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Pathway Analysis Report

Peter Cooper Markhams Site
Town of Dayton, New York

Submitted by:

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EXECUTIVE SUMMARY

A Pathway Analysis Report (PAR) was prepared for the Peter Cooper Markhams Site (the "Site") to assist the U.S. Environmental Protection Agency (U.S. EPA) in their review of the Baseline Risk Assessment (BRA) of the Site. The PAR and BRA are components of the Remedial Investigation/Feasibility Study (RI/FS) of the Site. The PAR consists of two components: (1) the approach to the Human Health Risk Assessment (HHRA); and (2) the approach to the Ecological Risk Assessment (ERA). For the Markhams Site, a screening-level ecological risk assessment was conducted as part of the PAR at the request of the U.S. EPA.

The PAR process for both the HHRA and ERA consists of (1) an extensive review of the available analytical data from previous site investigations (including the RI) and selection of chemicals of potential concern; (2) an analysis of the potential for receptors to come in contact with environmental media at the Site; and (3) a thorough review of the scientific information on the potential hazards associated with chemicals detected at the Site.

Human Health Risk Assessment

The results of the PAR process for the HHRA indicate that there are very few chemicals at the Site that may be of concern for human health. Following an extensive review of the data and a conservative comparison to U.S. EPA health-based screening criteria, the list of chemicals that may be a potential concern for human health is limited to the following:

Medium	Chemicals of Potential Concern for Human Health
Surface Soil	Arsenic, Trivalent Chromium, Benzo(a)pyrene
Subsurface Soil	Arsenic, Trivalent Chromium, Manganese, Benzo(a)pyrene
Groundwater	Aluminum, Antimony, Arsenic, Barium, Cadmium, Chromium VI, Cobalt, Copper, Lead, Manganese, Nickel, Selenium, Thallium, Zinc, Benzene, Trichloroethene, Benzo(b)fluoranthene, Bis(2-ethylhexyl)phthalate
Surface Water	Hexavalent Chromium
Sediment	Arsenic

The COPCs listed above for soil were conservatively selected using U.S. EPA screening criteria for a residential land use. If criteria based on industrial land use (which is more reasonable for this Site) are used, the only COPC remaining for soil is arsenic. Consequently, the selection process used in this HHRA is very conservative.

The PAR process for the HHRA also concluded that there are few pathways by which people may come in contact with COPCs at the Site under current or future land use. The Site is currently vacant and has not been legally used for any purpose (other than site investigations) for nearly 30 years. The only activities that could lead to potential exposure under current land use are associated with occasional trespassing for purposes of hunting, hiking, and/or off-road vehicle use. Therefore, potential exposures under current land use are those associated with occasional trespassing.

At the present time, there is no formal plan for future use of the Site. The Site carries an industrial zoning designation, which precludes other non-industrial uses. Because of the Site's remote location and the availability of developable land nearby, future development of the Site for any use is extremely unlikely. Based on this information, the most reasonable future use of the Site is infrequent trespassing, which is consistent with current use. However, because the site is zoned industrial, a future industrial land use will also be evaluated.

The PAR analysis also indicated that there is no current exposure to groundwater at the Site and that future exposure to groundwater is extremely unlikely.

Ecological Risk Assessment

A Screening Ecological Risk Assessment (SERA) was performed for the Peter Cooper Markhams Site. The goal of the SERA was to determine whether concentrations of constituents from the Site indicate the possibility for risk to plants, animals, and/or ecologically valuable habitats in the vicinity of the Site, thereby establishing a need for further evaluation of these potential risks via a more detailed, Baseline Ecological Risk Assessment.

Based on the terrestrial setting of the property, its location, climate, and observations noted during the site reconnaissance portion of the SERA, it was determined that the following general classes of ecological receptors potentially might be exposed to chemicals at and in the vicinity of the Site:

- Terrestrial wildlife species that may be in contact with the soils and that feed within the terrestrial food chain.
- Facultative aquatic wildlife species that may be in contact with the wetland sediments and/or frequently use the wetlands for foraging.

Comparison of the chemicals detected in soils, wetland sediments and wetland surface waters to conservative Environmental Data Quality Levels (EDQLs) and Sediment Quality Criteria (SQC) indicates that only a small number of parameters in various site media will require further evaluation through a Baseline Ecological Risk Assessment. These parameters/pathways are limited to:

- Arsenic and chromium in soils.
- Chromium in sediment.
- Hexavalent chromium in surface water.

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1.0 INTRODUCTION

The purpose of this Pathway Analysis Report (PAR) is to provide the U.S. Environmental Protection Agency (U.S. EPA) with technical information about the Baseline Risk Assessment for the Peter Cooper Markhams Site (the "Site"; Figure 1-1) so that the U.S. EPA can review how the risk assessment will be conducted.

The PAR consists of two sections. The first section (Section 2.0) discusses the planned approach to the Human Health Risk Assessment (HHRA), in accordance with the U.S. EPA's *Risk Assessment Guidance for Superfund (RAGS): Volume 1 Human Health Evaluation Manual Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments* (RAGS Part D; U.S. EPA, 1998a). The second section (Section 3.0) discusses the approach to the Ecological Risk Assessment (ERA) in accordance with the U.S. EPA's *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final (U.S. EPA, 1997a).*

2.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA will be conducted in accordance with U.S. EPA requirements, as described in the *Remedial Investigation/Feasibility Study (RI/FS) Work Plan* (Benchmark/Geomatrix, 2001) and subsequent response to comments (Benchmark, 2001). In accordance with U.S. EPA guidance, the HHRA for the Peter Cooper Markhams Site will consist of the following elements:

- Data Evaluation
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization and Uncertainty Analysis

The PAR presents the planned approaches to the first three of these steps. In accordance with RAGS Part D, the specific details of the planned approaches to Data Evaluation, Exposure Assessment and Toxicity Assessment are presented within RAGS Part D Standard Tables to aid in U.S. EPA's review. Included in this PAR are the following RAGS Part D tables:

<u>Data Evaluation</u>

- RAGS Part D Table 2 Occurrence, Distribution and Selection of Chemicals of Potential Concern

<u>Exposure Assessment</u>

- RAGS Part D Table 1 Selection of Exposure Pathways
- RAGS Part D Table 4 Values Used for Daily Intake Calculations

<u>Toxicity Assessment</u>

- RAGS Part D Table 5 Non-cancer Toxicity Data
- RAGS Part D Table 6 Cancer Toxicity Data

RAGS Part D Table 3 Medium-specific Exposure Point Concentration Summary is not included in this PAR as agreed to in discussions with U.S. EPA during the RI/FS development process. The Exposure Point Concentration Summary will be provided as part of the HHRA.

2.1 DATA EVALUATION

Data evaluation is the process of analyzing site characteristics and analytical data to identify chemicals of potential concern (COPCs) to be evaluated in the HHRA. This section of the report identifies data of sufficient quality for use in risk assessment and identifies all COPCs in each environmental medium at the site.

2.1.1 Data Quality

The first step in this process is to evaluate and select data for use in the HHRA. All of the RI data received a third-party review for validity. Validation reports and qualified results were previously transmitted to U.S. EPA in a letter dated April 4, 2002 and in the June 2002 Monthly Progress Report for the Site. Based on the data validation results, the RI data are considered useable for quantitative risk assessment. However, many of the results for hexavalent chromium (chromium VI) concentrations were rejected as an apparent result of matrix interference and poor matrix spike recoveries. A total of 116 soil/sediment samples were analyzed for chromium VI and 74 of the analytical results were rejected during data validation due to poor matrix recoveries resulting from rapid conversion of the spiked chromium VI to chromium III. The data were rejected in accordance with the U.S. EPA Functional Guidelines for Data Validation. However, the results of the matrix spike analyses show that chromium VI is not stable in the soil matrix and is rapidly reduced to chromium III. This suggests that there is little potential for chromium VI presence in the rejected soil samples and the total chromium present is comprised primarily of chromium III species. Figure 2-1 presents the sample locations for the RI data used in the risk assessment.

As indicated in the Work Plan, background data gathered in support of the 1989 RI and the 1993 Supplemental Site Investigation (SSI) were considered data of sufficient quality (i.e. definitive level) because they had the appropriate quality assurance/quality control (QA/QC) verification. Remaining historical data collected from the Site were only considered as screening level, and therefore, were not included in the HHRA as agreed upon in the RI/FS Work Plan.

2.1.2 Selection of Chemicals of Potential Concern

Not all chemicals detected at a site necessarily warrant a quantitative evaluation. U.S. EPA guidance allows for the exclusion of elements that are essential nutrients in the human diet (U.S. EPA, 1989a). Calcium, magnesium, potassium, and sodium, which were detected in groundwater, are considered essential nutrients. These elements were excluded from the data evaluation.

At many sites, most of the chemicals detected are at concentrations so low as to pose a negligible risk, and may be eliminated from further consideration. This leaves a subset of detected chemicals that merit quantitative evaluation. The chemicals in this subset are COPCs. The COPCs at the Peter Cooper Markhams Site were identified for each environmental medium by comparing detected concentrations to risk-based screening criteria. For this Site, the most appropriate risk-based screening criteria are the U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) (U.S. EPA, 2000a). PRGs serve as conservative, health risk-based screening concentrations below which no human health impacts are expected. The site is currently zoned for industrial use and future development of the Site of any kind is extremely unlikely. Nevertheless, Region 9 PRGs for residential land use were used to select COPCs per the RI/FS Work Plan. Use of residential PRGs provides an additional measure of conservatism in the COPC selection process for this site.

A chemical was selected as a COPC if the maximum detected concentration exceeded its respective risk-based screening criterion. The only exception to this rule is that detected chemicals considered by the U.S. EPA to be known human carcinogens (Group A) were included as COPCs regardless of the concentration.

To address potential cumulative non-carcinogenic effects, the screening for potential non-carcinogenic chemicals was conducted using the 1/10 the PRG.

2.1.2.1 Soil

COPCs for soil were identified by comparing concentrations of detected chemicals to U.S. EPA Region 9 PRGs for residential land use (U.S. EPA, 2000a). The comparison using the PRGs identifies chemicals that may pose a potential risk as a result of direct contact by humans with the affected soil. These comparisons are presented in the following RAGS Part D tables:

- Surface Soil - Table 2-1
- Subsurface Soil 0 – 10 ft below ground surface (bgs) - Table 2-2

As indicated in Table 2-1, the only COPCs for surface soil are benzo(a)pyrene, arsenic, and chromium (total). For purposes of the HHRA, total chromium will be evaluated quantitatively as trivalent chromium (chromium III) because hexavalent chromium was not detected above the laboratory practical quantitation limit in soil samples. The results indicate that chromium in soil is only present in the form of chromium III. If COPCs were selected using PRGs based on industrial land use, which is more realistic at this Site, then only arsenic would be a COPC.

The only COPCs in subsurface soil from 0 – 10 ft bgs are benzo(a)pyrene, arsenic, and manganese (Table 2-2). As with surface soil, only arsenic would be selected as a COPC if industrial PRGs were used instead of residential PRGs.

2.1.2.2 Groundwater

COPCs for groundwater were conservatively selected based on a comparison with U.S. EPA Region 9 PRGs for tap water. The COPC selection process for groundwater in the shallow and deep water-bearing zone are summarized in Tables 2-3 and 2-4, respectively. As indicated, COPCs in shallow and deep groundwater include a limited number of volatile chemicals, semi-volatile chemicals, as well as several metals. Although iron is also considered an essential nutrient, iron was considered as a COPC based on the maximum concentration which was conservatively compared with the tap water PRG.

2.1.2.3 Surface Water

Table 2-5 presents the COPC selection process for surface water from the wetland. Although surface water is not used as a drinking water source, tap water U.S. EPA Region 9 PRGs were used to select COPCs. This results in an extremely conservative screening process. The only COPC in surface water is chromium VI.

2.1.2.4 Sediment

There are no human health risk-based screening criteria for sediment. In the absence of such criteria, the PRGs for residential soil were used to identify COPCs in sediment according to the same selection process used for soil. This represents a conservative approach because the degree of potential exposure to sediment in a wetland is significantly lower than that for soil. Table 2-6 presents the COPCs for sediments from the wetland. The only COPC in sediment is arsenic.

2.2 EXPOSURE ASSESSMENT

Exposure assessment is the process of describing, measuring, or estimating the intensity, frequency, and duration of potential human exposure to COPCs in environmental media (e.g., soil, water, air) at a site. This section of the report discusses the mechanisms by which people (receptors) might come in contact with COPCs at the Peter Cooper Markhams Site. The exposure assessment follows the recommendations provided in *Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual Part A* (RAGS Part A; U.S. EPA, 1989a), and more recently in *Guidelines for Exposure Assessment* (U.S. EPA, 1992), and in associated guidance. Based on this guidance, an exposure assessment consists of three basic steps:

1. Characterization of the exposure setting (physical environment and potential receptors).
2. Identification of human exposure pathways (potential sources, points of release, and exposure routes).
3. Quantification of pathway-specific exposures (exposure point concentrations and intake [dose] assumptions).

The assumptions and approaches to be used in the HHRA are consistent with a Reasonable Maximum Exposure (RME) approach as defined by RAGS (U.S. EPA, 1989a). The RME scenario is defined by U.S. EPA as the "highest exposure that is reasonably expected to occur at the site." In order to achieve this goal, the RME approach requires the use of highly conservative exposure assumptions. The use of these upper-bound estimates of exposure most likely overestimates the potential health risks associated with the site.

As required by U.S. EPA, a Central Tendency (CT) analysis will also be conducted if the RME analysis results in risk estimates above the U.S. EPA acceptable risk range of 10^{-6} to 10^{-4} or hazard indices above 1. CT values are presented in the PAR tables.

2.2.1 Characterization of the Exposure Setting

Potential exposure to COPCs at a site depends on a number of factors related to the physical characteristics of a site and its surroundings. These factors include location, surrounding land use, surface topography, hydrogeology, meteorology, and vegetation. They also include factors related to the current and possible future uses of the property. These factors determine the types of activities that might occur at the site, the degree to which the site is accessible to the general public, and the mechanisms that might result in migration of COPCs to on-site and off-site populations.

2.2.1.1 Physical Setting

The Markhams Site is located off Bentley Road in the Town of Dayton, Cattaraugus County, NY, approximately 6 miles south of the Village of Gowanda. The Site encompasses approximately 103 acres and is bordered to the northwest by Bentley Road, to the northeast by wooded property and field, to the southeast by an Erie-Lackawanna Railroad right-of-way, and to the southwest by hardwood forest. Surrounding property is rural; consisting of small farm fields, open meadow and forests.

The majority of the Site, including the northeastern, northwestern and southwestern areas, consists of mature hardwood tree cover as well as open fields. An approximately 20-acre area in the central and southeast portion of the Site contains several covered/vegetated piles arranged in an elliptical pattern. During the RI investigation, it was found that several of the piles, representing approximately 15-25% of the total volume of pile material, consist only of re-worked native soil. Other piles consist of what appears to be vacuum filter sludge and cookhouse sludge covered by 0.5 to 4 feet of re-worked native soil. The piles vary in size and elevation, with approximate base dimensions of 1,100 to 160,000 square feet and elevations of 5 to 20 feet above surrounding grade. The total area covered by piles (base area) is approximately 7 acres.

Site topography, with the exception of the fill mounds, is relatively flat with some natural relief and a moderate grade to the west-southwest. An approximately 5-foot high berm runs along the entire southeast border of the Site and provides an elevated bed for the Erie Lackawanna Railroad track. A dirt/gravel access road extends to the fill area from Bentley Road and continues around a portion of the fill area perimeter. The road also appears to provide access to a natural gas wellhead located on the eastern side of the drive north of the fill areas.

A dense mat of grassy vegetation and low-lying brush is present over the fill piles, with healthy, low-lying brush and trees surrounding the fill pile area. Standing water is present on a seasonal basis in a forested wetland along the western and southwestern portion of the Site and in the open wetland areas north of the fill piles. No structures are present on the property, with the exception of the gas well located east of the access drive. Prior to initiation of RI field activities, the access drive had remained relatively clear from Bentley road to the fill area and along the northern perimeter of the fill piles, but had re-vegetated around the remainder of the fill areas, particularly along the southern and eastern sides of the fill mounds. Accordingly, the access road was re-established in Fall of 2001 to facilitate the RI investigation activities.

A former rail spur is present on the Site north of the main rail tracks. The spur is partially covered, and terminates below grade on the western end. The switchgear is not evident on the adjacent active rail line, indicating that the siding was disconnected from the main rail following Site closure.

The nearest named surface water bodies to the Site are Slab City Creek and Johnson Creek, which are small tributaries of Conewango Creek located respectively 3,000 feet southwest and 2,000 feet southeast of the Site. The Site lies between the two creeks, approximately 1.5 miles north from their confluence. Direct discharge of surface water from the wetland areas does not occur to tributaries of Slab City Creek or Johnson Creek. The wetland areas in the northern portion of the Site are generally not contiguous. Ponded water in the northern wetland areas infiltrates into the subsurface. A wetland in the southwestern portion of the Site appears to be an area of localized groundwater discharge. No visible drainage from this feature is apparent on topographic maps or aerial photographs, or visual inspection.

The depth to the shallow water-bearing zone ranges from being present near the ground surface on the western side of the site (near the adjacent wetland) to nearly 9 feet bgs along the eastern side (near the railroad tracks). Vertical hydraulic gradients are generally upward in more than half of the monitoring well pairs. Vertical gradients are slightly downward in the northwestern portion of the Site. Groundwater flows in a southwesterly direction at the Site. The shallow groundwater horizontal hydraulic gradient is approximately 0.01. Hydraulic conductivity tests conducted during the 1989 RI investigation yielded hydraulic conductivities ranging from 2×10^{-7} cm/s in MW-4S to 1×10^{-3} cm/s in MW-1S (O'Brien & Gere, 1989). Based on data collected during the Geomatrix/Benchmark RI, the upper range of hydraulic conductivity is approximately an order of magnitude greater (3.7×10^{-2} cm/s). Horizontal groundwater seepage velocity estimates were calculated to be approximately 10 feet per year in the shallow water-bearing zone at the Site (O'Brien & Gere, 1989).

The area of Western New York where the Site is located has a cold continental climate, with moisture from Lake Erie causing heavy snowfalls. Average annual snowfall is 110 inches with an average annual precipitation of nearly 40 inches. Average monthly temperatures range from 19 °F in January to 65 °F in July (Franklinville, 1961-1990). The ground and lakes generally remain frozen from December to March. Natural stream temperatures range from 32 °F (winter) to 80 °F (O'Brien & Gere, 1989). Winds are generally from the southwest (240 degrees) with a mean velocity of 10 miles per hour (Buffalo Airport, 1999).

2.2.1.2 Land and Water Use

Potential exposures to COPCs at a site are a function of the current and probable future land uses, both for the site and its surrounding area. RAGS guidance requires the evaluation of potential risks to human health under both current and foreseeable future land uses.

Land Use. The Markhams Site is located in the Town of Dayton, near the hamlet of Markhams, Cattaraugus County, New York, about six miles southwest of the Village of Gowanda. The Site is vacant and has not been legally used for any purpose, other than various historical New York State Department of Environmental Conservation (NYSDEC) and U.S. EPA-directed site investigations, for nearly 30 years. The Site carries an industrial zoning designation, which, in accordance with the Town Zoning Law, precludes other non-industrial uses. No plans exist to change the zoning of the property.

The only human activity that may occur at the Site under current land use is occasional trespassing for purposes of hunting, hiking, and/or off-road vehicle use. There are no current physical barriers to restrict access to the Site. However, the Site has limited frontage along the northwestern side (i.e., along Bentley Road where the Site access drive begins) and is bound on the remaining sides by private properties, limiting access by trespassers. In addition, the elevated railroad bed along the southeastern perimeter of the site and other physical features (i.e., tree lines on the northeastern and southwestern property boundaries) serve to demarcate the Site and deter unknowing trespassers who might otherwise enter the Site from the surrounding open fields. Frequent use of the Site for such purposes is unlikely because of its remote location, the sparse population in the vicinity, and the dense surface vegetation.

At the present time, there is no formal plan for future use of the Site. The Site is located in a sparsely populated rural area; the nearest residences are approximately ¼ mile from the Site. The Dayton area is zoned for mixed-use, the majority of which is designated agricultural (i.e., dairy and livestock farming and livestock feed crops) or forestry. Residential and commercial zones are primarily located northeast and upgradient of the Site along Route 62 and in the Village of South Dayton. Agricultural fields (livestock feed) are present south of the railroad tracks and northeast of the Site. Land use in the vicinity of the Site is consistent with the "agricultural/forestry" zoning designation for surrounding lands.

Surrounding demographics are rural and sparsely populated as indicated by both direct observations during Site reconnaissance and information provided by the Town of Dayton. The Town of Dayton (which includes the Village of South Dayton, and the Hamlets of Cottage, Wesley, and Markhams) had a population of less than 1900 people in the 1990 Census. This represented a decline of approximately 3% from the 1980 Census, which recorded 1981 people. Dayton encompasses an area of approximately 23,500 acres (Cattaraugus County 2000). Thus, population density is sparse with less than one person per 12 acres. Historical aerial photos of the Site and surrounding property from the years 1966 through 1990 also indicate no changes in the locations or numbers of structures/improvements in the area. This trend was substantiated by Ms. Marylin Turnbull of the Dayton Clerk's Office; only three permits for residential construction or improvement were issued for the entire Dayton area during 1999 and 2000 combined.

The current population density and population trend indicate that residential development of the Markhams Site property will not be necessary to support Town growth. Furthermore, because of the Site's remote location and the availability of developable land nearby, future development of the Site for any purpose (residential or non-residential) is extremely unlikely. Development, if desired, would require the difficult (if not impossible) act of transfer of Title from a dissolved owner, payment of back taxes by the buyer [as the previous owner, Peter Cooper Corporation (PCC), is no longer in existence], notification of Town officials, and/or foreclosure on the property by the Town or County. Thus, residential or any other use of the Site is not a "reasonably-anticipated future land use." Based on these site-specific factors, a hypothetical future residential exposure scenario will not be evaluated in the HHRA.

Based on this information, the most reasonable future use of the Site is one that is essentially consistent with current unpermitted use, namely, occasional trespasser use. However, because the site is zoned industrial, a future industrial land use will also be evaluated.

Groundwater Use. In addition to land use, water use also contributes to the degree of potential exposure to COPCs at a site. Shallow groundwater beneath the Site flows in a southwesterly direction, discharging to the adjacent wetland. There are no drinking water wells on-site. Residences in the area surrounding the Site rely on groundwater for their domestic water supply (NYDOH, 2001). However, as previously discussed the vast majority of residences and commercial properties within Markhams are located in the Village of South Dayton, which is situated approximately 3.5 miles away and hydraulically upgradient of the Site. Furthermore, there is no information to indicate that private wells have been affected by site-related constituents. The nearest downgradient residential well to the Site located at 12475 Bentley Road, approximately ½-mile from the Site, was sampled in December 2000 by the U.S. EPA and found to be free of potentially site-related chemicals (NYDOH, 2001). Accordingly, site-related constituents are not likely to impact local groundwater users.

2.2.1.3 Characterization of Potential Receptors

The identification of potential human receptors is based on the characteristics of the site, the surrounding land uses, and the probable future land uses.

Current On-Site Receptors. There is no current commercial, industrial or residential use of the Site. Under current conditions, the only activities that take place on site are those associated with occasional trespassers, including hunting, hiking, and off-road vehicle use. Based on this information, the only current potential on-site receptors are trespassers. These are assumed to be adults. Children are not assumed to trespass on site because of the distance from the Site to nearby residences.

Future On-Site Receptors. As indicated previously, there is no anticipated future use of the Peter Cooper Markhams Site. Site development would be extremely difficult (if not impossible) because of the legal obstacles associated with property ownership as discussed above and extremely unlikely because of the geographic and demographic circumstances. Therefore, the most likely receptors under a reasonably anticipated future use are the same as under current land use, occasional trespassers using the site for hunting, hiking and/or off-road vehicle riding.

Because the property is zoned industrial, a future industrial land use will also be evaluated. Under an industrial land use, the principal potential human receptor that may be exposed to COPCs in on-site media is an on-site industrial worker. Two types of on-site workers will be considered: one who spends most or all of his/her day engaged in outdoor activities, and one who spends most of his/her day indoors. In addition to the industrial worker, a worker involved in occasional construction or maintenance activities requiring excavation into the subsurface could also be exposed to on-site media.

Under a hypothetical future industrial use, there may also be occasional visitors to the Site, such as customers, vendors, or contractors. Visits by the same individual are likely to be much less frequent than the daily contact assumed for an industrial worker. Therefore, this potential receptor will not be evaluated quantitatively.

Current and Future Off-Site Receptors. Potential off-site receptors under both current and future land use include people residing or working downwind of the facility. However, because of the distance from the site to such locations, exposure is anticipated to be minimal. Thus, a quantitative evaluation will not be performed.

2.2.2 Identification Of Exposure Pathways

This section identifies the potential pathways by which the receptors described above could be exposed to COPCs located at or potentially released from the Peter Cooper Markhams Site. An exposure pathway is the mechanism by which an individual may come into contact with COPCs in the environment. An exposure pathway is defined by four elements (U.S. EPA, 1989a):

1. A source and mechanism of COPC release to the environment;
2. An environmental receiving or transport medium (e.g., air, soil) for the released COPC;
3. A point of potential contact with the medium of concern; and
4. An exposure route (e.g., ingestion) at the contact point.

An exposure pathway is considered "complete" only if all four elements are present, and only complete exposure pathways need be evaluated.

In accordance with RAGS (U.S. EPA, 1989a), all potential exposure pathways applicable to the Peter Cooper Markhams Site have been identified and addressed. This identification is based on existing information as presented in the Site Conceptual Model (SCM) (Figure 2-2). Potential on-site receptors may be exposed to COPCs in surface soil, subsurface soil, sediment, groundwater, surface water, and air. Potential off-site receptors may be exposed to COPCs in air. Further discussion of potential exposure pathways is presented in the following sections.

2.2.2.1 Sources, Release and Transport Mechanisms

COPCs at the site are derived from historical activities. There are a number of mechanisms by which the COPCs identified above can migrate to other areas or media. U.S. EPA has identified several of these mechanisms (U.S. EPA, 1989a). Based on current information, the relevance of these mechanisms to the HHRA for the Peter Cooper Markhams Site is discussed below.

Fugitive Dust Generation. Non-volatile chemicals present in soil can be released to ambient air as a result of fugitive dust generation. Although the majority of the Site is covered by vegetation that would prevent the resuspension of surface soil particles, there has been some erosion of surface cover on some of the fill piles. In addition, the use of off-road vehicles on Site may resuspend surface soil into the air. Consequently, this pathway is potentially relevant to the HHRA under current and future land use. Under a hypothetical future industrial land use, the majority of the Site would be covered by industrial or commercial structures, asphalt parking areas, grassed lawn and/or ornamental landscaping. However, the extent of surface cover cannot be predicted. Further, fugitive dusts may also be generated during excavation for new construction. Therefore, this migration pathway is potentially relevant under future land use.

Volatilization. Volatile chemicals in soil and groundwater may be released to ambient or indoor air through volatilization. There are no volatile COPCs in soil at the Site. Therefore, the release of these chemicals from soil is not relevant to the Site. Volatile COPCs were detected in groundwater at the Site. Therefore, the groundwater-to-air pathway may be relevant to the HHRA.

Surface Water Runoff. Chemicals present in on-site soil could be released to adjacent wetland areas as a result of surface water runoff. Therefore, this potential migration pathway is potentially relevant to the HHRA.

Leaching (percolation). Chemicals present in soil may migrate downward to groundwater as a result of infiltration of precipitation. Chemicals from the Site have entered groundwater on-site. This potential migration pathway is potentially relevant to the HHRA.

Groundwater Transport. Groundwater underlying the site discharges to adjacent wetlands. Chemicals present in groundwater may be transported to surface water and sediment via this pathway. Therefore, this potential migration pathway is relevant to the HHRA.

Bioaccumulation. There are no COPCs in soil or groundwater at the Site that tend to bioaccumulate in the food chain. Therefore, this potential migration pathway is not relevant to the HHRA.

2.2.2.2 Exposure Points and Routes

Based upon the COPC-affected media and migration pathways discussed above, points of potential human contact with site-related COPCs are the following:

<u>On-Site</u>

- Surface Soil
- Soil 0 – 10 ft bgs
- Groundwater
- Ambient Air

- Indoor Air
- Wetland Surface Water and Sediment

Off-Site

- Ambient Air

Potential exposure routes associated with COPCs in on-site soil are incidental ingestion and dermal contact. Exposure routes associated with on-site ambient air are inhalation of re-suspended soil particulates and inhalation of VOCs released from groundwater. The exposure route associated with indoor air is inhalation of VOCs released from groundwater. Exposure routes associated with sediment and surface water are incidental ingestion and dermal contact.

2.2.3 Exposure Scenarios

Given the characteristics of the identified COPCs and relevant release processes, the potential exposure pathways for current and future land use of the Peter Cooper Markhams Site are presented in the following sections. These exposure scenarios are summarized within the context of a site conceptual model (SCM). The purpose of the SCM is to describe current knowledge about chemical sources, likely migration pathways, exposure routes, and possible exposure scenarios. Figure 2-2 presents the SCM developed for the Peter Cooper Markhams Site. The RAGS Part D Table 1 Selection of Exposure Pathways is presented in Table 2-7.

2.2.3.1 Current On-site Trespasser Receptors

On-site receptors under current land use may be exposed to surface soil via incidential ingestion and dermal contact. They may also inhale fugitive dusts containing COPCs and volatile COPCs released to ambient air from groundwater.

2.2.3.2 Future On-site Receptors

Future Trespasser. Future on-site trespassers are assumed to be the same as current trespassers. Thus, they would have the same potential exposure pathways, incidental ingestion and dermal contact with surface soil, inhalation of fugitive dusts containing COPCs, and inhalation of volatile COPCs released to ambient air from groundwater.

Future Industrial Workers. Future industrial workers involved primarily in outdoor activities could be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of fugitive dusts. In general, direct contact pathways are only applicable if the soil is exposed, i.e. not covered by pavement, buildings, or lawns. Following hypothetical future industrial re-development, much of the site would be covered. Nevertheless, these pathways will be evaluated quantitatively because the presence or absence of such structures cannot be guaranteed. Fugitive dusts may also be generated during future construction activities. On-site workers may also be exposed to volatile COPCs that are released to ambient air as a result of volatilization from groundwater.

Future on-site industrial workers who spend most of their day indoors are unlikely to be exposed to soil. These workers may be exposed via inhalation to volatile COPCs released to indoor air from groundwater.

Future on-site industrial workers could hypothetically be exposed to COPCs in groundwater if it were used for potable use. There are currently no drinking water wells at the Site. These workers could be exposed via ingestion and dermal contact.

Future Construction Workers. Construction workers may be exposed to COPCs in both surface and subsurface soils via incidental ingestion and dermal contact. Construction workers may also be exposed to COPCs in soil via inhalation of fugitive dusts. This receptor may also inhale volatile COPCs released to air from groundwater. During excavation of soil, construction workers may also be exposed to COPCs in shallow groundwater via dermal contact.

2.2.3.3 Current and Future Off-Site Receptors

Current and Future Off-site Residents and Workers. Off-site residents and workers could be exposed to COPCs in ambient air as a result of off-site dispersion of fugitive dust and volatile emissions. However, the degree of exposure for off-site residents and workers via ambient air is likely to be significantly less than that of the on-site receptors, because of dispersion and dilution of COPCs in air. Therefore, these exposure pathways will not be evaluated quantitatively.

2.2.3.4 Exposure Equations

The "Annual Average Daily Dose" (AADD) or "Lifetime Average Daily Dose" (LADD) are used to quantify exposure doses in site risk assessments. The AADD is used as a standard measure for characterizing long-term non-carcinogenic effects. The LADD addresses exposures that may occur over varying durations from a single event to an average 70-year human lifetime and are used to estimate potential carcinogenic risks.

The equations for calculating AADD and LADD for ingestion and inhalation exposures were taken from RAGS (U.S. EPA, 2001). The AADD and LADD equations for dermal exposures were taken from the 2001 Supplemental RAGS dermal guidance (U.S. EPA, 2001). The equations and assumptions employed in this HHRA are consistent with the U.S. EPA definition of an RME scenario. Because of the multiple conservative assumptions incorporated into this type of approach, the resulting risks generated using this approach are likely to overestimate the true risks associated with the Site.

2.2.3.5 Exposure Parameters

Exposure parameters are quantitative estimates of the frequency, duration, and magnitude of exposure to various media. Except for these parameters discussed below, the exposure parameters used in this HHRA were default values selected from U.S. EPA guidance. The specific exposure parameters used for the receptors evaluated in this HHRA are presented in Tables 2-8 to 2-20 (RAGS Part D Table 4). Chemical-specific dermal absorption fractions, permeability constants, and the calculated dermal absorbed dose per event (Daevent) are presented in Tables 2-21 and 2-22, respectively.

The only exposure parameters that are based on professional judgement and not U.S. EPA guidance are the exposure frequencies and exposure times (also called event duration) for the current and future on-site trespasser, and future construction worker. The values selected for these parameters were based on professional judgment considering such factors as the relative accessibility of the site, the attractiveness of the site for trespassing activities, and the proportion of the year (8 months) during which the ground is not frozen (see Section 2.2.1.1).

In all cases, including the parameters based on professional judgment, the values selected represent upper-bound estimates of potential exposure. Consequently, the risk estimates generated based on these values represent a conservative upper-bound estimate of potential risks; the true value of the risk associated with this site is likely to be lower than that estimated in this HHRA.

2.2.3.6 Exposure Models

Potential inhalation exposure to COPCs adsorbed to potentially respirable particles (PM10) will be evaluated using the U.S. EPA's default particulate emission factor (PEF) that relates chemical concentration in soil with the concentration of respirable particles in air from dust emissions. The relationship is applicable to a typical hazardous waste site where chemicals in surface soil provide a relatively continuous and constant potential for emission over an extended period of time.

For volatile COPCs, the Johnson and Ettinger model, parameterized by U.S. EPA (U.S. EPA, 1997), will be used to estimate the transport of chemical vapors emanating from groundwater into indoor spaces located directly above or in close proximity to a source of chemicals.

For VOCs in ambient air, the VOC emission model presented in *"Soil Screening Guidance"* (U.S. EPA, 1996a and 1996b) will be used to estimate the vapor flux of chemicals from groundwater. On-site ambient air concentrations will then be estimated based on the emission rate from the VOC emission model and dispersion models.

The U.S. EPA's Air Emission Model for Quiescent Surface Impoundments will be used to estimate the concentrations in air resulting from volatilization of chemicals from surface water exposed during excavation activities (U.S. EPA, 1995).

2.3 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is two-fold (U.S. EPA, 1989a):

- To evaluate available information regarding the potential for a chemical to cause adverse health effects in exposed individuals (hazard identification), and
- To estimate the relationship between the extent of exposure and the increased probability and/or severity of adverse effects (dose-response assessment).

In the hazard identification step, the toxicity of a chemical is evaluated to determine (1) if the chemical can cause an increase in a particular adverse effect (e.g., cancer) and (2) the likelihood that the adverse effect will occur in humans. The result of the hazard identification is a toxicity profile composed by the U.S. EPA that summarizes the available toxicological information and its relevance to human exposure.

The dose-response assessment entails quantifying the relationship between the dose of a chemical and the incidence of adverse effects in the exposed population. The result of the dose-response assessment is a set of toxicity criteria derived by the U.S. EPA that are used in risk assessments to estimate the likelihood of adverse effects occurring in humans at different exposure levels. All of the COPCs identified for the Peter Cooper Markhams Site have been evaluated by the U.S. EPA and have available toxicity criteria.

The toxicity criteria used to evaluate noncarcinogenic and carcinogenic health risks are referred to as reference doses (RfDs) and slope factors (SFs), respectively. The basis for the criteria is described briefly in the following sections.

2.3.1 Noncarcinogenic Effects

Observable noncarcinogenic effects occur only after a threshold dose is reached. For the purposes of establishing health criteria, this threshold dose is usually estimated from the no-observed adverse effect level (NOAEL) or the lowest-observed adverse effect level (LOAEL) determined in chronic animal exposure studies. The NOAEL is defined as the highest dose at which no adverse effects occur, whereas the LOAEL is defined as the lowest dose at which adverse effects begin to occur. The U.S. EPA and other regulatory agencies use NOAELs and LOAELs derived from animal studies to establish RfDs in order to evaluate human intake of noncarcinogenic compounds. RfDs, which are expressed in terms of mg/kg-day, are criteria intended to represent the dose of a chemical that is not expected to cause adverse health effects for daily exposure over a lifetime, even in sensitive individuals, with a substantial margin of safety (U.S. EPA, 1989a).

Uncertainty factors are used in the development of RfDs in an attempt to account for limitations in the quality or quantity of available data. Up to five uncertainty factors may be incorporated into the calculation of an RfD, with each factor ranging in value from 1 to 10. Uncertainty factors may be incorporated for the following uncertainties: (1) extrapolating animal data to human health effects; (2) possible differences in sensitivity within the human population; (3) using a LOAEL in the absence of a NOAEL; (4) extrapolating from subchronic data to chronic exposures; and (5) potential limitations in the database.

2.3.2 Carcinogenic Effects

The U.S. EPA currently regulates most potential human carcinogens as non-threshold carcinogens. This approach assumes that the dose-response curve for carcinogens only allows for zero risk at zero dose (i.e., some risk is assumed to be present for all doses). Although recent draft U.S. EPA guidance on cancer allows for the evaluation of potential threshold carcinogens, typically data are insufficient to support such an evaluation. Various mathematical models are used to estimate theoretically plausible responses at low doses. The accuracy of the projected risk depends on how well the model predicts the true relationship between dose and risk at dose levels where the relationship cannot be actually measured. The accuracy of these models is currently unknown, but they are not believed to underestimate the true risk.

Health risks for exposure to carcinogens are defined in terms of probabilities that quantify the likelihood of a carcinogenic response in an individual receiving a given dose of a particular compound. The SF is defined as a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime and is usually the upper 95th percent confidence limit of the slope of the dose-response curve expressed in $(mg/kg/day)^{-1}$.

2.3.3 Toxicity Criteria Used in Health Risk Assessment

The U.S. EPA has completed toxicity assessments for the COPCs identified in this Pathways Analysis Report. Toxicity criteria used in this assessment were selected according to the following hierarchy:

1. U.S. EPA, 2002, Integrated Risk Information System (IRIS)
2. U.S. EPA, 1997b, Health Effects Assessment Summary Tables, FY-1997 Annual, Office of Solid Waste and Emergency Response, Washington, D.C.
3. U.S. EPA National Center for Environmental Assessment (NCEA)
4. U.S. EPA, 2000a, Region 9 PRGs

The toxicity criteria for noncarcinogenic effects are presented in Table 2-23 for oral and dermal exposures and Table 2-24 for inhalation exposures (RAGS Part D Table 5 Non-cancer Toxicity Data). The criteria for potential carcinogenic effects are presented in Table 2-25 for oral and dermal exposures and Table 2-26 for inhalation exposures (RAGS Part D Table 6 Cancer Toxicity Data).

GEOMATRIX

2.4 SUMMARY OF HHRA COPCS

Media	COPCs	
Surface Soil	**Metals:** Arsenic, Chromium III	**SVOCs:** Benzo(a)pyrene
Subsurface Soil 0 – 10 ft bgs	**Metals:** Arsenic, Chromium III, Manganese	**SVOCs:** Benzo(a)pyrene
Shallow Groundwater	**Metals:** Aluminum, Antimony, Arsenic, Barium, Cadmium, Cobalt, Copper, Lead, Manganese, Nickel, Selenium, Thallium, Zinc	**VOCs:** Benzene, Trichloroethene **SVOCs:** Benzo(b)fluoranthene, Bis(2-ethylhexyl)phthalate
Deep Groundwater	**Metals:** Aluminum, Barium, Manganese, Chromium VI[1]	**VOCs:** Acetone
Wetland Surface Water	**Metals:** Chromium VI	
Wetland Sediments	**Metals:** Arsenic	

[1] Hexavalent chromium was detected in only one out of 18 groundwater samples and was qualified as an estimated value (J flag).

3.0 SCREENING ECOLOGICAL RISK ASSESSMENT

This section of the PAR presents a Screening Ecological Risk Assessment (SERA) for the Peter Cooper Markhams Site (Site). The goal of the SERA is to determine whether constituents from the Site pose a potential risk to plants, animals, and/or ecologically valuable habitats in the vicinity of the Site.

This SERA report identifies and analyzes the following:

- Potential ecological receptors, including sensitive and protected species, wetlands and water bodies, and natural areas in the Site vicinity;
- Constituent sources, affected media, and chemicals of potential ecological concern (COPECs); and
- Potential exposure pathways for plants and animals.

Based on this analysis, potential ecological risks are identified and areas of the Site are prioritized according to the degree of the potential risk. Principal data gaps are identified and the need for further investigation is discussed.

Statutory authority for this assessment is found in the Comprehensive Environmental Resource Conservation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). The evaluation follows guidance contained in the following documents:

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final (USEPA, 1997)
- Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual, Interim Final, EPA/540/1-89/001 (USEPA, 1989).

According to this guidance, the SERA is the first tier in the process of evaluating potential ecological risks at a site. The purpose of the SERA is to screen available information to identify areas that need closer evaluation, and determine more specifically the type and degree of potential ecological risk. In cases where there is insufficient information, the SERA can identify data gaps that can be addressed by additional tiers of effort such as a Baseline Ecological Risk Assessment (BERA). Thus, the results of the SERA are not intended as a definitive description and characterization of ecological risks at the Peter Cooper Markhams

Site. Rather, the SERA provides a preliminary analysis to assist in determining the need for more comprehensive and detailed ecological investigations.

3.1 PROBLEM FORMULATION

The problem formulation establishes the goals and focus of the SERA. It establishes the assessment endpoints based on potentially complete exposure pathways and toxicological effects. Problem formulation results in the definition of the risk system, using the Conceptual Risk System Model (CRSM) as a vehicle. The CRSM describes a site and its environment and presents information regarding the fate and transport of chemical constituents released from the site through the environment to an exposed plant or animal. The model also lists potential routes of exposure.

3.1.1 Environmental Setting

3.1.1.1 Terrestrial Setting

The Site and surrounding area are located in a rural community that is mostly vegetated and can support a diversity of wildlife species. The Site is comprised of approximately 103-acres of property located off Bentley Road in the Town of Markhams, New York. In general, the majority of the Site including the northeastern, northwestern, and southwestern areas of the property is characterized by mature hardwood tree cover as well as forested and open wetland area. An approximately 20-acre area within the central and southeast portion of the Site contains several covered/vegetated fill piles arranged in an elliptical pattern. The fill piles vary in size and elevation, with base dimensions ranging from approximately 1,100-160,000 square feet and elevations of 12 to 20 feet above surrounding grade. The total area covered by fill piles (base area) is approximately 7 acres.

A Site reconnaissance was conducted from October 7th through 9th and four distinct terrestrial habitat types were identified in the vicinity of the Site (Figure 3-1). Plant species areas identified by cover type are presented in Table 3.1.

Each plant cover type area is described below as to the plant species composition, vegetation structure, and land use. Whenever possible, these areas were classified according to the New York State Natural Heritage Program's *Ecological Communities of New York State* (Reschke, 1990).

Cover Type 1: Successional Northern Hardwood Forest

This cover type is the dominant cover type at the Site. This cover type is a successional northern hardwood forest dominated by black cherry (*Prunus serotina*), cottonwood (*Populus deltoids*), and sugar maple (*Acer saccharium*). The understory is sparse except along the edges where more sunlight penetrates. It is comprised of staghorn sumac, dewberry (*Rubus flagellaris*) and tartarian honeysuckle. The ground layer also is sparse except along the forest edge and consists of hay scented fern (*Dennstaedtia punctiloba*) and garlic mustard (*Alliaria oficinalis*).

Cover Type 2: Successional Old Field

This cover type is characterized as a weedy field dominated by grasses and forbs that occur on sites that historically were cleared for development. This cover type is found around an active gas well that is located in the northwest portion of the Site. Dominant plant species include rough-stemmed goldenrod (*Solidago rugosa*), Canada goldenrod (*Solidago canadensis*), gray goldenrod (*Solidago nemoralis*), and late goldenrod (*Solidago gigantea*). In some areas, especially near the forested areas, woody vegetation such as staghorn sumac (*Rhus typhina*) and tartarian honeysuckle (*Lonicera tatarica*) has begun to invade these fields.

Cover Type 3: Early Successional Field

This cover type is found along the dirt roads and along the toe of some of the fill piles. This cover type is a successional field dominated by late goldenrod, rough-stemmed goldenrod, burdock (*Arctium minus*), and red fescue (*Festuca rubra*).

Cover Type 4: Successional Northern Hardwood Forest

This cover type is dominated by 4- to 6-inch diameter quaking aspen (*Populus tremuloides*) trees. The understory is dense and consists of staghorn sumac, black raspberry (*Rubus occidentalis*) and tartarian honeysuckle. The groundcover is dense and consists of goldenrods and burdock.

3.1.1.2 Wetlands

The New York State Freshwater Wetlands Map, Gowanda and Perrysburg, New York topographic map was reviewed for the presence of state wetlands within two miles of the Site. One state wetland, CK-3, is located on the Site.

The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Map, Gowanda and Perrysburg, New York topographic map identifies the presence of several federal wetlands. Many federal wetlands were identified on and adjacent to the Site.

Eight federal wetland plant communities were delineated within the boundary of the Site. The boundaries between these cover types are depicted in Figure 3-1. Plant species identified by cover type are presented in Table 3.1.

Each wetland is described below as to the plant species composition, vegetation structure, and land use. Whenever possible, these areas were classified according to the New York State Natural Heritage Program's *Ecological Communities of New York State* (Reschke, 1990). In addition, the soil color and chroma as defined on a Munsell color chart is provided in parenthesis after the soil description.

Cover Type 5: Forested Wetland

This wetland is located in a depressional area in the western portion of the Site near monitoring well MW-1S. It is not indicated on the NWI map. The wetland is dominated by cottonwood and red maple (*Acer rubrum*) trees. The understory consists of jewelweed (*Impatiens capensis*). The soil is a dark gray silty clay (gleyed 3/0). At the time of the survey, no standing water was present in the wetland.

Cover Type 6: Emergent/Scrub-Shrub Wetland

This wetland is located in the center of the Site. The wetland is identified on the NWI map as a palustrine, forested, broad-leaved deciduous, seasonal saturated (PFO1E) wetland. This wetland is dominated by silky dogwood (*Cornus amomum*), northern arrowwood (*Viburnum recognitum*), jewelweed, broad-leaved cattail (*Typhia latifolia*), false nettle (*Boehmeria cylindrical*), soft rush (*Juncus effusus*), and Canada rush (*Juncus canadensis*). The wetland was saturated to the surface at the time of the survey. The soil is a gleyed muck (2.5Y 0).

Cover Type 7: Emergent/Open Water Wetland

This wetland is located north of cover type 6. This wetland is identified on the NWI map as a palustrine, unconsolidated bottom, intermittently exposed/permanent, excavated (PUBZx) wetland. It is dominated by silky dogwood, soft rush, false nettle, black willow (*Salix nigra*), and cattails. At the time of the survey, 0.5 to 2 inches of standing water was present in the wetland. Auger refusal occurred at 2 inches below ground surface. The soil is a black organic material (2.5/0).

Cover Type 8: Forested/Scrub-Shrub Wetland

This wetland is located in the southeastern corner of the property. This wetland is identified on the NWI map as palustrine, forested, broad-leaved deciduous, seasonal saturated (PFO1E) wetland. It is dominated by cottonwood, slippery elm (*Ulmus rubra*), silky dogwood, false nettle and jewelweed. This area is a depressional area where runoff from the surrounding berm areas and railroad deposit here. Auger refusal occurred at 3 inches below ground surface. The soil is a silty loam (7.5YR 2.5/1).

Cover Type 9: Forested Wetland

This wetland borders the northern property line and extends into adjacent cornfields. This wetland is not identified on the NWI wetland maps. It is dominated by red maple trees. The understory consists of northern arrowwood, false nettle, and sensitive fern (*Onoclea sensibilis*). The soil is a light grey silty loam (10YR 5/2) with many orange mottles (7.5YR 5/8). An area of 3 to 6 inches of ponded water covered by duckweed with black muck (2.5Y 0) was observed. The soil in the nonponded portion of the wetland was a light gray silty clay (10YR 5/2) with many orange mottles (7.5YR 5/8).

Cover Type 10: Emergent/Scrub-Shrub/Forested Wetland

This is a large wetland complex that borders the western edge of the property. This wetland is identified as state wetland CK-3. It is also identified on the NWI maps as a palustrine, forested, broad-leaved, deciduous, seasonally saturated (PFO1E) wetland. The emergent portion of the wetland is near Bentley Road and is dominated by cattails and wool grass (*Scirpus cyperinus*). The scrub shrub borders the wetland and the dirt entrance road and is dominated by silky dogwood, northern arrowwood and spice bush (*Lindera benzoin*). The forested portion dominates the southern portion of the wetland. It consists of cottonwood and red maple. The soils in the emergent portion are an organic muck (2.5Y 0). The soils in the forested and scrub-shrub portion are a silty clay (10YR 5/2) with many yellow orange mottles (7.5YR 5/5).

Cover Type 11: Emergent/Scrub-Shrub Wetland

This wetland is located northeast of cover type 6. This wetland is identified on the NWI maps as a palustrine, forested, broad-leaved, deciduous, seasonally saturated (PFO1E) wetland. The forested portion is dominated by red maple and slippery elm. The emergent portion is dominated by wool grass, sensitive fern and *Carex lurida*. At the time of the survey, the wetland was saturated to the surface with less than an inch of standing water in some areas. The soil is a muck in the emergent area (2.5Y 0). The soil in the forested area is a silty clay (10YR 5/2) with many orange mottles (7.5YR 5/8).

Cover Type 12: Forested/Scrub-Shrub Wetland

This wetland is found near the gas well in the northwestern portion of the Site. It is not on the NWI wetland map. It is dominated by red maple, slippery elm, silky dogwood, wool grass and sensitive fern. Auger refusal occurred at 2 inches. Soils within this are a loam (10YR 3/2) with yellow orange mottles (10YR 6/8).

3.1.1.3 Surface Water Bodies

There are no surface water bodies (streams, creeks, ponds or lakes) located on the Site.

3.1.1.4 Fish and Wildlife Resources

Wildlife uses in the area were evaluated using literature sources and field observations. Wildlife sightings included direct observations and identifications based on vocalizations, tracks, browse, and scat, and observed general wildlife values (*e.g.*, food and cover availability).

The USFWS and the New York State Department of Environmental Conservation Natural Heritage program were contacted for information concerning endangered and threatened species. To date, no response has been received from the USFWS. No state listed threatened or endangered species are located on the site (Mackey, 2002).

In the vicinity of the Peter Cooper Markhams Site, land use is a mixture of wetlands, woodlands, and agricultural fields. This area appears to support a diversity of wildlife due to the limited amount of development. Tables 3.2 through 3.4 identify species of herptiles (amphibians and reptiles), birds, and mammals that may potentially occur within and adjacent to the Site based on the cover types identified during the field reconnaissance. The species observed during the field reconnaissance (which are representative for the point in time of the field reconnaissance) also are identified in the tables.

The successional old fields on the Site serve as wildlife openings that provide edge, cover and food. These areas will have songbirds and mammalian species such as goldfinches (*Carduelis tristis*), song sparrows (*Melospiza melodia*), white-footed mice (*Peromyscus leucopus*), and meadow voles (*Microtus pennsylvanicus*) which consume the seeds of grass and forbs. With an abundant prey base, carnivores, such as red fox (*Vulpes vulpes*), red-tailed hawks (*Buteo jamaicensis*), and barn owls (*Tyto alba*) may reside in the area.

When discussing the wildlife value of forest stands, the composition of tree species is important. The variability of each individual stand will slightly alter the wildlife present, and the greater the diversity of tree species, the greater the wildlife value. Although there is considerable overlap between food sources that wildlife may use in each stand, in general, the greater the diversity within the stand, and the larger the tract size, the more significant the value of the habitat.

The northern hardwood successional forest on the Site is dominated by a variety of species including cottonwoods, maple, and black cherry. Black cherry is one of the most important wildlife food sources. Wild cherries comprise most of the diet of songbirds such as rose-breasted grosbeaks (*Pheucticus ludovicianus*), American robin (*Turdus migratorius*), cedar waxwing (*Bombycilla cedrorum*) and small mammals such as chipmunks (*Tamias striatus*) (Martin *et al.,* 1951). The presence of sugar maples and cottonwoods increase the value of the area by providing additional sources of food and cover.

The wetland communities on or adjacent to the Site provide habitat for many animals because of the seasonal or perennial presence of water. This water may be used directly for drinking by animals in the general area. In addition, pooled water is essential for breeding populations of amphibians.

3.1.2 Fate and Transport

The fate and transport of chemicals in the environment are influenced by a variety of physicochemical- and site-specific factors. The chemical constituents detected on-Site include volatile organic compounds and semi-volatile organic compounds (primarily polynuclear aromatic hydrocarbons [PAHs] in soils) as well as some inorganic constituents (predominantly chromium and arsenic). Environmental fate and transport processes for these types of chemicals are briefly discussed in the following subsections.

3.1.2.1 Physicochemical Properties

The fate and transport of chemicals in the environment depends on the properties of both the chemicals and the environmental media in which they occur. Table 3.5 lists several principal organic constituents along with some of their respective physical and chemical properties (*e.g.,* water solubility, Henry's Law Constant, octanol-water partition coefficient, and organic-carbon partition coefficient).

Water solubility is the maximum concentration of a compound that dissolves in water at a specific temperature. Highly soluble compounds can be rapidly leached from soils and water and are generally mobile in groundwater and surface water. Chemicals of low water solubility are relatively immobile in aquifers but may be transported rapidly in turbulent surface waters as suspended particles. Some water-insoluble compounds become readily mobile when in contact with organic solvents.

Vapor pressure is a measure of the volatility of a chemical in its pure state and is a determinant of vaporization from waste sites. A compound's tendency to volatilize from water depends upon its Henry's Law Constant. Henry's Law Constant is the ratio, at equilibrium, of a compound's vapor pressure (atmospheres) to its water solubility (moles/m^3). Compounds with Henry's Law Constants greater than 10^{-3} atm-m^3/mol readily volatilize from water. Those with Henry's Law Constants from 10^{-3} to 10^{-5} atm-m^3/mol volatile less readily, while those with Henry's Law Constant less than 10^{-5} atm-m^3/mol volatilize slowly.

The octanol-water partition coefficient (K_{ow}) expresses the equilibrium distribution of an organic compound between octanol and water. K_{ow} is often used to estimate the extent to which a chemical will partition from water into fatty tissues of animals. Log K_{ow} values range from –2.5 to 10.5. Organic chemicals with log K_{ow} values less than 3 are generally considered not to concentrate in animal tissues: that is, they do not bioaccumulate.

The organic carbon partition coefficient (K_{oc}) is a measure of the tendency of organic compounds to sorb to soil and sediment and is expressed by this equation:

$$K_{oc} = \frac{\text{(mg chemical sorbed / kg organic carbon)}}{\text{(mg chemical dissolved / L of solution)}}$$

K_{oc} reflects the tendency of organic compounds to sorb to organic matter in soil and sediment. K_{oc} values for organic compounds range from 1 to 10^7; higher values indicate greater sorption potential. Chemicals with K_{oc} values than 10^3 generally do not sorb strongly enough to soil to affect overall leachability.

3.1.2.2 Fate and Transport Mechanisms

Volatile Organic Compounds – The volatile organic compounds detected have high vapor pressures and, therefore, would be expected to volatilize readily from surface soil and surface water to the atmosphere. Once released to the atmosphere, these compounds are rapidly photodegraded.

In deeper soils, these compounds degrade slowly, are water-soluble and may leach into groundwater. These compounds have low log K_{ow} and, therefore, do not readily adsorb to sediment or particulate matter present in the water column.

Bioconcentration factors (BCFs), which relate the concentration of the chemical in the organism at equilibrium to the concentration of the chemical in water, are used to assess the potential for chemical bioconcentration. BCFs correlate with the octanol/water partition coefficient and solubility of a chemical. Since the volatile organic compounds detected have low K_{ow} coefficients and high water solubilities, these chemicals have a low potential to bioconcentrate in organisms (Howard, 1990).

PAHs – PAHs, such as benzo(a)pyrene, were detected in Site soils. The compounds contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular or cluster arrangements. These compounds are the result of incomplete combustion of fossil fuels and are consequently ubiquitous in the environment. The number of rings in a PAH molecule affects its biological activity, and fate and transport in the environment. In general, most PAHs can be characterized as having low vapor pressure, low to very low water solubility, low Henry's Law constant, high log K_{ow}, and high organic carbon partition coefficient (K_{oc}).

High partition coefficients and low solubilities indicate that PAHs are likely to be adsorbed onto soil and sediment particles. Conversely, these properties indicate that most PAHs will not readily volatilize into the atmosphere. Accordingly, PAHs are not considered mobile in the environment.

Although PAHs are associated with low mobility, they are degradable by microorganisms. Environmental factors, microbial flora and physicochemical properties of the PAHs themselves influence degradation rates and degree of degradation. Environmental factors influencing degradation include temperature, pH, and redox potential and microbial species. Physicochemical properties, which influence degradation, include chemical structure, concentration and lipophilicity.

In general, PAHs show little tendency to biomagnify in food chains, despite their high lipid solubility, probably because most PAHs are rapidly metabolized (Eisler, 1987).

Metals – In a terrestrial setting, trace elements released to the environment accumulate in the soil (Sposito and Page, 1984). Mobility of these trace elements in soil is low and accumulated metals are depleted slowly by leaching, plant uptake, erosion, or chelation. The half-life of trace elements in temperate climate ranges from 75 years for cadmium to more than 3,000 for zinc.

The transport of trace elements in soil may occur via the dissolution of metals into pore water and leaching to groundwater, or colloidal or bulk movement (*i.e.,* wind or surface water erosion). The rate of trace element migration in soil is affected by the chemical, physical and biological characteristics of the soil. The most important characteristics include:

- Eh-pH system;
- Cation exchange capacity and salt content;
- Quantity of organic matter;
- Plant species;
- Water content and temperature; and
- Microbial activity.

Metals that do mobilize from the soil into the water column are most mobile under acid conditions and increasing pH usually reduces their bioavailability. Generally, metals do not exist in soluble forms for long and tend to accumulate in bottom sediment. Once in the sediment, most metals sorb onto hydrous iron and manganese oxides, clayey minerals and organic materials and are eventually partitioned into the sediments. Metal bioavailability from the sediment is enhanced under conditions of low pH, high dissolved oxygen, high temperature, and oxidation state. During these conditions, metals become soluble and freely move in the interstitial pore water and the water column (McIntosh, 1992).

Arsenic - Although arsenic minerals and compounds are soluble, arsenic migration is greatly limited due to the strong sorption by clays, hydroxides, and organic matter. The reactions of arsenic in soil are governed by its oxidation state. However, arsenate ions are known to be readily fixed by such soil components in order of retention as iron oxide, aluminum oxide, clay, humus, and calcium. Strongly adsorbed arsenic is unlikely to be desorbed and the retention of arsenic by soil increases with time (Kabata-Pendias and Pendias, 1992).

The chemistry of arsenic in water is complex and the form present in solution is dependent on such environmental conditions as Eh, pH, organic content, suspended solids and sediment. Arsenic is generally quite mobile in the environment. In aquatic environments, volatilization is important when biological activity or highly reducing conditions produce arsine or methylarsenics. Sorption by the sediment is an important fate for the chemical. Arsenic is metabolized to organic arsenicals by a number of organisms (Clement Associates, 1985)

Chromium – Chromium (III) tends to be adsorbed strongly on clay particles and organic particulate matter, but can be mobilized if it is complexed with organic molecules. Hexavalent compounds are not strongly adsorbed by soil components and chromium (VI) is mobile in groundwater. Chromium (VI) is quickly reduced to chromium (III) in organic rich sediments and poorly drained soils having a high content of organic matter. Chromium (VI) of natural origin is rarely found in soils (Clement Associates, 1985).

The ecological migration pathways for COPECs is illustrated on Figure 3-2.

3.1.3 Mechanisms of Ecotoxicity and Potential Receptors

The ecological effect of a chemical constituent depends on many factors, such as the constituent's bioavailability, its concentration in the environment and/or receptor organism, synergistic interactions among constituents, the duration and frequency of receptor biota exposure to that constituent, the species of the receptor, the metabolic rate of the species, and the characteristics of the metabolic processes of the species (USEPA, 1988). Constituents in the environment can affect receptor biota and ecosystems in both lethal and sublethal ways, such as the following:

- altered developmental rates, metabolic and physiologic processes and functions, or behavior;
- increased susceptibility to disease, parasitism, or predation;
- disrupted reproductive functions; and
- mutations or other reduction in the viability of offspring (USEPA, 1989).

When potential effects of an environmental constituent on biotic receptors are being evaluated, the toxicity of the constituent must be determined. The determination should be based on field data, monitoring data, and the results of toxicity testing of contaminated media (USEPA, 1989).

Appendix A of this report summarizes toxicological information from the scientific literature for all of the chemicals detected at the Site. The summaries present information on constituent toxicity, likely mechanisms of toxicity, and potential effects on receptor biota, populations, and ecosystems.

3.1.4 Exposure Pathways

A conceptual risk system model, which illustrates complete exposure pathways, is presented in Figure 3-2. The exposure pathway is a course that a COPEC may take from a source to an individual receptor, and includes a source, a release mechanism, an exposure point, and exposure route. The exposure point is the location of potential contact between an individual and a COPEC, while the exposure route is the way that a chemical comes in contact with an individual.

Ecological resources in the vicinity of the Site may be exposed to constituents through various exposure routes (see Figure 3-2). Surface soil and sediment are the environmental media most likely to be encountered by biota.

Upon their release, some of the Site constituents are persistent and may be transformed to more bioavailable forms and mobilized in the food chain. Mobilization of chemicals in the food chain could occur through the following pathways:

- root uptake by wetland and terrestrial macrophytes;
- contact and absorption of chemicals in surface soil and sediments, incidental ingestion; and feeding on contaminated food by aquatic and terrestrial invertebrates; and
- bioaccumulation from vegetation or animal prey at the base of the food chain by wildlife.

3.1.5 Ecological Receptors

Based on the pathways identified above, the following general classes of ecological receptors potentially might be exposed to chemicals at and in the vicinity of the Site:

- Terrestrial wildlife species that may be in contact with the soils and that feed within the terrestrial food chain;
- Facultative aquatic wildlife species that may be in contact with the wetland sediments and/or frequently use the wetlands for foraging.

3.1.6 Screening Endpoints

The ecological values of the Site include populations and communities of plants and animals in terrestrial and wetland habitats. In broad terms, the values to be protected (assessment endpoints) for each of these habitat types are the structure and function of site ecosystems, and the survival and reproduction of species typical of the region.

For purposes of this assessment, the measurement endpoints for the assessment endpoints (*i.e.*, the ecological receptors) are the likelihood of their occurrence in areas where they could be adversely affected by chemicals detected in environmental media at the Site. The likelihood of contact with Site-related constituents can be evaluated by analyzing the area of overlap of the Site with each of the broad habitat types found. The likelihood of adverse effects on survival or reproduction of ecological receptors can be evaluated by determining whether exposure pathways are complete *i.e.*, there is no break in the chain from source to receptor for the pathways (as shown in Figure 3-2), and by comparing known concentrations of constituents with ecological data quality levels (EDQL).

3.2 Potential Stressors

3.2.1 Soil

COPECs were identified by comparing available chemical concentrations detected in surface soil with EDQLs derived by USEPA Region 5. The EDQLs are initial screening levels to which the Site constituent concentrations can be compared. The EDQLs help to focus the investigation on those areas and chemicals that are most likely to pose an unacceptable risk to the environment. EDQLs also impact the data requirements for the planning and implementation of field investigations. The ecological risk assessment will be further refined based on this initial screening. The levels used in this process are intended only for screening purposes and identification of COPECs. They are not meant to imply any definitive level of risk or to be indicative of risk-based cleanup or remediation goals.

Chemical screening results for soil samples, including frequency of detection and range of detected concentrations, are presented in Table 3.6. Surface and subsurface soil samples were collected at the Site. Most burrowing animals create dens in the upper four feet of soil. In addition, the deeper subsurface soil samples (*i.e.,* greater than four feet) are below the root zone of most plants. Due to the lack of exposure routes to wildlife, data for deeper subsurface soils were not evaluated. Consequently, only the surface soil and shallow subsurface soil data (up to four feet below ground surface) were considered in this assessment.

Ninety-one surface soil and shallow subsurface soil samples were collected and analyzed for arsenic, chromium and hexavalent chromium. Eleven of these samples also were analyzed for volatile and semi-volatile organic compounds. Hexavalent chromium was not detected n any of the samples. Results of comparing the maximum detected concentration of each constituent to EDQLs indicated that:

- Methylene chloride, carbon disulfide, 2-butanone, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)fluoranthene,chrysene, diethylphthalate, fluoranthene, indeno(1,2,3-cd)pyrene, 4-methylphenol, naphthalene, phenanthrene, and pyrene did not exceed their respective EDQL.
- Dichlorodifluoromethane, trichlorofluoromethane, benzo(a)anthracene, benzo(a)pyrene, arsenic, and chromium, exceeded their respective EDQL.

It should be noted that acetone and benzaldehyde do not have EDQLs.

3.2.2 Sediment

The NYSDEC technical guidance for screening contaminated sediments (NYSDEC, 1998a) was used to evaluate chemical concentrations in sediment; the results are provided in Table 3.7.

The NYSDEC has established two levels of criteria for inorganic chemicals in sediments. These are the lowest effect level (LEL) and the severe effect level (SEL). The LEL indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms, but still causes toxicity to a few species. The SEL indicates the concentration where effects to the sediment-dwelling community indicate highly contaminated sediments. The LEL was used for screening purposes.

A total of 14 sediment samples were collected from the wetland areas and were analyzed for arsenic, chromium, and hexavalent chromium. Hexavalent chromium was not detected in any of the samples. Screening the maximum concentration indicated arsenic and chromium exceeded their respective NYS Sediment Quality Criteria.

3.2.3 Surface Water

The NYSDEC Technical and Operational Guidance Series (TOGS) for screening surface water and groundwater (NYSDRC, 1998b) was used to evaluate chemical concentrations in surface water; the results are provided in Table 3-8.

A total of seven surface water samples and two duplicates were collected from the wetland areas and were analyzed for arsenic, chromium, and hexavalent chromium. Arsenic was not detected in any of these samples. Screening the maximum concentration indicated that hexavalent chromium exceeded its NYSDEC surface water quality standard. A value for chromium could not be calculated due to lace of hardness data. Instead, this sample was compared to the USEPA Region 5 surface water quality EDQL. The maximum concentration of chromium did not exceed this value.

3.3 Risk Characterization

Potential risks posed by COPECs were evaluated by calculating a screening-level hazard quotient (HQ) for each constituent, for each endpoint species. The screening-level HQ for all pathways was determined by dividing the maximum concentration by the appropriate EDQL or sediment quality criteria (SQC) for the constituent:

$$HQ = C_{max}/EDQL \text{ or } SQC$$

If the resultant HQ is greater than 1, a potential risk for adverse effects from exposure to COPECs exists. The magnitude of the HQ indicates the relative risk posed to endpoint species. It is important to note that this screening-level approach is conservative, and probably overestimates the potential for adverse effects upon the wildlife populations.

3.3.1 Soil

Potential risks from constituents detected in surface soil are shown in Table 3.6. The hazard quotients are less than 1 for all organic constituents except dichlorodifluoromethane, trichlorofluoromethane, benzo(a)anthracene, and benzo(a)pyrene. Chromium and arsenic had hazard quotients greater than 1. However, it should be noted that the EDQLs for these parameters are extremely conservative. As indicated on Table 3.6, background concentrations of both arsenic and chromium also consistently exceeded EDQL values, producing a hazard quotient greater than one for the background condition as well.

3.3.2 Sediment

Potential risks from constituents detected in sediments are shown in Table 3.7. Chromium and arsenic had hazard quotients greater than 1. Similar to surface soils, background arsenic concentrations also exceed conservative NYSDEC sediment quality criteria, producing a HQ greater than one for the background condition.

3.3.3 Surface Water

Potential risks from constituents detected in surface water are shown in Table 3-8. Hexavalent chromium had a hazard quotient greater than 1. Chromium had a hazard quotient less than 1.

3.4 Ecological Significance

Many of the chemical constituents detected on the Site are common in areas of historical industrial growth. PAHs are ubiquitous chemicals that are found in rural as well as urban areas. PAHs are the result of both natural processes (*i.e.*, biosynthesis) and anthropogenic activities (*i.e.*, fossil fuel burning, asphalt). Consequently, sources of some of the PAHs detected at the Site likely came from sources other than the reported historic disposal activities. The volatile organic compounds that had a hazard quotient greater than 1 are common refrigerants, and were detected at trace levels in only a few of the samples.

In the data collected under the RI, screening level HQs for arsenic and chromium in soil were substantially greater than 1 in the surface soils. In addition, the hazard quotient for hexavalent chromium was elevated in surface water. This indicates that these elements suggest a potential risk to wildlife residing at the Site, which requires further evaluation beyond the screening level. However, screening level HQs determined in this manner are very conservative and the true extent of this risk is not known. Potential ecological risk is determined by exposure frequency, constituent concentration, mechanism of exposure, and duration of exposure. Also, additional modeling of uptake in the food chain is necessary to better determine the extent of the potential risk to wildlife for these parameters.

3.5 Conclusions

The analysis resulted in Hazard Quotients above unity (or 1.0) suggesting the potential for risks to ecological receptors due to constituents in surface soils and sediment. As such, this requires further and more in-depth risk evaluation. The SERA does not adequately assess the potential risks to ecological receptors beyond the screening level, and a baseline ecological risk assessment focusing on arsenic and chromium in soils; chromium in sediment; and hexavalent chromium in surface water is necessary.

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TABLE 2-1
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SURFACE SOIL

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Soil , Ambient Air
Exposure Point:	On-site

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value		COPC Flag	(5) Rationale for Contaminant Deletion or Selection
67641	Acetone	0.19	B	0.55	B	mg/kg	Lathe #122	6 / 10	0.01 -- 0.054	0.55	NA	160	NC	No	BSL
75150	Carbon Disulfide	0.002	J	0.002	J	mg/kg	Lathe #123	1 / 10	0.009 -- 0.019	0.002	NA	36	NC	No	BSL
78933	2-Butanone	0.05	B	0.05	B	mg/kg	Lathe #122	1 / 10	0.01 -- 0.031	0.05	NA	730	NC	No	BSL
75718	Dichlorodifluoromethane	0.003	J	0.006	J	mg/kg	Lathe #128	3 / 10	0.009 -- 0.019	0.006	NA	9.4	NC	No	BSL
75694	Trichlorofluoromethane	0.003	J	0.007	J	mg/kg	Lathe #129	3 / 10	0.009 -- 0.019	0.007	NA	39	NC	No	BSL
56553	Benzo(a)anthracene	0.027	J	0.037	J	mg/kg	Lathe #130	2 / 10	0.33 -- 0.33	0.037	NA	0.62	C	No	BSL
205992	Benzo(b)fluoranthene	0.038	J	0.082	J	mg/kg	Lathe #126	5 / 10	0.33 -- 0.33	0.082	NA	0.62	C	No	BSL
207089	Benzo(k)fluoranthene	0.028	J	0.041	J	mg/kg	Lathe #126	3 / 10	0.33 -- 0.33	0.041	NA	6.2	C	No	BSL
191242	Benzo(ghi)perylene	0.031	J	0.043	J	mg/kg	Lathe #126	2 / 10	0.33 -- 0.33	0.043	NA	230	NC	No	BSL
50328	Benzo(a)pyrene	0.031	J	0.071	J	mg/kg	Lathe #126	4 / 10	0.33 -- 0.33	0.071	NA	0.062	C	Yes	ASL
100527	Benzaldehyde	0.043	J	0.17	J	mg/kg	Lathe #125	3 / 10	0.33 -- 0.33	0.17	NA	610	NC	No	BSL
218019	Chrysene	0.032	J	0.042	J	mg/kg	Lathe #130	3 / 10	0.33 -- 0.33	0.042	NA	62	C	No	BSL
206440	Fluoranthene	0.033	J	0.097	J	mg/kg	Lathe #130	4 / 10	0.33 -- 0.33	0.097	NA	230	NC	No	BSL
193395	Indeno(1,2,3-cd)pyrene	0.04	J	0.04	J	mg/kg	Lathe #126	1 / 10	0.33 -- 0.33	0.04	NA	0.62	C	No	BSL
106445	4-Methylphenol	0.04	J	0.11	J	mg/kg	Lathe #126	3 / 10	0.33 -- 0.33	0.11	NA	31	NC	No	BSL
91203	Naphthalene	0.033	J	0.047	J	mg/kg	Lathe #128	3 / 10	0.33 -- 0.33	0.047	NA	5.6	NC	No	BSL
85018	Phenanthrene	0.065	J	0.065	J	mg/kg	Lathe #130	1 / 10	0.33 -- 0.33	0.065	NA	230	NC	No	BSL
129000	Pyrene	0.027	J	0.069	J	mg/kg	Lathe #130	4 / 10	0.33 -- 0.33	0.069	NA	230	NC	No	BSL
7440382	Arsenic (6)	1.6		95.5		mg/kg	Lathe #120	53 / 53	0 -- 0	95.5	NA	0.39	C	Yes	ASL
16065831	Chromium, Total (6)	13.7		65300		mg/kg	Lathe #121	53 / 53	0 -- 0	65300	NA	10000	NC	Yes	ASL
18540299	Hexavalent Chromium	ND	J or R	ND	J or R	mg/kg	Lathe #113	0 / 48	0.45 -- 20.3	ND	NA	30	NC	No	BSL

TABLE 2-1
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SURFACE SOIL

Peter Cooper - Markhams Site
Town of Dayton, New York

(1) Minimum/maximum detected concentration.

(2) Maximum value used as screening concentration.

(3) Background values not used per USEPA.

(4) Screening toxicity value -- EPA Region 9 Preliminary Remediation Goals, Residential Land Use (USEPA, 2000).
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
Based on similarities in chemical and physical structure, the following surrogate screening criteria were used:
benzo(ghi)perylene = fluoranthene phenanthrene = pyrene

(5) Rationale Codes

Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)

Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)

(6) Frequency of detection includes samples collected from 1989 RI and 1993 SSI and includes Sample No. 56, 52, 58 (1989) and S-8, S-8 DUP (1993).

Definitions:

B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
C = Carcinogenic
COPC = Chemical of Potential Concern
J = Estimated Value
R = Rejected Data
mg/kg = milligrams per kilogram
NA = Not Applicable
NC = Non-Carcinogenic
ND = Not detected above laboratory quantitation limit
PRG = Preliminary Remediation Goal

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TABLE 2-2
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SUBSURFACE SOIL (0 - 10 Feet Below Ground Surface)

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Future
Medium:	Subsurface Soil
Exposure Medium:	Soil
Exposure Point:	On-site

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value		COPC Flag	(5) Rationale for Contaminant Deletion or Selection
67641	Acetone	0.19	B	0.55	B	mg/kg	Lathe #122	6 / 10	0.01 -- 0.054	0.55	NA	160	NC	No	BSL
75150	Carbon Disulfide	0.002	J	0.002	J	mg/kg	Lathe #123	1 / 10	0.009 -- 0.019	0.002	NA	36	NC	No	BSL
78933	2-Butanone	0.05	B	0.05	B	mg/kg	Lathe #122	1 / 10	0.01 -- 0.031	0.05	NA	730	NC	No	BSL
75718	Dichlorodifluoromethane	0.003	J	0.006	J	mg/kg	Lathe #128	3 / 10	0.009 -- 0.019	0.006	NA	9.4	NC	No	BSL
75694	Trichlorofluoromethane	0.003	J	0.007	J	mg/kg	Lathe #129	3 / 10	0.009 -- 0.019	0.007	NA	39	NC	No	BSL
56553	Benzo(a)anthracene	0.027	J	0.037	J	mg/kg	Lathe #130	2 / 10	0.33 -- 0.33	0.037	NA	0.62	C	No	BSL
205992	Benzo(b)fluoranthene	0.038	J	0.082	J	mg/kg	Lathe #126	5 / 10	0.33 -- 0.33	0.082	NA	0.62	C	No	BSL
207089	Benzo(k)fluoranthene	0.028	J	0.041	J	mg/kg	Lathe #126	3 / 10	0.33 -- 0.33	0.041	NA	6.2	C	No	BSL
191242	Benzo(ghi)perylene	0.031	J	0.043	J	mg/kg	Lathe #126	2 / 10	0.33 -- 0.33	0.043	NA	230	NC	No	BSL
50328	Benzo(a)pyrene	0.031	J	0.071	J	mg/kg	Lathe #126	4 / 10	0.33 -- 0.33	0.071	NA	0.062	C	Yes	ASL
100527	Benzaldehyde	0.043	J	0.17	J	mg/kg	Lathe #125	3 / 10	0.33 -- 0.33	0.17	NA	610	NC	No	BSL
218019	Chrysene	0.032	J	0.042	J	mg/kg	Lathe #130	3 / 10	0.33 -- 0.33	0.042	NA	62	C	No	BSL
206440	Fluoranthene	0.033	J	0.097	J	mg/kg	Lathe #130	4 / 10	0.33 -- 0.33	0.097	NA	230	NC	No	BSL
193395	Indeno(1,2,3-cd)pyrene	0.04	J	0.04	J	mg/kg	Lathe #126	1 / 10	0.33 -- 0.33	0.04	NA	0.62	C	No	BSL
106445	4-Methylphenol	0.04	J	0.11	J	mg/kg	Lathe #126	3 / 10	0.33 -- 0.33	0.11	NA	31	NC	No	BSL
91203	Naphthalene	0.033	J	0.047	J	mg/kg	Lathe #128	3 / 10	0.33 -- 0.33	0.047	NA	5.8	NC	No	BSL
85018	Phenanthrene	0.065	J	0.065	J	mg/kg	Lathe #130	1 / 10	0.33 -- 0.33	0.065	NA	230	NC	No	BSL
129000	Pyrene	0.027	J	0.069	J	mg/kg	Lathe #130	4 / 10	0.33 -- 0.33	0.069	NA	230	NC	No	BSL
7440382	Arsenic	3.7		95.5		mg/kg	Lathe #120	59 / 59	0 -- 0	95.5	NA	0.39	C	Yes	ASL
16065831	Chromium, Total	12.4		65300		mg/kg	Lathe #121	59 / 59	0 -- 0	65300	NA	10000	NC	Yes	ASL
18540299	Hexavalent Chromium	ND	J or R	ND	J or R	mg/kg	Lathe #113	0 / 59	0.43 -- 20.3	ND	NA	30	NC	No	BSL
7439965	Manganese	561		561		mg/kg	MW-8S; 6-10 fbgs	1 / 1	0 -- 0	561	NA	360	NC	Yes	ASL

TABLE 2-2
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SUBSURFACE SOIL (0 - 10 Feet Below Ground Surface)

Peter Cooper - Markhams Site
Town of Dayton, New York

(1) Minimum/maximum detected concentration.
(2) Maximum value used as screening concentration.
(3) Background values not used per USEPA.
(4) Screening toxicity value -- EPA Region 9 Preliminary Remediation Goals, Residential Land Use (USEPA, 2000).
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
Based on similarities in chemical and physical structure, the following surrogate screening criteria were used:
benzo(ghi)perylene = fluoranthene   phenanthrene = pyrene
(5) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)

Definitions:
B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
C = Carcinogenic
COPC = Chemical of Potential Concern
J = Estimated Value
R = Rejected Data
mg/kg = milligrams per kilogram
NA = Not Applicable
NC = Non-Carcinogenic
ND = Not detected above laboratory quantitation limit
PRG = Preliminary Remediation Goal

TABLE 2-3
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SHALLOW GROUNDWATER

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Future
Medium:	Shallow Groundwater
Exposure Medium:	Tapwater, Indoor/Outdoor Air
Exposure Point:	On-site

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value			COPC Flag	(5) Rationale for Contaminant Deletion or Selection
67641	Acetone	21	J	21	J	µg/l	MW-2S	1 / 14	5 -- 10	21	ND	61	NC	PRG	No	BSL
71432	Benzene	0.22	J	1.8		µg/l	MW-2S	2 / 14	1 -- 10	1.8	ND	0.35	C	PRG	Yes	ASL
78933	2-Butanone	3.1	J	3.1	J	µg/l	MW-2S	1 / 14	5 -- 10	3.1	ND	190	NC	PRG	No	BSL
75150	Carbon Disulfide	0.28	J	0.35	J	µg/l	MW-2S	2 / 14	1 -- 10	0.35	ND	100	NC	PRG	No	BSL
108907	Chlorobenzene	0.27	J	0.27	J	µg/l	MW-1S	1 / 14	1 -- 10	0.27	ND	11	NC	PRG	No	BSL
156592	cis-1,2-Dichloroethene	0.57	J	1.4	J	µg/l	MW-8S HV	2 / 14	1 -- 10	1.4	ND	6.1	NC	PRG	No	BSL
79016	Trichloroethene	2.8		4.2	J	µg/l	MW-8S HV	2 / 14	1 -- 10	4.2	ND	1.6	C	PRG	Yes	ASL
205992	Benzo(b)fluoranthene	0.6	J	0.6	J	µg/l	MW-8S HV	1 / 8	10 -- 10	0.6	ND	0.092	C	PRG	Yes	ASL
117817	Bis(2-ethylhexyl) phthalate	5	J	5	J	µg/l	MW-6S	1 / 8	10 -- 10	5	ND	4.8	C	PRG	Yes	ASL
206440	Fluoranthene	0.8	J	0.6	J	µg/l	MW-8S HV	1 / 8	10 -- 10	0.8	ND	150	N	PRG	No	BSL
108952	Phenol	2	J	2	J	µg/l	MW-2S	1 / 8	10 -- 10	2	ND	2200	N	PRG	No	BSL
129000	Pyrene	0.5	J	0.5	J	µg/l	MW-8S HV	1 / 8	10 -- 10	0.5	ND	18	N	PRG	No	BSL
7429905	Aluminum	382		36400	J	µg/l	MW-2S	5 / 8	200 -- 200	36400	ND	3600	N	PRG	Yes	ASL
744360	Antimony	72.6	J	72.6	J	µg/l	MW-2S	1 / 8	60 -- 60	72.6	ND	1.5	N	PRG	Yes	ASL
7440382	Arsenic	133	J	133	J	µg/l	MW-2S	1 / 15	10 -- 10	133	ND	0.045	C	PRG	Yes	ASL
7440393	Barium	517	J	517	J	µg/l	MW-2S	1 / 8	200 -- 200	517	ND	280	N	PRG	Yes	ASL
7440439	Cadmium	50.1	J	50.1	J	µg/l	MW-2S	1 / 8	5 -- 5	50.1	ND	1.8	N	PRG	Yes	ASL
7440702	Calcium	26000	U	402000	EJ	µg/l	MW-6S	8 / 8	0 -- 0	402000	57500	--	N/A		No	NUT
16065831	Chromium, Total	10.6	E	981	EJ	µg/l	MW-2S	5 / 15	10 -- 10	981	ND	5500	NC	PRG	No	BSL
7440484	Cobalt	251	J	251	J	µg/l	MW-2S	1 / 8	50 -- 50	251	ND	220	NC	PRG	Yes	ASL
7440508	Copper	2220	J	2220	J	µg/l	MW-2S	1 / 8	25 -- 25	2220	ND	1300	NC	AL	Yes	ASL
7439896	Iron	218	J	3180000	J	µg/l	MW-2S	8 / 8	0 -- 0	3160000	326	1100	NC	PRG	No	NUT
7439921	Lead	9.7	E	1020	EJ	µg/l	MW-2S	4 / 8	3 -- 3	1020	ND	15	C	AL	Yes	ASL
7439954	Magnesium	9520		96400		µg/l	MW-6S	7 / 8	5000 -- 5000	96400	9050	--	N/A		No	NUT
7439965	Manganese	33.7	EJ	15000	EJ	µg/l	MW-1S	8 / 8	0 -- 0	15000	112	88	NC	PRG	Yes	ASL
7440020	Nickel	83.4	EJ	2820	EJ	µg/l	MW-2S	2 / 8	40 -- 40	2820	ND	730	NC	PRG	Yes	ASL
7440097	Potassium	9290	NJ	9290	NJ	µg/l	MW-2S	1 / 8	5000 -- 5000	9290	ND	--	N/A		No	NUT
7782492	Selenium	7.2	J	39.2	J	µg/l	MW-2S	2 / 8	5 -- 5	39.2	ND	18	NC	PRG	Yes	ASL
7440235	Sodium	5550		27800		µg/l	MW-7S	6 / 8	5000 -- 5000	27800	11200	--	N/A		No	NUT
7446186	Thallium	13.5	EJ	1300	EJ	µg/l	MW-2S	2 / 8	10 -- 10	1300	ND	0.24	NC	PRG	Yes	ASL
7440666	Zinc	36.1	N	146000	NJ	µg/l	MW-2S	3 / 8	20 -- 20	148000	ND	1100	NC	PRG	Yes	ASL

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TABLE 2-3
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SHALLOW GROUNDWATER

Peter Cooper - Markhams Site
Town of Dayton, New York

(1) Minimum/maximum detected concentration.

(2) Maximum value used for screening concentration.

(3) Background values from MW-9S. Highest value from November 2001 and April 2002 sampling events.

(4) Screening toxicity value -- USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2000). If unavailable the maximum contaminant level for drinking water was used.

(5) Rationale Codes

Selection Reason: Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)

Deletion Reason: Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)
- Not Historically Associated (NHIST)

Definitions:
- AL = Action Level
- B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
- C = Carcinogenic
- COPC = Chemical of Potential Concern
- E = Indicates a value estimated or not reported due to the presence of inferences
- J = Estimated Value
- μg/l = micrograms per liter
- MCL = Federal Maximum Contaminant Level
- N = Indicates spike sample recovery not within quality control limits.
- NC = Non-Carcinogenic
- N/A = Not Applicable
- PRG = Preliminary Remediation Goal

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TABLE 2-4
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – DEEP GROUNDWATER

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Future
Medium:	Deep Groundwater
Exposure Medium:	Tapwater, Indoor/Outdoor Air
Exposure Point:	On-site

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value			COPC Flag	(5) Rationale for Contaminant Deletion or Selection
67641	Acetone	6.3	J	74		µg/l	MW-7D	3 / 18	5 -- 10	74	ND	61	NC	PRG	Yes	ASL
75150	Carbon Disulfide	0.22	J	2.6	J	µg/l	MW-4D	8 / 16	1 -- 10	2.6	12	100	NC	PRG	No	BSL
117817	Bis(2-ethylhexyl) phthalate	0.7	J	2	J	µg/l	MW-8D	3 / 8	10 -- 10	2	19	4.8	C	PRG	No	BSL
84742	Di-n-butyl phthalate	3	J	3	J	µg/l	MW-7D	1 / 8	10 -- 10	3	ND	360	NC	PRG	No	BSL
85018	Phenanthrene	1	J	2	J	µg/l	MW-7D	2 / 8	10 -- 10	2	ND	18	NC	PRG	No	BSL
7429905	Aluminum	232		5660		µg/l	MW-2D	5 / 8	200 -- 200	5660	3020	3600	NC	PRG	Yes	ASL
7440393	Barium	230		519		µg/l	MW-2D	3 / 8	200 -- 200	519	ND	260	NC	PRG	Yes	ASL
7440702	Calcium	45300	EJ	356000	EJ	µg/l	MW-6D	7 / 8	55800 -- 57300	356000	ND	--			No	NUT
16065831	Chromium, Total	11.9	E	15.2		µg/l	MW-1D	6 / 16	10 -- 10	15.2	ND	5500	NC	PRG	No	BSL
7439896	Iron	413	J	15500	J	µg/l	MW-1D	8 / 8	0 -- 0	15500	2880	1100	NC	PRG	No	NUT
7439921	Lead	3.1	E	3.1	E	µg/l	MW-7D	1 / 8	3 -- 3	3.1	ND	15	C	AL	No	BSL
7439954	Magnesium	8220		125000		µg/l	MW-6D	8 / 8	0 -- 0	125000	11000	--			No	NUT
7439965	Manganese	72.1	EJ	2330	EJ	µg/l	MW-6D	8 / 8	0 -- 0	2330	141	88	NC	PRG	Yes	ASL
7440097	Potassium	19600	N	19600	N	µg/l	MW-1D	1 / 6	5000 -- 5000	19600	ND	--			No	NUT
7440235	Sodium	5850		22300		µg/l	MW-1D	6 / 8	5000 -- 5000	22300	5990	--			No	NUT
7440666	Zinc	23.1	N	25.9	N	µg/l	MW-2D	2 / 8	20 -- 20	25.9	ND	1100	NC	PRG	No	BSL
18540299	Hexavalent Chromium	321	NJ	321	NJ	µg/l	MW-5D	1 / 16	10 -- 10000	321	ND	11	NC	PRG	Yes	ASL

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TABLE 2-4
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – DEEP GROUNDWATER

Peter Cooper - Markhams Site
Town of Dayton, New York

(1) Minimum/maximum detected concentration.

(2) Maximum value used for screening concentration.

(3) Background values from MW-9S. Highest value from November 2001 and April 2002 sampling events.

(4) Screening toxicity value -- USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2000).
If unavailable, the maximum contaminant level for drinking water was used

(5) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)
- Not Historically Associated (NHIST)

Definitions:

AL = Action Level
B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
C = Carcinogenic
COPC = Chemical of Potential Concern
E = Indicates a value estimated or not reported due to the presence of inferences
J = Estimated Value
µg/l = micrograms per liter
MCL = Federal Maximum Contaminant Level
N = Indicates spike sample recovery not within quality control limits.
NC = Non-Carcinogenic
N/A = Not Applicable
PRG = Preliminary Remediation Goal

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TABLE 2-5
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SURFACE WATER

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water
Exposure Point:	Wetlands

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value	COPC Flag	(5) Rationale for Contaminant Deletion or Selection
16065831	Chromium, Total	13.8		13.8		µg/l	Surface Water #2	1 / 8	10 -- 10	13.8	N/A	5500 NC PRG	No	BSL
18540299	Hexavalent Chromium	10	J	14	J	µg/l	Surface Water #2	3 / 7	10 -- 10	14	N/A	11 NC PRG	Yes	ASL

(1) Minimum/maximum detected concentration.
(2) Maximum value used for screening concentration.
(3) Background values not applied for groundwater.
(4) Screening toxicity value – USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2000). If unavailable the maximum contaminant level for drinking water was used.
(5) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)

Definitions:
AL = Action Level
B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
C = Carcinogenic
COPC = Chemical of Potential Concern
E = Indicates a value estimated or not reported due to the presence of inferences
J = Estimated Value
MBD = This analyte is present in the associated method blank at an amount that is less than two times the reporting limit.
MCL = Federal Maximum Contaminant Level
N = Indicates spike sample recovery not within quality control limits.
NC = Non-Carcinogenic
N/A = Not Applicable
PG = The percentage difference between the original and confirmation analyses is greater than 40%
PRG = Preliminary Remediation Goal
SMCL = Secondary Maximum Contaminant Level
# = Co-Elution of 3-Methylphenol and 4-Methylphenol.

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TABLE 2-6
RAGS PART D – TABLE 2
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN – SEDIMENT

Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment
Exposure Point:	On-site wetlands

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	(2) Concentration Used for Screening	(3) Background Value	(4) Screening Toxicity Value	COPC Flag	(5) Rationale for Contaminant Deletion or Selection
7440382	Arsenic	2.3		11.4		mg/kg	Lathe #94A	9 / 14	2.3 -- 6.8	11	N/A	0.39 C	Yes	ASL
16065831	Chromium, Total	9.2		215		mg/kg	Lathe #89	13 / 14	9.2 -- 6.6	215	N/A	10000 NC	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum value used as screening concentration.
(3) Background values not used per USEPA.
(4) Screening toxicity value -- EPA Region 5 Preliminary Remediation Goals, Residential Land Use (USEPA, 2000).
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
Based on similarities in chemical and physical structure, the following surrogate screening criteria were used:
benzo(ghi)perylene = fluoranthene phenanthrene = pyrene
(5) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)

Definitions:
B = Method Blank Contamination. The associated method blank contains the target analyte at a reportable level
C = Carcinogenic
COPC = Chemical of Potential Concern
J = Estimated Value
mg/kg = milligrams per kilogram
N/A = Not Applicable
NC = Non-Carcinogenic
PRG = Preliminary Remediation Goal

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TABLE 2-7
RAGS PART D – TABLE 1
SELECTION OF EXPOSURE PATHWAYS
Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future	Soil	Soil	On-site Soil	Trespasser	Adult	Incidental Ingestion	On-site	Quant.	Inactive facility, current and future trespassers likely at this remote location
						Dermal Contact	On-site	Quant.	
		Ambient Air	Fugitive dust from on-site soil	Trespasser	Adult	Inhalation	On-site	Quant.	Inactive facility, current and future trespassers likely at this remote location
	Groundwater	Ambient Air	Volatile COPCs from on-site groundwater	Trespasser	Adult	Inhalation	On-site	Quant.	Inactive facility, current and future trespassers likely at this remote location
	Surface Water	Surface Water	Surface water from wetland	Trespasser	Adult	Ingestion	On-site	None	Standing surface water only, unlikely to be used for swimming or wading
						Dermal Contact	On-site	Quant.	Inactive facility, current and future trespassers likely at this remote location
	Sediment	Sediment	Sediment from wetland	Trespasser	Adult	Incidental Ingestion	On-site	Quant.	Inactive facility, current and future trespassers likely at this remote location
						Dermal Contact	On-site	Quant.	
Future	Soil	Soil	On-site Soil	On-site Outdoor Worker	Adult	incidental Ingestion	On-site	Quant.	Potentially complete if site is redeveloped into industrial/commercial use
						Dermal Contact	On-site	Quant.	
				Construction Worker	Aoult	Incidental Ingestion	On-site	Quant.	Potentially complete if the site is redeveloped
						Dermal Contact	On-site	Quant.	
		Ambient Air	Fugitive dust from on-site soil	On-site Outdoor Worker	Adult	inhalation	On-site	Quant.	Potentially complete if site is redeveloped into industrial/commercial use
				Construction Worker	Adult	Inhalation	On-site	Quant.	Potentially complete if the site is redeveloped
	Groundwater	Groundwater	On-site Groundwater	On-site Outdcor Worker	Adult	Ingestion	On-site	Quant.	Although unlikely, groundwater may be a future potable source if site is redeveloped into industrial/commercial use
						Dermal Contact	On-site	Quant.	
				Construction Worker	Adult	Dermal Contact	On-site	Quant.	Potentially complete if the site is redeveloped
		Ambient Air	Volatile COPCs from on-site groundwater	On-site Outdoor Worker	Adult	Inhalation	On-site	Quant.	Potentially complete if site is redeveloped into industrial/commercial use
				Construction Worker	Adult	Inhalation	On-site	Quant.	Potentially complete if the site is redeveloped
		Indoor Air	Volatile COPCs from on-site groundwater	On-site Indoor Worker	Adult	Inhalation	On-site	Quant.	Potentially complete if site is redeveloped into industrial/commercial use
	Surface Water	Surface Water	Surface water from wetland	Construction Worker	Adult	Dermal Contact	On-site	Quant.	Potentially complete if the site is redeveloped
	Sediment	Sediment	Sediment from wetland	Construction Worker	Adult	Ingestion	On-site	Quant.	Potentially complete if the site is redeveloped
						Dermal Contact	On-site	Quant.	

TABLE 2-8
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL AND SEDIMENT - TRESPASSER

Peter Cooper – Markhams Site
Town of Dayton, New York

Scenario Timeframe: Current/Future	**Exposure Point:** On-Site
Medium: Surface Soil/Sediment	**Receptor Population:** Trespasser
Exposure Medium: Soil/Sediment	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Incidental Ingestion	Cs	Chemical Concentration in Soil/Sediment	mg/kg	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRs	Ingestion Rate of Soil/Sediment	mg/day	100	EPA, 1997	50	EPA, 1997[3]	Cs x IRs x FI x EF x ED x 1/BW x 1/AT
	FI	Fraction Ingested	unitless	0.25	(1)	0.125	(1)	
	EF	Exposure Frequency	days/year	13	(2)	8	(4)	
	ED	Exposure Duration	years	30	EPA, 1997	9	EPA, 1997	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	10950	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25,550	EPA, 1997	25,550	EPA, 1997	
Dermal Contact	Cs	Chemical Concentration in Soil/Sediment	mg/kg	--	Chemical-specific	--	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) =
	SA	Skin Surface Area	cm^2	5700	EPA, 2001a	1800	EPA, 1992[5]	$\frac{Cs \times SA \times SAF \times ABSds \times EF \times ED \times CF2}{BW \times AT}$
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.07	EPA, 2001a	0.01	EPA, 2001a	
	ABSds	Dermal Absorption Factor	unitless	Table 2-21	EPA, 2001a	Table 2-21	EPA, 2001a	
	EF	Exposure Frequency	days/year	13	(2)	8	(4)	
	ED	Exposure Duration	years	30	EPA, 1997	9	EPA, 1997	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	10950	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	0.000001	--	

[1] Ingestion rate presented is a daily consumption rate. Intake adjusted to account for actual exposure (based on 2 out of 8 possible exposure hours (1/4 time)); CT intake adjusted assuming 1 out of 8 hours.

[2] 1 day/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[3] Mean value for adults.

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2001a, 1997.

[5] Assumes face and hands exposed (~10% of 50th percentile total body surface area of adult, 18,000); EPA 1992, 1997.

Sources:

EPA, 1992: Dermal Exposure Assessment: Principles and Applications, Office of Research and Development.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors and v.3: Activity Factors. ORD. EPA/600/P-95/002Fa and EPA/600/P-95/002Fc.

EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

TABLE 2-9
RAGS PART D - TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - TRESPASSER

Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Current/Future	**Exposure Point:** On-Site
Medium: Soil	**Receptor Population:** Trespasser
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Inhalation	Cs	Chemical Concentration in soil	mg/kg	--	Chemical-specific	--	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRa	Inhalation Rate	m^3/hour	1.6	EPA, 1997[1]	1.6	EPA, 1997[1]	$\frac{Cs \times IRa \times EF \times ED \times ET}{BW \times AT \times PEF}$
	EF	Exposure Frequency	days/year	13	(2)	8	(4)	
	ED	Exposure Duration	years	30	EPA, 1997	9	EPA, 1997	
	ET	Exposure Time	hours/day	2	(3)	1	(4)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	10950	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	PEF	Particulate Emission Factor	m^3/kg	1.32E+09	EPA, 1996	1.32E+09	EPA, 1996	

[1] Adults; moderate activities.

[2] 1 day/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[3] U.S. EPA recommended value (i.e., based on exposure values used for Peter Cooper Gowanda).

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2001a, 1997.

Sources:

EPA, 1996: Soil Screening Guidance: User's Guide. OSWER. Pub 9355.4-23.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors and v.3: Activity Factors. ORD. EPA/600/P-95/002Fa and EPA/600/P-95/002Fc.

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TABLE 2-10
RAGS PART D - TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - TRESPASSER
Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Current/Future	**Exposure Point:** On-Site
Medium: Groundwater	**Receptor Population:** Trespasser
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Inhalation	Ca	Chemical Concentration in Air	mg/m^3	Modeled concentration	EPA, 1996	Modeled concentration	EPA, 1996	VOC Emission Model and X/Q dispersion
	Cgw	Chemical Concentration in Groundwater	mg/L	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRa	Inhalation Rate	m^3/hour	1.6	EPA, 1997[1]	1.6	EPA, 1997[1]	$\frac{\text{Ca x IRa x EF x ED x ET}}{\text{BW x AT}}$
	EF	Exposure Frequency	days/year	13	(2)	8	(4)	
	ED	Exposure Duration	years	30	EPA, 1997	9	EPA, 1997	
	ET	Exposure Time	hours/day	2	(2)	1	(4)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	10950	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	

[1] Adults; moderate activities.

[2] 1 day/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[3] U.S. EPA recommended value (i.e., based on exposure values used for Peter Cooper Gowanda).

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2001a, 1997.

Sources:

EPA, 1996: Soil Screening Guidance: User's Guide. OSWER. Pub 9355.4-23.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors and v.3: Activity Factors. ORD. EPA/600/P-95/002Fa and EPA/600/P-95/002Fc.

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TABLE 2-11
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SURFACE WATER - TRESPASSER

Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Current/Future	**Exposure Point:** On-Site
Medium: Surface Water	**Receptor Population:** Trespasser
Exposure Medium: Surface Water	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Dermal Contact	Cw	Chemical Concentration in Surface Water	mg/L	--	Chemical-specific	--	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) =
	SA	Exposed Skin Surface Area	cm^2	7100	EPA 1997[3]	7100	EPA 1997[3]	$\frac{DAevent \times EV \times ED \times EF \times SA}{BW \times AT}$
	EF	Exposure Frequency	events/year	13	(1)	8	(4)	
	ED	Exposure Duration	years	30	EPA, 1997	9	EPA, 1997	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	10950	EPA, 1997	3285	EPA, 1997	DAevent (organics) =
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	$2 \times Kp \times Cw \times (6 \times \tau \times tevent/\pi)^{0.5}$
	EV	Event Frequency	events/month	4	(1)	1	(4)	DAevent (inorganics) = Kp x Cw x tevent
	tevent	Event Duration	hours/event	0.25	(2)	0.25	(2)	
	DAevent	Absorbed dose per event	mg/cm^2-event	Table 2.22	Chemical-specific	Table 2.22	Chemical-specific	τ = lag time (hr)
								Kp = Skin permeability constant (cm/hr)

[1] 1 day/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[2] Professional judgement

[3] Mean surface area, hands and lower extremities for men and women.

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2001a, 1997.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual (Part A). OERR. EPA/540/1-89/002.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. and v.3 Activity Factors. ORD. EPA/600/P-95/002Fa and EPA/600/P-95/002Fc.

EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

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TABLE 2-12
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL - CONSTRUCTION WORKER
Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Soil/Sediment	**Receptor Population:** Construction Worker
Exposure Medium: Soil/Sediment	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ References	Intake Equation/Model Name
Incidental Ingestion	Cs	Chemical Concentration in Soil/Sediment	mg/kg	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) = Cs x IRs x EF x ED x 1/BW x 1/AT
	IRs	Ingestion Rate of Soil/Sediment	mg/day	330	EPA, 2001b	100	EPA, 1997	
	EF	Exposure Frequency	days/year	180	EPA, 2001b[1]	100	EPA, 1991 2001b	
	ED	Exposure Duration	years	1	(2)	1	(2)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	365	EPA, 1997	365	EPA, 1997	
	ATca	Averaging Time - cancer	days	25,550	EPA, 1997	25,550	EPA, 1997	
Dermal Contact	Cs	Chemical Concentration in Soil/Sediment	mg/kg	--	Chemical-specific	--	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) = (Cs x SA x SAF x ABSds x EF x ED x CF2) / (BW x AT)
	SA	Skin Surface Area	cm^2	3300	EPA, 2001a	3300	EPA, 2001a	
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.3	EPA, 2001a	0.1	EPA, 2001a	
	ABSds	Dermal Absorption Factor	unitless	Table 2-21	EPA, 2001a	Table 2-21	EPA, 2001a	
	EF	Exposure Frequency	days/year	180	EPA, 2001b[1]	100	EPA, 1991 2001b	
	ED	Exposure Duration	years	1	(2)	1	(2)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	365	EPA, 1997	365	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	0.000001	--	

[1] U.S. EPA recommended value based on industrial land use (i.e., value used for Peter Cooper Gowanda)

[2] Professional judgement.

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

EPA, 2001b: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, March.

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TABLE 2-13
RAGS PART D -- TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - CONSTRUCTION WORKER

Peter Cooper -- Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Soil	**Receptor Population:** Construction Worker
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	Ct Rationale/ Reference	Intake Equation/Model Name
Inhalation	Ca	Chemical Concentration in Air	mg/m^3	Modeled concentration	EPA, 2001b	Modeled concentration	EPA, 2001b	Particulate Emission Factor and X/Q dispersion
	Cs	Chemical Concentration in Soil	mg/kg	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (particulates) (CDI) (mg/kg-day) =
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1997[1]	$\frac{Cs \times IRa \times EF \times ED \times ET}{BW \times AT \times PEF}$
	EF	Exposure Frequency	days/year	30	EPA, 1991 2001b[2]	30	EPA, 1991 2001b[2]	
	ED	Exposure Duration	years	1	(1)	1	(2)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	365	EPA, 1997	365	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	PEF	Particulate Emission Factor	m^3/kg	site-specific	Eq. 5-5; EPA, 2001b	site-specific	Eq. 5-5; EPA, 2001b	
	ET	Exposure Time	hours/day	8	Typical workday	8	Typical workday	

[1] Professional judgement.

[2] Adjusted for the number of days without precipitation. Dayton, New York has approximately 150 days of 0.01 inches of precipitation resulting in 30 days (total 180 - 150 days of precipitation)

Source:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001b: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. March 2001. OSWER 9355.4.24

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TABLE 2-14
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER/SURFACE WATER - CONSTRUCTION WORKER
Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Groundwater/Surface Water	**Receptor Population:** Construction Worker
Exposure Medium: Groundwater	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Dermal	Cgw	Chemical Concentration in Groundwater/Surface Water	mg/L	--	Chemical-specific	--	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) =
Contact	SA	Exposed Skin Surface Area	cm^2	7100	EPA 1997[2]	5500	EPA 1997[3]	$\frac{DAevent \times EV \times ED \times EF \times SA}{BW \times AT}$
	EF	Exposure Frequency	days/year	90	(1)	50	(1)	
	ED	Exposure Duration	years	1	(1)	1	(1)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	DAevent (organics) = 2 x Kp x Cw x $(6 \times t \times tevent/p)^{0.5}$
	ATnc	Averaging Time - noncancer	days	365	EPA. 1997	365	EPA, 1997	DAevent (inorganics) = Kp x Cw x tevent
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	EV	Event Frequency	events/day	1	(1)	1	(1)	τ = lag time (hr)
	tevent	Event Duration	hours/event	2	(1)	2	(1)	Kp = Skin permeability constant (cm/hr)
	DAevent	Absorbed dose per event	mg/cm^2-event	Table 2.22	Chemical-specific	Table 2.22	Chemical-specific	

1 Professional judgement; 1/2 the total exposure frequency from soil

2 Mean surface area, hands and lower extremities for men and women.

3 Forearms, hands, lower legs, and feet (30.6% total body area or 18,000 cm^2) exposed.

Source:

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. and v.3 Activity Factors. ORD. EPA/600/P-95/002Fa and EPA/600/P-95/002Fc.

TABLE 2-15
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - CONSTRUCTION WORKER
Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Groundwater	**Receptor Population:** Construction Worker
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Inhalation	Ca	Chemical Concentration in Air	mg/m^3	Modeled concentration	EPA, 1995	Modeled concentration	EPA, 1995	Quiescent Surface Impoundment Model and
	Cgw	Chemical Concentration in Groundwater	mg/L	--	Chemical-specific	--	Chemical-specific	X/Q dispersion model
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1997[1]	
	EF	Exposure Frequency	days/year	180	EPA, 2001b[1]	100	EPA, 1991 2001b	Chronic Daily Intake (CDI) (mg/kg-day) =
	ED	Exposure Duration	years	1	(1)	1	(2)	$\frac{Ca \times IRa \times EF \times ED \times ET}{BW \times AT}$
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	365	EPA, 1997	365	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	ET	Exposure Time	hours/day	8	Typical workday	8	Typical workday	

[1] U.S. EPA recommended value based on industrial land use (i.e., value used for Peter Cooper Gowanda)

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1995: Air Superfund National Technical Guidance Study Series: Guideline for Predictive Baseline Emissions Estimation for Superfund Sites Interim Final. Office of Air Quality Planning and Standards. Research Triangle Park.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001b: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, March.

TABLE 2-16
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL - OUTDOOR WORKER
Peter Cooper – Markhams Site
Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Soil	**Receptor Population:** Outdoor Worker
Exposure Medium: Soil	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ References	Intake Equation/Model Name
Incidental Ingestion	Cs	Chemical Concentration in Soil	mg/kg	--	Chemical-specific	--	--	Chronic Daily Intake (CDI) (mg/kg-day) = Cs x IRs x EF x ED x 1/BW x 1/AT
	IRs	Ingestion Rate of soil	mg/day	50	EPA, 1997	50	EPA, 1997	
	EF	Exposure Frequency	days/year	250	EPA, 1991	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2001a	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	9125	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25,550	EPA, 1997	25,550	EPA, 1997	
Dermal Contact	Cs	Chemical Concentration In Soil	mg/kg	--	Chemical-specific	--	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) = $\frac{Cs \times ED \times EF \times SA \times SAF \times CF2}{BW \times AT}$
	SA	Skin Surface Area	cm^2	3300	EPA, 2001a	3300	EPA, 2001a	
	EF	Exposure Frequency	days/year	250	EPA, 1991	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2001a	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	9125	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25,550	EPA, 1997	25,550	EPA, 1997	
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.2	EPA, 2001a	0.02	EPA, 2001a	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	--	--	

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.
EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.
EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

TABLE 2-17
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - OUTDOOR WORKER

Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Soil	**Receptor Population:** Outdoor Worker
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ References	Intake Equation/Model Name
Inhalation	Ca	Chemical Concentration in Air	mg/m^3	Modeled concentration	EPA, 1996	Modeled concentration	EPA, 1996	Particulate emission factor and X/Q dispersion model
	Cs	Chemical Concentration in Soil	mg/kg	--	Chemical-specific	--	Chemical-specific	
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1991	Chronic Daily Intake (CDI) (particulates) (mg/kg-day) =
	EF	Exposure Frequency	days/year	225	EPA, 2001b	219	EPA, 1991	$\frac{Cs \times IRa \times EF \times ED \times ET}{BW \times AT \times PEF}$
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 1991	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	9125	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	PEF	Particulate Emission Factor	m^3/kg	1.32E+09	EPA, 1996	1.32E+09	EPA, 1996	
	ET	Exposure Time	hours/day	8	Typical workday	8	Typical workday	

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. OSWER. Pub 9355.4-23.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001b: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites - Peer Review Draft, March 2001. OSWER 9355-4-24

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TABLE 2-18
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - OUTDOOR WORKER

Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Groundwater	**Receptor Population:** Outdoor Worker
Exposure Medium: Ambient Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Inhalation	Ca	Chemical Concentration in Air	mg/m^3	Modeled concentration	EPA, 1996	Modeled concentration	EPA, 1996	VOC Emission Model and X/Q dispersion
	Cgw	Chemical Concentration in Groundwater	mg/L	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1997[1]	$\frac{Ca \times IRa \times EF \times ED \times ET}{BW \times AT}$
	EF	Exposure Frequency	days/year	225	EPA, 2001b	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2001a	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	9125	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	ET	Exposure Time	hours/day	8	Typical workday	8	Typical workday	

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. OSWER. Pub 9355.4-23.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

EPA, 2001b: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites - Peer Review Draft, March 2001. OSWER 9355-4-24

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TABLE 2-19
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO INDOOR AIR - INDOOR WORKER

Peter Cooper – Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Groundwater	**Receptor Population:** Indoor Worker
Exposure Medium: Indoor Air	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Inhalation	Cia	Chemical Concentration in Indoor Air	mg/m^3	Modeled concentration	EPA, 2000a	Modeled concentration	EPA, 2000a	Johnson and Ettinger model
	Cgw	Chemical Concentration in Groundwater	mg/kg	--	Chemical-specific	--	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1997[1]	$\frac{Cia \times IRa \times EF \times ED \times ET}{BW \times AT}$
	EF	Exposure Frequency	days/year	250	EPA, 1991	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2001a	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	9125	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	ET	Exposure Time	hours/day	8	Typical workday	8	Typical workday	

Sources:

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2000a: The Johnson and Ettinger Model for Subsurface Vapor Intrusion Into Buildings, December.

TABLE 2-20
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
POTABLE GROUNDWATER - WORKER

Peter Cooper -- Markhams Site

Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Groundwater	**Receptor Population:** Worker
Exposure Medium: Potable Tap Wat	**Receptor Age:** Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Ingestion	Cw	Chemical Concentration in Water	µg/L	--	--	--	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-w	Ingestion Rate of Water	liters/day	1	EPA, 1991	0.7	EPA, 1997 [1]	Cw x IR-w x EF x ED x CF1 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	250	EPA, 1991	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 1997	
	CF1	Conversion Factor 1	mg/µg	0.001	--	0.001	--	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	AT-c	Averaging Time (Cancer)	days	25.550	EPA, 1989	25,550	EPA, 1989	
	AT-nc	Averaging Time (Non-Cancer)	days	9,125	EPA, 1989	3,285	EPA, 1989	
Dermal	Cw	Chemical Concentration in Water	µg/L	--	--	--	--	Dermally Absorbed Dose (DAD) (mg/kg-day) =
	CF1	Conversion Factor 1	mg/µg	0.001	--	0.001	--	DAevent x EV x ED x EF x SA x 1/BW x 1/AT
	CF2	Conversion Factor 2	L/cm^3	0.001	--	0 001	--	
	DAevent	Dermally absorbed dose per event per area of skin exposed	mg/cm^2-event	Table 2.22	EPA, 2001a	Table 2.22	EPA, 2001a	For Inorganics, DAevent = KP x Cw x ET x CF1 x CF2
	ET	Exposure Time[2]	hr/event	0.17	assumed 10 min	0.08	assumed 5 min	For Organics,
	FA	Fraction of absorbed dose	--	Chem-Spec.	EPA. 2001a	Chem-Spec.	EPA, 2001a	if ET< t*, then: DAevent =
	KP	Permeability Coefficient from Water	cm/hr	Table 2.21	EPA, 2001a	Table 2.21	EPA, 2001a	2FA x KP x Cw x CF1 x CF2 x sqrt[6T x ET)/PI]
	T	Lag time per event	hr/event	Chem-Spec.	EPA, 2001a	Chem-Spec.	EPA, 2001a	if ET> t*, then: DAevent =
	t*	Time to reach steady-state	hr	Chem-Spec.	EPA, 2001a	Chem-Spec.	EPA, 2001a	FA x KP x Cw x CF1 x CF2 x {ET/(1+B)+2T[(1+3B+3B2)/(1+B)2]}
	B	Constant	--	Chem-Spec.	EPA, 2001a	Chem-Spec.	EPA, 2001a	
	EV	Event Frequency	events/day	1	EPA, 2001a	1	EPA, 2001a	
	SA	Skin Surface Area Available for Contact	cm^2	18,000	EPA, 2001a	18,000	EPA, 2001a	
	EF	Exposure Frequency	days/year	250	EPA, 2001a	219	EPA, 2001a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 1997	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	AT-c	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-nc	Averaging Time (Non-Cancer)	days	9,125	EPA, 1989	3,285	EPA, 1989	

[1] Water ingestion rate is reduced by the same factor (2 to 1.4 L/day = 0.7) as the RME to average rate for residential adults.

[2] Assumed that industrial workers would shower during the day.

EPA, 1989: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual (Part A).

EPA, 1991: Risk Assessment Guidance for Superfund. v.1: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors". OERR. OSWER 9285.6-03.

EPA, 1997: Exposure Factors Handbook. v.1: General Factors. ORD. EPA/600/P-95/002Fa.

EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Interim Review Draft, September 2001.

GEOMATRIX

TABLE 2-21
DERMAL ABSORPTION FRACTIONS AND PERMEABILITY CONSTANTS FOR CHEMICALS OF POTENTIAL CONCERN

Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical	Dermal Soil[1] ABSds (--)	Permeability Constant[1] Kp (USEPA) (cm/hr)
Acetone	0.1	NA
Aluminum	0.01	0.001
Antimony	0.01	0.001
Arsenic	0.03	0.001
Barium	0.01	0.001
Benzene	0.1	0.015
Benzo(a)pyrene	0.13	0.7
Benzo(b)fluoranthene	0.13	0.7
Bis(2-ethylhexyl)phthalate	0.1	0.025
Cadmium	0.001	0.001
Chromium, Total	0.01	0.001
Chromium, hexavalent	0	0.002
Cobalt	0.01	0.001
Copper	0.01	0.001
Iron	0.01	0.001
Lead	0.01	0.0001
Manganese	0.01	0.001
Nickel	0.01	0.0002
Selenium	0.01	0.001
Thallium	0.01	0.001
Trichloroethene	0.1	0.012
Zinc	0.01	0.0006

Notes:

[1] U.S. EPA, 2001a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment, Review Draft, September.

TABLE 2-22
CALCULATION OF DERMALLY ABSORBED DOSE PER EVENT (DAevent)
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical	Molecular Weight (MW) (g/mole)	Log Octanol Water Partition Coefficient (log Kow) (--)	Permeability Constant (Kp) (cm/hr)	Permeability Ratio (B) (--)	Diffusivity Through Skin (Dsc) (cm^2/hr)	Lag Time (tau) (hr)	Constant b (--)	Constant c (--)	Steady-state Time (t*) (hr)	Concentration Groundwater[1] (Cgw) (mg/l)	Concentration Groundwater (Cgw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Trespasser (mg/cm^2-event)	Dermal Absorbed Dose Per Event (DAevent) Industrial (mg/cm^2-event)	Dermal Absorbed Dose Per Event (DAevent) Construction (mg/cm^2-event)
Acetone	58	-0.24	0.001	2.93E-03	7.50E-07	2.22E-01	3.05E-01	3.35E-01	0.53	0.001	1.0E-06	6.5E-10	6.5E-10	2.4E-09
Aluminum	27	NA	0.001	2.00E-03	1.12E-06	1.49E-01	3.04E-01	3.35E-01	0.36	0.001	1.0E-06	5.3E-10	5.3E-10	2.3E-09
Antimony	122	NA	0.001	4.25E-03	3.29E-07	5.07E-01	3.06E-01	3.36E-01	1.22	0.001	NA	NA	NA	NA
Arsenic	75	NA	0.001	3.33E-03	6.03E-07	2.77E-01	3.05E-01	3.36E-01	0.66	0.001	6.1E-05	4.4E-08	4.4E-08	1.6E-07
Barium	137	NA	0.001	4.50E-03	2.71E-07	6.15E-01	3.06E-01	3.36E-01	1.48	0.001	2.8E-04	3.0E-07	3.0E-07	8.9E-07
Benzene	78.11	2.13	0.015	5.10E-02	5.79E-07	2.88E-01	3.35E-01	3.68E-01	0.70	0.001	3.6E-06	4.0E-08	4.0E-08	1.4E-07
Benzo(a)pyrene	252.32	6.11	0.66	4.28E+00	6.12E-08	2.72E+00	1.34E+01	4.34E+00	11.67	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	252.32	6.20	0.757	4.28E+00	6.12E-08	2.72E+00	1.34E+01	4.34E+00	12.03	0.001	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	390.57	7.30	0.677	1.90E-01	1.03E-08	1.62E+01	4.31E-01	4.70E-01	41.85	0.001	NA	NA	NA	NA
Cadmium	112	NA	0.001	4.07E-03	3.74E-07	4.46E-01	3.06E-01	3.36E-01	1.07	0.001	NA	NA	NA	NA
Chromium, Total	52	NA	0.001	2.77E-03	8.11E-07	2.06E-01	3.05E-01	3.35E-01	0.49	NA	NA	NA	NA	NA
Chromium, hexavalent	52	NA	0.002	5.55E-03	8.11E-07	2.06E-01	3.07E-01	3.37E-01	0.49	0.001	2.9E-05	3.6E-08	3.6E-08	1.4E-07
Cobalt	59	NA	0.001	2.95E-03	7.41E-07	2.25E-01	3.05E-01	3.35E-01	0.54	0.001	NA	NA	NA	NA
Copper	64	NA	0.001	3.08E-03	6.94E-07	2.40E-01	3.05E-01	3.35E-01	0.58	0.001	NA	NA	NA	NA
Iron	55.847	NA	0.001	2.87E-03	7.71E-07	2.16E-01	3.05E-01	3.35E-01	0.52	0.001	NA	NA	NA	NA
Lead	207	NA	0.0001	5.53E-04	1.10E-07	1.52E+00	3.04E-01	3.34E-01	3.64	0.001	NA	NA	NA	NA
Manganese	55	NA	0.001	2.85E-03	7.80E-07	2.14E-01	3.05E-01	3.35E-01	0.51	0.001	2.2E-03	1.4E-06	1.4E-06	5.3E-06
Nickel	59	NA	0.0002	5.91E-04	7.41E-07	2.25E-01	3.04E-01	3.34E-01	0.54	0.001	NA	NA	NA	NA
Selenium	79	NA	0.001	3.42E-03	5.72E-07	2.91E-01	3.05E-01	3.36E-01	0.70	0.001	NA	NA	NA	NA
Thallium	204	NA	0.001	5.49E-03	1.14E-07	1.46E+00	3.07E-01	3.37E-01	3.50	0.001	NA	NA	NA	NA
Trichloroethene	131	2.71	0.012	5.28E-02	2.93E-07	5.69E-01	3.36E-01	3.69E-01	1.39	0.001	3.6E-06	4.5E-08	4.5E-08	1.3E-07
Zinc	65	NA	0.0006	1.86E-03	6.85E-07	2.43E-01	3.04E-01	3.35E-01	0.58	0.001	NA		NA	NA

If tevent < t* DAevent = 2 * Kp * Cgw * (6 * tau * tevent/Pi)1/2

If tevent > t* DAevent = Kp * Cgw * [tevent/(1+B) + 2*tau*(1 + 3*B + 3*B2) / (1+B2)]

B = Kp * (MW)1/2 / 2.6

Dsc = 10^(-5.8 - 0.0056*MW)

tau = 1E-6 / 6 * Dsc

If log Kow < 4
Kp = Kp USEPA, 2001a, Exhibit B-3 and B-4 if available, or
10^(-2.8 + 0.66*logKow - 0.0056*MW)

If log Kow >4
Kp = 10^(-2.8 + 0.66*logKow - 0.0056*MW)

t* = USEPA, 2001a Exhibit B-3, or

If B < 0.6, t* = 2.4 * tau

If B > 0.6, t* = (b - (b2 - c2)1/2)*1E-6 / Dsc

b = 2*(1 + B)2 / Pi

c = 1 + 3*B + 3*B2 / 3*(1 + B)

Source: USEPA, 2001a

Parameter	Symbol	Value (hr)
Event Duration - industrial worker	tevent	0.25
Event Duration - construction worker	tevent	2
Event Duration - trespasser	tevent	0.25

NA = Not Applicable; Chemical is not COPC in groundwater

[1] All chemicals of potential concern (COPCs) in groundwater were given a 1 ppb concentration for the purpose of presenting the DAevent calculations.

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GEOMATRIX

TABLE 2-23
RAGS PART D – TABLE 5
NON-CANCER TOXICITY DATA - ORAL/DERMAL
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value (RfD_o)	Oral RfD Units	(1) Oral to Dermal Adjustment Factor (ABS_{GI})	(2) Adjusted Dermal RfD (RfD_{ABS})	Unit	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	(3) Dates of RfD: Target Organ (MM/DD/YY)
Volatile Organic Compounds										
Acetone	Chronic	0.1	mg/kg-day	100%	0.1	mg/kg-day	Liver, Kidney	1000	IRIS	05/31/02
Benzene	Chronic	0.003	mg/kg-day	100%	0.003	mg/kg-day	Blood	N/A	PRG	11/01/00
Trichloroethene	Chronic	0.006	mg/kg-day	100%	0.006	mg/kg-day	N/A	N/A	PRG	11/01/00
Bis(2-ethylhexyl) phthalate	Chronic	0.02	mg/kg-day	100%	0.02	mg/kg-day	Liver	1000	IRIS	05/31/02
Semi-Volatile Organic Compounds										
Benzo(a)pyrene	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metals										
Aluminum	Chronic	1	mg/kg-day	100%	1	mg/kg-day	N/A	N/A	PRG	11/01/00
Antimony	Chronic	0.0004	mg/kg-day	15%	0.00006	mg/kg-day	Blood	1000	IRIS	05/31/02
Arsenic	Chronic	0.0003	mg/kg-day	100%	0.0003	mg/kg-day	Skin	3	IRIS	05/31/02
Barium	Chronic	0.07	mg/kg-day	7%	0.0049	mg/kg-day	N/A	3	IRIS	05/31/02
Cadmium	Chronic	0.0005	mg/kg-day	2.5%	0.000013	mg/kg-day	Kidney	10	IRIS	05/31/02
Chromium	Chronic	1.5	mg/kg-day	1.3%	0.02	mg/kg-day	None	1000	IRIS	05/31/02
Hexavalent Chromium	Chronic	0.003	mg/kg-day	2.5%	0.000075	mg/kg-day	N/A	900	IRIS	05/31/02
Cobalt	Chronic	0.06	mg/kg-day	100%	0.06	mg/kg-day	N/A	N/A	PRG	11/01/00
Copper	Chronic	0.037	mg/kg-day	100%	0.037	mg/kg-day	Gastrointestinal	N/A	HEAST	7/97
Iron	Chronic	0.3	mg/kg-day	100%	0.3	mg/kg-day	N/A	N/A	PRG	11/01/00
Lead	N/A	N/A	mg/kg-day	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A
Manganese	Chronic	0.14	mg/kg-day	4%	0.0056	mg/kg-day	CNS	1	IRIS	05/31/02
Nickel	Chronic	0.02	mg/kg-day	4%	0.0008	mg/kg-day	Various	300	IRIS	05/31/02
Selenium	Chronic	0.005	mg/kg-day	80%	0.004	mg/kg-day	Various	3	IRIS	05/31/02
Thallium (4)	Chronic	0.00008	mg/kg-day	100%	0.00008	mg/kg-day	Blood	3000	IRIS	05/31/02
Zinc	Chronic	0.3	mg/kg-day	100% (Highly Variable)	0.3	mg/kg-day	Blood	3	IRIS	05/31/02

(1) Refer to RAGS, Part E
(2) $RfD_{ABS} = RfD_O \times ABS_{GI}$
(3) For IRIS values, the date IRIS was searched is provided.
For HEAST values, the date of HEAST is provided
For NCEA values, a reference to the PRGs is provided.
(4) Based on Thallium Sulfate

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2000
N/A = Not applicable

GEOMATRIX

TABLE 2-24
RAGS PART D – TABLE 5
NON-CANCER TOXICITY DATA - INHALATION
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	(1) Inhalation RfD	Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfC:RfD: Target Order	(2) Dates (MM/DD/YY)
Volatile Organic Compounds									
Acetone	N/A	N/A	N/A	0.1	mg/kg-day	N/A	N/A	RE	11/01/00
Benzene	Chronic	N/A	N/A	0.0017	mg/kg-day	N/A	N/A	PRG	11/01/00
Bis(2-ethylhexyl) phthalate	Chronic	N/A	N/A	0.02	mg/kg-day	N/A	N/A	RE	11/01/00
Trichloroethene	Chronic	N/A	N/A	0.006	mg/kg-day	N/A	N/A	RE	11/01/00
Semi-Volatile Organic Compounds									
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metals									
Aluminum	Chronic	N/A	N/A	0.0014	mg/kg-day	N/A	N/A	PRG	11/01/00
Antimony	Chronic	N/A	N/A	0.0004	mg/kg-day	N/A	N/A	RE	11/01/00
Arsenic	Chronic	N/A	N/A	0.0003	mg/kg-day	N/A	N/A	RE	11/01/00
Barium	Chronic	N/A	N/A	0.00014	mg/kg-day	Fetus	1000	HEAST	07/97
Cadmium	Chronic	N/A	N/A	0.0005	mg/kg-day	N/A	N/A	RE	11/01/00
Chromium	Chronic	N/A	N/A	1.5	mg/kg-day	N/A	N/A	RE	11/01/00
Hexavalent Chromium	Chronic	0.0001	mg/m^3	0.000029	mg/kg-day	Lung	300	IRIS	05/31/02
Cobalt	Chronic	N/A	N/A	0.006	mg/kg-day	N/A	N/A	RE	11/01/00
Copper	Chronic	N/A	N/A	0.037	mg/kg-day	N/A	N/A	RE	11/01/00
Iron	Chronic	N/A	N/A	0.3	mg/kg-day	N/A	N/A	RE	11/01/00
Lead	N/A	N/A	N/A	N/A	mg/kg-day	N/A	N/A	N/A	N/A
Manganese	Chronic	0.00005	mg/m^3	0.000014	mg/kg-day	CNS	1000	IRIS	05/31/02
Nickel	Chronic	N/A	N/A	0.02	mg/kg-day	N/A	N/A	RE	11/01/00
Thallium (3)	Chronic	N/A	N/A	0.00008	mg/kg-day	N/A	N/A	RE	11/01/00
Selenium	Chronic	N/A	N/A	0.005	mg/kg-day	N/A	N/A	RE	11/01/00
Zinc	Chronic	N/A	N/A	0.3	mg/kg-day	N/A	N/A	RE	11/01/00

(1) RfD = RfC x 20 m^3/day/70 kg or oral RfD (RE) or inhalation RfD (PR(IRIS = Integrated Risk Information System
(2) For IRIS values, the date IRIS was searched is provided.
For HEAST values, the date of HEAST is provided
For NCEA values, a reference to the PRGs is provided.
(3) Based on Thallium Sulfate

HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2000
RE = Route Extrapolation
N/A = Not applicable

GEOMATRIX

TABLE 2-25
RAGS PART D - TABLE 6
CANCER TOXICITY DATA - ORAL/DERMAL
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical of Potential Concern	Oral Cancer Slope Factor (SF_O)	Oral to Dermal Adjustment Factor (ABS_{GI})	(1) Adjusted Dermal Cancer Slope Factor (SF_{ABS})	Units	Weight of Evidence/ Cancer Guideline Description	(2) Source	(3) Date (MM/DD/YY)
Volatile Organic Compounds							
Acetone	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Benzene	0.055	100%	0.055	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Bis(2-ethylhexyl) phthalate	0.0014	100%	0.0014	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	05/31/02
Trichloroethene	0.011	100%	0.011	$(mg/kg\text{-}day)^{-1}$	N/A	PRG	11/01/00
Semi-Volatile Compounds							
Benzo(a)pyrene	7.3	100%	7.3	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	05/31/02
Benzo(b)fluoranthene	0.73	100%	0.73	$(mg/kg\text{-}day)^{-1}$	B2	PRG	11/01/00
Metals							
Aluminum	N/A	100%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Antimony	N/A	15%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Arsenic	1.5	100%	1.5	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Barium	N/A	7%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Cadmium	N/A	2.5%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	05/31/02
Chromium	N/A	1.3%	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Cobalt	N/A	100%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Copper	N/A	100%	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Hexavalent Chromium	N/A	2.5%	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Iron	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Lead	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	05/31/02
Manganese	N/A	4%	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Nickel	N/A	4%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Selenium	N/A	80%	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Thallium	N/A	100%	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Zinc	N/A	Highly Variable	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02

(1) $SF_{ABS} = \frac{SF_O}{ABS_{GI}}$

(2) IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2000
N/A = Not applicable

(3) For IRIS values, the date IRIS was searched is provided.
For HEAST values, the date of the HEAST is provided
For NCEA & PRG values, the date of the PRG is provided

Weight of Evidence/EPA Group:
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

TABLE 2-26
RAGS PART D - TABLE 6
CANCER TOXICITY DATA - INHALATION
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical of Potential Concern	Unit Risk	Units	(1) Adjustment	(1) Inhalation Cancer Slope Factor (SFi)	Units	Weight of Evidence/ Cancer Guideline Description	(2) Source	(3) Date (MM/DD/YY)
Volatile Organic Compounds								
Acetone	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Benzene	0.0000078	$(\mu g/m^3)^{-1}$	3500	0.0273	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Bis(2-ethylhexyl) phthalate	N/A	N/A	N/A	0.014	$(mg/kg\text{-}day)^{-1}$	B2	RE	11/01/00
Trichloroethene	N/A	N/A	N/A	0.006	$(mg/kg\text{-}day)^{-1}$	N/A	PRG	11/01/00
Semi-Volatile Compounds								
Benzo(a)pyrene	N/A	N/A	N/A	3.1	$(mg/kg\text{-}day)^{-1}$	B2	PRG	11/01/00
Benzo(b)fluoranthene	N/A	N/A	N/A	0.31	$(mg/kg\text{-}day)^{-1}$	B2	PRG	11/01/00
Metals								
Aluminum	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Arsenic	0.0043	$(\mu g/m^3)^{-1}$	3500	15	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Barium	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Cadmium	0.0018	$(\mu g/m^3)^{-1}$	3500	6.3	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	05/31/02
Chromium	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Hexavalent Chromium	0.012	$(\mu g/m^3)^{-1}$	3500	42	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Cobalt	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Copper	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Iron	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	RE	11/01/00
Manganese	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	05/31/02
Nickel	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	A	IRIS	05/31/02
Selenium	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Zinc	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	N/A	N/A

(1) SFi = Unit Risk x Adjustment Factor or Inhalation RfD (PRG) or Oral Slope Factor (F

(2) IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2000
RE = Route extrapolation
N/A = Not applicable

(3) For IRIS values, the date IRIS was searched is provided
For HEAST values, the date of HEAST is provided
For NCEA & PRG values, the date of the PRG is provided

Weight of Evidence/EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 3-1

PLANT SPECIES IDENTIFIED DURING FIELD RECONNAISSANCE

Peter Cooper Site
Markhams, New York

Common Name	Scientific Name	Cover Type	Common Name	Scientific Name	Cover Type
American beech	*Fagus grandifolia*	1	Orchard grass	*Dactylis glomerata*	2
Big-toothed aspen	*Populus grandidentata*	1	Ostrich fern	*Mateuccia struthopteris*	1
Bittersweet nightshade	*Solanum dulcamara*		Partridge berry	*Mitchella repens*	1
Black cherry	*Prunus serotina*	1	Poison ivy	*Rhus radicans*	5, 8, 12
Black raspberry	*Rubus occidentalis*	2, 3, 4	Pokeweed	*Phytolacca americana*	3
Black willow	*Salix nigra*	6, 7, 8, 10, 12	Quaking aspen	*Populus tremuloides*	4
Blue flag iris	*Iris versicolor*	11	Queen Anne's lace	*Daucus carota*	2
Boneset	*Eupatorium perfoliatum*	7, 10	Red fescue	*Festuca rubra*	3
Bracken fern	*Pteridium aquilinum*	1, 2	Red maple	*Acer rubrum*	5, 7, 9, 10, 11, 12
Broad-leaved cattail	*Typhia latifolia*	6, 7, 10	Red osier dogwood	*Cornus stolonifera*	5, 10
Bull thistle	*Cirsium vulgare*	3	Reed canary grass	*Phalaris arundinacea*	6, 7, 10
Burdock	*Arctium minus*	3, 4	Rough-stemmed goldenrod	*Solidago rugosa*	2, 3, 4
Button bush	*Cephalanthus occidentalis*	6, 11	Sandbar willow	*Salix interior*	7
Burweed	*Sparganium sp.*	6	Sedge	*Carex lurida*	6, 11
Canada goldenrod	*Solidago canadesis*	2, 4	Sedge	*Carex lupulina*	6, 7, 11, 12
Christmas fern	*Polystichum acrostichoides*	1	Sensitive fern	*Onoclea sensibilis*	5, 6, 7, 9, 11, 12
Cinnamon fern	*Osmunda cinnamomea*	5, 6, 9	Silky dogwood	*Cornus amomum*	6, 7, 8, 10, 11, 12
Clubmoss		12	Slippery elm	*Ulmus rubra*	5, 8, 11, 12
Common cinquefoil	*Potentilla simplex*	2	Small white aster	*Aster vimineus*	2
Common milkweed	*Asclepias syriaca*	2, 3	Soft rush	*Juncus effuses*	6, 7, 9
Common mullein	*Verbascum thapsus*	3	Spearmint	*Mentha spicata*	3
Cottonwood	*Populus deltoides*	1, 5, 8, 10, 12	Spicebush	*Lindera benzoin*	10, 11
Dewberry	*Rubus flagellaris*	1	Spotted jewelweed	*Impatiens capensis*	5, 6, 8
English plantain	*Plantago lanceolata*	2	Spotted knapweed	*Centarea maculosa*	2
Evening primrose	*Oenothera biennis*	2, 3	Spreading dogbane	*Apocynum androsaemifolium*	3
False nettle	*Boehmeria cylindrical*	5, 6, 7, 8, 9	Staghorn sumac	*Rhus typhina*	1, 2, 4
Garlic mustard	*Alliaria officinalis*	1	Sugar maple	*Acer saccharum*	1
Gray goldenrod	*Solidago nemoralis*	2, 3	Tartarian honeysuckle	*Lonicera tatarica*	1, 2, 3, 4
Green ash	*Fraxinus pennsylvanica*	5, 8	Tear thumb	*Polygonum sagittatum*	6, 11

TABLE 3-1

PLANT SPECIES IDENTIFIED DURING FIELD RECONNAISSANCE

Common Name	Scientific Name	Cover Type	Common Name	Scientific Name	Cover Type
Hawthorne	*Crataegus sp.*	1	Tussocks sedge	*Carex stricta*	10
Hay-scented fern	*Dennstaedtia punctiloba*	1	Vervain	*Verbena hastate*	6, 10
Late goldenrod	*Solidago gigantea*	1, 2, 3, 4	White ash	*Fraxinus americana*	1
Many flowered aster	*Aster ericoides*	5, 7, 8, 10, 12	White wood aster	*Aster divaricatus*	1
Multi-flora rose	*Rosa multiflore*	1	Wild strawberry	*Fragaria virginiana*	2
New England aster	*Aster novae-angliae*	2	Witch hazel	*Hamamelis virginiana*	1
Northern arrowwood	*Viburnum recognitum*	5, 6, 9, 10	Wool grass	*Scirpus cyperinus*	6, 10, 11, 12
Nutsedge	*Cyperus esculentus*	6, 7, 11	Yellow birch	*Betula lutea*	1

GEOMATRIX

TABLE 3-2

HERPTILE SPECIES THAT MAY BE PRESENT BASED ON COVER TYPES

Peter Cooper Site
Markhams, New York

Common Name	Scientific Name	Habitat Requirements
Eastern toad	*Bufo americanus*	Found in almost any habitat.
Northern spring peeper	*Hyla crucifer*	Second growth woodlots.
Gray treefrog	*Hyla veriscolor*	Forested regions with small trees, shrubs and bushes near or in shallow water. Will breed in roadside ditches.
Green frog	*Rana clamitans*	Margins of shallow permanent water.
Northern leopard frog	*Rana pipiens*	Commonly found in wet open fields and woods.
Marbled salamander	*Ambystoma opacum*	Sandy and gravelly areas of mixed deciduous woodlands, especially oak-maple and oak-hickory.
Spotted salamander	*Ambystoma maculatum*	Found in moist woods, stream banks, beneath stones, logs and boards.
Red-spotted newt	*Notophthalmus viridescens*	Adults found in water with abundant submerged vegetation including lakes, marshes, ditches, and backwaters. Terrestrial juveniles live in moist areas on land.
Redback salamander	*Plethodon cinerus*	Entirely terrestrial. Mixed deciduous or coniferous woods, inhabiting interiors of decaying logs and stumps.
Northern two-lined salamander	*Euryce bislineata*	Along brooks and streams. Found under objects at water's edge in moist soil.
Northern dusky salamander	*Desognathus fuscus*	Woodlands at the margins of running water.
Eastern painted turtle	*Chrysemys picta*	Quiet, shallow ponds and marshes. Sometimes in brackish tidal waters and salt marshes.
Spotted turtle	*Clemmys guttata*	Small shallow bodies of water including roadside ditches and brackish tidal creeks.
Eastern box turtle	*Terrapene Carolina*	Typically found in well-drained forest bottomlands.
Red-eared slider	*Pseudemys scripta*	Ponds, shallow areas of lakes, creeks and drainage ditches.
Eastern painted turtle	*Chrysemys picta*	Quiet shallow ponds.
Northern water snake	*Nerodia sipedon*	Inhabits salt or fresh water. Common around spillways and bridges.
Northern brown snake	*Storeria dekayi*	Ubiquitous.
Northern ringneck snake	*Diadophis punctatus*	Secretive. Found hiding in stony woodland pastures, under rocks, stone walls, junk piles, logs, debris, stumps and logs.
Northern black racer	*Coluber constrictor*	Moist or dry areas, forests and wooded areas, fields, roadsides, near old buildings.
Eastern smooth green snake	*Opheodrys vernalis*	Upland areas, grassy fields.
Eastern worm snake	*Carpophis amoenus*	Dry to moist forests, often near streams, in the loose soil of gardens or weedy pastures. Sandy areas are favored.
Black rat snake	*Elape obsolete*	Thickets, woodland edges, farmlands.

GEOMATRIX

TABLE 3-2

HERPTILE SPECIES THAT MAY BE PRESENT BASED ON COVER TYPES

Common Name	Scientific Name	Habitat Requirements
Eastern ribbon snake	*Thamnophis sauritus*	Semi-aquatic, inhabiting stream edges and ditches.
Eastern garter snake	*Thamnophis srtalis*	Ubiquitous.
Eastern hognose snake	*Heterodon platyrhinos*	Where sandy soils predominate, such as beaches, open fields, dry open woods.
Eastern milk snake	*Lampropeltis triangulum*	Various habitats, usually with brushy or woody cover.

Source: DeGraaf and Rudis, 1983; Conat and Collins, 1975

GEOMATRIX

TABLE 3-3

BIRD SPECIES THAT MAY BE PRESENT BASED ON COVER TYPES

Peter Cooper Site
Markhams, New York

Common Name	Scientific Name	Habitat Requirements
Great blue heron	*Ardea herodias*	Shallow shores of ponds, lakes, streams, fresh marshes.
Green heron	*Butorides virescens*	Makes use of nearly all fresh and salt water habitats.
Canada goose[a]	*Branta Canadensis*	Shores of ponds, wetland areas, grassy fields.
Black-crowned night heron	*Nycticorax nycticorax*	Occupies freshwater wetlands.
Sharp-shined hawk	*Accipter striatus*	Open woodlands, edges and clearings.
Red-tailed hawk[a]	*Buteo jamaicensis*	Deciduous and mixed woodlands interspersed with meadows.
Turkey vulture	*Cathartes aura*	Various habitats including wet, dry, open, and wooded.
Killdeer[a]	*Charadrius vociferous*	Fields, roadsides lawns.
American kestrel	*Falco sparverius*	Open areas, forest edges, cities.
Spotted sandpiper	*Actitis macularia*	Breeding in the vicinity of fresh water in dry pastures or fields.
Ruffed grouse[a]	*Bonasa umbellus*	Areas with dense woody cover.
Rock dove	*Columbia livia*	Near human habitation.
Mourning dove	*Zenaida macroura*	Suburbs, cities, open woodlands.
Eastern screech owl	*Otus asio*	Shade trees in suburbs.
Great horned owl	*Bubo virginianus*	Woodlands near large streams.
Barred owl	*Strix varia*	Low, wet woodlands.
Common nighthawk	*Chordeiles minor*	Cities, open areas.
Chimney swift	*Chaetura pelagica*	Buildings, cities.
Ruby-throated hummingbird	*Archilochus colubris*	Shade trees in residential landscapes.
Belted kingfisher	*Ceryle alcyon*	Near water containing fish.
Pileated woodpecker	*Dryocopus pileatus*	Extensive second growth woodlands.
Downy woodpecker	*Picoides pubescens*	Shade trees in towns and suburbs.
Hairy woodpecker[a]	*Picoides villosus*	Open coniferous, deciduous and mixed woodlots
Northern flicker	*Colaptes auratus*	Suburbs, woodland edges.
Eastern wood peewee	*Contopus virens*	Roadsides, parks. Closely associated with oaks.
Eastern phoebe	*Sayornis phoebe*	Suburban areas.
Great crested flycatcher	*Myiarchus crinitus*	Edges of deciduous woodlands
Eastern kingbird	*Tyrannus tyrannus*	Forest edges, fields, pastures.
Purple martin	*Progne subis*	Suburban areas near water.
Blue jay[a]	*Cyanocitta cristata*	Suburbs, cities, parks and gardens.
American crow[a]	*Corvus brachyrhynchos*	Edges of woodlots, coastal areas.
Black-capped chickadee[a]	*Parus atricapilus*	Residential areas, woodlands.

TABLE 3-3

BIRD SPECIES THAT MAY BE PRESENT BASED ON COVER TYPES

Common Name	Scientific Name	Habitat Requirements
Tufted titmouse	*Parus bicolor*	Residential areas in shade trees.
White-breasted nuthatch[a]	*Sitta carolinensis*	Shade trees in villages.
House wren	*Troglodytes aedon*	Near human dwellings.
American robin[a]	*Turdus migratorius*	Shade trees in residential areas.
Gray catbird	*Dumetella carolinensis*	Shrubbery around buildings.
Cedar waxing	*Bombycilla cedrorum*	Shade trees in residential areas.
Red-winged blackbird[a]	*Agelaius phoeniceus*	Swamps and marshes.
Common grackle	*Quiscalus quiscula*	Suburbs.
Northern oriole[a]	*Icterus galbula*	Shade trees in residential areas.
Purple finch	*Carpodacus purpureus*	Residential areas.
House finch	*Carpodacus mexicanus*	Suburban and urban yards.
American goldfinch	*Cardeulis tristis*	Suburban gardens, shade trees.
Starling	*Sturnus vulgaris*	Cities, gardens, parks.
Yellow warbler	*Dendroica petechia*	Farmlands and roadsides.
American redstart	*Mniotilta varia*	Shade trees near dwellings.
Common yellowthroat	*Geothlypis trichas*	Fresh or salt water marshes.
Blue-winged warbler	*Vermivora pinus*	Edges of woods, brushy overgrown fields.
Nashville warbler	*Vermivora ruficapilla*	Moist open deciduous woods.
Chestnut-sided warbler	*Dendroica pensylvanica*	Second-growth woodland edges.
Ovenbird	*Seiurus aurocapillus*	Mature deciduous woodlands.
Mourning warbler	*Oporornis philadelphia*	Dense underbrush.
Hooded warbler	*Wilsonia citrina*	Brushy, swampy lowlands.
Northern cardinal	*Cardinalis cardinalis*	Suburban gardens.
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Shade trees in suburban areas.
House sparrow	*Passer domesticus*	Cities, parks.
Chipping sparrow	*Spizella paserina*	Suburban residential areas.
Field sparrow	*Spizella pusilla*	Briar thickets, old fields.
Song sparrow	*Melospiza melodia*	Suburbs, cities.
Swamp sparrow	*Melospiza georgiana*	Marshes, swamps, bogs.
Brown-headed cowbird	*Molothrus ater*	Open coniferous and deciduous woodlands.
Eastern towhee	*Pipilo erythrophthalmus*	Woodland edges.
Scarlet tanager	*Piranga olivacea*	Roadside shade trees, mixed woodlands.
Indigo bunting	*Passerina cyanea*	Edges of woods.
Bobolink	*Dolichonyx oryzivorus*	Hayfields, meadows, marshes.
Brown thrasher	*Toxostoma rufum*	Woodland edges. Often in cities.
Veery	*Catharus fuscescens*	Low moist deciduous woods.
Hermit thrush	*Catharus fuscescens*	Lowlands in wooded swamps.

GEOMATRIX

TABLE 3-3

BIRD SPECIES THAT MAY BE PRESENT BASED ON COVER TYPES

Common Name	Scientific Name	Habitat Requirements
Wood thrush	*Hylocichla mustelina*	Mature lowland forest.
Barn swallow	*Hirundo rustica*	Man-made structures for nesting.
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Nearly any open area with nest sites.
Tree swallow	*Tachycineta bicolor*	Farmlands, river bottomlands.
Bank swallow	*Riparia riparia*	Riverbanks, gravel pits.
Cliff swallow	*Petrochelidon pyrrhonota*	Farmlands, villages, cliffs, bridges.
White-throated sparrow[a]	*Zonotricvhia albicollis*	Edges of deciduous forests.
Red-eyed vireo	*Vireo olivaceus*	Open deciduous and second-growth woodlands.
Northern harrier	*Circus cyaneus*	Fresh marshes, open country, swamps.
Common moorhen	*Gallinla chloropus*	Fresh water marshes.
Least flycatcher	*Empidonaz minimus*	Deciduous forest edges.
Warbling vireo	*Vireo gilvus*	Open deciduous woodlands.
Black-throated blue warbler	*Dendroica caerulescens*	Woodland edges.
Savannah sparrow	*Passerculus sandwixhensis*	Grassy swales, meadows, moist lowland habitat with dense ground vegetation.
Eastern meadowlark	*Sturnella magna*	Open grassy meadows.
American woodcock	*Scolopax minor*	Moist woodlands.
Willow flycatcher	*Empidonax traillii*	Open, newly clear cut areas.
Acadian flycatcher	*Empidonax virescens*	Deciduous woodlands.
Black-billed cuckoo	*Coccyzus erythropthalmis*	Shrubby hedgerows.
Yellow-billed cuckoo	*Coccyzus americnus*	Open woods, overgrown weedy fields.
Northern bobwhite	*Colinus virginianus*	Open fields of grass.
Ring-necked pheasant	*Phasianus colchicus*	Meadows with abundant weedy growth.

Source: DeGraaf and Rudis, 1983; NYSDEC, 2002

[a]Species observed during field reconnaissance.

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TABLE 3-4

MAMMALS THAT MAY POTENTIALLY BE PRESENT BASED ON COVER TYPES

Peter Cooper Site
Markhams, New York

Common Name	Scientific Name	Habitat Requirements
Virginia opossum	*Didlphis virginiana*	Near human habitation.
Masked shrew	*Sorex cinereus*	Damp deciduous woodlands with grass.
Least shrew	*Cryptosis parva*	Salt marshes, woodland edges.
Northern short-tailed shrew	*Blarina brevicauda*	Both timbered and fairly open habitats.
Eastern moles	*Scalopus aquaticus*	Lawns, sandy soils.
Star-nosed moles	*Condylura cristata*	Prefers low wet ground.
Keen's myotis	*Myotis keenii*	Barns, attics, tree cavities.
Little brown myotis	*Myotis lucifugus*	Dark warm sites for maternity colonies.
Big brown bat	*Eptesicus fuscus*	Buildings, bridges, tunnels.
Eastern cottontail	*Sylvilagus floridanus*	Suburban areas with adequate food and cover.
Eastern chipmunk[a]	*Tamias striatus*	Tree or shrub cover with elevated perches.
Woodchuck[a]	*Marmota monax*	Edges of woodlands, open cultivated land, meadows, open brushy hillsides.
Gray squirrel	*Sciurus carolinensis*	Suburban parks, shade trees, especially oaks.
Red squirrel	*Tamiascuirus hudsonicus*	Rural woodlands.
Deer mouse	*Peromyscus maniculatus*	Near out-buildings in shrubs.
White-footed mouse	*Peromyscus leucopus*	Edges of woodlands.
Meadow vole	*Microtus pennsylvanicus*	Freshwater and salt water marshes.
Norway rat	*Rattus morevegicus*	Buildings, dumps, cities.
House mouse	*Mus musculus*	Buildings.
Meadow jumping mouse	*Zapus hudsonius*	Moist, open grassy and brushy marshes and meadows.
Woodland jumping mouse	*Mapaeozapus insignis*	Areas with herbaceous groundcover and low woody plants.
Coyote	*Canis latrans*	Edges of second-growth forests.
Red fox[a]	*Vulpes vulpes*	Found in a variety of habitats. A mixture of forest and open areas is preferred.
Mink	*Mustela vison*	Stream banks.
Long-tailed weasel	*Mustela frenata*	Open woods and woodland edges.
Ermine	*Mustela erminea*	Open country with thickets, rock piles or other heavy cover.
White-tailed deer[a]	*Odocoileus virginianus*	Forest edges, swamp borders, areas interspersed with fields and woodlands.
Raccoon[a]	*Procyon lotor*	Found in wetlands near human habitation.
Striped skunk[a]	*Mephitis mephitis*	Suburban areas.

Source: DeGraaf and Rudis, 1983
[a]Species observed during field reconnaissance

GEOMATRIX

TABLE 3-5
PHYSICAL-CHEMICAL PROPERTIES OF PRINCIPAL ORGANIC CHEMICAL CONSTITUENTS
Peter Cooper Site
Markhams, New York

Chemical Name	CAS Number	Molecular Weight (g/mole)	Physical State at 20° C	Water Solubility (mg/l)	Ref.	Henry's Law Constant (atm-m^3/mol)	Ref.	K_{oc} (L/kg)	Ref.	Log K_{ow}	Ref.
Volatile Organic Compounds											
Acetone	67-64-1	58.1	Liquid	4.24E+00	A	3.88E-05	A	5.75E-01	A	-0.24	A
2-Butanone	78-93-3	72.1	Liquid	2.56E+05	B	5.59E-05	C			0.29	C
Carbon disulfide	75-15-0	76.1	Liquid	1.19E+03	A	3.03E-02	A	4.57E+01	A	2.00	A
Dichlorodifluoromethane	75-71-8	120.9	Gas	2.80E-01	C	3.43E-01	C			2.16	C
Methylene chloride	75-09-2	84.9	Liquid	1.30E+04	A	2.19E-03	A	1.17E+01	A	1.25	A
Trichlorofluoromethane	75-69-4	137.4	Liquid	1.08E+03	C	9.70E-02	C			2.53	C
Semi-Volatile Organic Compounds											
Benzo(a)anthracene	56-55-3	228	Solid	9.40E-03	A	3.35E-06	A	3.98E+05	A	5.70	A
Benzo(a)pyrene	50-32-8	252.3	Solid	1.62E-03	A	1.13E-06	A	1.02E+06	A	6.11	A
Benzo(b)fluoranthene	205-99-2	252	Solid	1.50E-03	A	1.11E-04	A	1.23E+06	A	6.20	A
Benzo(k)fluoranthene	207-08-9	252	Solid	8.00E-04	A	8.29E-07	A	1.23E+06	A	6.20	A
Benzo (ghi)perylene	191-24-2	276	Solid	2.6E-04	B	1.41E-07	C			6.58	C
Benzaldehyde	100-52-7	106.1	Solid	3.00E+03	C					1.48	C
Chrysene	218-01-9	228.2	Solid	1.60E-03	A	9.46E-05	A	3.98E+05	A	5.70	A
Diethylphthalate	84-66-2	222.2	Solid	1.08E+03	A	4.50E-07	A	2.88E+02	A	2.50	A
Fluoranthene	206-44-0	202	Solid	2.06E-01	A	1.61E-05	A	1.07E+05	A	5.12	A
Indeno(1,2,3-cd)pyrene	193-39-5	276.3	Solid	2.20E-05	A	1.60E-06	A	3.47E+06	A	6.65	A
4-Methylphenol	106-44-5	108.9	Solid			7.92E-07	C			1.94	C
Naphthalene	91-20-3	128.2	Solid	3.10E+01	A	4.83E-04	A	2.00E+03	A	3.36	A
Phenanthrene	85-01-8	178.2	Solid	1.15E+00	C	2.28E-05	C			4.57	C
Pyrene	129-00-0	202.3	Solid	1.35E-01	A	1.10E-05	A	1.05E+05	A	5.11	A

Notes:

A – USEPA, 1996, Soil Screening Guidance: Fact Sheet, Office of Solid Waste and Emergency Response, EPA/540/F-95/041, Washington, D.C.
B – www.chemfinder.com
C - http://esc_plaza.syrres.com/efdb/Chemfate.htm

GEOMATRIX

Table 3-6
COMPARISON OF SURFACE SOIL DATA TO SCREENING CRITERIA
Peter Cooper Site
Markhams, New York

		Background Surface Soil		Site Surface Soil		
Constituent	**USEPA Region 5 Soil EDQL**	**Frequency of Detection**	**Range of Detected Concentrations**	**Frequency of Detection**	**Range of Detected Concentrations**	**Screening Level HQ**
Total Metals (mg/kg)						
Arsenic	5.9	6/6	1.4-8.1	91/91	1.9 - 95.5	16.19
Chromium	0.4	6/6	7.8-31.8	91/91	7.1 - 65300	163250
Hexavalent Chromium	NE			0/91	0 - 0	
Volatile Organic Compounds (µg/kg)						
Methylene chloride	4060	NA		9/11	2 - 3	0.00074
Acetone	NE	NA		11/11	5 - 550	
Carbon Disulfide	94.1	NA		1/11	2 - 2	0.021
2-Butanone	137	NA		10/11	1 - 50	0.36
Dichlorodifluorometham	1.33	NA		3/11	3 - 6	4.51
Trichlorofluoromethane	3.07	NA		3/11	3 - 7	2.28
Semi-Volatile Organic Compounds (µg/kg)						
Benzo(a)anthracene	31.7	NA		3/11	20 - 37	1.17
Benzo(b)fluoranthene	59600	NA		6/11	34 - 82	0.0014
Benzo(k)fluoranthene	148000	NA		3/11	28 - 41	0.00028
Benzo(ghi)perylene	119000	NA		2/11	31 - 43	0.00036
Benzo(a)pyrene	31.9	NA		5/11	22 - 71	2.23
Benzaldehyde	NE	NA		3/11	43 - 170	
Chrysene	4730	NA		4/11	24 - 42	0.009
Diethyl phthalate	24800	NA		11/11	63 - 600	0.024
Fluoranthene	122000	NA		5/11	33 - 97	0.00080
Indeno(1,2,3-cd)pyrene	109000	NA		1/11	40 - 40	0.00037
4-Methylphenol	3490	NA		3/11	40 - 110	0.032
Naphthalene	99.39	NA		3/11	33 - 47	0.47
Phenanthrene	45700	NA		2/11	24 - 65	0.0014
Pyrene	78500	NA		5/11	27 - 69	0.00088

Notes:
Surface soil is any sample collected within the upper 4 feet of soil
EDQL = Environmental Data Quality Limit.
NA = Not analyzed for
HQ = Hazard quotient. Maximum site concentration divided by Soil EDQL

GEOMATRIX

Table 3-7
COMPARISON OF SEDIMENT DATA TO SCREENING CRITERIA
Peter Cooper Site
Markhams, New York

				Background Sediment		Site Sediment		
Constituent	**NYSDEC Sediment Quality Criteria**		**USEPA Region 5 Sediment EDQL**	**Frequency of Detection**	**Range of Detected Concentrations**	**Frequency of Detection**	**Range of Detected Concentrations**	**Screening Level HQ**
	LEL	**SEL**						
Total Metals (mg/kg)								
Arsenic	6	33	5.9	9/10	4.2-10.3	9/14	2.3 - 11.4	1.90
Chromium	26	110	26	10/10	7.8-23.1	13/14	9.2 - 215	8.27
Hexavalent Chromium	NE	NE	NE	NA		0/14	0 - 0	

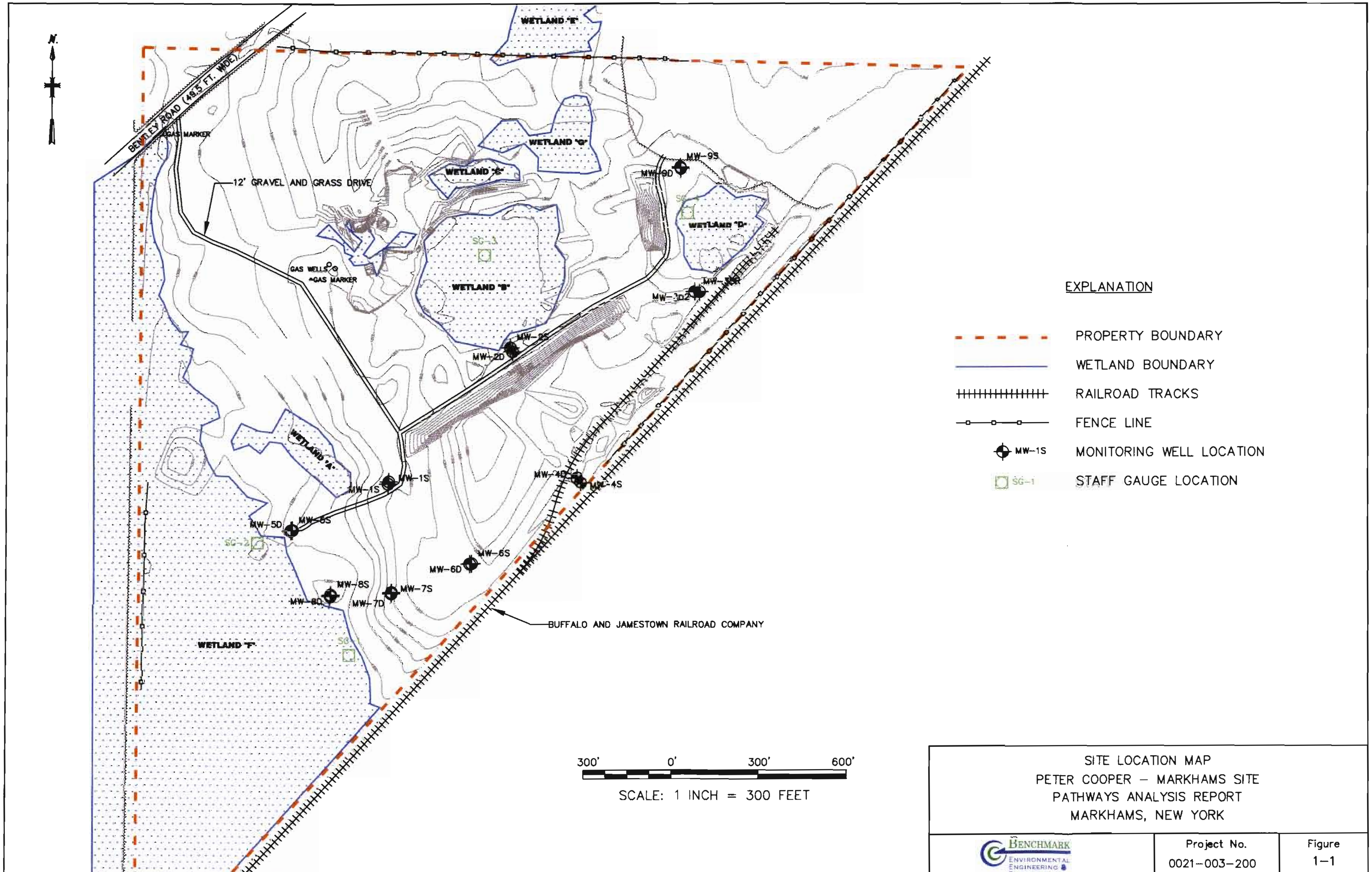
Notes:
EDQL = Environmental Data Quality Limit.
NYSDEC = New York State Department of Environmental Conservation
LEL = Lowest Effect Level
SEL = Severe Effect Level
HQ = Hazard quotient Maximum site concentration divided by Sediment LEL

GEOMATRIX

Table 3-8
COMPARISON OF SURFACE WATER DATA TO SCREENING CRITERIA
Peter Cooper Site
Markhams, New York

Constituent	NYSDEC Surface Water Quality Criteria	USEPA Region 5 Surface Water EDQL	Frequency of Detection	Range of Detected Concentrations	Screening Level HQ
Total Metals (mg/kg)					
Arsenic	150	53	0/9	0 - 0	0.00
Chromium*	---	42	1/9	13.8 - 13.8	0.33
Hexavalent Chromium	11	NE	3/9	11.8 - 14	1.3

Notes:
EDQL = Environmental Data Quality Limit.
NYSDEC = New York State Department of Environmental Conservation
NE = Screening criteria not available
HQ = Hazard quotient Maximum site concentration divided by Sediment LEL
*hardness dependant criteria (0.86)exp(0.819[ln(ppm hardness)]+0.6848)



SITE LOCATION MAP
PETER COOPER – MARKHAMS SITE
PATHWAYS ANALYSIS REPORT
MARKHAMS, NEW YORK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Project No.	Figure
0021-003-200	1-1

DATE: JUNE 2002
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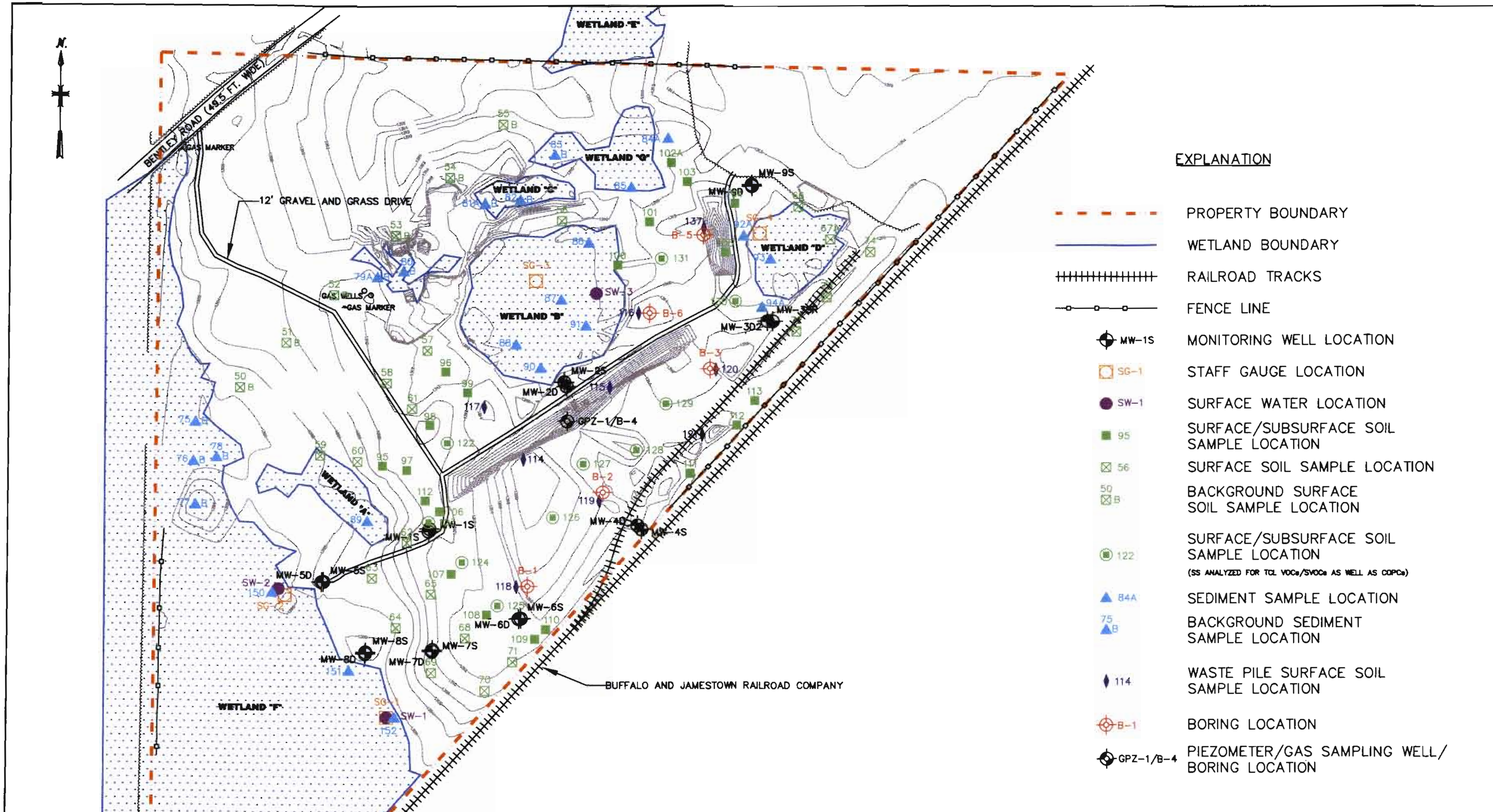

SAMPLE LOCATIONS
PETER COOPER – MARKHAMS SITE
PATHWAYS ANALYSIS REPORT
MARKHAMS, NEW YORK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Project No.	Figure
0021-003-200	2-1

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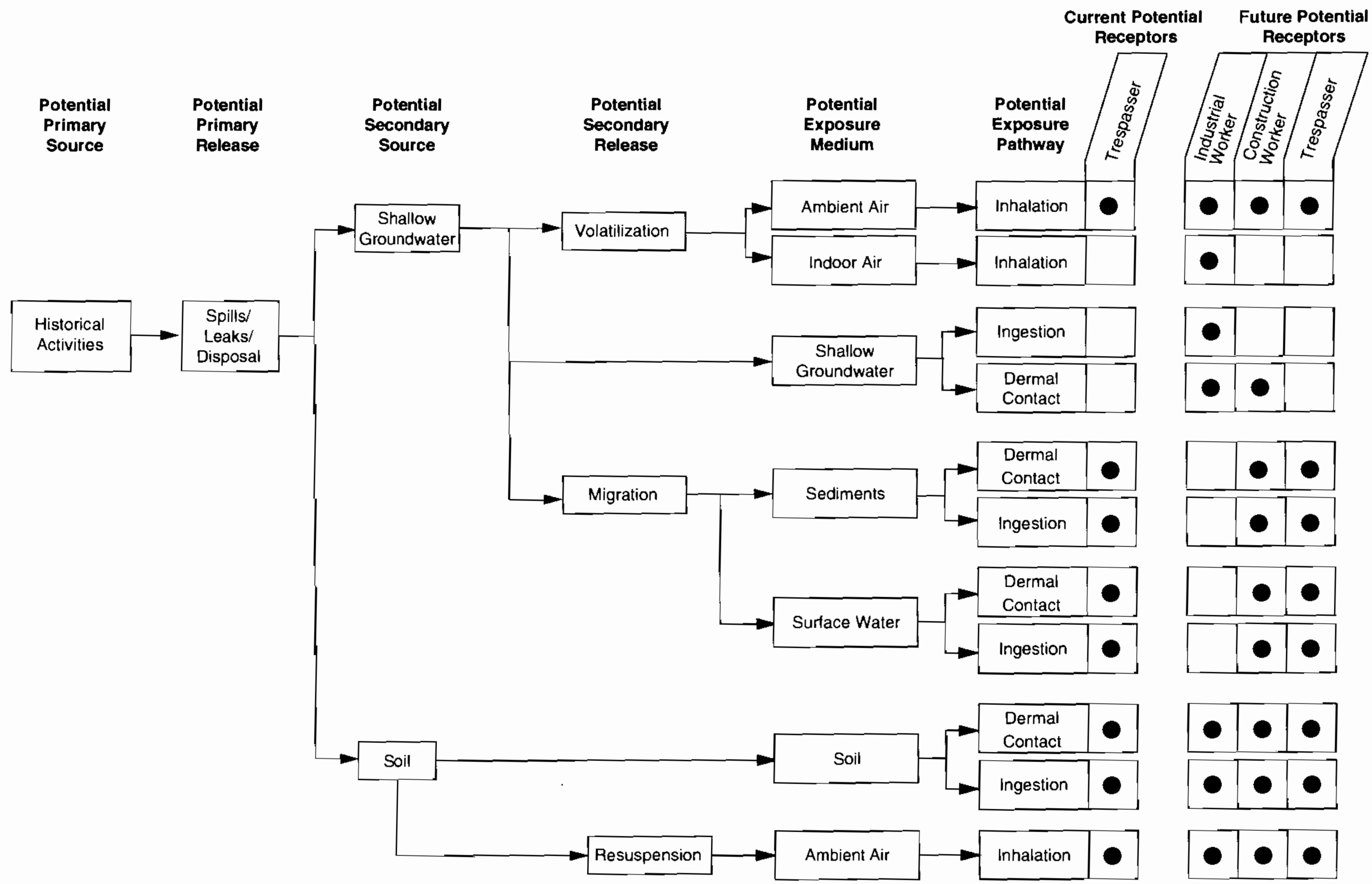
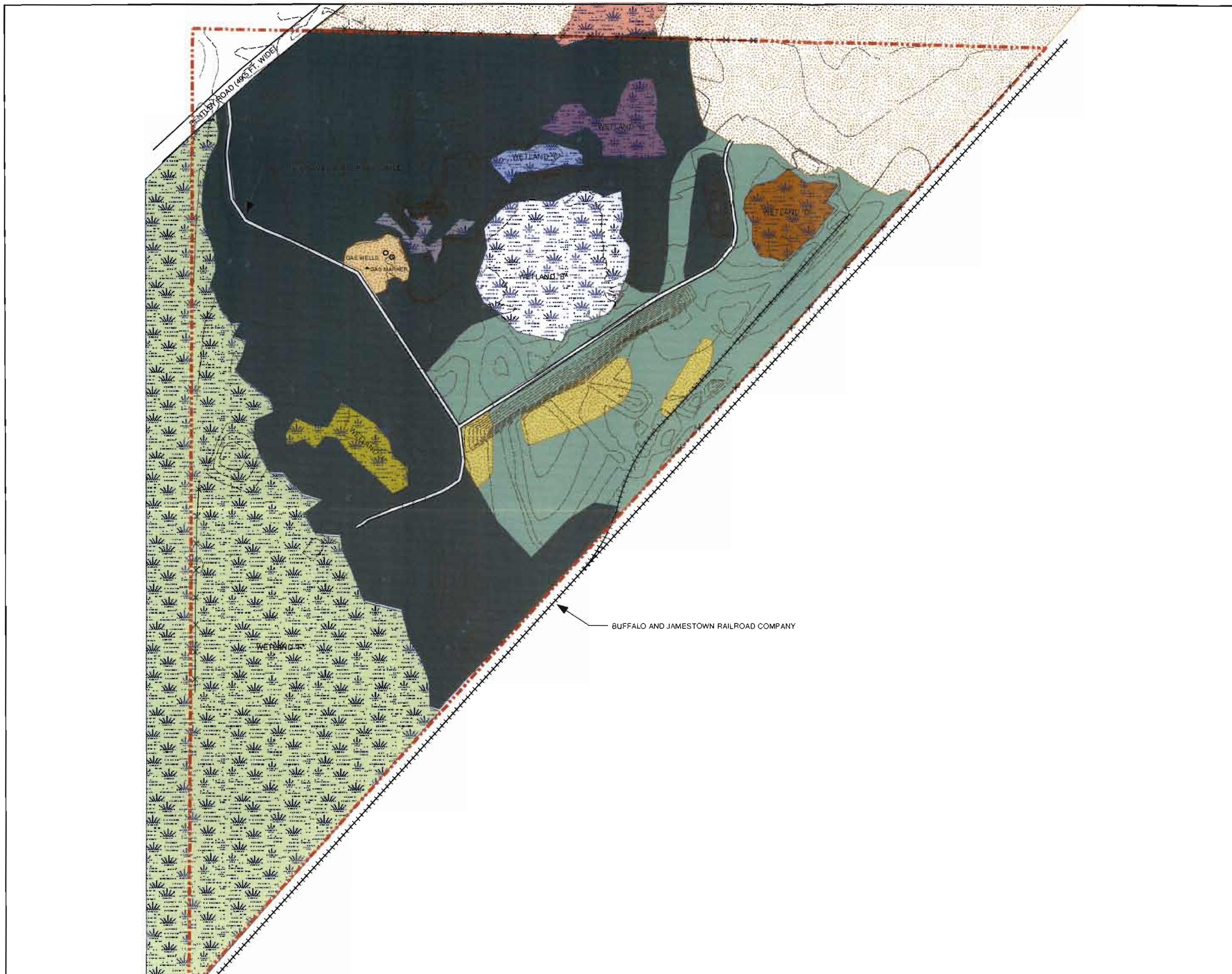


GEOMATRIX

SITE CONCEPTUAL MODEL
Peter Cooper–Markhams Site
Town of Dayton, New York

Project No. 7603

Figure 2-2



Legend

Land Cover

- Cover Type 1 - Northern Hardwood Forest
- Cover Type 2 - Successional Old Field
- Cover Type 3 - Successional Old Field
- Cover Type 4 - Northern Hardwood Forest
- Cover Type 5 - Forested Wetland
- Cover Type 6 - Emergent/Scrub-Shrub Wetland
- Cover Type 7 - Open Water/Emergent Wetland
- Cover Type 8 - Forested/Scrub-Shrub Wetland
- Cover Type 9 - Forested Wetland
- Cover Type 10 - Emergent/Scrub-Shrub/Forested Wetland
- Cover Type 11 - Emergent/Forested Wetland
- Cover Type 12 - Forested/Scrub-Shrub Wetland
- Corn
- Contours
- Fence Line
- Railroad Tracks
- Property Boundary

N
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0 325 650 Feet

Basemap based on CAD drawing provided by Benchmark, February 2002
Land cover types based on field visit.
Map Compiled by VHB, Inc. June 2002

VHB *Vanasse Hangen Brustlin, Inc.*
Transportation Land Development Environmental Services

Peter Cooper - Markhams Site
Markhams, New York

Figure 3-1 Land Cover Types

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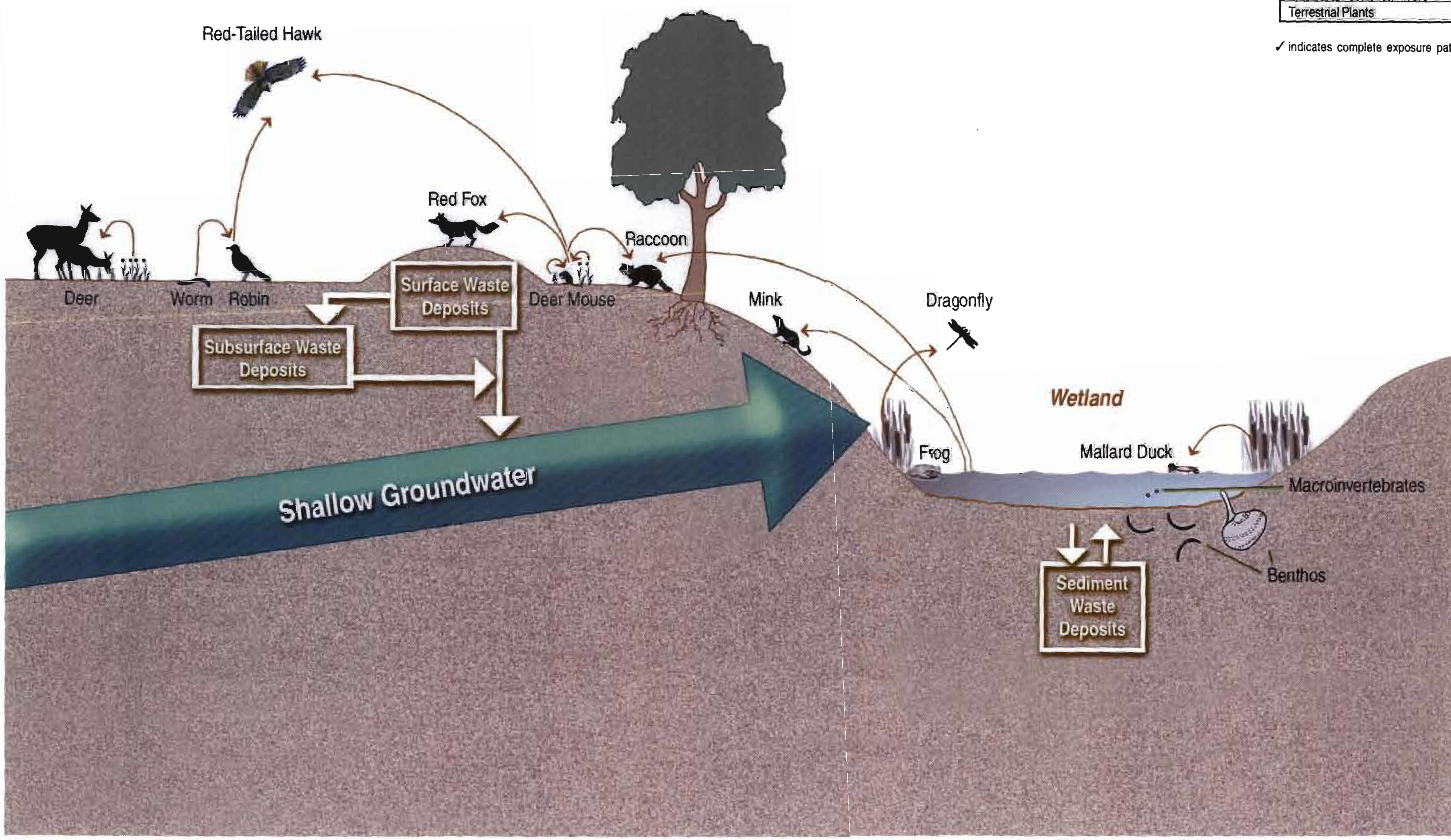
Potential Exposure Pathways					
	Physico-Chemical				Biological
	Surface Soil		Sediment		
Ecological Receptors	Dermal Contact	Ingestion	Dermal Contact	Ingestion	Predation
Aquatic Plants				✓	✓
Wildlife, Obligate aquatic, insectivore			✓	✓	✓
Wildlife, Obligate aquatic herbivore			✓	✓	✓
Benthic macroinvertebrate			✓	✓	
Wildlife, Obligate aquatic carnivore			✓	✓	✓
Wildlife, Facultative aquatic	✓	✓	✓	✓	✓
Terrestrial invertebrates	✓	✓			
Wildlife, terrestrial herbivore	✓	✓			✓
Wildlife, avian insectivore	✓	✓			✓
Wildlife, terrestrial carnivore	✓	✓			✓
Terrestrial Plants	✓	✓			

✓ indicates complete exposure pathway



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Conceptual Risk System Model

Figure 3-2
Prepared for: Benchmark Environmental Engineering & Science, PLLC

Peter Cooper Site
Markhams, NY

Vanasse Hangen Brustlin, Inc.

APPENDIX A

Ecological Effects of Detected Compounds

Appendix A

Ecological Effects of Detected Compounds

The ecological effect of a chemical constituent depends on many factors, such as the constituent's bioavailability, its concentration in the environment and/or receptor organism, synergistic interactions among constituents, the duration and frequency of receptor biota exposure to that constituent, the species of the receptor, the metabolic rate of the species, and the characteristics of the metabolic processes of the species (USEPA 1988). Constituents in the environment can affect receptor biota and ecosystems in both lethal and sublethal ways, such as the following:

- Altered developmental rates, metabolic and physiologic processes and functions, or behavior.
- Increased susceptibility to disease, parasitism, or predation.
- Disrupted reproductive functions.
- Mutations or other reduction in the viability of offspring (USEPA, 1989a).

When the potential effects of an environmental chemical on biotic receptors are being evaluated, the toxicity of the constituent must be determined. The determination should be based on field data, monitoring data, and the results of toxicity testing of contaminated media (USEPA, 1989a).

The following sections summarize toxicology information from scientific literature for the Markhams Site. The summaries present information on chemical toxicity; likely mechanisms of toxicity; and potential effects on receptor biota, populations, and ecosystem.

Volatile Organic Compounds

Acetone. Acetone is a chemical that is naturally found in the environment. It is also normally present in animals from the breakdown of fat. It can also be used in normal processes that make sugar and fats for energy. Chronic exposure to acetone can cause liver and nerve damage, birth defects, and impaired reproduction (in males only) in animals. Acetone does not cause skin cancer when applied dermally. It is unknown whether ingesting or inhaling acetone can cause cancer (ATSDR 1994a).

Acute oral LD50 values were calculated only for rats. In general, the lethality of acetone decreases with the age of the rat (Kimura et al., 1971). The LD50 values ranged from 1,726 mg/kg for newborn rats to 6,667 mg/kg for older adults.

No effects were observed in male rats exposed to 1,071 mg/kg/day for 6 weeks in drinking water (Larsen et al., 1991). Mice treated with 3,500 mg/kg/day during gestation had reduced postnatal pup survival, increased gestation duration, and reduced reproduction index (EHRT, 1987)

Acetone is moderately toxic to the liver and kidney of animals. In a 13-week drinking water study, increased liver weights were observed in rats treated with 1,600 mg/kg/day (Dietz et al., 1991). Acetone also induces liver microsomal enzymes. Kidney weights were increased in male and female rats exposed to 3,400 mg/kg and 1,600 mg/kg, respectively for 14-days in drinking water (Dietz et al., 1991).

2-Butanone. Only limited information is available on the toxicity of 2-butanone to wildlife. LC50 concentrations for two freshwater fishes were around 5,600 µg/l. 2-Butanone was toxic to brine shrimp at LC50 levels of 1,950 mg/l (Clement Associates, 1985). In animals, short-term studies suggest that 2-butanone is of low oral toxicity. The LD50 of 2-butanone in the rat has been reported to be between 2,700 and 5,530 mg/kg (Fawell and Hunt, 1988).

Carbon disulfide. No ecological toxicity data were found for carbon disulfide. Carbon disulfide mainly affects the central nervous system. At acutely poisonous levels, carbon disulfide is a narcotic and anesthetic and leads to respiratory failure and death. Chronic doses damage the central and peripheral nervous system. Carbon disulfide also produces developmental and other reproductive effects. The lowest published toxic concentration for humans is 14-mg/kg body weight. In rabbits, 350-mg/kg body weight adversely affected reproduction (Sax and Lewis, 1989).

Dichlorodifluoromethane. Dichlorofluoromethane has not been manufactured in the United States since 1995; however, it was formerly used as an aerosol propellant, a foaming agent, and a refrigerant. An estimated bioconcentration factor of 25 indicates that the potential for bioconcentration in aquatic organisms is low. Mobility in soil may be characterized as moderate given an estimated K_{oc} value of 356 (HSDB 2002). Reported LD50 concentrations for inhalation exposure ranged from 760,000 ppm/30 minutes to greater than 800,000 ppm/30 minutes for mice, guinea pigs, rats, and rabbits. An oral LD50 of > 1g/kg was reported for the rat (Verschueren 1983).

Trichlorofluoromethane. Trichlorofluoromethane was formerly used in refrigeration and air conditioning units, in fire extinguishers, and as an aerosol propellant. The potential for bioconcentration of this compound is moderate given an estimated bioconcentration factor of 49. Trichlorofluoromethane is considered to be moderately mobile in soils (HSDB 2002). LD50 concentrations of 250,000 ppm/30 minutes were reported for guinea pigs and rabbits exposed to the compound via inhalation. An inhalation LD50 concentration of 100,000/30 minutes was reported for the rat (Verschueren 1983). In rats orally exposed to trichlorofluoromethane, an LD50 of 3,725 mg/kg was reported (HSDB 2002). LC50 concentrations of 10,000 ppm/30 minutes (mouse, inhalation) and 571 g/m3/4 hours (hamster, inhalation) were reported (HSDB 2002).

Semi-Volatile Organic Compounds

Benzaldehyde. Benzaldehyde is used as a flavoring agent, an odorant and as an intermediate in the manufacture of dyes and other chemicals. It also is released to the environment from engine combustion as well as through incinerators and wood burning. The compound occurs naturally in several fruits. Based upon estimated K_{oc} values, benzaldehyde may leach in soil. Reported oral LD50 concentrations range from 1,000 mg/kg for the guinea pig to 1,300 mg/kg for the rabbit (HSDB 2002).

Diethylphthalate. Diethylphthalate is widely used in the manufacture of polyvinyl chloride; as a fixative for perfumes; and denaturing alcohol. It also is used in insecticidal sprays. The potential for diethylphthalate to bioconcentrate in aquatic organisms is high based upon experimental bioconcentration values of 117 as measured in bluegill sunfish. Oral LD50 concentrations in rats were reported to range from 9.5 - 31 mg/kg body weight. An LC50 concentration of 110 mg/L /96 hours was reported in the bluegill. LC50 concentrations in the sheepshead minnow were 38 ppm/48 hours, 36 ppm/72 hours, and 30 ppm/96 hours. An LC50 concentration for the earthworm of 850 ug/cm2 filter paper was reported (HSDB 2002).

4-Methylphenol. 4-Methylphenol (p-cresol) is used as a solvent, a disinfectant, and is a chemical intermediate in the production of synthetic resins. It is also released to the environment via automobile exhaust and tobacco smoke. In ambient air, 4-methylphenol exists in the vapor phase. It exhibits moderate to high mobility in soil and biodegrades rapidly. If released into water, 4-methylphenol may adsorb to suspended solids and sediment in the water column (HSDB 2001).

Animal toxicity data for 4-methylphenol is limited. Administration of 4-methylphenol by gavage for six to eighteen days during gestation resulted in hypoactivity of the central nervous system, respiratory distress and maternal death in rabbits (HEAST 1997). Skin application studies of mice indicate that cresols can serve as tumor promoters of a polycyclic aromatic hydrocarbon. In these studies mice were given a single dose of 0.3% dimethylbenzanthracene (DMBA) followed by application of cresols. The mice were subsequently examined for the presence of skin papillomas. In one study, 7/20 mice developed papillomas; in the other study approximately 29% developed skin papillomas (Boutwell and Bosch 1959). In an acute dermal toxicity study, technical grade p-cresol caused severe skin damage on at least a third of shaved, female, albino New Zealand rabbits within 4 hours of application of 300 mg/kg p-cresol (Vernot et al. 1977). The oral LD_{50} for rats is 207 mg/kg (Sax and Lewis 1989).

Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are ubiquitous in the environment. PAH levels are typically elevated in nonbiological materials in industrial areas because of anthropogenic sources; human activities release approximately 43,000 metric tons of PAHs into the atmosphere and 230,000 metric tons into aquatic environments each year. Most PAHs released to the atmosphere eventually reach surface soils and waters by direct deposition (Eisler , 1987a).

Terrestrial vegetation and invertebrates can accumulate significant levels of PAHs. Plants can assimilate PAHs deposited on leaf surfaces as well as take up PAHs through the roots. Translocation of PAHs occurs, and concentrations are usually greater on plant surfaces than in internal tissues. Aboveground vegetation typically has higher PAH levels than do the roots. Reported plant PAH concentrations range from 20 to 1,000 μg/kg (fresh weight) in vegetation from nonpolluted areas, and up to 25,000 μg/kg (fresh weight) in polluted areas. Phytotoxic effects of PAHs are rare. The biomagnification potential of PAHs in vegetation in terrestrial and aquatic food chains has not been adequately investigated (Eisler, 1987a).

Concentrations of PAHs in fish do not appear to be elevated. Reported values range from 3 μg/kg (fresh weight) for fish muscle from specimens collected in Lake Ontario to >15,000 μg/kg (fresh weight) in fish muscle from specimens collected near a wastewater treatment plant in Michigan. In aquatic systems, the PAH toxicity generally increases with increased molecular weight and increased alkyl substitution on the aromatic ring. Toxicity is most pronounced among crustaceans and least pronounced among fish. Most aquatic organisms appear to bioconcentrate PAHs rapidly, and uptake is highly species-specific. Bioconcentration factors for whole organisms and tissues are affected by biotic and abiotic factors and range from 0.02 to >82,0000. The many carcinogenic, and cytotoxic effects, as well as inhibited reproduction, inhibited respiration, and inhibited photosynthesis, have been reported among various biota (Eisler, 1987a).

Little information is available on the effects of PAHs on terrestrial wildlife, but significant concentrations that could cause adverse effects are unlikely. Reported LD50 acute oral doses for laboratory rodents range from 50 to 2,000 mg/kg body weight. Adverse effects observed in laboratory mammals include carcinomas, testicular damage, oocyte and follicle destruction, and altered blood serum chemistry and nephrotoxicity.

Metals

Arsenic. Background concentrations of arsenic are generally <10 μg/L in surface water and <15 mg/kg in soil; uncontaminated soils in the United States have a mean arsenic concentration of 7.4 mg/kg soil (Eisler 1988a). Commercial use and production of arsenic compounds, such as agricultural insecticides and herbicides, have raised local concentrations above natural background concentrations in some areas. In the United States, arsenic levels >240,000 μg/L in surface water and 2.5 x 106 mg/kg soil (DW) in arsenic-pesticide-treated soils have been reported (Eisler 1988a). Arsenic concentrations of up to 3,500 mg/kg sediment (DW) in contaminated areas (Eisler 1988a), up to 30 mg/kg sediment in Lake Michigan (Eisler 1988a), and 47 to 209 μg/g sediment in Lake Texoma (Hunter et al. 1981) have been reported.

Arsenic toxicity depends strongly on its chemical form and oxidation state. In general, inorganic arsenic compounds are more toxic than organic compounds, and trivalent forms are the most toxic (Eisler 1988a). Biota may take up arsenic via ingestion, inhalation, or absorption through body surfaces, and cells take up arsenic via the active transport system normally used in phosphate transport (Eisler 1988a).

Adverse effects on crops and vegetation, such as poor growth, seedling death, defoliation, and inhibition of photosynthesis, have been reported at concentrations of 1 to 25 mg water soluble arsenic/kg soil (equivalent to approximately 25 to 85 mg total arsenic/kg soil) (Eisler 1988a). Data on effects of arsenic on soil biota and insects are limited. Tolerant soil microbiota can withstand arsenic concentrations as high as 1,600 mg/kg soil (NAS 1977). In contrast, reduced growth and metabolism in sensitive species have been reported at arsenic concentrations of 375 mg/kg soil (NAS 1977), and soils with arsenic levels of 150 to165 mg/kg soil lost their earthworm biota and showed reduced quantities of microfauna (Eisler 1988a).

Mammals and birds are exposed to arsenic primarily by ingestion of contaminated vegetation and water. Arsenic is bioconcentrated by organisms but is not biomagnified in the food chain (Eisler 1988a). In birds, arsenic poisoning produces many effects, including loss of muscular coordination, slowness, loss of righting reflex, seizures, and death. Single oral doses producing 50% fatality in sensitive species (such as the turkey) range from 17 to 33 mg/kg body weight. In mammals, arsenic toxicosis can produce trembling, extreme weakness, vomiting, and death (Eisler 1988a). Because arsenic detoxification and excretion are rapid, poisoning is generally caused by acute or subacute exposures. Single doses reported to produce 50% fatality in sensitive mammal species ranged in concentration from 2.5 to 33.0 mg/kg body weight. Susceptible species have been adversely affected at chronic arsenic doses of 1 to 10 mg/kg body weight or 50 mg/kg diet (Eisler 1988a).

Adverse effects on aquatic biota have been reported at concentrations of 19 to 85 μg/L (Eisler 1988a). Fish exposed to 1 to 2 mg/L total arsenic for 2-3 days exhibited gill hemorrhages; fatty infiltration of the liver; and necroses of the heart, liver, and ovarian tissues. Developing toad embryos exhibited increased malformity or mortality following a 7-day exposure to 40 μg trivalent arsenic/L, and concentrations of 48 μg pentavalent arsenic/L significantly reduced growth in freshwater algae (USEPA 1986). Many organisms accumulate arsenic from water, but there is little evidence of magnification through aquatic food chains (NAS 1977; Eisler 1988a). The AWQC for trivalent arsenic for the protection of aquatic life are 360 and 190μg/L for acute and chronic exposure, respectively (USEPA 1986). Although no criteria for the protection of aquatic life have been developed for pentavalent arsenic because of insufficient data, the lowest-observed-effect levels for freshwater acute and chronic exposure are 850 and 48 μg/L.

Chromium. Chromium concentrations range from 5 to 300 mg/kg in soils and 1 to 10 μg/L in contaminated rivers and lakes (Eisler 1986). Sheppard and Evenden (1990) reported a mean chromium concentration of 38 μg/g for soil collected from 64 sites throughout Canada, and the World Health Organization (WHO 1988) reported an average concentration of 53 mg/kg for 863 samples collected in the United States. Chromium is most frequently encountered in the trivalent (III) or hexavalent (VI) oxidation states; the hexavalent form is more toxic because it has a higher oxidation potential and can easily penetrate biological membranes (Eisler 1986).

A variety of plants take up and accumulate chromium. Adverse effects include decreased growth and leaf necrosis (Peterson and Girling 1981). Treatment of plants with nutrient solutions containing chromium (VI) concentrations of 5 mg/L or less resulted in decreased chlorophyll concentration, inhibition of seed germination and growth, and decreased root uptake of nutrients (WHO 1988). The high chromium concentrations reported in many plants may represent a significant pathway of chromium transport to herbivorous biota. Adverse effects of chromium on sensitive wildlife species have been reported at concentrations of 5.1 and 10.0 mg/kg of diet for chromium (VI) and chromium (III), respectively (Eisler 1986). Documented effects in birds include limb deformities, everted viscera, and stunting. In mammals, chromium exposure has resulted in altered blood chemistry, skin ulcerations, bronchial carcinomas, kidney and liver lesions, and teratogenic effects (Eisler 1986).

In aquatic systems, exposure to 10 μ/L of chromium (VI) inhibited growth in algae; frond growth in common duckweed; and survival and fecundity in Daphnia (Eisler 1986). For chromium (VI), acute toxicity values range from 23.07 μg/1- for a cladoceran to 1,870,000 μg/L for a stonefly; chronic values range from <2.5 μg/L for a daphnid to 1,987 μg/L for fathead minnows (USEPA 1986). Acute values for chromium (VI) range from 2,221 μg/L for a mayfly to 71,060 μg/L for a caddisfly; chronic values range from 66 μg/L for Daphnia to 1,025 μg/L for fathead minnows (USEPA 1986). For fish, chromium (VI) concentrations of 16 to 21 μg/L resulted in reduced growth; altered plasma cortisol metabolism; altered enzyme activities;

chromosomal aberrations; and morphological changes in gill, stomach, and kidney tissues. The AWQC for chromium (VI) for the protection of freshwater biota are 16 and 11 μg/L for acute and chronic exposure, respectively (USEPA 1986). The AWQC for chromium (III) is hardness dependent. At a hardness of 200, the AWQC are 3,100 and 370 μg/L for acute and chronic exposure, respectively.

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