104-28

Decision Criteria Document

for Solid Waste Management Units (SWMU)s and other Sites

at the Seneca Army Depot Activity (SEDA)

at Romulus, New York

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March 1998

DECISION CRITERIA DOCUMENT
FOR SOLID WASTE MANAGEMENT (SWMU) and OTHER SITES
SENECA ARMY DEPOT ACTIVITY (SEDA)
ROMULUS, NEW YORK

TABLE OF CONTENTS

DECISION CRITERIA DOCUMENT
FOR SOLID WASTE MANAGEMENT SITES and OTHER SITES
SENECA ARMY DEPOT ACTIVITY (SEDA)
ROMULUS, NEW YORK

1.0 INTRODUCTION

Identification of potential sites has been an on-going effort since the depot applied for their RCRA operating permit. The RCRA permit identified 72 Solid Waste Management Units (SWMU)s. These were locations where waste was produced and/or stored. Following inclusion on the National Priorities List (NPL) in 1991 and the signing of the Federal Facilities Agreement (FFA) in 1992 between Environmental Protection Agency (EPA), the New York State Department of Environmental Conservation (NYSDEC) and the Army, the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) were included in the evaluation of each site. Each of the SWMUs were evaluated to determine if releases to the environment have occurred or were likely to have. This was determined from previous investigative reports and from an understanding of the operations that occurred. An initial screening of sites from this information was performed to refine the status of these sites and establish a hierarchy of the sites. Financial and resource considerations had required establishing an investigation hierarchy of sites based upon a "worst first" philosophy. Sites perceived to exhibit the greatest threats were given higher priority status and were subsequently investigated first. Since 1990, efforts have been on-going to identify and address any issues associated with the final disposition of these sites.

In October of 1995, SEDA was selected as a base requiring closure. Closure requirements are described in the Base Realignment and Closure (BRAC) Act regulations and are intended to support a transition from military activities to civilian activities with the least disruption to the economic stability of the local communities as possible. Reuse of base facilities for economic development is a key component of the transition. BRAC required that the initial investigative hierarchy for sites be modified in order to address sites that are located within areas that have been identified as either leaseable or transferable parcels. Sites that are within areas that will be released from Army control will be given higher priority in order to limit any delays in the transfer or lease. The BRAC process also required an additional base-wide survey, the Environmental Baseline Survey (EBS), be conducted in order to identify any sites that had not been identified previously. Following the completion of the EBS, the number of potential sites have increased as a result of interviews with former employees and rumors uncovered during the preparation of the EBS.

With the number of confirmed or rumored sites now exceeding 100, a decision process has been developed to expedite the classification, evaluation and remediation (if necessary) for the remaining sites. The process developed is a refinement of the current decision process. The intent is to streamline and improve the efficiency of the existing process in order to achieve final disposition in as timely a manner as possible. This refinement of the decision making process is necessary, if BRAC closure goals are to be realized. Although many of the priority sites have either Record of Decisions (ROD)s pending or are nearing completion of the RI/FS efforts, the timeframe required

has been, in some cases, over 7 years. Improvement in resolving site conditions are essential for efficient resource allocation.

1.1 Purpose Of Document.

This document describes the decisions required for managing the remediation of sites at the Seneca Army Depot Activity. The plan is intended to streamline the remedial investigation procedure by allowing site which have little or no risk from chemical exposure to be dropped from further investigation. The plan will additionally identify sites that have more than minimal risk and serve as justification for further investigation or accelerated remedial action.

1.2 Recommendations of the Peer Review Team.

During 1997, an Army-wide program involving the reevaluation of the decisions and mechanisms used to resolve environmental conditions at sites was initiated. SEDA was selected as one of several facilities included in the review. On 1-4 April 1997, the projects at the Seneca Army Depot were reviewed by the peer review process. The peer review process is a mechanism through which Army installations can obtain outside, independent technical recommendations and limited technical applications assistance to ensure that there is an adequate level of risk reduction at all sites, while ensuring the efficient and effective use of the Army's environmental restoration funds.

The objectives of the peer review process are:

- Validate/enhance decision credibility,
- Evaluate rationale to scope and select action,
- Ensure the use of a site-specific risk assessment for chemical contamination,
- Ensure the use of a risk-based approach as the remediation decision tool for chemical contamination,
- Implement the most cost-effective solution which meets clean-up requirements,
- Utilize an "out of the box" thought process, and
- Refine cost estimates for budget submission requirements.

The Peer Review Team's recommendations involved a reevaluation of the decision criteria previously used at the SEDA and are outlined below:

Recommendation 1 : The Technical Assistance Team, also known as the Peer Review Team, recommends that Seneca Army Depot Activity clarify the site decision process through better specification of decision requirements in order to easily recognize, from data collection, when success has been obtained.

Rationale for Recommendation 1 : The current process needs specification of objective decision rules for how site data shall be used in determining the need to move from site screening to a site Remedial Investigation/Feasibility Study (RI/FS) and a Record of Decision (ROD). A process (i.e. removal action) should be implemented to accelerate final decisions so that Army resources may be shifted from studying site problems to expedited resolution and remediation, if appropriate.

Recommendation 2 : The Technical Assistance Team recommends that a policy be developed that provides a process for the determination of chemical remediation goals on the basis of risk assessment scenarios utilizing realistic future land use. Past/current land use and technical practicality of remedial activities should be considered when evaluating future reuse of the property. For example, if a site area is currently industrial and envisioned as industrial in its future proposed land use, then using residential risk limits to drive the site screening or TAGM limits may be overly restrictive and unnecessarily costly to the Army.

Rationale for Recommendation 2 : Remediation goals based on anything other than the proposed future use of the property, while recognizing past land use as potentially limiting, are inappropriate, resulting in elevated investigation and remediation costs. The Environmental Protection Agency (EPA) and individual state regulatory agencies no longer require that sites be restored to pristine conditions or to conditions that pose no risk under any risk scenario, including residential. Additionally, the Army has the ability to restrict access and future land use across specific limited areas of the site through deed restrictions or retention of the property of concern.

2.0 DECISION TREE APPROACH.

The tiered approach used in this report involves comparing site data to criteria, developed to represent media levels that are protective of the intended future use, with each evaluation becoming increasingly more site-specific. The initial, first tiered, decisions are made with a limited amount of data and therefore the criteria used to compare the data are conservative. However, as a site progresses through the decision tree additional amounts of data are collected and the comparisons are made against more site-specific criteria, eventually leading to a complete site-specific risk assessment, as described by CERCLA. The goal of this scheme is to provide the installation and the regulatory community with a defensible position regarding the health implications of each site. Comparisons to predetermined, "screening", criteria will allow remedial decisions to be attained as quickly as possible, thereby conserving the resources of all parties involved. The plan outlined in this document involves comparison screening of the site data from the Site Investigation/Preliminary Assessment reports using the NYSDEC Technical Administrative Guidance Memorandum (TAGMs) values; the Site Background Concentrations, Preliminary Remediation Goals (PRGs), a "mini-risk assessment" and, if necessary, a site-specific risk assessment. The process is graphically depicted in Figure 1. The following sections describe the processes and decisions highlighted in Figure 1.

The decision processes depicted in Figure 1 are grouped by the decisions to be made and the actions associated with these decisions. Decisions and actions are assigned either number or a letter so as to allow an easier understanding of what actions and decisions have been made and what need to be made for site disposition. Decisions are numbered and actions are given a letter designation. Each site will be designated with both a letter and a number in order to identify the point at which the site is within the decision tree.

Upon identification of a site, a limited amount of chemical data is collected to support the decision process. Although limited in the number and type of analyses performed, the data represents the

SENECA ARMY DEPOT ACTIVITY
Decision Criteria Flowchart

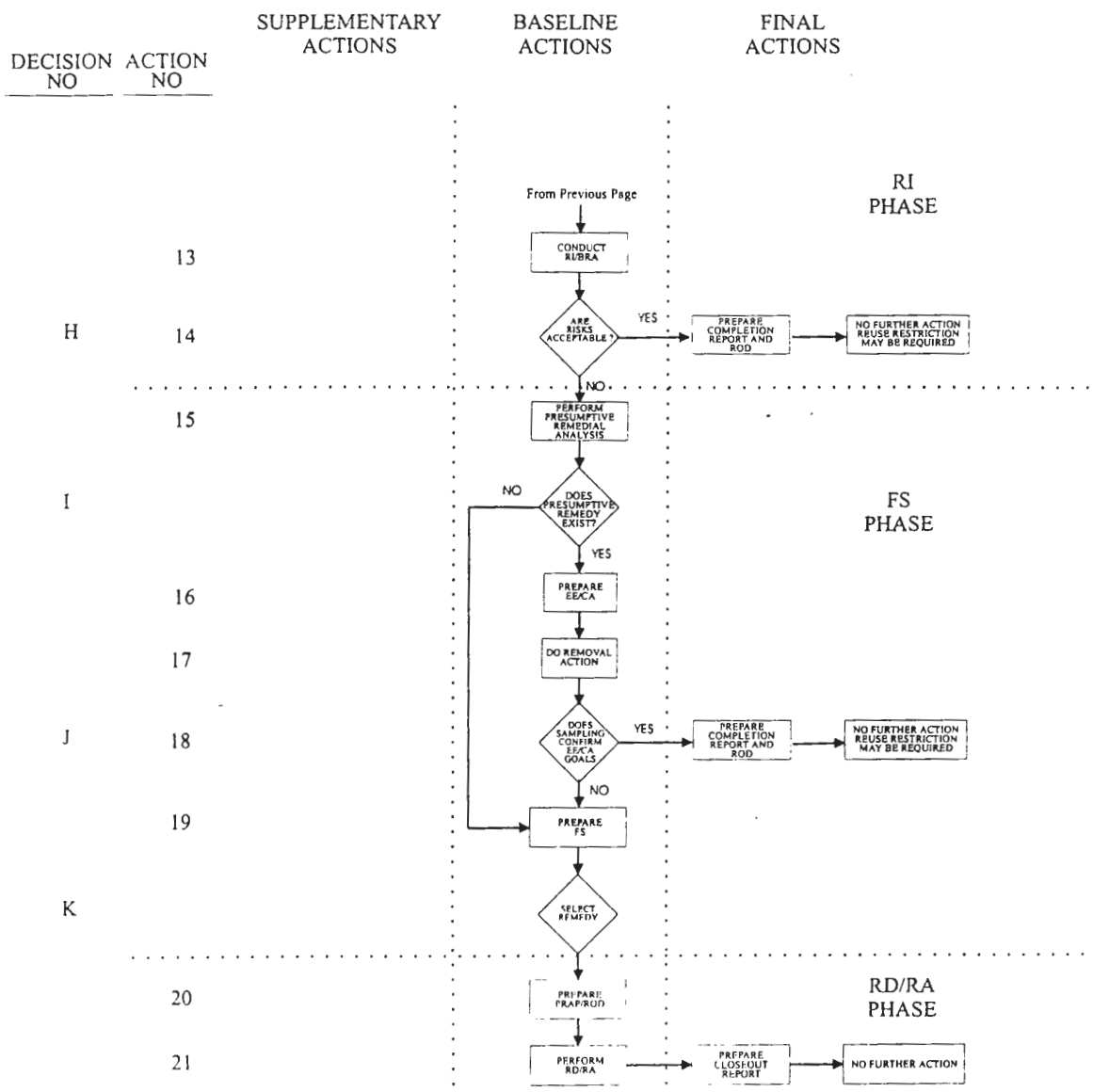

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FIGURE 1

Decision Criteria
Remediation Flowchart

SENECA ARMY DEPOT ACTIVITY
Decision Criteria Flowchart

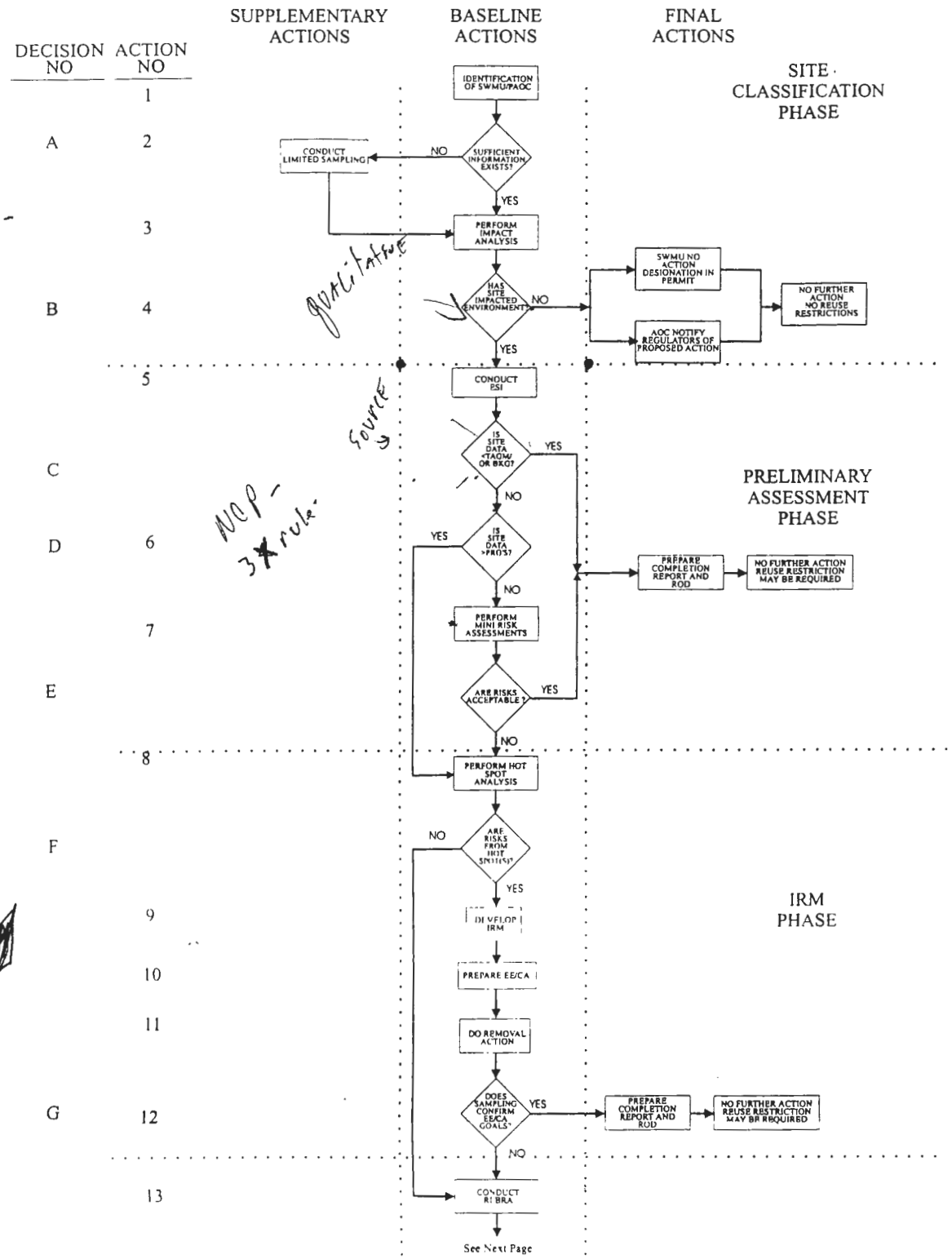

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FIGURE 1
Decision Criteria
Remediation Flowchart

worst conditions at the site observed to exist at the time of the data collection. The first decision to be made involves a comparison "screening" of the data against the TAGM values and background concentrations. If the comparison reveals exceedances above the TAGM value or background concentrations then the site may be retained for evaluation. However, if the concentrations are below these "screening" levels or in the opinion of the regulators that the exceedances are minimal, using professional judgment, then the site is eliminated from further consideration.

2.1 Technical Administrative Guidance Memorandum (TAGM) Values.

The NYSDEC has provided guidance for conducting site investigations through a series of guidance memorandums called Technical Administrative Guidance Memorandums (TAGM)s. One TAGM, TAGM Number 4046 included generic soil "screening" criteria that can be used in determining if site conditions warrant further investigative or remedial effort. The concentrations of chemicals in soil, described in this guidance memorandum, are regulatory guidance values, developed by the New York State Department of Environmental Protection (NYSDEC), intended to be protective of public health and the environment. They assume worst case exposure assumptions and are thus conservative. During the initial stages of the decision process ,the TAGM concentrations are compared to the maximum concentrations for each chemical determined to be at the site. If site concentrations are below the TAGM value then no further action is warranted. The procedures for applying the TAGM criteria are outlined in the state memorandum, which has been reproduced in Appendix B.

2.2 Site Background Concentrations.

During the years that activities have been on-going, soil and groundwater samples have been collected from locales that, at the time of collection, represent pre-release conditions at the site. Approximately 60 soil samples and nearly 25 groundwater wells have been included in this database. These values represent measured concentrations of the pristine environment within the Seneca Army Depot Activity. They generally consist only of inorganic parameters in samples collected from natural areas believed to have no impact from any depot operations or other incidental human activity. Infrequent occurrences of anthropogenic organic compounds, such as Polynuclear Aromatic Hydrocarbons, are also included in the background database.

2.3 Preliminary Remedial Goals (PRG)s.

PRGs have been developed and were proposed as a, SEDA-specific, decision criteria alternative to the current conservative NYSDEC TAGM criteria. These alternative values are media concentrations that represent assumptions of exposure for future land use at SEDA, outlined in the future land use plan and would be compared to the maximum concentrations for each chemical present at a site. PRG values were derived assuming that a carcinogenic risk of 1E-06 and a non-carcinogenic risk of 1 are the defined points of departure for determining health risk to human receptors. Ecological receptor evaluations uses a risk threshold of 10 as a point of departure. The NYSDEC have rejected PRGs or any other risk-based derived alternative to TAGM as unacceptable decision criteria. Although PRGs cannot be used to satisfy regulatory criteria for site release.

comparisons to PRGs have been retained for inclusion in the decision process. Comparisons to PRGs are, however, only useful as guidelines for internal Army decisions regarding the efficacy of implementing an IRM. PRG values for human health and ecological protection are presented as Tables 1 and 2.

2.4 Miniature Risk Assessment.

Since the use of PRGs as an alternative to TAGMs is unacceptable, a streamlined risk evaluation process, called the miniature risk assessment, i.e. the "mini-risk assessment", has been proposed as an alternative. The "mini-risk assessment" will follow the same processes required for an RI risk assessment, utilizing previously established, standardized exposure assumptions, without the text required to detail the risk assessment. In this manner, site evaluation methods acceptable for regulatory review can be used as the final criteria in support of site disposition. This is a calculation following the CERCLA Baseline Risk Assessment paradigm. It uses site specific assumptions for exposure and the upper 95th level values for each chemical. The calculated cumulative risk is compared to a non-carcinogenic risk range of 1-10 and a carcinogenic risk range of 1E-04 to 1E-06.

max number

2.5 Interim Remedial Measures (IRM).

Sites can exit the process without having to complete the entire RI/FS process. This will expedite the disposition of many of the remaining sites at the SEDA. These sites are limited in extent and the problems associated with them can be readily identifiable and eliminated. This will result resource expenditures for site remediation rather than report preparation. To achieve this goal the decision process makes full use of the Interim Remedial Measure (IRM), also known as a Removal Action. Implementation of IRMs, where appropriate, is promoted as a viable option to the RI/FS process in achieving rapid and final site resolution. IRMs are a key facet of the process and can be proposed once site conditions are sufficiently understood to identify the problem. This requires collection of a sufficient amount of environmental quality data, usually as performed as an Expanded Site Investigation (ESI), prior to the implementation of the RI. In some respects an ESI and an IRM is a streamlined RI/FS process. An IRM, like an FS, involves preparation and submission of documents will describe the reasons for and justify the selection of a particular action. Regulatory agencies will be afforded an opportunity to provide comment and input as part of reviewing the IRM supporting documents. This will include preparation of an Engineering Evaluation/Cost Analysis (EE/CA) that will describe the evaluation process for alternative selection and present cost information for the alternatives.

IRMs are identified at two levels of the process to eliminate exceedances of PRGs and/or to eliminate "hot spots". Site data above PRGs would be candidates for an IRM. In most instances, IRMs are mutually inclusive as a means to eliminate both "hot-spots" and PRG exceedances. If PRGs are exceeded without "hot spots", a "mini-risk assessment" may be preferred to document site conditions. If an IRM is conducted, site confirmation data will be combined with a "mini-risk assessment" to substantiate the conditions at the site have been attained and there is no need to proceed with additional investigative efforts. If, on the other hand, unacceptable conditions remain, the site is considered to be a candidate for a full RI/FS.

3.0 COMPARISON TO PRELIMINARY REMEDIAL GOALS (PRG)s

3.1 Uses and Limitations.

The PRG tables contain reference doses and carcinogenic potency slopes (obtained from IRIS through April 1, 1996, HEAST through May 1995, the EPA-NCEA Superfund Health Risk Technical Support Center, and other EPA sources) for the chemicals found at the SEDA. These toxicity constants have been combined with exposure scenarios applicable to the reasonably expected for the future development of the SEDA. The combination of these factors yields risk based concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of one, or lifetime cancer risk of 1E-06, whichever occurs at a lower concentration) in water, air and soil. These values can be used to screen sites for IRMs, identify hot spots, or rapidly respond to citizen inquiries.

These PRG values also have limitations, most notable is the lack of any consideration of cumulative risk from multiple media or chemicals.

3.2 Development of PRGs

Separate carcinogenic and non-carcinogenic PRGs were calculated for each compound, pathway and exposure scenario. The controlling concentration in the final tables are the lower of the two for each exposure scenario. The controlling concentration can be found in bold type. Table 1 and Table 2 list the terms and values were used in the calculations:

3.3 Age-Adjusted Factors.

Because contact rates with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risks for the residential setting during the first 30 years of life are usually calculated using age-adjusted factors. These factors approximate the integrated exposure from birth to age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults. Age-adjusted factors were not used for soil or ambient air exposures in this evaluation since none of the sites at the SEDA are within areas designated for residential development. Therefore, residential exposure has not been included in the development of PRGs. However, age-adjusted factors were used in the tap water exposure (including the exposure to chemicals volatilized from the tap water) since groundwater contaminants may be mobile. These values are provided to evaluate the off-post residential groundwater exposure, if it is applicable to any site.

Air Inhalation:

$$IF_{Aadj}\left(\frac{m^3 * y}{kg * d}\right) = \frac{EDc * IRAc}{BWc} + \frac{(EDtot - EDc) * IRAa}{BWa}$$

Tap Water Ingestion:

$$IFWadj\ \frac{L*y}{kg*d} = \frac{EDc*IRWc}{BWc} + \frac{(EDtot-EDc)*IRWa}{BWa}$$

Table 1. General Exposure Variables

Exposure Variable	Value	Symbol
Carcinogenic Potency Slope Oral(risk per mg/kg/d)	Chemical Specific	CPSo
Carcinogenic Potency Slope Inhaled(risk per mg/kg/d)	Chemical Specific	CPSi
Reference Dose Oral (mg/kg/d)	Chemical Specific	RfDo
Reference Dose Inhaled (mg/kg/d)	Chemical Specific	RfDi
Target Cancer Risk	1E-06	TR
Target Hazard Quotient	1	THQ
Body Weight, Adult (kg)	70	BWa
Body Weight, Child (kg)	15	BWc
Averaging Time, Carcinogens (d)	25550	ATc
Averaging Time, Non-Carcinogens (d)	ED*365	ATn
Inhalation, Adult (m3/d)	20	IRAa
Inhalation, Child (m3/d)	12	IRAc
Inhalation Factor, age adjusted (m3-y/kg-d)	11.66	IFAadj
Tap Water Ingestion, Adult (L/d)	2	IRWa
Tap Water Ingestion, Child (L/d)	1	IRWc
Tap Water Ingestion Factor, age adjusted(L-y/kg-d)	1.09	IFWadj
Soil Ingestion, Adult (mg/d)	100	IRSa
Soil Ingestion, Child (mg/d)	200	IRSc
Soil Ingestion, Construction Worker (mg/d)	480	IRSw

Table 2. Scenario Specific Exposure Variables

Exposure Variable	Value	Symbol
Industrial Exposure Scenario		
Exposure Frequency (d/y)	250	EFo
Exposure Duration (y)	25	EDo
Fraction of Contaminated Soil Ingested (unitless)	0.5	FCo
Recreational/Trespasser Exposure Scenario		
Exposure Frequency (d/y)	50	EFrec
Exposure Duration (y)	5	EDrec
Fraction of Contaminated Soil Ingested	1	FCr
Surface Water Ingestion, Adult (L/d)	0.08	IRSWa
Surface Water Ingestion, Child (L/d)	0.05	IRSWc

3.4 Residential Water.

Volatilization terms were calculated only for compounds with Henry's Law constants greater than 1E-05. The equations and the volatilization factor (K) were obtained from RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds. PRGs for carcinogens were based on combined childhood and adult exposure; for Non-Carcinogens PRGs were based on adult exposure.

Carcinogens:

$$PRGs\left(\frac{ug}{L}\right) = \frac{TR*ATc*1000\ ug/mg}{EFr*([K*IFAadj*CPSi]+[IFWadj*CPSo])}$$

Non-Carcinogens:

$$PRGs\left(\frac{ug}{L}\right) = \frac{THQ*BWa*ATn*1000\ ug/mg}{EFr*EDtot*(([K*IRAa]/RfDi)+(IRWa/RfDo))}$$

3.5 Ambient Air.

PRGs for carcinogens were based on combined childhood and adult exposure; Non-carcinogen PRGs were based on adult exposure only.

Carcinogens:

$$PRGs\left(\frac{ug}{m3}\right) = \frac{TR * ATc * 1000\ ug/mg}{EFr * IFAadj * CPSi}$$

Non-Carcinogens:

$$PRGs\left(\frac{ug}{m3}\right) = \frac{THQ * RfDi * BWa * ATn * 1000ug/mg}{EFr * EDtot * IRAa}$$

3.6 Commercial/Industrial Soil Ingestion.

PRGs were based on adult occupational exposure, including an assumption that only 50% of the total soil ingested is work-related.

Carcinogens:

$$PRGs\left(\frac{mg}{kg}\right) = \frac{TR * ATc * BWa}{EFo * EDo * (IRSa/1E\text{-}06) * FC * CPSo}$$

Non-Carcinogens:

$$PRGs\left(\frac{mg}{kg}\right) = \frac{THQ * RfDo * ATn * BWa}{EFo * EDo * (IRSa/1E\text{-}06) * FC}$$

3.7 Residential Soil.

PRGs for the residential exposure were not calculated since sites at the SEDA do not exist in the areas scheduled for residential development.

3.8 Recreational Soil.

PRGs for carcinogens were based on adult exposure; for non-carcinogen PRGs were based on childhood exposure.

Carcinogens:

$$PRGS\left(\frac{mg}{kg}\right) = \frac{TR * ATc * BWa}{EFrec * EDrec * (IRSa/1E\text{-}06) * FCr * CPSo}$$

Non-Carcinogens:

$$PRGS\left(\frac{mg}{kg}\right) = \frac{THQ * RfDo * ATn * BWc}{EFrec * EDc * (IRSc/1E\text{-}06)}$$

3.9 Recreational Surface Water.

These values are based on the incidental ingestion of surface water. PRGs for carcinogens were based on adult exposure; for non-carcinogen PRGs were based on childhood exposure.

Carcinogens:

$$PRGs\text{------} = \frac{ug}{L} = \frac{TR*ATc*BWa}{EFrec*EDrec*(IRSWa/1E\text{-}06)*FCr*CPSo}$$

Non-Carcinogens:

$$PRGs\text{------} = \frac{ug}{L} = \frac{THQ*RfDo*ATn*BWc}{EFrec*EDc*(IRSWc/1E\text{-}06)}$$

3.10 Ecological Receptor.

Ecological PRGs were calculated based on the toxicological response of the field mouse to chemicals in the soil. The route of exposure was assumed to be ingestion with the mouse's diet being chemical containing plants, insects, and soil. The mouse is further assumed to have its entire range wholly contained in the site. The evaluation was conducted using a hazard quotient approach, similar to the non-carcinogenic calculations performed for the human health evaluation. Ecological Quotients (EQ), quantitative expression of risk, were calculated by chemical for the receptors of concern. The EQs assumed for this evaluation were 10. The equations used for calculating the threshold soil concentration were:

$$CS= [(TRV)(EQ)(BW)]/[(SUF)((IS)+(IP*SP)+(IA*BAF))]$$

Where:

EQ = Quantification of risk to a species
TRV = Toxicity reference value
SFF = Site foraging factor (unitless)
CS = Concentration in soil (mg/kg)
IS = Ingestion rate of soil (mg soil/day)
BW = Body weight of an organism
IP = Ingestion rate of plant material(mg plant material/day)
SP = Soil to plant transfer ratio for a specific chemical (unitless)
IA = Ingestion rate of animal/insect material(mg animal tissue/day)
BAP = Bioaccumulation Factor for a specific chemical (unitless).

4.0 MINIATURE RISK ASSESSMENT

The threat from a site can be quantified by performing a streamlined risk assessment, the mini-risk assessment. The mini-risk assessment is intended to provide a quantitative evaluation of the threat that each site may pose by evaluating the site risk. Risk assessment has already been performed at several of the higher priority sites and the future land use scenarios have been clearly described as part of the Base Realignment Plan. As a result, the use of risk assessment as a tool for developing and supporting planning decisions regarding the disposition of the remaining sites that exist at SEDA is appropriate.

The mechanisms of conducting the mini-risk assessment will follow the same mechanisms that have been used for conducting baseline risk assessments at several of the other sites with the exception that the maximum concentration of a component will be used instead of the Upper 95th Confidence Limit (UCL) of the mean. This is because at many of these sites, the existing database is small. Using the maximum detected value will provide an added degree of conservatism because the sampling that has been performed was biased in areas that, based upon historical information, were representative of a release.

The objectives of the mini-risk assessment are: to quantify the threat that a site may pose; to help determine whether a remedial investigation is necessary; to provide a basis for determining if a removal action will eliminate the threat; and to help support selection of the "No Action" remedial alternative, where appropriate. To meet these objectives, the Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989a) was followed when possible and applicable. Technical judgment, consultation with USEPA staff, and recent publications were used in the development of the baseline risk assessment.

4.1 Identification Of Chemicals Of Concern

Data collected during the Expanded Site Inspections (ESI)s will be evaluated for use in the mini-risk assessment. The suitable ESI data were then evaluated to determine maximum exposure point concentrations (EPCs) for all chemicals of potential concern.

4.1.1 Background Screening

Providing the database is large enough to justify a comparison, comparisons between site data and background will be performed for each site constituent, including, where practicable, anthropogenic organic constituents. Both soil and groundwater datasets will be screened against background.

The Wilcoxon Rank Sum test (WRS test) or other appropriate statistical method will be used to compare the on-site datasets to background datasets. The basis for this statistical comparison was obtained from the EPA Guidance document Statistical Methods For Evaluating The Attainment Of Cleanup Standards (EPA, 1994) and Statistical Methods For Environmental Pollution Monitoring (Gilbert, 1987). The use of the WRS test as a statistical method used to determine if the differences between contaminant concentrations in background areas and the sites being investigated are beyond what would be expected from measurement error.

4.2 Exposure Assessment

An exposure point concentration is the concentration of chemical(s) in a given medium to which an actual or hypothetical receptor may be exposed at a specific location, known as the "exposure point." Exposure point concentrations can be based on analytical data obtained from on-site sampling, estimated through modeling, or based on a combination of the two.

For purposes of this mini-risk assessment, three potentially exposed populations will be considered. Under the current land-use scenario, the single exposed population will include a site worker. Under the future land-use scenario, two exposed populations will be considered: a child and an adult trespasser, and a construction worker. Future on-site residential land use will not be considered as this would be inconsistent with the intended future land uses as defined by the Base Realignment Committee (BAC). The pathways presented reflect the current onsite and the projected future onsite uses of the remaining sites. This section, describes the exposure pathways that will be considered for each exposure scenario.

Ingestion and dermal contact from surface water and sediment while swimming were considered to be an unrealistic current and future pathways of exposure because of the depth of nearby drainage ditches are at most only a few inches and would prevent a receptor from swimming.

4.3 Exposure Receptor Groups

4.3.1 Site Worker

Exposure to a site worker will be considered. For this scenario, ingestion and dermal contact with on-site surface soils, and inhalation of particulates in ambient air will be considered.

4.3.2 Site Construction Worker

The site construction worker will also be considered. For this scenario, ingestion and dermal contact with all surface and subsurface on-site soils, and inhalation of particulates in ambient air will be considered.

4.3.3 Site Trespasser/Recreational User

The third exposure scenario will be the site trespasser/recreational user. For this scenario, ingestion and dermal contact with on-site soils, and inhalation of particulates in ambient air will be considered.

4.4 Exposure Pathways

4.4.1 Inhalation of Particulates in Ambient Air

Particulates in ambient air will be estimated using a model to determine the release rate from soils to air. Each of the three receptors will be considered. The site worker and the site trespasser will be exposed to particulates from the surface soils at the sites. This pathway will also be evaluated for the future construction worker exposure scenario. For the construction worker, the source of the particulate matter will be both subsurface soils and surface soils. Subsurface soils may be brought to the surface during excavation activities, thereby increasing the amount of particulates that are inhaled. The concentration that is the highest from either surface of subsurface soils will be used as the exposure concentration.

4.4.2 Incidental Ingestion and Dermal Contact to On-Site Soils

During the course of daily activities, a site worker or trespasser could come into contact with surface soils and may involuntarily ingest and/or have their skin exposed to them. Therefore, a quantitative assessment pathway for both dermal contact and soil ingestion will be performed. The site construction worker will also be considered, however, this receptor will be exposed to both surface and subsurface soils, whichever concentration is higher. For the site worker and site tresspasser/recreator, exposure will be from only surface soil data collected from the 0 to 0.5 foot interval. For the construction worker exposure, all soil data will used as it is assumed that the construction worker will engage in intrusive activities

4.4.3 Incidental Ingestion and Dermal Contact to Surface Water and Sediments While Wading

In general, surface water and sediment exposures occur simultaneously because of the logistics involving both media. An on-site trespasser/recreator may become exposed to surface water and/or sediments, following precipitation events, through wading. Because of the limited size and depth of the drainage ditches, swimming was not deemed a potential exposure scenario. Exposure to surface water and sediments will be considered separately.

4.5 Quantification of Exposure

Quantitative assumptions of exposure will be made using the Standard Default Exposure Factors (USEPA, 1991), the methodologies contained within RAGS, (USEPA, 1989a) or the Exposure Factors Handbook (USEPA, 1989b).

Exposure Point Concentrations (EPC)s will be estimated for all pathways selected for quantitative evaluation. These concentrations will be obtained from the maximum measured values (for soil, sediment, surface water, and groundwater) or on modeling results (for air). Exposure-point concentrations will be multiplied by human intake variables to obtain chronic daily intake values. Intakes will be normalized for body weight over time and will be expressed in milligrams per kilogram of body weight per day (mg/kg-day). The total exposure will be averaged over the time period of interest to obtain an average exposure. For noncarcinogenic effects, the exposure time will be 30 years, for carcinogenic effects, it will be a lifetime, 70 years.

Intake doses associated with exposure pathways for each scenario will be obtained. These doses will be used to characterize the risk for carcinogenic and non-carcinogenic risk. Noncarcinogenic (Nc) risks will be expressed as a Hazard Quotient (HI). Carcinogenic (Car) risks will be expressed as a dimensionless value representing increased cancers per population size. A Reference Dose (RfD), for Nc risks, and a Slope Factor (SF) will used to establish Car risks values.

For pathways involving inhalation of ambient air or groundwater only adult receptors will be considered. For all other pathways, a combined child/adult receptor will be used which corresponds

to a 6 year/24 year breakdown over a 30 year exposure period. Intake calculations by media and exposure routes are presented in the following subsections.

Estimates of exposure concentration relative to the four media (air, surface water, sediment and soil), are established and discussed prior to quantification in the representative exposure pathways. For most exposure pathways involving soil, only surface soil data from the 0 to 0.5 foot depth interval were used. The exception is the future construction worker scenario, in which all soil data were used. In determining the RME exposure point concentrations (EPCs), the maximum detected value will be selected.

4.5.1 Inhalation of Particulates and VOCs in Ambient Air

This pathway consists of volatile organics being released from soils to the air and then being transported via wind dispersion to all current and future receptors.

The exposure concentrations for inhalation of volatile organics in ambient air will be derived from a flux equation estimating E_i, the emission rate of the organics from the soil.

During construction activities, construction workers may be exposed to chemicals in site soils via inhalation. Construction activities, such as excavation, have the potential to create dust, or suspended particulate matter (PM), originating from the soils being removed. This dust would contain the chemicals present in the soil. In addition to PM, VOCs contained in the soil may be released at an enhanced rate due to excavation. Construction workers in the construction area would breathe this PM and VOC in the ambient air.

Air concentrations of site chemicals of concern were estimated for this exposure pathway using excavation models recommended in the USEPA's "Models for Estimating Air Emission Rates from Superfund Remedial Actions" (EPA 451/R-93-001).

4.5.2 Inhalation of Particulates in Ambient Air

The quantification of this exposure pathway will be performed for all receptors. The equation for the intake is as follows (EPA,1989a):

$$\text{Intake (mg/kg/day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

where:

CA = Chemical concentration in air (mg/m^3) (modeled value)
IR = Inhalation Rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Bodyweight (kg)

AT = Averaging Time (days)

Compounds detected in soil during the sampling program will be modeled to predict receptors concentrations in air (CA). The inhalation rate (IR) will be 20 m^3/day, the average adult inhalation rate (EPA, 1989a). The exposure frequency (EF) will be assumed to be 250 days/year for the site worker. For site workers, an exposure duration (ED) of 25 years will be assumed. For the construction worker, of 1 year an EF of 250 days/year will be assumed. For body weight, (BW) a value of 70 kg will be used, which reflects the average for an adult male (EPA, 1989a). The averaging time (AT) used for noncarcinogenic substances for the site worker and construction worker, will be 9,125 and 365 days, respectively. For carcinogenic substances, an AT of 25,500 days was used for all scenarios.

4.5.3 Incidental Ingestion of Soil

The quantitative assessment of this exposure pathway will include the current site worker, future resident, and future site and construction worker exposures. The equation for the intake is taken from the RAGS (USEPA, 1989a) and the pathway variables were taken from the Standard Default Exposure Factors (EPA, 1991).

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical Concentration in Soil (mg/kg soil)
IR	=	Ingestion Rate (mg soil/day)
CF	=	Conversion Factor (1 Kg/10^6 mg)
FI	=	Fraction Ingested from Contaminated Source (unitless)
EF	=	Exposure Frequency (days/years)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (period over which exposure is averaged in days)

For the site worker and construction worker exposure, the exposure periods were 25 years and 1 year, respectively. The construction worker scenario remained as a 1 year time interval reflecting a short-term large exposure.

An RME Ingestion Rate (IR) of 200 mg soil/day was assumed for children, and 100 mg soil/day for adults (EPA, 1991). The RME Ingestion Rates for the industrialized scenarios, (e.g. site worker and construction worker were assumed to be 100 mg soil/day and 480 mg soil/day, respectively. For the site worker and for the construction worker, the RME EF will be 250 days/year. The Fraction Ingested (FI) was conservatively assumed to be 1 in all scenarios, as incidental soil ingestion is an event-based phenomenon. The assumed child body weight is 15 kg and the adult body weight is 70 kg. The remaining values are the same as presented previously.

4.5.4 Dermal Contact to On-site Soils

The equation for the absorbed dose was taken from RAGS (USEPA, 1989a).

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical Concentration in Soil (mg/kg soil)
CF	=	Conversion Factor (10^{-6} kg/mg)
SA	=	Skin Surface Area Available for Contact (cm^2)
AF	=	Soil to Skin Adherence Factor (mg/cm^2)
ABS	=	Absorption Factor (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (period over which exposure is averaged in days)

In calculating the RME, values for the skin surface area are in the 50th percentile. "The rationale here is that bodyweight of a typical male (70 kg) is closely correlated to the 50th percentile for the skin surface area: (USEPA, 1989a). The skin surface area available for contact (SA) in the residential exposure to soil is 5,800 cm^2 and 2,300 cm^2 (adult & child) respectively (EPA, 1992). This is representative of the RME surface area involved with the hands, arms, legs, neck and head. The child value is based on the 50th percentile for 6 to 7-year old children. For the site worker, the tresspasser and future construction worker, an RME value of 4,290 cm^2 will be used for the skin exposure area. The soil adherence factor (AF) is a mass weight (mg) of soil per cm^2 of skin surface area being exposed under the exposure pathway scenario. The factor 1.0 mg soil/cm^2 (EPA, 1992) will be used as the RME adherence factors for direct contact with soil and sediment throughout this assessment. The same dermal absorption factors (ABS) that will be used for dermal contact to sediment will also be used for exposure to soils. For PCBs, an absorption factor (ABS) of 6 percent (0.06) will be used in the total soils scenario for the construction worker, which is at the high end of the range recommended by EPA, 0.6 to 6 percent (EPA, 1992b). All other compounds will be assigned a ABS of 0% and will not considered for dermal absorption in non-aqueous media for this risk assessment. Values for exposure frequency (EF), exposure duration (ED), and averaging time (AT) are the same as discussed previously.

4.6 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to weigh available evidence regarding the potential of the chemicals to cause adverse effects in exposed individuals, and to provide, where possible, an estimate of the relationship between the extent of exposure to a chemical and the increased likelihood and/or severity of adverse effects. The types of toxicity information considered in this assessment include the reference dose (RfD) and reference concentration (RfC) used to evaluate noncarcinogenic effects, and the slope factor and unit risk to evaluate carcinogenic potential.

Most toxicity information used in this evaluation was obtained from the Integrated Risk Information System (IRIS). If values were not available from IRIS, the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1994) were consulted. Finally, the USEPA Region II was consulted to provide any additional values not included in these two sources. The toxicity factors that will be used in the evaluation will be summarized in a table for both noncarcinogenic and carcinogenic effects.

4.6.1 Toxicity Values for Oral and Inhalation Exposure

The types of toxicity values used to evaluate the noncarcinogenic effects of chemicals include RfDs for oral exposure, and RfCs for inhalation exposure. The chronic RfD or RfC for a chemical is ideally based on studies where either animal or human populations were exposed to a given chemical by a given route of exposure for the major portion of the life span (referred to as a chronic study). Various effect levels may be determined in a study; however, the preferred effect level for calculating noncarcinogenic toxicity values is the no-observed-adverse-effect level, or NOAEL. Second to the NOAEL is the lowest-observed-adverse-effect level, or LOAEL. RfDs and RfCs represent thresholds for toxicity. They are derived such that human lifetime exposure to a given chemical via a given route at levels at or below the RfD or RfC, as appropriate, should not result in adverse health effects, even for the most sensitive members of the population.

4.6.2 Toxicity Values for Dermal Exposure

In the absence of dermal reference toxicity values, USEPA has suggested (USEPA, 1989a) that in some cases it is appropriate to modify an oral RfD so it can be used to estimate the hazard incurred by dermal exposure. This requires that the toxic endpoints observed are the same for both oral and dermal exposure, and that one have quantitative estimates of both dermal and oral absorption of the chemical. This information is generally not available for most priority pollutants, and oral toxicity values are nevertheless often used to quantify risks associated with dermal exposure. As a consequence, any valuation of the contribution of dermal exposure to the overall hazard needs to be viewed as highly tentative at best.

USEPA RAGS (1989a) provides guidance for use of oral toxicity values in determining dermal toxicity. RfDs are expressed as the amount of substance administered per unit time and unit body weight (administered-dose), whereas exposure estimates for the dermal route of exposure are expressed as the amount of substance absorbed into the body per unit time and unit body weight (absorbed-dose). Thus, for dermal exposure to contaminants in water or in soil, it will be necessary to adjust an oral toxicity value from an administered to an absorbed dose. Where oral absorption efficiencies are available (Owen, 1990), the oral RfD will be converted to a dermal RfD by dividing by oral absorption efficiency. In the absence of any information on absorption for a substance or chemically related substances, an oral absorption efficiency of 100 percent will be assumed. Assuming 100 percent absorption in an oral administration study could overestimate risk for dermal exposure to contaminants in water or soil.

4.6.3 Health Criteria for Carcinogenic Effects

USEPA's Carcinogen Risk Assessment Verification Endeavor (CRAVE) has developed slope factors and unit risks (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The carcinogenic slope factors can be used to estimate the lifetime excess cancer risk associated with exposure to a potential carcinogen. Risks will be estimated using slope factors. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of 1×10^{-6} (one in a million), for example, represents the probability of an individual developing cancer over a lifetime as a result of exposure to the specific carcinogenic chemical. USEPA considers total excess lifetime cancer risks within the range of 10^{-4} (one in ten thousand) to 10^{-6} (USEPA, 1989a) to be acceptable when developing remedial alternatives for cleanup of Superfund Sites.

4.6.4 Toxicity Values for Oral and Inhalation Exposure

Oral slope factors are reported as risk per dose $(mg/kg\text{-}day)^{-1}$. Inhalation unit risk factors are reported in units of risk per concentration $(mg/m^3)^{-1}$. To make use of the unit risk factors in calculating risks they will be converted to inhalation slope factors in units of (mg/kg-day). This conversion will be made by assuming an inhalation rate of 20 m^3/day and an adult bodyweight of 70 kg. Thus:

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

$$UnitRisk\left(\frac{ug}{m^3}\right)^{-1} \times \frac{day}{20m^3} \times 70kg \times \frac{1000ug}{mg}$$

When slope factors and unit risks were not available for all potentially carcinogenic members of a chemical class, toxicity values were calculated using toxicity equivalency factors (TEFs). TEFs are values that compare the carcinogenic potential of a given chemical in a class to the carcinogenic potential of a chemical in the class that has a verified slope factor and/or unit risk. USEPA has provided TEFs for PAHs (USEPA, 1993b). TEF values are as follows:

PAH	TEF
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Dibenzo(a,h)anthracene	1.0
Chrysene	0.01
Indeno(1,2,3-cd)pyrene	0.1

To calculate a slope factor or unit risk for a given PAH the appropriate TEF value is multiplied by the slope factor or unit risk for benzo(a)pyrene.

4.7 RISK CHARACTERIZATION

To characterize risk, toxicity and exposure assessments will be summarized and integrated into quantitative and qualitative expressions of risk. To characterize potential non-carcinogenic effects, comparisons will be made between projected intakes of substances and toxicity values. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure will be estimated from projected intakes and chemical-specific dose-response information. Major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in the assessment are also presented.

4.7.1 Non-Carcinogenic Effects

The potential for non-carcinogenic effects will be evaluated by comparing an exposure level over a specified time period with an RfD derived for a similar exposure period. This ratio of exposure to toxicity is the Hazard Quotient (HI) :

$$\text{Non-cancer Hazard Quotient} = E/RfD$$

Where:

E = Exposure level or intake (mg/kg-day), and
RfD = Reference Dose (mg/kg-day)

The non-cancer hazard quotient assumes that there is a level of exposure (i.e., an RfD) below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level (E) exceeds the threshold (i.e., If E/RfD exceeds unity) there may be concern for potential non-cancer effects.

To assess the overall potential for non-carcinogenic effects posed by more than one chemical, the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to respective acceptable exposures.

This is expressed as:

$$HI = E_1/RfD_1 + E_2/RfD_2 + \ldots + E_i/RfD_i$$

Where:

E_i = the exposure level or intake of the I toxicant, and
RfD_i = reference dose for the i^{th} toxicant.

4.7.2 Carcinogenic Effects

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e., excess individual lifetime cancer risk). The slope factor converts estimated daily intakes averaged over a lifetime of

exposure directly to incremental risk of an individual developing cancer. It can generally be assumed that the dose-response relationship will be linear in the low-dose portion of the multistage model dose-response curve. Under this assumption, the slope factor is a constant, and risk will be directly related to intake. Thus, the following linear low-dose equation was used in this assessment:

$$Risk = CDI \times SF$$

Where:

Risk = A unitless probability of an individual developing cancer,
CDI = Chronic Daily Intake over 70 years (mg/kg-day), and
SF = Slope Factor $(mg/kg\text{-}day)^{-1}$

For simultaneous exposure to several carcinogens, the USEPA assumes that the risks are additive. That is to say:

$$Risk_T = Risk_i$$

Where:

$Risk_T$ = Total cancer risk, expressed as a unitless probability, and
$Risk_i$ = Risk estimate for the ith substance.

According to guidance in the National Contingency Plan, the target overall lifetime carcinogenic risks from exposures for determining clean-up levels should range from 10^{-4} to 10^{-6}.

APPENDIX A

New York State Technical and Administrative Guidance Memorandum

TO: Regional Haz. Waste Remediation Engineers, Bureau Dir. & Section Chiefs
FROM: Michael J. O'Toole, Jr., Director, Div. Of Hazardous Waste Remediation
SUBJECT: DIVISION TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM: DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS.
DATE: Jan 24, 1994

The cleanup goal of the Department is to restore inactive hazardous waste sites to predisposal conditions, to the extent feasible and authorized by law. However, it is recognized that restoration to predisposal conditions will not always be feasible.

1. INTRODUCTION:

This TAGM provides a basis and procedure to determine soil cleanup levels at individual Federal Superfund, State Superfund, 1986 EQBA Title 3 and Responsible Party (RP) sites, when the Director of the DHWR determines that cleanup of a site to predisposal conditions is not possible or feasible.

The process starts with development of soil cleanup objectives by the Technology Section for the contaminants identified by the Project Managers. The Technology Section uses the procedure described in this TAGM to develop soil cleanup objectives. Attainment of these generic soil cleanup objectives will, at a minimum, eliminate all significant threats to human health and/or the environment posed by the inactive hazardous waste site. Project Managers should use these cleanup objectives in selecting alternatives in the Feasibility Study (FS). Based on the proposed selected remedial technology (outcome of FS), final site specific soil cleanup levels are established in the Record of Decision (ROD) for these sites.

It should be noted that even after soil cleanup levels are established in the ROD, these levels may prove to be unattainable when remedial construction begins. In that event, alternative remedial actions or institutional controls may be necessary to protect the environment.

2. BASIS FOR SOIL CLEANUP OBJECTIVES:

The following alternative bases are used to determine soil cleanup objectives:

(A) Human health based levels that correspond to excess lifetime cancer risks of one in a million for Class A1 and B2 carcinogens, or one in 100,000 for Class C3 carcinogens. These levels are contained in USEPA'S Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation:

(B) Human health based levels for systemic toxicants, calculated from Reference Douses (RfDs). RfDs are an estimate of the daily exposure an individual

(Including sensitive individuals) can experience without appreciable risk of health effects during a lifetime. An average scenario of exposure in which children ages one to six (who exhibit the greatest tendency to ingest soil) is assumed. An intake rate of 0.2 gram /day for a five-year exposure period for a 16-kg child is assumed. These levels are contained in USEPA's Health Effects Assessments Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;© Environmental concentrations which are protective of groundwater/drinking water quality;based on promulgated or proposed New York State Standards:

(D) Background values for contaminants; and

(E) Detection limits.

A recommendation on the appropriate cleanup objective is based on the criterion that produces the most stringent cleanup level using criteria a, b, and c for organic chemicals, and criteria a, b, and d for heavy metals. If criteria a and/or b are below criterion d for a contaminant, its background value should be used as the cleanup objective. However, cleanup objectives developed using this approach must be, at a minimum, above the method detection limit (MDL) and it is preferable to have the soil cleanup objectives above the Contract Required Quantitation Limit (CRQL) as defined by NYSDEC. If the cleanup objective of a compound is "non-detectable", it should mean that it is not detected at the MDL. Efforts should be made to obtain the best MDL detection possible when selecting a laboratory and analytical protocol.

The water/soil partitioning theory is used to determine cleanup objectives which would be protective of groundwater/drinking water quality for its best use. This theory is conservative in nature and assumes that contaminated soil and groundwater are in direct contact. This theory is based upon the ability of organic matter in soil to absorb organic chemicals. The approach predicts the maximum amount of contamination that may remain in soil so that leachate from the contaminated soil will not violate groundwater and/or drinking water standards.

(1) Class A are proved human carcinogens
(2) Class B are probable human carcinogens
(3) Class C are possible human carcinogens

This approach is not used for heavy metals, which do not partition appreciably into soil organic matter. For heavy metals, eastern USA or New York State soil background values may be used as soil cleanup objectives. A list of values that have been tabulated is attached. Soil background data near the site, if available, is preferable and should be used as the cleanup objective for such metals. Background samples should be free from the influences of this site and any other source of contaminants. Ideal background samples may be obtained from uncontaminated up gradient and up wind locations.

3. DETERMINATION OF SOIL CLEANUP GOALS FOR ORGANICS IN SOIL FOR PROTECTION OF WATER QUALITY

Protection of water quality from contaminated soil is a two-part problem. The first is predicting the amount of contamination that will leave the contaminated media as leachate. The second part of the

problem is to determine how much of that contamination will actually contribute to a violation of groundwater standards upon reaching and dispersing into groundwater. Some of the contamination which initially leaches out of soil will be absorbed by other soil before it reaches groundwater. Some portion will be reduced through natural attenuation or other mechanism.

PART A: PARTITION THEORY MODEL

There are many test and theoretical models which are used to predict leachate quality given a known value of soil contamination. The Water-Soil Equilibrium Partition Theory is used as a basis to determine soil standard or contamination limit for protection of water quality by most of the models currently in use. It is based on the ability of organic carbon in soil to adsorb contamination. Using a water quality value which may not be exceeded in leachate and the partition coefficient method, the equilibrium concentration (C_s) will be expressed in the same units as the water standards. The following expression is used:

$$\text{Allowable Soil Concentration } C_s = f \times K_{oc} \times C_w \quad \ldots\ldots(1)$$

Where: f = fraction of organic carbon of the natural soil medium.

K_{oc} = partition coefficient between water and soil media. K_{oc} can be estimated by the following equation:

$$\log K_{oc} = 3.64 - 0.55 \log S$$

S = water solubility in ppm
C_w = appropriate water quality value from TOGS 1.1.1

Most D_{oc} and S values are listed in the Exhibit A-1 of the USEPA Superfund Public Health Evaluation Manual (EPA/540/1-86/060). The K_{oc} values listed in the manual should be used for the purpose. If the K_{oc} value for a contaminant is not listed, it should be estimated using the above mentioned equation.

PART B: PROCEDURE FOR DETERMINATION OF SOIL CLEANUP OBJECTIVES

When the contaminated soil is in the unsaturated zone above the water table, many mechanisms are at work that prevent all of the contamination that would leave the contaminated soil from impacting groundwater. These mechanisms occur during transport and may work simultaneously. They include the following: (1) volatility, (2) sorption and desorption, (3) leaching and diffusion, (4) transformation and degradation, and (5) change in concentration of contaminants after reaching and/or mixing with the groundwater surface. To account for these mechanisms, a correction factor of 100 is used to establish soil cleanup objectives. This value of 100 for the correction is consistent with the logic used by EPA in its Dilution Attenuation Factor (DAF) approach for EP Toxicity and TCLP. (Federal Register/Vol. 55, No. 61, March 29, 1990/Pages 11826-27). Soil cleanup objectives are calculated by multiplying the allowable soil concentration by the correction factor. If the contaminated soil is very close (3' - 5') to the groundwater table or in the groundwater, extreme caution should be excerised when using the correction factor of 100 (one hundred) as this may not give conservative cleanup objectives. For such situations the Technology Section should be consulted for site-specific cleanup objectives.

Soil cleanup objectives are limited to the following maximum values. These values are consistent with the approach promulgated by the States of Washington and Michigan.

1. Total VOCs $\leq$ 10 ppm.
2. Total Semi VOCs $\leq$ 500 ppm.
3. Individual Semi VOCs $\leq$ 50 ppm.
4. Total Pesticides $\leq$ 10 ppm.

One concern regarding the semi-volatile compounds is that some of these compounds are so insoluble that their C_s values are fairly large. Experience (Draft TOGS on Petroleum Contaminated Soil Guidance) has shown that soil containing some of these insoluble substances at high concentrations can exhibit a distinct odor even though the substance with not leach from the soil. Hence any time soil exhibits a discernible odor nuisance, it shall not be considered clean even if it has met the numerical criteria.

4. DETERMINATION OF FINAL CLEANUP LEVELS:

Recommended soil cleanup objectives should be utilized in the development of final cleanup levels through the Feasibility Study (FS) process. During the FS, various alternative remedial actions developed during the Remedial Investigation (RI) are initially screened and narrowed down to the list of potential alternative remedial actions that will be evaluated in detail. These alternative remedial actions are evaluated using the criteria discussed in TAGM 4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites, revised May 15, 1990, and the preferred remedial action must be established. Remedy selection, which will include final cleanup levels, is the subject of TAGM 4030.

Recommended soil cleanup objectives that have been calculated by the Technology Section are presented in Appendix A. These objectives are based on a soil organic carbon content of 1% (0.01) and should be adjusted for the actual organic carbon content if it is known. For determining soil organic carbon content, use attached USEPA method (Appendix B). Please contact the Technology Section, Bureau of Program Management for soil cleanup objectives not included in Appendix A.

TABLE 1
Seneca Army Depot
Human Health PRGs

		SOIL					GROUND WATER		SURFACE WATER		AIR
CHEM_CLASS/PARAM	Carc	Recreational mg/Kg	Residential mg/Kg	Industrial mg/Kg	Construction mg/Kg	NYSDEC TAGM mg/Kg	NYS Class GA Standard ug/L	SEAD-PRG Drinking Water ug/L	SEAD-PRG Surface Water ug/L	NYS AWQS CLASS C ug/L	SEAD-PRG ug/m3
VOLATILE ORGANICS											
Chloromethane		5291	49	440	1146			1 44	3307138		0 99
Bromomethane		1506	112	752	1957			8 70	3011250		5 22
Vinyl Chloride		36	0	3	8	0 2	2	0.02	22628		0 02
Chloroethane		421154	31286	210240	547500	1.9	5	8591.77	842307692		10439.00
Methylene Chloride	c	9172	85	763	1987	0 1	5	4.12	5732372		3 82
Acetone	n	105288	7821	52560	136875	0 2		3650 00	210576923		0 00
Carbon Disulfide	n	105288	7821	52560	136875	2 7		1042 86	210576923		730.00
1,1-Dichloroethene	c	115	1	10	25	0 4	5	0 04	71655		0 04
1,1-Dichloroethane	n	105288	7821	52560	136875	0.1	5	811.74	210576923		521 95
1,2-Dichloroethene (total)							5				
Chloroform	c	11277	105	938	2443	0 3	7	0 15	7047998		0 08
1,2-Dichloroethane	c	756	7	63	164	0 1	5	0 12	472448		0 07
2-Butanone											
1,1,1-Trichloroethane	n	36851	2738	18396	47906	0 8	5	792 55	73701923		1043 90
Carbon Tetrachloride	c	529	5	44	115	0 6	5	0 16	330714		0 12
Bromodichloromethane	c	1109	10	92	240			1 08	693432		0 00
1,2-Dichloropropane	c	1012	9	84	219		5	0 99	632247		0 00
cis-1,3-Dichloropropene							5				
Trichloroethene	c	6253	58	520	1355	0 7	5	1 56	3908435		1 04
Dibromochloromethane											
1,1,2-Trichloroethane	c	1207	11	100	261			0 19	754259		0 11
Benzene	c	2372	22	197	514	0 06	0 7	0 36	1482510		0 22
trans-1,3-Dichloropropene							5				
Bromoform	c	8707	81	724	1887			2 35	5442125		1 63
4-Methyl-2-Pentanone											
2-Hexanone											
Tetrachloroethene	c	1323	12	110	287	1 4	5	1 07	826784		3 08
1 1,2,2-Tetrachloroethane	c	3439	32	286	745	0 6	5	0 52	2149639		0 31
Toluene	n	210577	15643	105120	273750	1 5	5	747 04	421153846		416.10
Chlorobenzene	n	21058	1564	10512	27375	1 7	5	39 43	42115385	5	20 84
Ethylbenzene	n	105288	7821	52560	136875	5 5	5	1328 12	210576923		1043 90
Styrene											
Xylene (total)	n	2105769	156429	1051200	2737500	1 2	5	73000 00	4211538462		0 00
HERBICIDES											
2,4-D						0 5	4 4				
2 4-DB											
2,4,5-T						1 9	35				
2 4 5-TP (Silvex)						0 7	0 26				
Dalapon							50				
Dicamba							0 44				
Dichloroprop											
Dinoseb							1				
MCPA							0 44				
MCPP											
NITROAROMATICS											
HMX											

TABLE 1
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Human Health PRGs

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CHEM_CLASS/PARAM	Carc	Recreational mg/Kg	Residential mg/Kg	Industrial mg/Kg	Construction mg/Kg	NYSDEC TAGM mg/Kg	NYS Class GA Standard ug/L	SEAD-PRG Drinking Water ug/L	SEAD-PRG Surface Water ug/L	NYS AWQS CLASS C ug/L	SEAD-PRG ug/m3
RDX											
1,3,5-Trinitrobenzene	n	53	4	26	68		5	1.83	105288		0 00
1,3-Dinitrobenzene	n	105	8	53	137		5	3.65	210577		0.00
Tetryl							5				
2,4,6-Trinitrotoluene	c	2293	21	191	497		5	2 24	1433093		0 00
4-amino-2,6-Dinitrotoluene							5				
2-amino-4,6-Dinitrotoluene							5				
2,6-Dinitrotoluene	n	1053	78	526	1369		5	36 50	2105769		0 00
2,4-Dinitrotoluene	n	2106	156	1051	2738		5	73 00	4211538		0 00
SEMIVOLATILE ORGANICS											
Phenol	n	631731	46929	315360	821250	0 03	1	21900 00	1263461538	5	0 00
bis(2-Chloroethyl) ether	c	63	1	5	14			0 01	39084		0 01
2-Chlorophenol	n	5264	391	2628	6844	0 8		182.50	10528846		0 00
1,3-Dichlorobenzene	n	93707	6961	46778	121819	1 6	5	3248.50	187413462	5	0 00
1,4-Dichlorobenzene	c	2866	27	238	621	8 5	4 7	2.80	1791366	5	0 00
1,2-Dichlorobenzene	n	94760	7039	47304	123188	7 9	4 7	268 16	189519231	5	146 00
2-Methylphenol	n	52644	3911	26280	68438	0 1	5	1825 00	105288462		0 00
2,2'-oxybis(1-Chloropropane)											
4-Methylphenol						0 9	5				
N-Nitroso-di-n-propylamine	c	10		1	2			0 01	6142		
Hexachloroethane	c	4913	46	409	1065			0 75	3070913		0 45
Nitrobenzene	n	526	39	263	684	0 2		3 39	1052885		2 08
Isophorone						4.4					
2-Nitrophenol						0 33					
2,4-Dimethylphenol	n	21058	1564	10512	27375		5	730 00	42115385		0 00
bis(2-Chloroethoxy) methane											
2,4-Dichlorophenol	n	3159	235	1577	4106	0 4		109 50	6317308		0 00
1,2,4-Trichlorobenzene	n	10529	782	5256	13688	3 4	5	194.60	21057692	5	208 42
Naphthalene	n	42115	3129	21024	54750	13		1460.00	84230769		0 00
4-Chloroaniline	n	4212	313	2102	5475	0.22	5	146 00	8423077		0 00
Hexachlorobutadiene	c	882	8	73	191			0.14	551190		0 08
4-Chloro-3-methylphenol						0.24					
2-Methylnaphthalene						36.4					
Hexachlorocyclopentadiene	n	7370	548	3679	9581			0 15	14740385		0 07
2,4,6-Trichlorophenol	c	6253	58	520	1355			0.97	3908435		0 57
2,4,5-Trichlorophenol	n	105288	7821	52560	136875			3650 00	210576923		0 00
2-Chloronaphthalene											
2-Nitroaniline	n	63	5	32	82	0 43		0 35	126346		0 21
Dimethylphthalate	n	10528846	782143	5256000	13687500	2		365000 00	21057692308		0 00
Acenaphthylene						41					
2,6-Dinitrotoluene	n	1053	78	526	1369	1	5	36.50	2105769		0 00
3-Nitroaniline	n	3159	235	1577	4106	0 5		109 50	6317308		0 00
Acenaphthene						50					
2,4-Dinitrophenol	n	2106	156	1051	2738	0 2		73 00	4211538		0 00
4-Nitrophenol	n	63173	4693	31536	82125	0 1		2190 00	126346154		0 00
Dibenzofuran	n	4212	313	2102	5475	6 2		146 00	8423077		0 00
2,4-Dinitrotoluene	n	2106	156	1051	2738		5	73.00	4211538		0 00
Diethylphthalate	n	842308	62571	420480	1095000	7 1		29200 00	1684615385		0 00

TABLE 1
Seneca Army Depot
Human Health PRGs

		SOIL					GROUND WATER		SURFACE WATER		AIR
CHEM_CLASS/PARAM	Carc	Recreational mg/Kg	Residential mg/Kg	Industrial mg/Kg	Construction mg/Kg	NYSDEC TAGM mg/Kg	NYS Class GA Standard ug/L	SEAD-PRG Drinking Water ug/L	SEAD-PRG Surface Water ug/L	NYS AWQS CLASS C ug/L	SEAD-PRG ug/m3
4-Chlorophenyl-phenylether											
Fluorene	n	42115	3129	21024	54750	50		1460 00	84230769		0 00
4-Nitroaniline	n	3159	235	1577	4106		5	109 50	6317308		0 00
4,6-Dinitro-2-methylphenol							5				
N-Nitrosodiphenylamine	c	14038	130	1168	3042			13 72	8774038		
4-Bromophenyl-phenylether	n	61067	4536	30485	79388			2117 00	122134615		0 00
Hexachlorobenzene	c	43	0	4	9	0 41	0.35	0 01	26870		0 00
Pentachlorophenol	c	573	5	48	124	1	1	0 56	358273	0.4	0 00
Phenanthrene						50					
Anthracene	n	315865	23464	157680	410625	50		10950 00	631730769		0 00
Carbazole	c	3439	32	286	745			3 36	2149639		0 00
Di-n-butylphthalate						8 1	50				
Fluoranthene	n	42115	3129	21024	54750	50		1460 00	84230769		0 00
Pyrene	n	31587	2346	15768	41063	50		1095 00	63173077		0 00
Butylbenzylphthalate	n	210577	15643	105120	273750	50		7300 00	421153846		0 00
3,3'-Dichlorobenzidine	c	153	1	13	33			0 15	95540		0 00
Benzo(a)anthracene	c	94	1	8	20	0 224		0 02	58894		0 01
Chrysene	c	9423	88	784	2042	0 4		1 68	5889423		1 03
bis(2-Ethylhexyl)phthalate	c	4913	46	409	1065	50	50	4 80	3070913	0 6	0 00
Di-n-octylphthalate	n	21058	1564	10512	27375	50		730 00	42115385		0 00
Benzo(b)fluoranthene	c	94	1	8	20	1 1		0 02	58894		0 01
Benzo(k)fluoranthene	c	942	9	78	204	1.1		0 17	588942		0 10
Benzo(a)pyrene	c	9	0	1	2	0.061	10	0 00	5889		0 00
Indeno(1,2,3-cd)pyrene	c	94	1	8	20	3,2		0 02	58894		0 01
Dibenz(a,h)anthracene	c	9	0	1	2	0.014		0.00	5889		0 00
Benzo(g,h,i)perylene						50					
PESTICIDES/PCB											
alpha-BHC						0.11					
beta-BHC						0 2	5				
delta-BHC						0.3					
gamma-BHC (Lindane)	c	53	0	4	11	0.06	5	0 05	33071		
Heptachlor	c	15	0	1	3	0.1	0 05	0 00	9554	0 001	0 00
Aldrin	c	4	0	0	1	0 041	0 055	0 00	2529		0 00
Heptachlor epoxide	c	8	0	1	2	0.02	0 05	0 00	4724	0 001	0 00
Endosulfan I	n	6317	469	3154	8213	0.9		219 00	12634615		0 00
Dieldrin	c	4	0	0	1	0.044	0 1	0 00	2687		0 00
4,4'-DDE	c	202	2	17	44	2 1	0 1	0.20	126449	0 001	0 00
Endrin	n	316	23	158	411	0 1	0 1	10.95	631731	0.002	0 00
Endosulfan II	n	6317	469	3154	8213	0 9		219 00	12634615		0 00
4,4'-DDD	c	287	3	24	62	2.9	0.1	0 28	179137	0 001	0 00
Endosulfan sulfate						1					
4,4'-DDT	c	202	2	17	44	2 1	0 1	0.03	126449	0 001	0 02
Methoxychlor	n	5264	391	2628	6844		35	182 50	10528846	0 03	0 00
Endrin ketone	n	316	23	158	411		5	10 95	631731		0 00
Endrin aldehyde	n	316	23	158	411		5	10 95	631731		0 00
alpha-Chlordane							5				
gamma-Chlordane						0 54					
Toxaphene											

TABLE 1
Seneca Army Depot
Human Health PRGs

		SOIL					GROUND WATER		SURFACE WATER		AIR
CHEM_CLASS/PARAM	Carc	Recreational mg/Kg	Residential mg/Kg	Industrial mg/Kg	Construction mg/Kg	NYSDEC TAGM mg/Kg	NYS Class GA Standard ug/L	SEAD-PRG Drinking Water ug/L	SEAD-PRG Surface Water ug/L	NYS AWQS CLASS C ug/L	SEAD-PRG ug/m3
Aroclor-1016	n	74	5	37	96			2.56	147404		0 00
Aroclor-1221											
Aroclor-1232											
Aroclor-1242											
Aroclor-1248											
Aroclor-1254	n	21	2	11	27	10	0 1	0.73	42115	0 001	0 00
Aroclor-1260						10	0.1			0.001	
METALS											
Aluminum	n	1052885	78214	525600	1368750	14592.84		36500 00	2105769231	100	0 00
Antimony	n	421	31	210	548	3.59		14.60	842308		0 00
Arsenic	c	46	0	4	10	7.5	25	0.01	28662	190	0 00
Barium	n	73702	5475	36792	95813	300	1000	1 04	147403846		0 52
Beryllium	c	16	0	1	3	0 73		0 00	9998	1 111	0 00
Cadmium	n	526	39	263	684	1	10	0 41	1052885	1 8628217	0 21
Calcium						101903 8					
Chromium	n	1052885	78214	525600	1368750	22 13	50	0 00	2105769231	347 27015	0 00
Cobalt	n	63173	4693	31536	82125	30		2190 00	126346154	5	0 00
Copper	n	42115	3129	21024	54750	25	200	1460 00	84230769	20 287735	0 00
Iron	n	315865	23464	157680	410625	26626.65	300	10950 00	631730769	300	0 00
Lead						21.86	25			7 1638103	
Magnesium						12221.77					
Manganese	n	24216	1799	12089	31481	669.38	300	0 10	48432692		0 05
Mercury	n	316	23	158	411	0 1	2	0.59	631731		0 31
Nickel	n	21058	1564	10512	27375	33 62		730 00	42115385	154 48855	0 00
Potassium						1761 48					
Selenium	n	5264	391	2628	6844	2	10	182 50	10528846	1	0 00
Silver	n	5264	391	2628	6844	0.4	50	182.50	10528846	0 1	0 00
Sodium						103.74	20000				
Thallium	n	84	6	42	110	0 28		2 92	168462	8	0 00
Vanadium	n	7370	548	3679	9581	150		255 50	14740385	14	0 00
Zinc	n	315865	23464	157680	410625	82 5	300	10950.00	631730769	141 37982	0 00
Cyanide						0 3	100			5 2	

TABLE 2
CALCULATED ECOLOGICAL
PRELIMINARY REMEDIAL GOALS

Parameter	Toxicological Reference Value (mg/kg/day)	SP (2)	ref	BAF (3)	ref	Soil Concentration (mg/kg)
N-Nitroso-di-n-propylamine	0.64					1.45E+03
N-Nitrosodiphenylamine (1)						0.00E+00
Naphthalene	0.711	3.98E-01	5	1.11E-03	5	1.50E+02
Pentachlorophenol	2	4.99E-02	5	4.02E-02	5	1.42E+03
Phenanthrene	0.933	1.02E-01	5	1.22E-01	8	3.26E+02
Phenol	4.8	5.55E+00	5	1.16E-05	5	7.95E+01
Pyrene	5	5.85E-02	5	9.20E-02	8	2.42E+03
bis(2-Ethylhexyl)phthalate	5.2	1.94E-01	5	1.20E+01	11	3.94E+01
Pesticides						
4,4'-DDD	6.5	1.01E-02	5	6.37E-01	5	8.75E+02
4,4'-DDE	3.8	3.48E-03	5	4.02E+00	5	8.66E+01
4,4'-DDT	0.867	1.01E-02	5	9.00E+00	6	8.87E+00
Aroclor 1242	5.667	0		0		1.29E+04
Aroclor 1254	1.727					3.93E+03
Aroclor 1260	1					2.27E+03
Aldrin	0.167	3.35E-02	5	5.55E+00	12	2.75E+00
Endosulfan I	0.058					1.32E+02
Endosulfan sulfate	0.058	2.97E-01	5	1.84E-03	5	1.58E+01
Endrin	0.106					2.41E+02
Endrin aldehyde	0.011	3.17E-02	#	8.79E-02	5	6.35E+00
Endrin ketone	0.011	3.17E-02	#	8.79E-02	5	6.35E+00
Heptachlor	0.05	1.11E-01	5	1.01E-02	5	2.86E+01
Heptachlor epoxide	0.001	1.07E+00	5	1.00E+01	16	8.34E-03
alpha-Chlordane	0.78	4.67E-01	5	8.40E-04	5	1.42E+02
beta-BHC	0.031	2.16E-01	5	3.19E-03	5	1.11E+01
gamma-Chlordane	0.26	4.67E-01	5	8.40E-04	5	4.74E+01
Herbicides						
Dicamba	5	2.04E+01	5	1.21E-06	5	2.26E+01
MCPP	0.36					8.18E+02
Metals						
Aluminum						0.00E+00
Antimony	9.333	1.30E-04	#	6.00E-03	15	1.84E+04
Arsenic	2.2	4.00E-02	#	8.30E-01	15	2.24E+02
Barium	0.19	1.50E-01	#	8.10E-04	15	9.18E+01
Beryllium	0.032	1.00E-02	#	4.00E-01	15	6.57E+00
Cadmium	11.4	5.50E-01	#	8.40E-01	15	7.38E+02
Calcium		3.50E+00	#	4.40E-02	15	0.00E+00
Chromium	2.28	7.50E-03	#	2.00E-01	15	8.50E+02

TABLE 2
CALCULATED ECOLOGICAL
PRELIMINARY REMEDIAL GOALS

Parameter	Toxicological Reference Value (mg/kg/day)	SP (2)	ref	BAF (3)	ref	Soil Concentration (mg/kg)
Cobalt		8.10E-02	#	5.00E-01	15	0.00E+00
Copper	8.5	4.00E-01	#	5.10E-01	15	8.28E+02
Cyanide	6					1.36E+04
Iron		4.00E-03	#	1.50E+00	15	0.00E+00
Lead	0.56	4.50E-02	#	2.00E-01	15	1.81E+02
Magnesium		1.00E+00	#	3.00E-03	15	0.00E+00
Manganese	62	5.60E-01	#	5.00E-02	15	8.82E+03
Mercury	0.022	9.00E-01	#	2.50E-01	15	1.71E+00
Nickel	10	2.80E-01	#	6.00E-03	15	2.83E+03
Potassium		1.00E+00	#	4.00E-01	15	0.00E+00
Selenium	17.867	2.50E-02	#	8.50E+00	15	1.93E+02
Silver		2.70E-04	#	5.00E-01	15	0.00E+00
Sodium		7.50E-02	#	5.50E-02	15	0.00E+00
Thallium		6.60E-03	#	4.00E-03	15	0.00E+00
Vanadium						0.00E+00
Zinc		1.40E+00	#	6.50E+00	15	0.00E+00

(1) Log Kow values obtained from Karickhoff an
(2) SP: soil-to-plant uptake factor.
(3) BAF: bioaccumulation factor.
(4) Oldfield mouse exposure calculated as
ED = [(Cd * SP * Ip) + (Cd * BAF * Ia) + (Cd
Where, ED = exposure dose
Cd = RME conc in sediment (mg/kg)
SP = soil-to-plant uptake factor
Ip = plant-matter intake rate (kg/day, se
BAF = bioaccumulation factor (unitless)
Ia = animal-matter intake rate (kg/day, see Table 4.24)
Is = incidental sediment intake rate (kg/day, see Table 4.24)
SFF = site foraging factor (unitless, see Table 4.24)
BW = body weight (kg, see Table 4.24)

(5) Source: Travis and Arms, 1988.
(6) Source: Baes et al., 1984.
(7) Substituted value for 2,3,7,8-TCDD.
(8) Source: Marquenie et al., 1987 from Beyer, 1990.
(9) Substituted value for benzo(a)pyrene.
(10) Default where no experimental data available, no evidence of bioconcentration.
(11) Source: USEPA, 1994.
(12) Source: Ma, 1983.
(13) Source HSDB, 1995