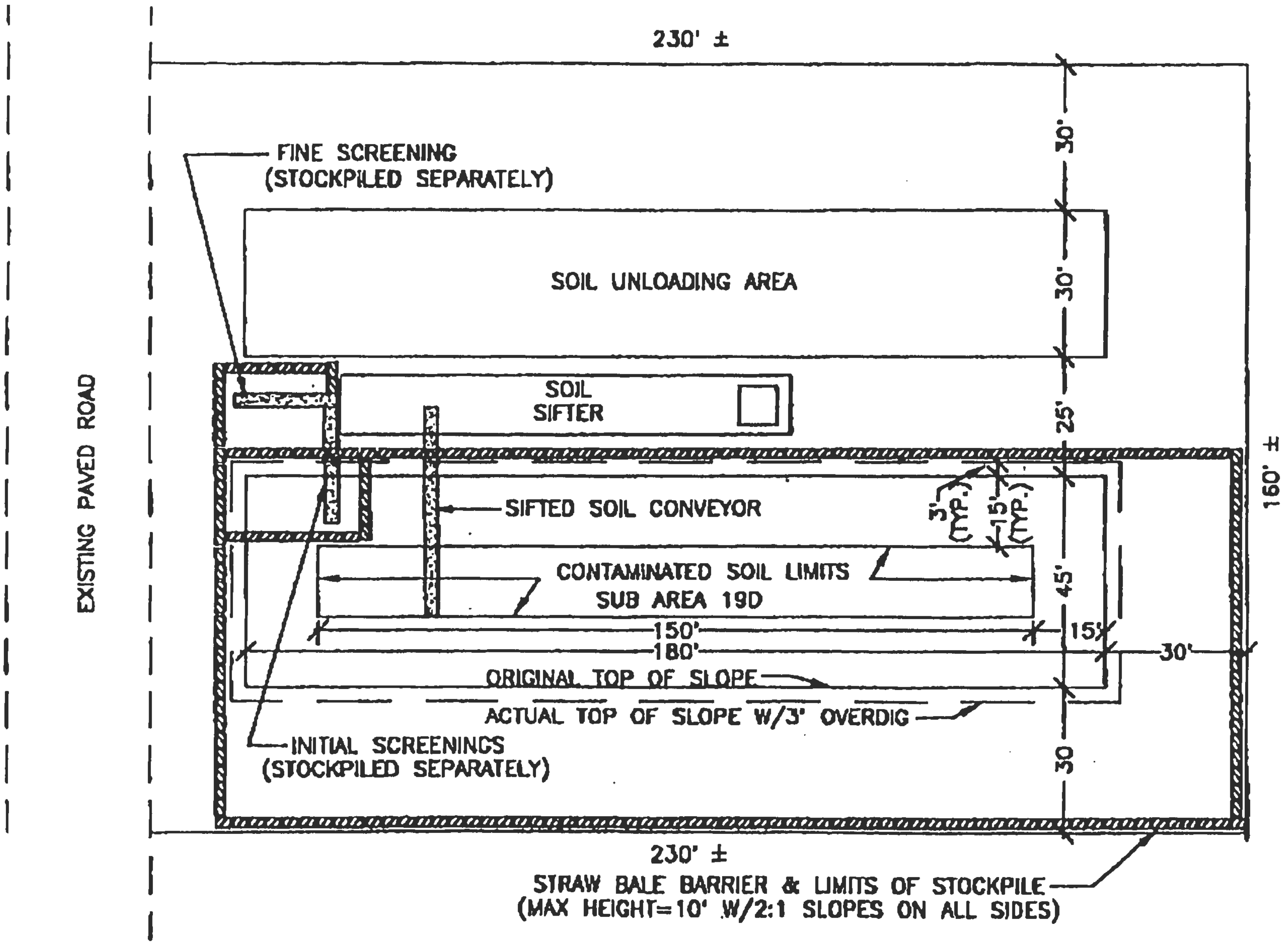
- The final two (2) screens will each be equipped with a side conveyor to transport oversized material not passing through the screen to an inspection and stockpile area. UXO Specialist stationed at each of these inspection areas will visually inspect at the screened materials and remove all UXO materials.
- In the event UXO not safe to move is encountered, all excavation and sifting operations will cease and all non-UXO personnel will leave the exclusion zone until the item is destroyed in place.
- Recovered inert metals will be stored in a collection bin and removed by a local scrap company as needed.
- This excavation and UXO removal process will be repeated until either the target excavation depth at each area is reached or no further ordnance is located, whichever occurs first.

The fueling and maintaining of the equipment will occur so as to minimize the down-time of the operations.

Figure 1 illustrates the layout of the excavation/sifting operation.

Excavations

The Site Safety Officer will examine excavations less than five feet in depth and determine if protective measures are necessary. For excavations deeper then five feet, UXO personnel will provide adequate shoring., sloping, and/or protective measures.



SIFTING OPERATIONS
Figure 1

CONSERVARE SALUTEM

AEHA

UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATION
INVESTIGATION OF SOIL CONTAMINATION AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT
ROMULUS, NEW YORK
13-19 AUGUST 1984

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

CPT Schroeder/orl/AUTOVON 584-2024

REPLY TO ATTENTION OF

HSHB-ES-E/WP

8 MAR 1985

SUBJECT: Hazardous Waste Study No. 37-26-0479-85, Phase 4 of AMC Open- Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at The Open Burning Grounds, Seneca Army Depot, Romulus, New York, 13-19 August 1984

Commander
US Army Materiel Command
ATTN: AMCSG
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

1. Copies of report with Executive Summary are enclosed.

2. This report presents results, for Seneca Army Depot, of the fourth phase of a comprehensive USAEHA program to investigate soil contamination at AMC open-burning/open-detonation (OB/OD) grounds, to evaluate these areas with respect to Federal hazardous waste regulations, and to determine which sites are best suited for continued OB/OD operations. Phase 1 involved screening AMC installations for potential soil, surface-water, and ground-water contamination in and around the OB/OD areas. Phase 2 involved a series of field studies to sample surface soils at the OB/OD areas. Phase 3 involved summarizing all of the Phase 2 studies into one overall evaluation of AMC OB/OD grounds. Phase 4 involved resampling selected OB/OD grounds to determine the horizontal and vertical extent of contamination identified during the Phase 2 studies. Reports for Phases 1 through 3 were issued under USAEHA Project No. 37-26-0147. For administrative purposes, Phase 4 reports will be issued under individual USAEHA project numbers.

3. Additional copies of this report are enclosed for mailing to Commander, US Army Corps of Engineers (DAEN-ZCF-U/DAEN-ZCE), and Commandant, Academy of Health Sciences (HSHA-IPM).

FOR THE COMMANDER:

Encl

KARL J. DAUBEL
Colonel, MS
Director, Environmental Quality

CF:
HQDA(DASG-PSP) (wo/encl)
Cdr, AMCCOM (AMSMC-SG/AMSMC-ISE) (w/encl)
Cdr, DESCOM (AMSDS-T) (w/encl)
Cdr, HSC (HSPA-P) (w/encl)
Cdr, SEAD (2 cy) (w/encl)
Cdr, USATHAMA (AMXTH-TE-D/AMXTH-ES) (w/encl)
Cdr, WRAMC (PVNTMED Svc) (w/encl)
Cdr, MEDDAC, Ft Devens (PVNTMED Svc) (2 cy) (w/encl)
C, USAEHA-Rgn Div North (w/encl)

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ES-E/WP

EXECUTIVE SUMMARY
HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATION
INVESTIGATION OF SOIL CONTAMINATION AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT
ROMULUS, NEW YORK
13-19 AUGUST 1984

1. PURPOSE.

a. To confirm the presence of specific heavy metals and explosives at open-burning (OB) pads B, F, and H.

b. To determine the vertical and horizontal migration of heavy metal and explosive contaminants at these OB pads at Seneca Army Depot.

2. ESSENTIAL FINDINGS.

a. Pad B contained lead and barium above the Extraction Procedure (EP) Toxic limits.

b. Pad F did not contain hazardous levels of 2,4,6-TNT.

c. The soils of Pads F and H were not hazardous and required no remedial action.

d. Trace explosives and EP Toxic metals were not migrating from pads B, H and F.

3. MAJOR RECOMMENDATIONS.

a. Close Pad B, level its berms, and cover the remnants of the pad with 2 feet of indigenous clay compacted in 6-inch lifts with a sheepsfoot roller.

b. Take no remedial action regarding Pads F and H.

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ES-E/WP

HAZARDOUS WASTE STUDY NO. 37-26-0479-85
PHASE 4 OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATION
INVESTIGATION OF SOIL CONTAMINATION AT THE OPEN BURNING GROUNDS
SENECA ARMY DEPOT
ROMULUS, NEW YORK
13-19 AUGUST 1984

1. AUTHORITY. Letter, HQ DARCOM, DRCIS-A/DRCSG, 13 March 1981, subject: Request for Services, Open-Burning/Open-Dentonation Grounds, with initial indorsement, HQ HSC, HSPA-P, 20 March 1981.

2. REFERENCES. A list of references is included in Appendix A.

3. PURPOSE.

a. To confirm the presence of specific heavy metals and explosives at OB Pads B, F, and H.

b. To determine the vertical and horizontal migration of heavy metal and explosive contaminants at these OB pads at SEAD.

4. GENERAL.

a. Abbreviations and Definitions. Definitions of terms and abbreviations used in this report are included in Appendix B.

b. USAEHA Personnel Conducting Study.

(1) CPT Joe R. Schroeder, P.E., Sanitary Engineer.

(2) Mr. William P. Smithson, Engineering Technician.

c. Personnel Contacted at SEAD.

(1) Mr. T. Battaglia, Environmental Coordinator.

(2) Mr. J. Jensen, Supervisor, OB/OD Grounds.

d. Background.

(1) Depot. Seneca Army Depot, established in 1941, primarily receives, stores, issues, and maintains munitions. The installation, which covers approximately 1,000 acres, is located near Romulus, New York, about 50 miles southwest of Syracuse. The active OB/OD operations are performed in the northwest portion of the installation, an area which has been used for this purpose since the post was activated. Figure 1 shows the layout of the OB/OD area. Some of the items burned in this area were machine gun ammunition (including tracers), fuses, and artillery projectiles containing TNT, Composition B explosive, and amatol.

(2) Previous OB Study at SEAD. A Phase 2 OB/OD Hazardous Waste Management Study was performed by USAEHA in May 1982. Twenty-four soil samples were taken from the upper 6 inches of the OB pads. These samples were analyzed for EP Toxic metals (arsenic, barium, cadmium, chrome, mercury, lead, selenium, and silver) and for explosives (RDX, tetryl, HMX, 2,4,6-TNT, 2,6-DNT and 2,4-DNT). During this previous study, lead was found in two samples from Pad B in excess of the hazardous waste limits established in 40 CFR 261. Nineteen of the twenty-four samples contained measurable explosives. RDX was found on all pads tested in the range of 1.0 to 7.0 µg/g, and tetryl was found in one sample from Pad D at 2.7 µg/g. One sample contained 9,270 µg/g of 2,4,6-TNT, 23.0 µg/g of 2,6-DNT, and 45 µg/g of 2,4-DNT. No other significant explosive levels were noted. This study concluded that the low number of contaminated soil samples did not warrant additional sampling at SEAD. AMCCOM, however, requested further study of the site.

e. Sampling Procedure.

(1) Soil Sampling. Soil samples were taken with a track-mounted, Mobile B-24 auger drill. A 4-inch-outside-diameter hollow-stem auger was used with the drill. Where possible, a 2-inch inside-diameter Shelby tube sampler was driven into the ground to extract an in situ sample for analysis of physical soil properties. This in situ sampling procedure was extremely difficult at SEAD due to the large amount of shale. Soil samples were taken for chemical analysis (see Appendix C for results) at the surface (0 to 6 inches) and at a depth of 6-12 inches. Subsequent samples were taken at 3- to 5-foot intervals or at any pronounced change in soil strata. Physical samples were taken of the clayey soil underlying the burning pads to roughly characterize its permeability. Due to difficulties encountered in using the Shelby samplers, in situ soil could not be extracted and, therefore, soil permeabilities were measured by recompacting the soil in a mold to standard proctor density. Drilling logs for the bore holes placed in this study are found in Appendix D.

(2) Water Sampling. Upon completion of bore holes, temporary monitoring wells were installed. The wells were constructed of schedule 40 polyvinyl chloride well screen. The screen was placed in the bore hole, and the lower 1 to 2 feet was surrounded by clean, medium- to coarse-

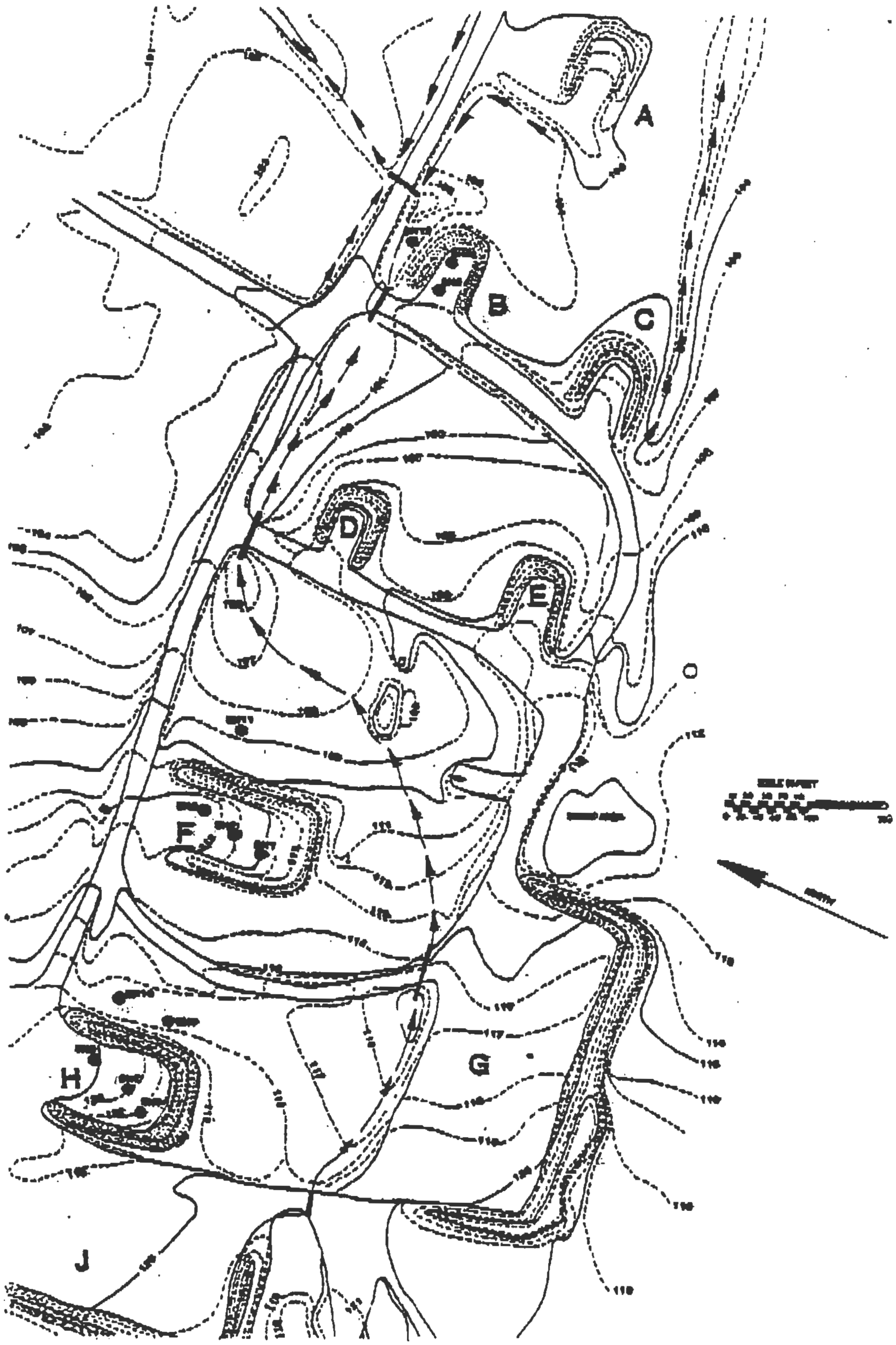


FIGURE 1. Site Plan of SEAD OB/OD Area

grained sand. The rest of the annular space surrounding the screen was sealed with bentonite clay. This enabled the water sample to be taken from the lower part of the well only. Many of the bore holes were not drilled into water-bearing strata. In all cases the amount of water found in the wells was, at the most, 2 gallons. The hard shale underlying the entire area prohibited drilling deeper with the available equipment. Immediately upon extraction from the temporary well, the water samples were filtered, preserved, and cooled for transport to the USAEHA laboratory. Analysis was conducted for EP Toxic metals and explosives (HMX, RDX, tetryl, 2,4,6-TNT, 2,6-DNT, and 2,4-DNT).

f. Surface Hydrology. The burning pads investigated in this report were located as shown on Figure 1. This is the general layout of the OB/OD area. Immediately south of the road connecting the three pads (B, F, and H), a very small ditch carried surface-water runoff to the east. The ditch was choked with weeds, and the area around the pads was marshy and contained standing water, indicating slow runoff. Out of the pad area, the ditch intersected a larger stream from which the surface water eventually drained into Seneca Lake. Sediment samples were taken at points where the ditch crossed under the road. At these points noticeable silting had occurred as the runoff velocity decreased forward of the culvert restriction.

5. FINDINGS AND DISCUSSION.

a. General. The primary purpose of this survey was to confirm the existence of barium on Pad B and lead on Pad H. These chemical constituents are of primary concern because they have been designated by the EPA as toxic hazardous waste, and concentration limits have been set as shown in Table C-5, Appendix C. Also of concern was the presence of trace explosives, primarily on Pad F. The objectives of the study were accomplished by drilling through the pad and taking soil samples at various depths. Drilling was halted when the drill met shale which it could not penetrate. Soil samples were labeled as to the approximate depth from which they came. This was by no means an exact process, as the samples were collected from the auger tailings. This means that the soil sample rode the auger to the top of the bore hole before it was taken. It is possible that soil from any particular depth could mix with soil from shallower depth, as it ascended the auger. In general, however, the soil samples are representative of the labeled depths. Soil samples were also taken from the surface of each of the three berms surrounding each pad. A sample of soil was taken from each berm by simply exposing the surface at several spots and collecting some soil. This method resulted in a composite sample representative of each berm. In analyzing results of such sampling, it must be kept in mind that a positive chemical result will definitely indicate the presence of the particular consituent, but a negative result does not positively indicate its absence. Conversely, any positive result does not imply that the chemical constituent is found throughout the berm in such concentration.

b. Pad F. The results of the chemical analysis of Pad F soil samples are presented in Table C-1, Appendix C. The layout of Pad F is shown in Figure 2. Trace amounts of lead, RDX, TNT and 2,4-DNT were found. All chemical constituents located here were found in very low concentrations, with the exception of lead in bore hole 3 at the 1- to 2-foot depth. This sample contained lead above the RCRA limit. Lead was not found in such concentration on Pad F in the Phase 2 study of this site. The presence of lead in this sample, on what was previously considered a lead-free pad, is indicative of what is generally a diverse and random scatter of material. Finding such a constituent is a hit-or-miss operation.

c. Pad B. The results for Pad B soil samples are presented in Table C-2, Appendix C. Pad B, shown in Figure 3, more than any other, presents a definite and logical pattern of contamination. All pads were constructed by placing crushed shale fill over the clay natural ground surface and then dozing up the berms around the pad. It was apparent from the subsurface drilling on Pad B that the pad was in use prior to placement of the shale. At approximately the 4-foot level, evidence of prior use (charred wood, bullets, and nails) was found in the auger turnings. In bore hole 5, two 1-quart jars were filled with the 50-caliber bullets (primarily tracers) that emerged from the hole. This indicates that there was a considerable number of lead bullets on the original pad when it was covered. Because of the presence of these bullets, it is not surprising that lead was found at that depth and that the barium level (a constituent of tracer mix) exceeded the RCRA standards. The highest barium and lead contamination was found in the composite samples taken from the north and east berms. These berms were probably constructed from the surface soil of an old burn pad or at least the soil surrounding such a pad. The berms are literally filled with bullets and assorted munition fragments and residue. Of all the pads investigated, Pad B, with its buried tracer bullets and littered berms, offers the most logical need for remedial cleanup action.

d. Pad H. Table C-3, Appendix C, shows the results of the chemical analysis of Pad H soil. Pad H, shown in Figure 4, was the cleanest of the pads examined in this study. All soil samples from the drillings were free of EP Toxic metals. The explosive HMX and the two DNT's were found at only trace levels. As with Pad B, the berm did show the existence of lead. Only the south berm had lead in it, and no other metal was detected. The lead was over the RCRA established limit by about 13 percent. The presence of this amount of lead in one sample should not be construed to mean that the entire berm has such a lead concentration and that remedial clean up or closure of the pad is, thereby, automatically the required procedure. This pad was exceptionally clean; if any action at all is taken, it should be strictly limited to the south berm, which should not be considered any more hazardous than the backstop of any US Army small arms firing range.

e. Soil Adjacent to Pads. Three soil borings were taken adjacent to the pads on the downgradient sides. Results are presented in Table C-4, Appendix C. No hazardous levels of EP Toxic constituents were found. Trace amounts of lead were found in the hole drilled adjacent to Pad B. Sediment from the runoff ditch was taken just north of Pad B where the ditch makes a sharp turn northward and enters a road culvert. Trace lead was reported to be in that sediment sample. All other sediment samples for the surface runoff ditch were clean. It is apparent from this sampling that the area around the pads and the runoff drainage paths were not constituting an environmental hazard.

f. Water Samples.

(1) Adjacent to Pads. Water samples were extracted from the wells installed in the bore holes. Not all bore holes held water. Therefore, Table C-6, Appendix C, does not contain representative samples for each hole. Bore holes 11 and 12, the last two on Table C-6, are the same referred to on Table C-4 concerning soil samples. These were taken outside the pads. No EP Toxic metals and only trace amounts of verifiable explosives were in the water extracted from these holes. It is apparent that if any significant amounts of trace metals or explosives are, in fact, on the pads, they are not migrating through the pads and to the ground water in detectable amounts. A physical analysis of the soil underlying the berms shows why this migration through the ground is limited. As shown in Table C-7, Appendix C, soil permeability tests on samples of the clay were very low. This clay has a permeability so low that, for practical engineering purposes, it is considered impermeable. Migration of hazardous metals or explosives through this soil and into the ground water is not an environmental hazard on SEAD.

(2) On Pads. Six of the bore holes drilled into the pads themselves collected enough water to provide samples for chemical analysis. Trace amounts of five of the EP Toxic metals were found in these samples. This is water that has percolated through the crushed shale on the pad. The water taken from two bore holes on each of Pads B and F contained concentrations of selenium and lead, respectively, in excess of the NIPDWR established by the EPA (40 CFR 141) and, as such, should not be consumed as a public drinking water source on a long-term basis. Selenium on Pad B was almost three times the drinking water standard. The lead found in bore holes 1 and 3 of Pad F exceeded the standard approximately twofold. Bore hole 2 on Pad F produced a water sample containing no detectable amount of lead. It is apparent from these results that although lead and selenium were found in the water under Pads F and B, the concentrations will be a problem only if the water is used as a public drinking water supply. Since there is no evidence of these constituents migrating from the pads, the adverse environmental impact is minimal.

g. Pad Closure. The contamination on Pad B, and only Pad B, is significant enough to require remedial action. This is primarily due to the quantity of buried tracer bullets which has been burned there and the similar material incorporated in the pad's berms. Although this contamination is not migrating off the site, it would be prudent to ensure that it never does so. Capping the pad and its berms with an impervious soil, such as the clay which is naturally occurring all over that area, will resist any hydrostatic force tending to drive the contaminant into the ground water. The best way to do this would be to simply push the berms over on the pad with a dozer and cover the pad with 2 feet of local clay. This should be compacted in 6-inch lifts with a sheepsfoot roller. The site should be graded to an even slope no greater than 2 to 3 percent and seeded with a fast-growing grass. Periodic inspections should be made to ensure no erosion or ponding of water on the site. No other pad requires such action.

6. CONCLUSIONS.

a. Pad B and its organic east and north berms contained lead and barium in levels exceeding established RCRA limits.

b. Pad F did not contain 2,4,6-TNT at levels which would require remedial action.

c. Pads F and H did not pose an environmental hazard which would require remedial action.

d. Contamination in the form of explosives or EP Toxic metal had not migrated beyond Pads B, H, and F and did not pose an environmental hazard which would require remedial action.

e. Although one sample of soil from Pad F and one from Pad H exceeded the EP Toxic limit for lead, the bulk of the soil and residue on these pads showed no contamination and, therefore, was not hazardous.

f. Soil borings on Pad B indicated extensive barium contamination existed at approximately the 4-foot level and that the material used in berm construction had similar contamination.

g. Capping of Pad B with impervious clay will prevent contaminants from moving down into the ground water in the future.

7. RECOMMENDATIONS. The following recommendations are based on good environmental engineering practices.

a. Close Pad B, level its berms, and cover the remnants of the pad with 2 feet of indigenous clay compacted in 6-inch lifts with a sheepsfoot roller.

b. Take no remedial action regarding Pads F and H.

8. TECHNICAL ASSISTANCE. Requests for services should be directed through appropriate command channels of the requesting activity to the Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-ES, Aberdeen Proving Ground, MD 21010-5422, with an information copy furnished the Commander, US Army Health Services Command, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000.

JOE R. SCHROEDER
CPT, MS
Sanitary Engineer
Waste Disposal Engineering Division

APPROVED:

for Richard L. Kussman, CPT, MS
FREDERICK W. BOECHER
MAJ, MS
Chief, Waste Disposal Engineering
Division

APPENDIX A

REFERENCES

1. Public Law (PL) 94-580, 21 October 1976, Resource Conservation and Recovery Act of 1976.

2. Title 40, Code of Federal Regulations (CFR), 1984 rev, Part 141, National Interim Primary Drinking Water Regulations.

3. Title 40, CFR, 1984 rev, Part 261, Identification and Listing of Hazardous Waste.

4. Title 40, CFR, 1984 rev, Part 262, Standards Applicable to Generators of Hazardous Waste.

5. Title 40, CFR, 1984 rev, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

6. Title 40, CFR, 1984 rev, Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

7. Installation Assessment of Seneca Army Depot, Records Evaluation Report No. 157, January 1980, USATHAMA, Aberdeen Proving Ground, MD.

8. Letter, USAEHA, HSHB-ES-H/WP, 14 September 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Seneca Army Depot, Seneca, New York, 2-13 May 1982.

9. Letter, USAEHA, HSHB-ES-E/WP, 19 October 1984, subject: Preliminary Report, Hazardous Waste Study No. 37-26-0479-85, Phase 4 of AMC Open Burning/Open Detonation Ground Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Seneca Army Depot, Romulus, New York, 13-18 August 1984.

APPENDIX B

ABBREVIATIONS AND DEFINITIONS

disposal	the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters
EPA	US Environmental Protection Agency
EP Toxicity	an extraction test to evaluate the leachability of eight different metals from a hazardous waste. The metals are arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), and selenium (Se)
facility	all contiguous land and structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste. For permitting purposes, a facility may consist of an entire installation or any part or combination of parts of that installation where treatment, storage, or disposal operations are located (see OB grounds, OD grounds, OB area, OD area)
ground water	water below the surface in a zone of saturation
hazardous waste	a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may: (1) cause, or significantly contribute to, any increase in mortality or an increase in serious irreversible or incapacitating reversible illness (2) pose a substantial present or potential hazard to human health or the envionment when improperly treated, stored, transported or disposed of, or otherwise managed
leachate	any liquid, including suspended components in the liquid, that has percolated through or drained from hazardous waste

NIPDWR	National Interim Primary Drinking Water Regulations
OB	open burning
OB area	that area or portion of the facility where open-burning operations are conducted (syn - OB grounds)
OB grounds	that area or portion of the facility where open-burning operations are conducted (syn - OB area)
OD	open detonation
OD area	that area or portion of the facility where open-detonation operations are conducted (syn - OD grounds)
OD grounds	that area or portion of the facility where open-detonation operations are conducted (syn - OD area)
open burning	Combustion of any material without the following characteristics: (1) Control of combustion air. (2) Containment of combustion reaction in an enclosed device. (3) Control of gaseous combustion product emissions. This definition includes open detonation.
RCRA	Resource Conservation and Recovery Act of 1976
SEAD	Seneca Army Depot
treatment	any method, technique, or process designed to change the chemical, physical, or biological character or composition of any hazardous waste so as to recover energy or material resource from the waste or to render such waste nonhazardous, or less hazardous, or safer to transport
USAEHA	US Army Environmental Hygiene Agency
USATHAMA	US Army Toxic and Hazardous Materials Agency

APPENDIX C

ANALYTICAL RESULTS

TABLE . PAD F SOIL SAMPLES

Sample No. and Description	As	Ba	Cd	Cr	Hg	Pb	Se	Ag	HMX	RDX	Tetryl	2.4.6-TNT	2.6-DNT	2.4-DNT
	EP Toxicity*								Explosives†					
0479-001 Bore hole 1, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND	1.3	ND	ND
0479-002 Bore hole 1, 6-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	ND	ND	ND	ND
0479-003 Bore hole 1, 4-6 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-004 Bore hole 2, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	ND	ND
0479-005 Bore hole 2, 6-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18.7	ND	ND
0479-006 Bore hole 2, 4-6 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-007 Bore hole 2, 5-6 feet	ND	ND	ND	ND	ND	1.430	ND	ND	ND	ND	ND	ND	ND	ND
0479-008 Bore hole 2, 7-8 feet	ND	ND	ND	ND	ND	0.79	ND	ND	ND	ND	ND	ND	ND	ND
0479-009 Bore hole 3, 0-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	ND
0479-010 Bore hole 3, 1-2 feet	ND	ND	ND	ND	ND	10.7	ND	ND	ND	ND	ND	ND	ND	ND
0479-011 Bore hole 3, 4-5 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-042 East Berm, composite	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-043 South Berm, composite	ND	ND	ND	ND	ND	2.616	ND	ND	ND	1.6	ND	124.5	ND	1.1
0479-044 West Berm, composite	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.2	ND	1.2	ND	ND
Detection Limit	0.500	10.000	0.100	0.500	0.020	0.600	0.100	0.500	1.0	1.0	5.0	1.0	1.0	1.0
RCRA Criteria Limit	5.000	100.000	1.000	5.000	0.020	5.000	1.000	5.000	NA	NA	NA	NA	NA	NA

* All units in mg/L
† All units in µg/g
ND - not detected
NA - not applicable

Table C-2. PAD B SOIL SAMPLES

Sample No. and Description	As	Ba	Cd	Cr	Hg	Pb	Se	Ag	HMX	RDX	Tetryl	2.4.6-TNT	2.6-DNT	2.4-DNT
	EP Toxicity*								Explosives†					
0479-012 Bore hole 4, 0-12 inches	ND	ND	ND	ND	ND	1.41	ND	ND	4.0	ND	ND	ND	ND	ND
0479-013 Bore hole 4, 1-2 feet	ND	ND	ND	ND	ND	3.81	ND	ND	ND	ND	ND	11.6	ND	ND
0479-014 Bore hole 4, 4 feet	ND	42.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-015 Bore hole 4, 4 1/2-6 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-016 Bore hole 5, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-017 Bore hole 5, 6-12 inches	ND	ND	ND	ND	ND	0.830	ND	ND	3.6	ND	ND	ND	ND	ND
0479-018 Bore hole 5, 3 1/2 to 4 1/2 feet	ND	187.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-019 Bore hole 5, 5-6 feet	ND	ND	ND	ND	ND	101.5	ND	ND	ND	ND	ND	ND	ND	ND
0479-045 North Berm, composite	ND	ND	ND	ND	ND	0.81	ND	ND	ND	ND	ND	ND	ND	ND
0479-046 East Berm, composite	ND	424.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-047 South Berm, composite	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR
Detection Limit	0.500	10.000	0.100	500	0.020	0.600	0.100	0.500	1.0	1.0	5.0	1.0	1.0	1.0
RCRA Criteria Limit	5.000	100.000	1.000	5000	0.020	5.000	1.000	5.000	NA	NA	NA	NA	NA	NA

* All units in mg/L
† All units in µg/g
ND - not detected
NR - not reported by laboratory
NA - not applicable

TABLE C-3. ..d H SOIL SAMPLES

Sample No. and Description	As	Ba	Cd	Cr (EP Toxicity*)	Hg	Pb	Se	Ag	HMX	RDX	Tetryl (Explosives†)	2.4.6-TNT	2.6-DNT	2.4-DNT
0479-020 Bore hole 6, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.3	1.7
0479-021 Bore hole 6, 6-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-022 Bore hole 6, 2-3 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-023 Bore hole 6, 4-6 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-024 Bore hole 7, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	2.0
0479-025 Bore hole 7, 6-18 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-026 Bore hole 7, 18-24 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-027 Bore hole 7, 3-4 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-028 Bore hole 8, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2
0479-029 Bore hole 8, 6-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
0479-030 Bore hole 8, 3 feet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-039 East Berm, composite	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-040 South Berm, composite	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-041 West Berm, composite	ND	ND	ND	ND	ND	5.64	ND	ND	ND	ND	ND	ND	ND	ND
Detection Limit	0.500	10.000	0.100	0.500	0.020	0.500	0.100	0.500	1.0	1.0	5.0	1.0	1.0	1.0
RCRA Criteria Limit	5.000	100.000	1.000	5.000	0.020	5.000	1.000	5.000	NA	NA	NA	NA	NA	NA

* All units in mg/L
† All units in ug/g
ND - not detected
NA - not applicable

C-3

TABLE C-4. SAMPLES TAKEN ADJACENT TO PADS

Sample No. and Description	As	Ba	Cd	Cr (EP Toxicity*)	Hg	Pb	Se	Ag	HMX	RDX	Tetryl (Explosives†)	2.4.6-TNT	2.6-DNT	2.4-DNT
0479-031 Bore hole 10 (East of Pad F, sample depth 0-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-032 Sample Destroyed in Transit	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0479-033 Bore hole 17 (East of Pad F) sample depth 0-12 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-034 Bore hole 12 (North of Pad B) sample depth 0-18 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-035 Bore hole 12 (North of Pad B) sample depth 18-30 inches	ND	ND	ND	ND	ND	1.510	ND	ND	ND	ND	ND	ND	ND	ND
0479-036 Ditch Sediment adjacent to Pad B	ND	ND	ND	ND	ND	0.603	ND	ND	ND	ND	ND	ND	ND	ND
0479-037 Ditch Sediment adjacent to Pads H and F	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0479-038 Ditch Sediment Northwest of Pad D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Detection Limit	0.500	10.000	0.100	0.500	0.020	0.500	.0100	0.500	1.0	1.0	5.0	1.0	1.0	1.0
RCRA Criteria Limit	5.000	100.000	1.000	5.000	0.020	5.000	1.000	5.000	NA	NA	NA	NA	NA	NA

* All units in mg/L
† All units in ug/g
ND - not detected
N/A - not applicable

TABLE C-5. DETECTION AND RCRA CRITERIA LIMITS

Analytical Limits[1]	As	Ba	Cd	Cr	Hg	Pb	Se	Ag
Detection Limit	0.500	10.000	0.100	0.500	.020	0.500	0.100	0.500
RCRA Criteria Limit	5.0	100.000	1.000	5.000	.020	5.000	1.000	5.000

[1] All units in mg/L

TABLE C-6. WATER SAMPLES

	EP Toxicity*							Explosives†					
Sample No. and Description	As	Ba	Cd	Cr	Pb	Se	Ag	HMX	RDX	Tetryl	2,4,6-TNT	2,6-DNT	2,4-DNT
0479-101 Bore hole 1, Pad F before rain	ND	ND	ND	ND	75.1	ND	ND	124.8	<30	<10	5.9	<1	<1
0479-102 Bore hole 1, Pad F after rain	ND	ND	ND	ND	112	ND	ND	<100‖	<30	<10	2.1	<1	<1
0479-103 Bore hole 2, Pad F	ND	ND	ND	1.27	ND	ND	ND	126.1‖	<30	<10	<1	<1	<1
0479-104 Bore hole 3, Pad F	ND	ND	ND	ND	95.2	ND	ND	165.5	<30	32.3	8.9	8.6	2.3
0479-105 Bore hole 4, Pad B	ND	374	ND	ND	ND	28.1	ND	<100	<30	<10	<1	<1	<1
0479-106 Bore hole 8, Pad H	6.90§	ND	ND	ND	ND	7.86	ND	139.9‖	<30	<10	89.9	3.1	1.6
0479-107 Bore hole 5, Pad B	ND	ND	ND	ND	13.3	22.9	ND	<100	<30	<10	3.3	<1	4.2
0479-108 Bore hole 11, East of Pad F	ND	ND	ND	ND	ND	ND	ND	<100	<30	<10	4.3	<1	<1
0479-109 Bore hole 12, North of Pad B	ND	ND	ND	ND	ND	ND	ND	166.6‖	<30	43.0	2.1	<1	<1
Detection Limit	10	300	1.00	1.00	5.00	5.00	255	100	<30	10	1	1	1

* All units in mg/L
† All units in μg/g
‖ interference - may not be HMX
§ The validity of this data is questionable since it is reported as less than the detection limit.
ND - not detected
NA - not applicable

TABLE C-7. LABORATORY ANALYSIS OF SOILS

Bore Hole No.	1	2	2	4	8
Depth of Sample	3	4	7	4	3
Sample Type	Bag	ST	Bag	ST	Bag
Grain Size Analysis					
% Passing No. 4 (sieve)	91.1	99.3	97.3	100.0	98.7
% Passing No. 10 (sieve)	78.8	98.4	91.4	99.7	96.3
% Passing No. 20 (sieve)	63.3	97.8	88.1	99.4	94.5
% Passing No. 40 (sieve)	60.6	91.8	79.2	96.0	82.6
% Passing No. 100 (sieve)	60.6	91.8	79.2	96.0	82.6
% Passing No. 200 (sieve)	45.8	84.7	76.6	92.7	71.8
Atterberg Limits					
Liquid Limit W_L	36.2	41.9	34.6	44.0	37.1
Plastic Limit W_P	30.1	24.2	20.7	30.9	23.4
Plastic Index I_P	6.1	17.7	13.9	13.1	13.7
Unified Soil Classification	SM	CL	CL	ML	CL
Permeability Cm/sc (k)					
Proctor Density - compaction mold	3.01×10^{-7}	1.41×10^{-7}	4.22×10^{-7}	6.88×10^{-7}	3.30×10^{-7}
Void Ratio (k)	0.588	0.585	0.620	0.793	0.515
% Saturation (k)	101.85	112.10	98.69	110.25	100.64
% Porosity (k)	37.0	36.9	34.2	44.2	34.0
Dry Density (k)	1.70	1.70	1.78	1.51	1.78
% Moisture Content (k)	22.0	24.3	19.0	32.4	19.2
Specific Gravity *assumed	2.7*	2.7*	2.7*	2.7*	2.7*

Hazardous Waste Study No. 37-26-0479-85, SEAD, NY, 13-19 Aug 84

200 sieve ≈ 75 μm
100 sieve ≈ 150 μm
40 sieve ≈ 400 μm
20 sieve ≈ 800 μm

APPENDIX D

DRILLING LOGS

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot — DATE 14 August 1984

LOCATION Southwest corner of Pad F — DRILLERS Schroeder, Smithson

DRILL RIG Mobile B-24 Track — BORE HOLE 1

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	composite	Shale fill w/fines, wood particles	
1	composite	crateing and 20 mm projectiles	
2			Damp Shale
3		Shale Fill	
4			
	composite		
5			
	physical	Weathered Gray Brown Clay	
6			
7		Shale	Refusal in Shale
8			
9			
10			

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT: Seneca Army Depot
DATE: 15 August 1984
LOCATION: Center of Pad F
DRILLERS: Schroeder, Smithson
DRILL RIG: Mobile B-24 Track
BORE HOLE: 2

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0–1	composite; composite	Shale fill on pad, unconsolidated	
3			Botton of Fill
3–5	composite and physical sample	Brown Clay	
5–6	composite	Water lens/Gray Brown Clay	
6–7		Dry Brown Clay	
7–9	composite and physical sample	Gray Shale and Gravelly Clay	Damp
9			Refusal

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 15 August 1984

LOCATION Northeast corner of Pad F DRILLERS Schroeder, Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 3

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
0–1	composite	Unconsolidate Shale Fill	
1–2	composite		Water at 1-1/2 ft.
3		Grey Brown Clay	
4	composite		
5		NOTE: Water filled the hole at the 1.5 foot depth. A shelby tube was pushed into the clay below the shale to set a well. The water level appeared to be about the same level as the marsh area to the west of Pad F.	

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT: Seneca Army Depot
DATE: 15 August 1984
LOCATION: Eastern Portion of Pad B
DRILLERS: Schroeder, Smithson
DRILL RIG: Mobile B-24 Track
BORE HOLE: 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
0–1	composite	Unconsolidated Shale Fill	Ground covered w/nails and hardware of burned crates and with bullets.
1–2	composite		
2–3			
3–4	composite		
4–5	composite and physical sample	Brown Clay	probably original clay under burn pad
5–6		Consolidated Shale	End of hole /Refusal
7			NOTE: Numerous 50 caliber bullets appeared at the 4-foot level. These bullets/tracers were burned approximately 20 years ago. Remains of burned wood also present.

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 16 August 1984

LOCATION Western end of Pad B DRILLERS Schroeder

Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
	composite		
1	composite	Unconsolidated Shale Fill	
2			→ Numerous 50 caliber bullets
3	composite sample	Brown Clay	
4		Weathered Shale	NOTE: The sample taken in the shelby tube had ash and wood mixed in the clay layer
5	Physical Sample		
6		Refusal/end of hole	

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95; 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT: Seneca Army Depot
DATE: 16 August 1984
LOCATION: Southwest corner of Pad H
DRILLERS: Schroeder, Smithson
DRILL RIG: Mobile B-24 Track
BORE HOLE: 6

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
	composite		
1	composite	Unconsolidated Shale Fill	
2			
	composite		
3		Gray color silty clay	Just under pad fill
4	composite	Sand and yellow streaks in clay	Probably below pad in original ground surface
5			
6		Consolidated Shale	Refusal/end of hole

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot

DATE 16 August 1984

LOCATION Center of Pad H

DRILLERS Schroeder, Smithson

DRILL RIG Mobile B-24 Track

BORE HOLE 7

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0–1	composite	Unconsolidated Shale Fill	
1	composite		
2	composite	Black silty material mixed in shale	odor of fuel oil
3	composite	Stiff Brown Clay	
4		Refusal/end of hole Consolidated Shale	
5			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 16 August 1984

LOCATION North end of Pad H DRILLERS Schroeder

Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 8

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
0–1	composite / composite	Unconsolidated Shale Fill	
1–2			
3–4	composite and physical samples	Brown Stiff Clay	
5		Consolidated Shale	end of hole/refusal

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 17 August 1984

LOCATION East of Pad H DRILLERS Schroeder, Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 9

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
1		Stiff Brown Clay	moist
2			
3		Grey/black weathered shale	dry
4			
5			no water
6			end of hole

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 17 August 1984

LOCATION East of Pad H DRILLERS Schroeder

Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 10

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
1	composite sample	Brown Stiff Clay	moist
2			
3		Gray-black weathered shale	dry
4			progessively harder drilling
5			End of hole/Refusal

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 17 August 1984

LOCATION East of Pad F DRILLERS Schroeder

Smithson

DRILL RIG Mobile B-24 Track BORE HOLE 11

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
1	composite sample	Brown Clay	
2			
3		Weathered Clay	water in hole slight seepage
4			
5			end of hole

HSHB-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT Seneca Army Depot DATE 17 August 1984
LOCATION North of Pad B DRILLERS Schroeder
Smithson
DRILL RIG Mobile B-24 Track BORE HOLE BH 12

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0–1	composite	Brown Clay	
1–2	composite sample	Weathered Grey/Black Shale	Water seepage
2–5			
5			end of hole NOTE: Bore hole located in marshy area adjacent to Pad B to the north between Pad and drainage ditch by road.

HSHB-ES Form 78, 1 Jun 80

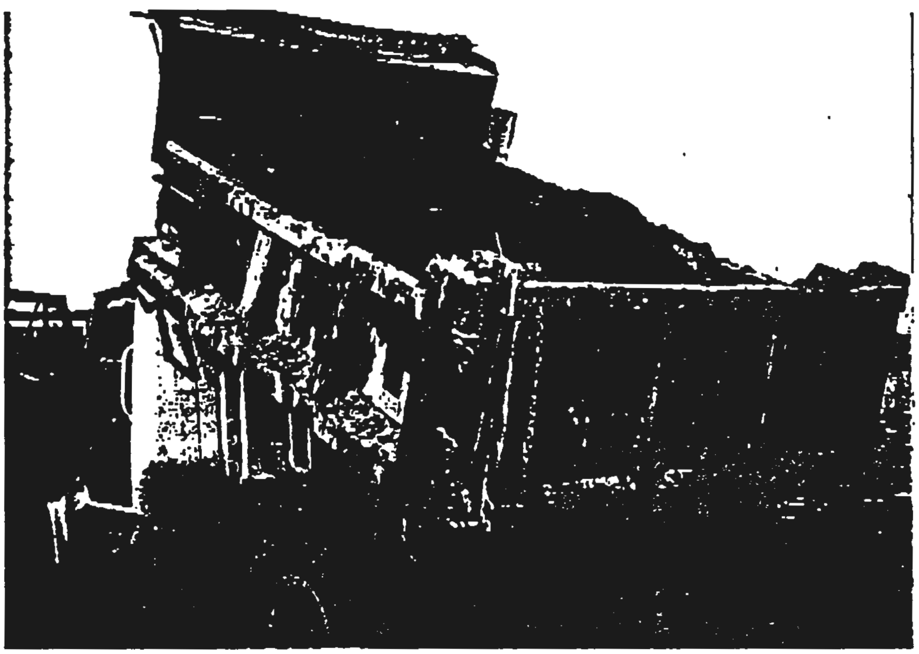
Replaces USAEHA Form 95, 12 Aug 74, which will be used.

APPENDIX G

PHOTOGRAPHS OF UXO CLEARANCE

AREA 3 (VALLEY) REMEDIATION.

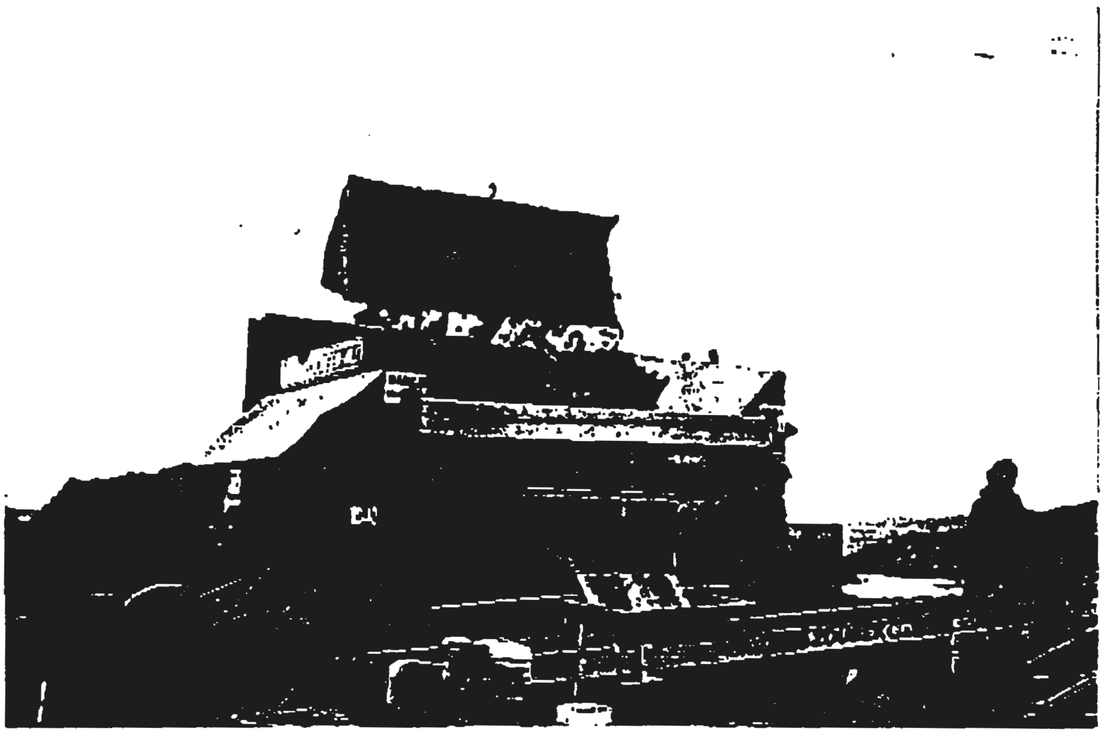
EXCAVATION OF AREA 3 VALLEY TO BE SIFTED.



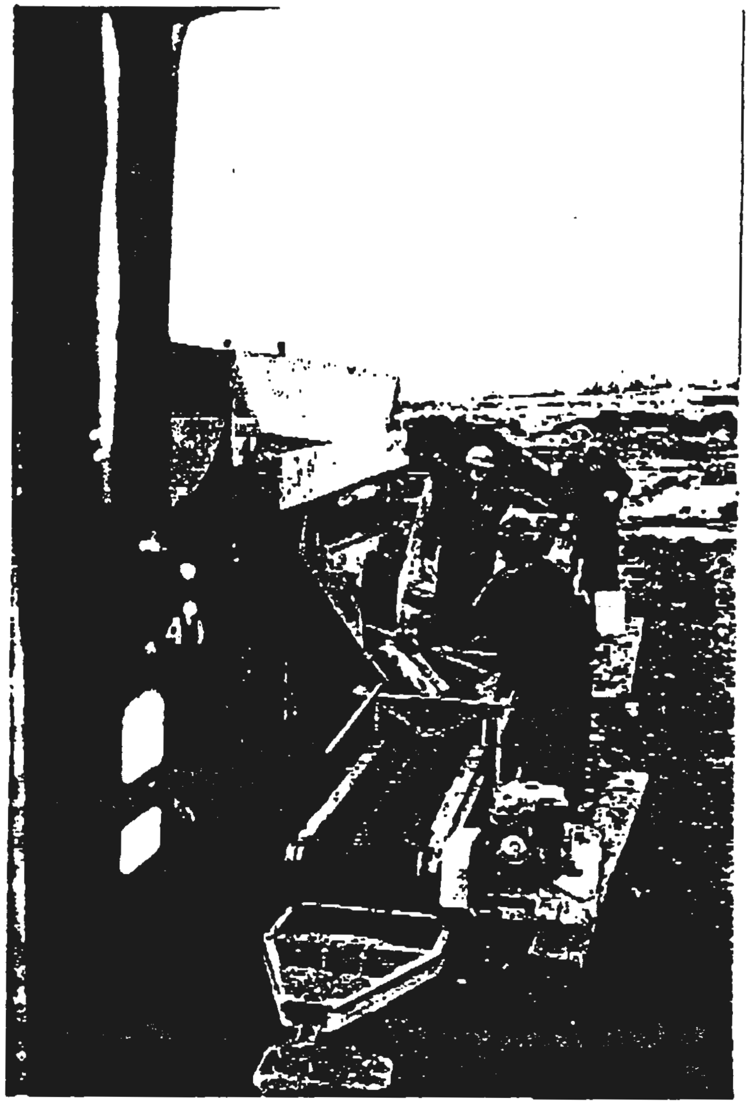
DIRT FROM VALLEY EXCAVATION BEING TAKEN TO SIFTER AREA.

Sifting Operation of dirt from Area 3 Valley.

Backhoe getting a front bucket load of dirt to be sifted.



Dirt to be sifted being dumped into sifter.



Items to large to go thru sifter are pulled onto belt and sorted and inspected by UXO Technicians.