Baseline Human Health Risk Assessment

Peter Cooper Markhams Site
Town of Dayton, New York

July 2006

Project No. 7603.001

Geomatrix

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1.0 INTRODUCTION

This baseline human health risk assessment (HHRA) has been prepared by Geomatrix Consultants, Inc. (Geomatrix) for the Peter Cooper Markhams Site near the Towns of Dayton and Markhams, New York (the Site; Figures 1 and 1-1). This report was prepared as part of the Remedial Investigation/Feasibility Study (RI/FS) conducted by Benchmark Environmental Engineering & Science, PLLC (Benchmark) and Geomatrix in response to the Unilateral Administrative Order (UAO) with the United States Environmental Protection Agency (U.S. EPA) and in accordance with the U.S. EPA approved Pathway Analysis Report (Geomatrix, August 2002) and subsequent comments.

1.1 OBJECTIVE

The objective of this HHRA is to provide an analysis of the potential for adverse health and ecological effects as a result of possible exposure to chemicals measured at the Site under a no-action alternative; that is, the potential effects that may result if no remedial action or institutional controls were to take place. The results of this assessment will indicate if further evaluation, controls, or remediation are necessary.

1.2 APPROACH

A quantitative human health risk assessment (HHRA) was conducted to evaluate chemicals detected in soil and groundwater at the Site and chemicals detected in surface water and sediments from the on-site wetlands. The HHRA follows standard and customary practice according to U.S. EPA risk assessment policies and guidelines for the performance of risk assessments as specified in the following documents:

- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). U.S. EPA. Office of Emergency and Remedial Response. OSWER Directive 9285.7-01a. September 1989.

- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part D: Standardized Planning, Reporting, and Review of Superfund Risk Assessments). U.S. EPA. Office of Emergency and Remedial Response. Publication 9285.7-47, December 2001.

- Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment), Final. U.S. EPA. Office of Superfund Remediation and Technology Innovation. OSWER Directive 9285.7-02EP. July 2004.

These documents were supplemented by additional U.S. EPA guidance and policies as necessary. Other guidance documents that were consulted are referenced in appropriate sections and presented in Section 9.0.

Although the technical approaches employed in this HHRA are based on the latest scientific information, there remain numerous uncertainties in the extent to which environmental exposures affect human health and the environment. This lack of knowledge means that assumptions must be made based on information presented in the scientific literature or on professional judgment. Although some assumptions have significant scientific basis, many do not. These uncertainties may result in overestimation or underestimation of the potential health risks and hazards. However, in most cases, the assumptions utilized in this risk assessment are conservative and are consistent with U.S. EPA guidance and policies.

1.3 REPORT ORGANIZATION

This report is organized in a manner consistent with the referenced guidance documents. The remaining sections of the report are as follows:

- Section 2.0 – Site Characterization summarizes background information for the site, including location, historical uses, and a brief summary of previous investigations.
- Section 3.0 – Data Evaluation presents an evaluation of the data and the selection of the chemicals of potential concern used in the HHRA.
- Section 4.0 – Exposure Assessment presents the analysis of the mechanisms by which human receptors may be exposed to chemicals at the site.
- Section 5.0 – Toxicity Assessment presents the quantitative criteria developed by U.S. EPA to evaluate potential adverse health effects of chemicals.
- Section 6.0 – Risk Characterization presents the results of the quantitative analysis of the potential carcinogenic risks and noncarcinogenic health effects.
- Section 7.0 – Conclusions present the conclusions of the HHRA.
- Section 8.0 – References present the sources of information cited in the text.

2.0 SITE DESCRIPTION

The Markhams Site is located off of Bentley Road in the Town of Dayton, Cattaraugus County, NY, approximately 6 miles south of the Village of Gowanda (Figures 1 and 1-1). The Site encompasses approximately 103 acres and is bordered to the northwest by Bentley Road, to the northeast by wooded property and a field, to the southeast by an Buffalo and Jamestown Railroad Company 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 fill piles arranged in an elliptical pattern. For the purpose of this HHRA, the terms "fill piles" and "fill mounds" refer to the elevated piles of materials disposed at the Site. Several of the fill piles consist only of re-worked native soil. Other fill piles consist of vacuum filter sludge and cookhouse sludge (defined in Section 2.1) covered by 0.5 to 4 feet of re-worked native soil. The fill piles vary in size and elevation, with base dimensions of approximately 1,100 to 160,000 square feet and elevations of 5 to 20 feet above surrounding grade. The total area covered by fill 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 Buffalo and Jamestown Railroad Company 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 provides access to a natural gas wellhead located on the eastern side of the drive several hundred yards 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. During the Spring, standing water is present 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 except for the gas well located east of the access drive. Prior to RI field activities, the access drive was relatively clear from Bentley road to the fill area and along the northern perimeter of the fill piles. The area around the fill areas subsequently re-vegetated, particularly along the southern and eastern sides of the fill mounds. The access road was re-established in the 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 eastern end of the Site. The switchgear is not evident on the adjacent active rail line, indicating that the siding was disconnected from the main rail, presumably following Site closure.

The nearest named surface water bodies are Slab City Creek and Johnson Creek, located respectively 3,000 feet southwest and 2,000 feet southeast of the Site. These creeks are small tributaries of Conewango Creek. The Site lies between the two creeks, approximately 1.5 miles north of 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, aerial photographs, or visual inspection.

The depth to the shallow water-bearing zone ranges from near the ground surface on the western side of the site (near the adjacent wetland) to nearly 9 feet below ground surface (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, {OBG}, 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 165.5 inches with an average annual precipitation of nearly 40 inches (NOAA, 1998). Average monthly temperatures range from 21 ^{o}F in January to 66 ^{o}F in July (NOAA, 1998). The ground and surface water, if present, generally remain frozen from December to March. Natural stream temperatures range from 32 ^{o}F (winter) to 80 ^{o}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).

2.1 SITE HISTORY

The Peter Cooper Markhams Site was used for the disposal of certain wastes from a former animal glue and adhesives manufacturing company located in Gowanda, New York. Materials disposed at the Peter Cooper Markhams Site were reported to consist of residue pile material, vacuum filter sludge and cookhouse sludge (O'Brien & Gere, 1971). Cookhouse sludge reportedly was derived from the animal glue manufacturing process, and is comprised of settled sludge resulting from the processing of animal hides, some of which were chrome-tanned. Residue pile material is described as air-dried cookhouse sludge, which was stabilized to a fairly dry, granular form. Vacuum filter sludge reportedly was produced during primary (settling) treatment of liquid wastes, including liquids generated during gravity dewatering of cookhouse sludge.

Peter Cooper Corporations (PCC) reportedly purchased the Site in 1955. PCC sold the site in 1976 to a buyer that was subsequently renamed Peter Cooper Corporation (PCCII). PCCII continues to own the site today. From approximately 1955 until September 1971, it was reported that approximately 9,600 tons of residuals had been placed at the Peter Cooper Markhams Site over an approximately 15-acre area. Pursuant to a New York State Supreme Court Order dated June 1971, approximately 38,600 tons of previously-accumulated residual materials from the Gowanda Plant reportedly were also transferred to the Markhams Site. No further disposal reportedly occurred at the Markhams Site, and the fill area has since re-vegetated.

Historic aerial photos of the site from the years 1939, 1956, 1966, 1980 and 1990 were obtained by Benchmark Environmental Engineering & Science, PLLC from the Cattaraugus County Soil Conservation Office, located in Ellicottville, New York. Although the scale of the photos limits detailed observations, the photos substantiate a historically sparse population and rural property use in the Dayton area, with the 1939 photo corroborating the recorded use of the Markhams property for farming prior to purchase by PCC in 1955. The 1939 photo also indicates the presence of the open field immediately north of the fill area and a forested boundary on the southwest side of the Site. Photos from 1956 and 1966 support the recorded use of the south-central portion of the Site for disposal. Both of these photos indicate the presence of a rail spur extending into the property from the bordering railroad tracks. In the 1966 photo, the access drive from Bentley Road had been completed to the fill area as well. In the 1980 photo, significant vegetation is present across the fill area, and the current fill pile configuration is evident. Further vegetation and tree growth are evident in the 1990 photo. The rail spur is not apparent on either the 1980 or 1990 photos, and the site access drive is filled-in considerably on both photos, consistent with termination of site use in 1972.

2.2 PREVIOUS INVESTIGATIONS AND REMEDIAL MEASURES

In accordance with the June 1971 State Supreme Court Order, PCC initiated transfer of residue pile material to the Markhams site in August 1971. Shortly thereafter, PCC submitted to the NYDEC a Solid Waste Management Report (OBrien & Gere, 1971) documenting the means for transfer of these materials to the Markhams site. Follow-up discussions between PCC and the New York State Department of Environmental Conservation (NYSDEC) in August 1972 provided for grading the waste piles to a height of approximately 10 feet and covering them with 6-inches of soil or stabilized residue, followed by seeding to promote fast growing cover vegetation.

The NYSDEC completed Phase I and Phase II Environmental Site Investigations at the Peter Cooper Markhams Site in 1983 and 1985, respectively (Recra Research, 1983 and 1985). In 1986, PCCII, under NYSDEC Consent Order, commissioned to perform a Remedial Investigation and Feasibility Study (RI/FS) at the site, which included a quantitative human health risk assessment (OBG, 1989, herein referred to as the 1989 RI). The 1989 HHRA was prepared by O'brien & Gere Engineers and was reviewed by the EPA following the first set of risk assessment guidance and policies. At that time risk assessment methodologies were still being developed by the EPA, therefore, this current risk assessment provides a more in-depth analysis and includes the use of current scientific data and risk assessment guidance. In conjunction with the 1989 RI, interim remedial measures were performed in 1989 to remove a number of buried containers that had been disposed within an isolated area of the site (OBG, 1991). The containers and impacted soils were excavated and transported off-site for proper disposal.

The 1989 RI indicated the presence of total chromium, hexavalent chromium and arsenic above background levels in waste materials and some adjacent soils. Low levels of these parameters were also detected in groundwater samples collected from shallow monitoring wells installed immediately adjacent to the fill piles. None of the samples tested exhibited hazardous waste (toxicity) characteristics. The 1989 RI concluded that the Site does not pose a risk to human health or the environment.

A Feasibility Study (FS) was completed for the site by OBG in March 1991. The FS recommended a remedial alternative involving consolidation, compaction, and covering of the waste materials.

NYSDEC apparently did not pursue any remedial action because the Site did not meet the statutory definition of an inactive hazardous waste disposal site. Consequently, NYSDEC removed the site from its Registry of Inactive Hazardous Waste Sites.

In 1993, the United States Environmental Protection Agency (U.S. EPA) conducted a Site Sampling Inspection, which included the collection and analysis of soil and surface water samples from the Peter Cooper Markhams Site (Malcolm Pirnie, Inc., 1993, herein referred to as the 1993 SSI). Chromium and arsenic were detected in soils on and within the waste piles.

In March 1999, U.S. EPA Region II prepared a Hazard Ranking System Model score for the site and listed the Peter Cooper Markhams Site on the National Priority List (NPL). On September 29, 2000 U.S. EPA issued a Unilateral Administrative Order (UAO) to several potentially responsible parties (PRPs) directing completion of an updated RI/FS for the Site. Benchmark and Geomatrix were retained by the responding PRPs to develop an RI/FS Work Plan (Geomatrix, February 2001). RI field activities were performed in fall of 2001 and spring of 2002. Limited soil and sediment resampling to address data quality issues was conducted in fall of 2003.

3.0 DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Data evaluation is the process of analyzing site characteristics and analytical data to identify Constituents of Potential Concern (COPCs) to be evaluated in the HHRA. This section of the report identifies data of sufficient quality for use in the risk assessment, summarizes the chemical characterization of each environmental medium at the Site (i.e., soil, surface water, groundwater, and sediment), and provides a summary of all COPCs identified at the Site by medium. A more complete discussion of the data collected from the Site is presented in the RI report.

The focus of the RI conducted by Benchmark and Geomatrix was to supplement existing data to define chemical constituent migration pathways, assess human health and ecological risks, and perform the FS. The investigation included the collection of surface and subsurface soil, surface water, sediment, and groundwater samples and laboratory analyses of COPCs to support remedial action objectives.

3.1 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 presented in Appendix B of the RI, the RI data are considered useable for quantitative risk assessment. Figure 2-1 presents the sample locations for the RI data used in the risk assessment.

As indicated in the RI/FS Work Plan, data gathered in support of the 1989 RI and the 1993 Supplemental Site Investigation (SSI) were considered data of sufficient quality 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 with the exception of background inorganic data, as agreed upon in the RI/FS Work Plan.

One issue that arose during the course of the data quality review concerned the hexavalent chromium results for soil and sediment samples collected by Geomatrix during the RI. Hexavalent chromium results for 74 of 116 soil or sediment samples were rejected by a third party data validator. No total chromium sample analytical results were rejected by the data validator. On February 26, 2003, Geomatrix and Benchmark submitted a plan describing methods to confirm the hexavalent chromium laboratory analytical results for soil and wetland samples collected during the RI. The U.S EPA verbally approved the plan for sample confirmation in May 2003. The objective of the plan was to establish if hexavalent chromium is to be considered a COPC in soil and/or wetland sediments at the Site.

The confirmation sample analysis plan stipulated re-sampling approximately 50% of the soil/sediment locations where hexavalent chromium results were rejected and where total chromium results indicated the potential for exceedance of the U.S. EPA Region 9 Preliminary Remedial Goal (PRG) for hexavalent chromium in industrial soil (64 mg/kg). Specifically, total chromium concentrations were detected above 64 mg/kg in only 32 of the 74 samples for which hexavalent chromium data were rejected. Therefore, there were 32 samples where hexavalent chromium concentrations could have possibly exceeded the respective U.S. EPA Region 9 industrial PRG if all the chromium were in the hexavalent state, which is very unlikely. In accordance with the confirmation sample analysis plan, resampling was conducted at 50% of these locations, for a total of 16 supplemental samples.

The supplemental soil and sediment samples were collected on December 3 and 4, 2003. All samples were collected in accordance with the approved Quality Assurance Project Plan and analyzed for total and hexavalent chromium. Twelve surface soil locations (and one duplicate), one subsurface soil location and three sediment locations were sampled. Only two data qualifications were necessary for the results and all were considered useable for quantitative risk assessment.

3.2 CHEMICAL CHARACTERIZATION

This section briefly summarizes the chemicals detected in each medium for purposes of providing context to the risk assessment. Summary tables of the chemicals detected in each medium are presented in Tables 3.1 through 3.6. Samples were analyzed for Target Compound List (TCL) VOCs and SVOCs, and metals. Tables 3.1 through 3.6 present a summary of the constituents that were detected, total number of samples analyzed, total number of detections, frequency of detection, range of detection limits, and range of concentrations detected. Details of the sampling and analytical program are presented in the RI.

3.2.1 Soil

Tables 3.1 through 3.2 present a summary of the soil data collected from surface and subsurface, respectively. The data consists of sample results from October 2001 and December 2003. Results from one sampling location collected during both the 1989 RI and the 1993 SSI were also considered of sufficient quality based on appropriate quality assurance/quality control verification. Remaining historical data collected from the Site were only considered as screening level, and therefore, were not included in the HHRA as indicated in the RI/FS Work Plan (Benchmark/Geomatrix 2001) and the Pathway Analysis Report (PAR; Geomatrix, 2002). For the purposes of this HHRA, analytical results of soil samples are divided into: (1) surface soil from 0 to 2 feet bgs; and (2) subsurface soil from 0 to approximately 10 feet bgs. Only soil data collected between 0 and 10 feet bgs are presented. Soil samples from depths deeper than 10 feet bgs are not relevant for the purposes of this risk assessment because shallow groundwater is present within 9 feet of the ground surface and the general low exposure potential of soil deeper than 10 feet.

Fifty-nine soil samples and four duplicate samples were collected from 4 borings, 1 monitoring well, and 37 surface soil locations throughout the Site from the 2001 RI sampling. Ten surface soil samples (Lathe #22 to 31) were collected and analyzed for metals (arsenic, chromium, and hexavalent chromium), VOCs and SVOCs. The 37 other surface and 12 subsurface soil samples were analyzed for arsenic, chromium, and hexavalent chromium. Manganese was analyzed at one subsurface monitoring well location.

As described in Section 3.1, additional soil sampling was performed in December of 2003 and results were analyzed for total and hexavalent chromium. Twelve surface soil samples and one subsurface soil sample were collected from previously sampled locations during this sampling event. Data evaluated in this HHRA are presented in Appendix A.

As presented in Tables 3.1 and 3.2, select VOCs, SVOCs, and metals, including hexavalent chromium, were detected in surface and subsurface soils. VOC detections were generally limited to a few locations at low concentrations. Polynuclear aromatic hydrocarbons (PNAs), also referred to as polycyclic aromatic hydrocarbons (PAHs), were the most frequent SVOCs detected in soil.

3.2.2 Groundwater

Groundwater data collected from both shallow and deep overburden monitoring well pairs were considered for use in the risk assessment and summaries of the results are presented in Tables 3.3 and 3.4. Groundwater samples were analyzed for VOCs, SVOCs, metals, and hexavalent chromium. Nine well pairs are screened in the shallow and deep saturated overburden. One of these well pairs, MW-9S/MW-9D, is located upgradient of the Site and is considered to represent background water quality. Groundwater samples were collected and analyzed from all of these wells in November 2001 and April 2002.

Select VOCs, SVOCs, and metals were detected in shallow groundwater. As shown in Table 3.3, a majority of the maximum detected concentrations for metals in shallow groundwater were reported from monitoring well MW-2S. Monitoring well MW-2S is a low yielding well resulting in elevated turbidity that produced metals concentrations that are not considered representative of dissolved groundwater chemistry. Nine metals detected from MW-2S were not detected in any other shallow groundwater well. These metals are: antimony, arsenic, barium, cadmium, cobalt, copper, nickel, selenium and thallium.

The metals analytical results for MW-2S vary significantly between the November 2001 and April 2002 sampling events which suggests the well is not yielding representative samples. Furthermore, the metals concentrations are far higher than historically measured in this well. A comparison of metal analytical results for samples collected previously from the well in 1987 and 1988 by OBG and analyzed for arsenic, chromium, hexavalent chromium, and zinc indicated concentrations of these constituents were either not detected or detected at significantly lower concentrations than those detected during the most recent sampling events.

As indicated in the RI, the difficulty in obtaining representative samples from MW-2S may be related to its age and construction materials. The well was installed more than twenty years ago and is constructed with a carbon-steel riser having a wire-wrap well screen. Only one other well, MW-4S, was similarly constructed (the newer wells are constructed of PVC) and it was not sampled for most of the metals because it was dry during the first RI sampling event. Considering the age and construction of MW-2S and the extremely high and extremely variable concentrations of iron and other metals in the RI samples, it appears that water samples from this well are no longer representative of groundwater quality in the surrounding formation.

Comparison of results with those from MW-2D provide further evidence that MW-2S no longer yields representative samples. MW-2D is co-located with MW-2S and monitors an interval approximately 10 feet beneath that monitored by MW-2S. However, it has the newer well construction consisting of PVC well screen and riser. There is no confining layer which would provide a barrier to groundwater flow between the intervals monitored by the two wells. That said, metals concentrations, and in particular naturally occurring metals concentrations, would be expected to be similar in samples collected from the two wells (as is generally seen in other paired wells across the Site). However, with the exception of iron (7,850 μg/l), which when filtered was detected at a much lower concentration (351 μg/l), metals concentrations were not elevated in MW-2D and were in fact orders of magnitude lower in comparison to MW-2S. Such a large concentration gradient over 10 feet in granular soil is unlikely.

Based on this information, groundwater analytical results collected from MW-2S during the first and second sampling events are considered not representative of site groundwater.

Metals were detected most frequently in deep groundwater, including one detection of hexavalent chromium, which was qualified as "NJ", indicating that the corresponding spike sample recovery was not within quality control limits and the concentration is an estimated value. After considering only data that met the data quality objectives, it was concluded that no hexavalent chromium was detected at or above the laboratory reporting limits in groundwater. Several of the metals detected in shallow and deep groundwater are natural constituents of groundwater and are considered essential nutrients in the human diet.

3.2.3 Surface Water

Seven surface water samples and two duplicates were collected from four wetland areas in December 2001 and April 2002. Surface water samples from both sampling events were analyzed for arsenic, chromium and hexavalent chromium. Chromium and hexavalent chromium were detected in surface water and summarized in Table 3.5. Arsenic was not detected in surface water.

3.2.4 Sediment

Fourteen sediment samples were collected from the Site in October 2001 and analyzed for arsenic, chromium and hexavalent chromium. The hexavalent chromium results were rejected during data validation. Three sediment samples were collected in December 2003 for chromium and hexavalent chromium. Arsenic and hexavalent chromium were detected in wetland sediments and are presented in Table 3.6.

3.3 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Not all chemicals detected at a site warrant a quantitative evaluation. According to U.S. EPA guidelines (U.S. EPA, 1989), COPCs can be selected based on criteria such as frequency of detection, toxicity, or whether a chemical can be considered a laboratory contaminant. U.S. EPA guidance also allows for the exclusion of elements that are essential nutrients in the human diet (U.S. EPA, 1989). Calcium, magnesium, potassium, and sodium, which were detected in groundwater at low levels, are considered essential nutrients, and as a result, 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. In this way, the risk assessment can focus solely on those chemicals (COPCs) which are expected to account for the majority of the estimated health impacts at a site. The COPCs at the Site were selected 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 PRGs (U.S. EPA, 2004b). PRGs are intended to serve as health-risk based screening concentrations below which no human health impacts are expected. Although extremely unlikely with respect to the projected future land use for the site, PRGs for residential land uses were used to identify COPCs for the HHRA.

A chemical was selected as a COPC if the maximum detected concentration exceeded its respective risk-based screening criterion. In some instances, the maximum concentrations were qualified as estimated values (i.e., "J" flagged) and therefore, were below the reporting limit (RL). Therefore, a detected chemical was also selected as a COPC if its maximum RL exceeded the criterion.

To address potential cumulative non-carcinogenic effects, the screening for potential non-carcinogenic chemicals was conducted using the 1/10 the PRG unless the PRG is based on the saturation limits. A concentration associated with a risk of 1×10^{-6} was used to evaluate the carcinogens in the screening.

3.3.1 Soil

For chemicals detected in soil, residential PRGs were used as the screening criteria even though it is unlikely that the Site will ever be developed for residential use. The use of residential PRGs is inconsistent with the assumed future land use, but is a conservative measure used in the screening process. Chemicals detected in surface and subsurface soil were considered COPCs if the maximum detected concentration or the maximum reporting limit exceeded their respective PRG criteria. Tables 3.1 and 3.2 summarize the COPCs for surface and subsurface soil from the Site, respectively. COPCs in surface soil are benzo(a)pyrene, arsenic, hexavalent chromium, and total chromium. COPCs in subsurface soil are benzo(a)pyrene, arsenic, hexavalent chromium, total chromium, and manganese.

3.3.2 Groundwater

COPCs for groundwater were selected based on a comparison with U.S. EPA Region 9 PRGs for tap water. Use of tap water PRGs is a conservative method because groundwater underlying and downgradient of the site, although classified as potable by NYSDEC, is within ¼-mile has not been and is unlikely to be used for human consumption (refer to Section 4.1.2). COPCs identified in shallow and deeper overburden groundwater are summarized in Tables 3.3 and 3.4, respectively.

Chemicals identified as COPCs in shallow groundwater are aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, selenium, thallium, zinc, benzene, trichloroethene, benzo(b)fluoranthene, and bis(2-ethylhexyl)phthalate. Chemicals identified as COPCs in deep groundwater are aluminum, barium, manganese, and hexavalent chromium. COPCs in deep groundwater represent a subset of the COPCs in shallow groundwater with the exception of the hexavalent chromium.

If analytical results for MW-2S are not considered in the COPC selection, the metals remaining as COPCs in shallow groundwater are iron and manganese (Appendix F, Table F-1). Although iron is considered an essential nutrient, it was considered a COPC at the request of U.S. EPA.

3.3.3 Surface Water

Table 3.5 presents the COPC selection process for surface water from the wetland areas. Although surface water is not used as a drinking water source, tap water U.S. EPA Region 9 PRGs were conservatively used to select COPCs. Tap water PRGs were used in absence of any published surface water screening levels and represents a conservative method since surface water is unlikely to be used for human consumption. Hexavalent chromium was the only chemical identified as a COPC in surface water.

3.3.4 Sediment

There are no human health risk-based screening criteria for sediment. In the absence of such criteria, the residential PRGs for 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 ponded water is significantly lower than that for soil. Residential PRGs were used even though the Site is unlikely to be redeveloped into residential use. Table 3.6 presents the COPCs for sediments from the wetland areas. Based on the selection criteria, only arsenic was identified as a COPC from the wetland sediment.

4.0 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 and air) at a site. This section of the report discusses the mechanisms by which people (receptors) might come in contact with COPCs at the Site. The exposure assessment follows the recommendations for conducting an exposure assessment provided in the U.S. EPA's "Risk Assessment Guidance for Superfund" (U.S. EPA, 1989), "Standard Default Exposure Factors" (U.S. EPA, 1991), the more recent guidance in U.S. EPA's "Guidelines for Exposure Assessment" (U.S. EPA, 1992b), and U.S. EPA's Soil Screening Levels guidance (U.S. EPA, 1996a, 1996b, 2002a). In accordance with U.S. EPA (1989), an exposure assessment consists of three basic steps:

- Characterization of the exposure setting (physical environment and potential receptors).

- Identification of exposure pathways (potential sources, points of release, and exposure routes).
- Quantification of pathway-specific exposures (exposure point concentrations and intake (dose) assumptions).

The purpose of the first step is to characterize the salient features of the site that might influence current or future human exposure to COPCs and to identify potential receptors. Potential pathways of human exposure are identified in the second step by characterizing the sources of COPCs released to the environment, points of release, and potential exposure routes. In the third step, the qualitative information from the first two steps is integrated with estimates of exposure concentrations and intake assumptions to quantitatively estimate exposure (dose).

Exposure assessment is conducted within the context of a site conceptual model (SCM). As described in U.S. EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (U.S. EPA, 1988), the purpose of the SCM is to describe what is known about chemical sources, migration pathways, exposure routes, and possible exposure scenarios. Figure 3-1 and Table 4.1 present the SCM developed for the Site.

4.1 CHARACTERIZATION OF 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 reasonably anticipated future site uses of the property, which 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.

4.1.1 Physical Setting

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 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 climate in this part of the State is cold continental. Average temperatures range from 21°F in January to 66°F in July

(NOAA, 1998). Winter snowfall averages 165.5 inches per year (NOAA, 1998). The ground is generally frozen from December to March.

4.1.2 Land and Water Use

The only human activity that may occur at the Site under current land use is trespassing for purposes of hunting, hiking, and/or dirt biking. A cable gate and lock, maintained by Benchmark and Seneca Resources, is present across the entrance of the access drive. The Site has limited frontage along the northwestern side and is bound on the remaining sides by privately owned, vacant and undeveloped properties, further 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 residential structure to the fill area of the Site is located over ¼-mile southeast and hydraulically upgradient from the Site perimeter. 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 in both 1999 and 2000.

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, the presence of wetlands on the site, and the availability of developable land nearby, future residential development of the Site 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 current owner, PCCII, is no longer in existence], notification of Town officials, and/or foreclosure on the property by the Town or County. Thus, residential use of the Site is not a "reasonably-anticipated future land use." Based on these site-specific factors, a hypothetical future residential exposure scenario is not evaluated in this HHRA.

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

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, 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 approximately ¼-mile away, was sampled in December 2000 by the U.S. EPA and potential site-related chemicals were not found (NYDOH, 2001).

All fresh groundwater (non-saline) in New York State, including groundwater at the Markhams Site, is classified Class GA and considered a potential source of drinking water. However, its potential use for potable purposes is generally unrelated to groundwater designation. New York has not established a State-wide well head protection program and has not categorized groundwater uses. Therefore, potential potable use is determined by probable well yield and the availability of municipally supplied water supply.

Notifications and permits would be required in order for a private water supply well to be installed in the future. Therefore, it is not expected that people would be exposed to constituents in groundwater via direct consumption. However, for the purposes of this HHRA, it is conservatively assumed that groundwater underlying the Site will be used as a future potable source. Because groundwater is a mobile medium with no physical barriers, potential exposures to chemicals in groundwater were assumed to occur from the entire Site. It was also assumed that potential exposures could occur to chemicals measured in both shallow and deep overburden groundwater.

4.1.3 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. Risk assessment guidance requires the evaluation of potential risks to human health under both current and foreseeable future land uses.

Given the land-use projections discussed above, the site is likely to remain "recreational." However, because of zoning, an industrial land use is also considered. Potential off-site receptors under both current and future land use include people residing or working downwind of the facility. The nearest residential structure to the fill area of the site is located over ¼ mile southeast and hydraulically upgradient from the perimeter of the Site. Because of the distance from the site to nearest off-site receptor, exposure is anticipated to be minimal and a quantitative evaluation has not been performed. Under current land uses, potential on-site receptors are limited to unauthorized trespassers. Although site redevelopment is extremely unlikely, a construction scenario for Site development was identified as an interim future land use. Following the hypothetical completion of Site redevelopment activities, potential future on-site receptors consist of industrial workers. These receptors are further described in the sections below.

4.1.3.1 Current Receptors

There is no current use of the Site. Under current conditions, the only activities that take place are limited to those associated with unauthorized trespassers who access the Site for hunting, hiking, and/or dirt biking. These receptors are assumed to include adults and adolescent teens from 10 to 18 years old.

4.1.3.2 Future Receptors

The most probable future use of the Site will likely be similar to current conditions at the Site, with future trespassers representing the future on-site receptors. The hypothetical future use of the Site is an industrial business park. Under this scenario, the principal human receptors are an industrial worker and a construction worker. Two types of industrial workers were considered: one who spends most or all of his/her day engaged in outdoor activities (i.e., outdoor industrial worker), and one who spends most of his/her day indoors (i.e., indoor industrial worker). In addition to the industrial worker, an interim worker involved in construction or maintenance activities requiring occasional excavation into the subsurface could also be exposed to on-site media.

In the future, following industrial development, there may also be occasional visitors to the facility or facilities, 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, occasional visitors were not quantitatively evaluated.

4.1.3.3 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 Site. 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 were not evaluated quantitatively.

4.2 IDENTIFICATION OF EXPOSURE PATHWAYS

This section describes the potential pathways by which the receptors described above could be exposed to COPCs located at or released from the Site. An exposure pathway is a description of the mechanism by which an individual may come into contact with COPCs in the environment. In accordance with U.S. EPA RAGS (U.S. EPA, 1989), all potential exposure pathways applicable to the Site have been identified and addressed. An exposure pathway is defined by four elements (U.S. EPA, 1989):

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" if all elements are present. Only complete exposure pathways are evaluated. The characterization of the potential exposure pathways at the Site based on existing information is presented in the preliminary SCM in Figure 3-1.

Potential on-site receptors may be exposed to COPCs in soil, groundwater, surface water, sediment, seep water and landfill gas. Further discussion of potential exposure pathways is presented in the following subsections. The exposure pathways evaluated in this HHRA conservatively assume no remediation and no institutional controls that would limit environmental exposures.

4.2.1 Sources, Mechanisms of Releases, and Mechanisms of Transport

COPCs at the Site may be derived from historical activities or, as in the case of metals such as arsenic and ubiquitous compounds such as PAHs, may be naturally occurring and/or the result of regional anthropogenic activity. There are a number of mechanisms by which the COPCs identified above can migrate to other areas or to other media. U.S. EPA (1989) has identified several of these mechanisms. Based on current information, the relevance of these mechanisms to the 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 and wetlands that would prevent soil suspension due to wind erosion or physical disturbance of surface soil particles, some erosion of surface cover is possible. In addition, the use of recreational vehicles may resuspend surface soil into the air. Consequently, this pathway is potentially relevant to the HHRA under current land uses. Under a hypothetical industrial future land use, the majority of the Site would be covered by grass, industrial structures, asphalt, and/or ornamental landscaping. However, the extent of surface cover cannot be predicted based on existing information, therefore, ornamental landscaping, hardscape, or future buildings are not considered in this HHRA for the evaluation of potential exposure to fugitive dust. Further, fugitive dusts may also be generated during excavation activities. Therefore, this migration pathway is potentially relevant under the hypothetical future land use.

Volatilization. Volatile chemicals present in soil and groundwater at certain locations may be released to ambient or indoor air through volatilization either from or through the soil or fill underlying future building structures. Volatile chemicals typically have a low organic-carbon partition coefficient (Koc), low molecular weight, and a high Henry's Law constant. Volatile COPCs are not present in soil, but two COPCS in groundwater are volatile. Therefore, the groundwater-to-air pathway may be relevant.

Surface Water Runoff. Chemicals present in soil could be released to wetland areas as a result of surface water runoff. Thick grasses and abundant vegetation across the majority of the site minimize off-site transport via storm water runoff. However, this potential migration pathway may be relevant.

Leaching (percolation). Chemicals present in soil may migrate downward to groundwater as a result of infiltration of precipitation. Some chemicals detected in soil are also present in groundwater underlying the Site. This potential migration pathway is potentially relevant.

4.2.2 Exposure Points and Routes

Based upon the migration pathways discussed above, points of potential human contact with site-related chemicals are soil, groundwater, indoor and ambient air, and surface water and wetland sediments.

Potential exposure routes associated with chemicals in soil are incidental ingestion, dermal contact, and inhalation of re-suspended particulates in air. For this HHRA, exposure routes associated with affected groundwater consist of dermal contact and ingestion of potable tap water, inhalation of volatile chemicals released to air through volatilization, and incidental dermal contact when groundwater is encountered in an excavation trench. Exposure routes applicable to chemicals in surface water are incidental ingestion and dermal contact. Potential exposure routes associated with chemicals in sediment are incidental ingestion and dermal contact.

4.2.3 Exposure Pathways

Given the characteristics of the COPCs and release processes, the potential exposure pathways under current and future land uses at the Site are presented below. A summary of the potentially complete exposure pathways is presented in Table 4.1 and Figure 3-1.

Current Trespassers

Under current uses, trespassers may be exposed to surface soil via incidental ingestion and dermal contact. These trespassers may also inhale fugitive dusts containing COPCs and/or volatile COPCs released to ambient air from groundwater (i.e., site wide). Trespassers may also be exposed to COPCs via dermal contact with surface water and incidental ingestion and dermal contact with sediments from the wetland areas.

Future Workers

Under future uses, industrial workers involved primarily in outdoor activities at the Site could be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of fugitive dusts. These workers may also be exposed to volatile COPCs that are released to ambient air as a result of volatilization from groundwater (i.e., site wide). In addition, in the unlikely event that groundwater underlying the Site is a future source of potable water, potential exposures associated with ingestion and dermal contact of groundwater were conservatively considered as potentially complete. However, future consumption of groundwater is extremely unlikely because well yield requirements for industrial purposes would not likely be met by the overburden groundwater system.

Future industrial workers at the Site 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 underlying groundwater.

Future Construction Workers

Construction workers may be exposed to COPCs in sediments and both surface and subsurface soils via incidental ingestion and dermal contact. Construction workers may be exposed to COPCs in soil via inhalation of fugitive dusts. Construction workers may also be exposed to COPCs in surface water via dermal contact. These receptors may also inhale volatile COPCs released to air from groundwater (i.e., site wide). It should be noted that dermal contact with groundwater by construction workers is extremely unlikely. Excavation of saturated soil may be necessary during any future construction or redevelopment activities; however, it is expected that under these conditions, heavy equipment will most likely be used to remove saturated soil in place of any construction worker. In addition, the frequency of dermal contact with groundwater is considered minor in comparison to other complete exposure pathways (i.e., soil ingestion or dermal contact). However, for the purposes of this risk assessment, and consistent with EPA guidance that calls for the development of risk assessments in the absence of institutional controls or remedial actions, it is assumed that construction workers will be exposed to COPCs in shallow groundwater via dermal contact during construction activities.

4.3 EXPOSURE QUANTIFICATION

The following paragraphs describe how exposure was quantified for the above exposure scenarios. U.S. EPA guidance and policy requires an evaluation of a central estimate of risk, and an estimate of risk under a reasonable maximum exposure (RME). The estimation of potential health risks based on central tendency (CT), or average exposures at a site (U.S. EPA, 1995), represents a more typical exposure that is believed to be the most likely to occur. The RME scenario represents the maximum exposure that is reasonably expected to occur under baseline conditions at the Site. An estimate of the RME can be obtained by determining estimates of likely "high-end" exposure factors and then combining these high-end factors with average factors. It is assumed that by evaluating an RME scenario, the potential health risks to sensitive individuals within a particular receptor population will be adequately addressed. In this HHRA, point estimates of exposure were developed for both CT and RME exposures for all exposure pathways that are considered complete.

4.3.1 Exposure Point Concentrations

The concentrations of chemicals at specific exposure points will vary over space and time. However, a single estimate of an exposure point concentration is required for risk assessment calculations as currently required by U.S. EPA guidance (1989, 1992a). This single value must be representative of the average concentration to which a person would be exposed over the duration of the exposure.

Exposure point concentrations are chemical concentrations that are considered representative of the average to which an individual might be exposed over an extended period of time. For purposes of evaluating an RME scenario, U.S. EPA recommends the 95 percent upper confidence limit (95% UCL) of the arithmetic mean be used to estimate the exposure point concentration to account for the uncertainty in estimating the true average concentration at a site (U.S. EPA, 1992b). U.S. EPA Pro UCL version 3.0, a program designed to calculate upper confidence limits, was used to determine the appropriate exposure point concentration for the RME scenario. As an initial step, the analytical data were evaluated to establish the type of distributional assumption that best fits the data. To make this determination, the ProUCL version 3.0 software program provided by U.S. EPA (2004c) was used to evaluate the data. This program allows one to test the normality or lognormality of the data using the Shapiro-Wilkes W test; the default is to test for normality.

ProUCL calculates the relevant test statistic and the associated critical value and then makes a recommendation on the UCL95 value based on the type of distribution. If the data distribution is determined to be normal, the UCL95 is based on the Student's t-statistic. For lognormal distributions, ProUCL may recommend a UCL95 using the Land's H-statistic method, or a UCL95 or UCL99 based on Chebyshev Minimum Variance Unbiased Estimates of the mean and standard error of the mean [MVUE method]. For data distributions that are neither normal nor lognormal, the UCL95 concentration is calculated using non-parametric methods. The statistical summary of the data for each COPC is presented in Tables 4.2-4.9 with the ProUCL output files presented in Appendix B.

If the UCL of the arithmetic mean is greater than the maximum detected concentration, then U.S. EPA recommends using the maximum detected concentration (U.S. EPA, 1992b). For the

CT scenario, the arithmetic mean was used to represent the exposure point concentration. For duplicate sample results, the higher concentration was used in the statistical evaluation. If a COPC was not detected in a particular sample, it was assumed to be present at one-half the sample quantitation limit (SQL), which is consistent with U.S. EPA (1992b) guidance for calculating exposure point concentrations. This approach assumes that, on average, all values between zero and the SQL could be present. Output from the Pro UCL program which includes the recommended UCL is presented in Appendix B.

4.3.1.1 Soil

Exposure point concentrations for soil were derived separately for two soil depths: surface soil and subsurface soil. Surface soil represents the soil to which the trespassers and workers may be exposed and was defined by soil samples collected between 0 and 2 foot bgs. Subsurface soil represents soil to which a construction worker may be directly exposed and was defined by soil samples collected between 0 and approximately 10 foot bgs. The recommended UCL on the mean was used unless the sample size was too small to calculate one; in this case, the maximum detected concentration was used. Summaries of the exposure point concentrations for soil are presented in Tables 4.2 and 4.3. Analytical data used to calculate the exposure point concentrations and the ProUCL output are presented in Appendix A and B, respectively.

4.3.1.2 Groundwater

As discussed in Section 4.2.3, it is extremely unlikely that groundwater underlying the Site will be used for drinking water. For the purpose of this HHRA, exposure point concentrations in groundwater were derived assuming that potential exposures could occur to COPCs in both shallow and deep overburden groundwater. Separate UCLs were estimated from data collected from shallow and deep groundwater. For COPCs detected in both the shallow and deep zones, the higher of the two UCLs was selected to represent potential exposures from groundwater. Tables 4.4 and 4.5 present the exposure point concentrations in shallow and deep groundwater. Analytical data used to calculate the exposure point concentrations and the ProUCL output are presented in Appendix A and B, respectively.

Exposure point concentrations were also developed for COPCs in shallow groundwater without considering the analytical results for MW-2S (Table F-2). Similar to the process described above, the higher of the two exposure point concentrations for shallow and deep groundwater were used in the analysis.

4.3.1.3 Surface Water

For COPCs in surface water the recommended UCL was used as the representative concentration and is presented in Table 4.6. Analytical data used to calculate the exposure point concentrations and the ProUCL output are presented in Appendix A and B, respectively.

4.3.1.4 Sediment

The recommended UCL was used as the representative concentration for the one COPC in wetland sediments (Table 4.7). Analytical data used to calculate the exposure point concentrations and the ProUCL output are presented in Appendix A and B, respectively.

4.3.1.5 Indoor Air

Exposure point concentrations in indoor air were estimated using the Johnson & Ettinger model (2003a). The Johnson & Ettinger model was parameterized by U.S. EPA to evaluate potential emissions from subsurface soil or groundwater to indoor air. A more detailed description of the model is provided in Appendix C. Table 4.8 presents the exposure point concentrations in indoor air calculated by the model.

4.3.1.6 Ambient Air

Ambient air concentrations were estimated independently for fugitive dust emissions and volatilization. Fugitive dust emissions from soil were estimated using the particulate emission factor model (U.S. EPA, 2002a). Volatilization from soil and groundwater was estimated using the volatilization factor model developed by U.S. EPA (1996b). A more detailed description of these models is presented in Appendix C. Table 4.9 presents the exposure point concentrations for COPCs in ambient air volatilized from groundwater.

4.3.2 Exposure Equations

The "Annual Average Daily Dose" (AADD) and "Lifetime Average Daily Dose" (LADD) are the general parameters 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 are those presented by the U.S. EPA in their 1989 RAGS guidance (U.S. EPA, 1989). The AADD and LADD equations for dermal exposures and chemical-specific absorption fractions for all of the COPCs are taken from the RAGS dermal guidance (U.S. EPA, 2004a). Permeability constants and the estimated dermally absorbed dose per event (DA_{event}) for each COPC are presented in Appendix D.

4.3.3 Exposure Parameters

Exposure parameters are quantitative estimates of the frequency, duration, and magnitude of exposure to various media. The exposure parameters were selected from U.S. EPA (1989; 1991; 1997a, 1999a and 2004a) guidance, as appropriate, or are based on conservative assumptions taking into account site characteristics. For parameters lacking U.S. EPA recommended values conservative estimates were employed. For instance, the exposure frequency for the adolescent trespasser of 39 days/year was selected based on a U.S. EPA recommendation (comments to PAR, 2002) and assuming 3 days/week for a 13 week summer duration. Tables 4.10 through 4.26 present the exposure parameters for each of the receptors based on RME and CT. References and the rationale for selecting the exposure value also are presented in Tables 4.10 through 4.26.

5.0 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is twofold (U.S. EPA, 1989):

1. **Hazard Identification** evaluates available information regarding the potential for a chemical to cause adverse health effects in exposed individuals (hazard identification); and

2. **Dose-Response Assessment** estimates the relationship between the extent of exposure and the increased likelihood (e.g., probability or chance) and/or severity of adverse effects.

Hazard identification entails determining if a chemical can cause an increase in a particular adverse effect (e.g., cancer) and the likelihood that the adverse effect will occur in humans. The result of hazard identification is a profile of the available toxicological information and its relevance to human exposure under conditions present in the environment.

Dose-response assessment entails quantifying the relationship between the dose of a chemical and the incidence of adverse effects in the exposed population. The results of the dose-response assessment are toxicity criteria that are used in the risk characterization to estimate the likelihood of adverse effects occurring in humans at different exposure levels. The toxicity criteria used to evaluate noncarcinogenic and carcinogenic health risks are commonly referred to as reference doses (RfDs) and slope factors (SFs), respectively. The basis for these criteria is described briefly in the following sections.

5.1 TOXICITY CRITERIA FOR NONCARCINOGENIC HEALTH RISKS

Observable adverse noncancer effects of chemicals 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) typically determined in chronic animal exposure studies. The NOAEL is defined as the highest dose at which no adverse effects were observed, whereas the LOAEL is defined as the lowest dose at which adverse effects were observed. NOAELs and LOAELs derived from either animal or human studies are used by the U.S. EPA and other regulatory agencies to establish RfDs to evaluate human intake of noncarcinogenic compounds. A RfD, which is expressed in terms of mg/kg-day, is a criterion intended to represent the dose of a chemical that is not expected to cause adverse health effects over a lifetime of daily exposure, even in sensitive individuals, with a substantial margin of safety.

There are four standard uncertainty factors that are used to set RfDs in an attempt to account for limitations in the quality or quantity of available toxicity data. Most RfDs include an up-to-10-fold factor to account for potential uncertainties in extrapolating animal data to human health effects, and another factor of 10 to account for possible differences in sensitivity within the human population. If the available database is incomplete and an LOAEL is used to establish an RfD, or if a chemical is persistent or bioaccumulative, then an additional tenfold safety factor is applied. Furthermore, an additional tenfold factor may be used to account for the uncertainty involved in extrapolating from less than chronic NOAELs to chronic NOAELs.

The duration of exposure is considered in the development of RfDs. Exposure duration is divided into three categories for purposes of risk assessment (U.S. EPA, 1989):

- **Acute** refers to exposures for short durations measured in seconds, minutes, or hours and to effects that appear promptly after exposure.
- **Subchronic** refers to exposures of intermediate duration from 2 weeks to 7 years.
- **Chronic** refers to prolonged or repeated exposures and effects that develop only after exposures from 7 years to a lifetime.

The exposure durations for complete exposure pathways in this risk assessment include subchronic and chronic exposures. Chronic RfDs have been conservatively used for both exposure durations. For example, chronic RfDs were used for both the industrial worker (duration = 25 years), and the construction worker (duration = 1 year). For the hypothetical current/future trespasser, chronic RfDs were used for the adolescent (duration = 9 years) and adult (duration = 30 years).

5.2 TOXICITY CRITERIA FOR CARCINOGENIC HEALTH RISKS

Regulatory guidance assumes that chemicals that are carcinogenic should be treated as if they do not have thresholds except where mode of action data is available suggesting an alternative hypothesis (U.S. EPA, 1989; U.S. EPA, 2005). This approach assumes that the dose-response curve for carcinogens only allows for zero risk at zero dose (i.e., for all doses, some risk is assumed to be present). To estimate theoretically plausible responses at these low doses, various mathematical models are used. 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 feasibly measured. The accuracy of these models is currently unknown, but they are believed not 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 an upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, which is expressed in units of proportion (of a population) affected per mg/kg-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100 (U.S. EPA, 2003b).

5.3 TOXICITY CRITERIA USED IN HEALTH RISK ASSESSMENT

The U.S. EPA has completed toxicity assessments for all of the COPCs identified in this HHRA. The associated toxicity criteria for the COPCs evaluated in this HHRA are presented in Tables 5.1, 5.2, 5.3 and 5.4. These criteria were selected according to the following hierarchy:

a) U.S. EPA Integrated Risk Information System (IRIS) on-line database, 2004d; and

b) U.S. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs), 2004e.

c) Updates from the Superfund Technical Support Center of EPA's National Center for Environmental Assessment.

This hierarchy is consistent with tiered guidance provided for use in Superfund Risk Assessments (U.S. EPA, 2003b). At the time this risk assessment was developed, when an RfD or SF was not available for the oral or inhalation route of exposure, the RfD or SF for the other route (oral if inhalation was absent, inhalation if oral was absent) was used in the calculations[1].* In addition, toxicity values are not available for evaluating dermal exposure. In this case, the oral RfDs or SFs (Tables 5.1 and 5.3, respectively) for certain chemicals recommended by U.S. EPA were adjusted based on the absorption factors presented by U.S. EPA (2004a).

5.4 TOXICITY ASSESSMENT FOR LEAD

U.S. EPA has not derived a cancer slope factor or an RfD to assess exposure to lead because there is no discernible safe threshold for lead. The U.S. EPA has provides a methodology for assessing the potential health risks associated with exposure to lead in soil to non-residential adults, that focuses on estimating blood-lead concentrations in adults and in fetuses carried by women exposed to lead-affected soil (U.S. EPA, 2003c). Lead is not a COPC in soil at this Site. However, lead is a COPC in groundwater. In order to evaluate potential exposure to lead in groundwater, the Adult Lead Model (U.S. EPA, 2003c) for lead was used to estimate blood lead levels for exposed receptors at this Site. This spreadsheet model was designed to assess risks associated with non-residential adult exposures to lead in soil. However, Geomatrix modified the spreadsheet in order to evaluate risks to lead in groundwater. Specifically, the concentration of lead in groundwater in units of micrograms per liter was used in place of the concentration in soil of micrograms per gram. The water ingestion rate in liters per day was used instead of a soil ingestion rate of grams per day. A soluble lead absorption fraction of 0.2 was used instead of the default absorption fraction specific to soil (0.12). U.S. EPA default input parameters, including the biokinetic slope factor and soluble lead absorption fraction were used.

[1] The Superfund Technical Support Center indicated that route-to-route extrapolation is scientifically supported according to the guidance supplied in U.S. EPA (1994) and U.S. EPA (2005). However, the Center recommends further analysis to demonstrate that this extrapolation is appropriate based on a review of chemical specific pharmacokinetic data. This type of analysis was not conducted within the timeframe of the risk assessment. Review of the risk assessment results found that those chemicals for which a route-to-route extrapolation was performed were not risk drivers and therefore revisions to the document and tables were not made since they did not impact the final conclusions from this assessment.

6.0 RISK CHARACTERIZATION

Risk characterization represents the final step in the risk assessment process. In this step, the results of the exposure and toxicity assessments are integrated into quantitative or qualitative estimates of potential health risks. Potential noncarcinogenic health effects and carcinogenic health risks are characterized separately.

6.1 NONCARCINOGENIC HEALTH EFFECTS

Potential adverse noncarcinogenic health effects will be evaluated using the hazard index (also called HI) approach as recommended by U.S. EPA (1989). The first step in this approach is to compare the AADD for each chemical to the appropriate RfD. This comparison is expressed in terms of a "hazard quotient," which is calculated as follows:

$$\text{Hazard Quotient}_i = \frac{\text{AADD}_i}{\text{RfD}_i}$$

A hazard quotient less than or equal to 1 indicates that the predicted exposure to that chemical should not result in an adverse noncarcinogenic health effect (U.S. EPA, 1989). In cases where individual chemicals potentially act on the same organs or result in the same health endpoint (e.g., respiratory irritants), potential additive effects were addressed by calculating a HI as follows:

$$\text{Hazard Index} = \sum_{i=1}^{n} \text{Hazard Quotient}_i$$

A HI of less than or equal to 1 indicates acceptable levels of exposure for chemicals having an additive effect. In this HHRA, the HI was calculated by summing the hazard quotients for all chemicals, regardless of toxic endpoint, as recommended by agency guidance (U.S. EPA, 1989). This approach is generally believed to overestimate the potential for noncarcinogenic health effects due to simultaneous exposure to multiple chemicals because it does not account for different toxic endpoints (U.S. EPA, 1989; NRC, 1988; Risk Commission, 1997; Seed, et al., 1995).

It should be noted that hazard quotients or HIs greater than 1 do not necessarily mean that adverse health effects will be observed. As discussed in Section 5.1 and as shown in Tables 5.3 and 5.4, Uncertainty Factors are incorporated into the RfDs developed for the COPCs. Therefore, for these chemicals, adverse health effects may not be observed even if the hazard quotient or HI is much larger than 1. If the screening HI is greater than 1, a target organ-specific HI was calculated in order to more accurately assess the potential for noncarcinogenic effects to specific target organs.

The following sections summarize the results of the noncarcinogenic hazard characterization for the five receptors evaluated. A summary of the HIs is presented in Tables 6.1 through 6.5; the calculations supporting these values are presented in Appendix E. The information presented in Appendix E is substantially equivalent to Tables 7 and 8 as presented in RAGS, Part D (U.S. EPA, 2001). As such, Tables 7 and 8 are presented in Appendix E-1.

For receptors with HIs exceeding the acceptable level of 1 due to metals in groundwater, an HI was calculated from exposure point concentrations that do not consider the elevated metals concentrations from the monitoring well with high turbidity, MW-2S. A summary of these HIs are presented in Appendix F.

Current Adult Trespasser

The potential noncancer hazard quotients and HIs associated with exposure to the COPCs in soil, groundwater, sediments, and surface water by current adult trespassers are summarized in Table 6.1. The total RME HI is 0.01.

Current Adolescent Trespasser

The potential noncancer hazard quotients and HIs associated with exposure to the COPCs in soil, groundwater, sediments, and surface water by current adolescent trespassers are summarized in Table 6.2. The total RME HI is 0.03.

Future Outdoor Industrial Worker

The potential noncancer hazard quotients and HIs associated with exposure to the COPCs in soil and groundwater by future outdoor industrial workers at the Site are summarized in Table 6.3. The total RME HI is 230. Groundwater contributes to essentially all of this HI, 50 percent of which is due to ingestion thallium and 40 percent is due to ingestion of iron based on questionable results from monitoring well MW-2S. If groundwater is not evaluated as a drinking water source, the total RME HI is 0.17 which is the HI associated with exposure to soil.

The Central Tendency (or Average) non-cancer HI for this receptor was a total HI = 89.5 with the primary contributors to the HI thallium (HI = 81.9) and Cadmium (HI = 3.5). The calculations are provided in Table 6.3.A.

If results from MW-2S are not considered representative of site groundwater, the noncancer hazard index for the outdoor industrial worker is 8.0 (Table F-3). Table F.3.A provides the results of the Central Tendency or Average risks where the HI is 1.9 based on HQs of 1 and 0.9 for hexavalent chromium and manganese, respectively.

Future Indoor Industrial Worker

The potential noncancer hazard quotients and HIs associated with exposure to the COPCs in groundwater by future indoor industrial workers are summarized in Table 6.4; the calculation spreadsheets are presented in Appendix E. The total RME HI is 1.1×10^{-4}.

Future Construction Worker

The potential noncancer hazard quotients and HIs associated with exposure to the COPCs in soil, sediment, surface water and groundwater by future construction workers are summarized in Tables 6.5. The total RME HI is 5.2. Approximately 66 percent of the RME HI is from the dermal contact with thallium and cadmium in groundwater. The HI associated with exposure to soil, sediment and surface water is 0.4. Based on the duration of the exposure a Central Tendency calculation was not calculated.

If results from MW-2S are not considered representative of site groundwater conditions, the noncancer hazard index for future construction workers is 1.0 (Table F-4).

6.2 CARCINOGENIC EFFECTS

Carcinogenic health risks are defined in terms of the incremental increased probability of an individual developing cancer as the result of exposure to a given chemical at a given concentration. The term "incremental" implies the risk due to environmental chemical exposure above the background cancer risk experienced by all individuals in the course of daily life. The quantitative assessment of carcinogenic risks involves the evaluation of lifetime average daily dose and application of toxicity factors reflecting the carcinogenic potency of the chemical. U.S. EPA risk assessment guidelines for carcinogens were first published in 1986 and updated in an interim 1999 document (U.S. EPA, 1999b). As required by U.S. EPA (1989), lifetime excess cancer risks are estimated as follows:

$$\text{Lifetime Excess Cancer Risk}_i = \text{LADD}_i \times \text{SF}_i$$

As with HIs, the estimated excess cancer risks for each chemical and exposure route are summed regardless of toxic endpoint to estimate the total excess cancer risk for the exposed individual.

According to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; U.S. EPA, 1990b), acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between $1x10^{-4}$ and $1x10^{-6}$ using information on the relationship between dose and response. The $1x10^{-6}$ risk level shall be used as the point of departure for determining remediation goals for alternatives when Applicable or Relevant and Appropriate Requirements (ARARs) are not available or are not sufficiently protective because of the presence of multiple chemicals at a site or multiple pathways of exposure (U.S. EPA, 2001)

It should be noted that cancer risks in the $1x10^{-6}$ to $1x10^{-4}$ range or higher do not necessarily mean that adverse health effects will be observed. Current methodology for estimating the carcinogenic potential of chemicals is believed to not underestimate the true risk. In instances where the RME analysis results in risks above $1x10^{-4}$, a CT scenario is provided to more fully describe the range of potential health risks associated with any exposure that result in a risk greater than 10^{-4} and an HI = 1. The following sections summarize the results of the carcinogenic risk characterizations for the receptors evaluated. The summary total estimated lifetime excess cancer risks are presented in Tables 6.1 through 6.5; the calculations supporting these values are presented in Appendix E.

Current Adult Trespasser

The estimated theoretical lifetime excess cancer risks associated with exposure to the COPCs in sediment, soil, groundwater and surface water by current adult trespassers are summarized in Table 6.1. Under the RME scenario, the total theoretical lifetime excess cancer risk is $2x10^{-6}$, which is within the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

Current Adolescent Trespasser

The estimated theoretical lifetime excess cancer risks associated with exposure to the COPCs in sediment, soil, groundwater and surface water by current adolescent trespassers are summarized in Table 6.2. Under the RME scenario, the total theoretical lifetime excess cancer risk is $2x10^{-6}$, which is within the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

Future Outdoor Industrial Worker

The estimated theoretical lifetime excess cancer risks associated with exposure to the COPCs in soil and groundwater by future outdoor industrial workers at the FMPA are summarized in Table 6.3. Under the RME scenario, the total theoretical lifetime excess cancer risk is $3x10^{-4}$, which is above the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$. Almost seventy percent of the total RME risk is attributed to ingestion of arsenic in groundwater. Table 6.3.A provides the Central Tendency (or Average) risks associated with this exposure. The theoretical lifetime excess cancer risk from exposure to arsenic under a Central Tendency analysis is $5.9x\ 10^{-5}$, which is within the risk range. If groundwater is not evaluated as a drinking water source, the theoretical lifetime excess cancer risk associated with exposure to soil is $1x10^{-5}$, which is within the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

If results from MW-2S are not considered representative of site groundwater conditions, the total excess cancer risk for the outdoor industrial worker is $7x10^{-5}$ (Table F-3).

Future Indoor Industrial Worker

The estimated theoretical lifetime excess cancer risks associated with exposure to the COPCs in groundwater by future indoor industrial workers are summarized in Table 6.4. Under the RME scenario, the total theoretical lifetime excess cancer risk is $1x10^{-7}$, which is below the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

Future Construction Worker

The estimated theoretical lifetime excess cancer risks associated with exposure to the COPCs in soil and groundwater by future construction workers are summarized in Table 6.5. Under the RME scenario, the total theoretical lifetime excess cancer risk is $3x10^{-6}$, which is within the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

6.3 EVALUATION OF LEAD

As discussed in Section 5.4, U.S. EPA's Adult Lead Model (2003c) for non-residential adults was used to evaluate potential health risks. The Centers for Disease Control and Prevention (CDC) have established a blood-lead level of concern at 10 micrograms per deciliter (µg/dl) of whole blood to protect young children from adverse neurological effects. Similar to the policy applied to children, a cutoff blood-lead concentration of 10 µg/dl was selected as the level of concern for protection of the fetus (U.S. EPA, 1996c). In addition to estimating the predicted blood lead levels for the worker and fetus, the model also estimates the probability of fetal blood lead levels exceeding 10 µg/dl. Exposure to lead in different environmental media should be limited to levels that will result in less than 5 percent of the fetuses in working women of child-bearing age or less than a 5 percent probability of a fetus having blood-lead concentrations which exceed the cutoff concentration of 10 µg/dL.

The output and results from the U.S. EPA lead model are presented in Table 6.6. If the maximum detected concentration of lead from MW-2S is considered a representative concentration, the blood lead concentrations for both the fetus and future industrial worker exceed the 10 µg/dL level of concern. As indicated in Section 3.2.2, groundwater results from MW-2S are not considered representative of Site conditions. If results from MW-2S are not considered, the estimated lead-blood concentrations for future industrial workers and fetuses are below the level of concern (10 µg/dl) at 2.2 and 7.9 µg/dL, respectively. The probability that fetal blood lead levels will exceed the EPA blood lead level of concern is 2.7 percent. These results indicate that exposure to lead should not pose an unacceptable risk if results from MW-2S are not considered.

6.4 UNCERTAINTY ANALYSIS

Uncertainty is inherent in many aspects of the risk assessment process, and generally arises from a lack of knowledge of (1) site conditions, (2) toxicity and dose-response of the COPCs, and (3) the extent to which an individual will be exposed to those chemicals. This lack of knowledge means that assumptions must be made based on information presented in the scientific literature or professional judgment. While some assumptions have significant scientific basis, others have much less. The assumptions that introduce the greatest amount of uncertainty and their effect on the noncarcinogenic and carcinogenic risk estimates are discussed below. An understanding of the uncertainties associated with this risk assessment provides the risk manager with additional information considered during risk management. This discussion is generally qualitative in nature, reflecting the difficulty in quantifying the uncertainty in specific assumptions. These uncertainties may result in overestimation or underestimation of the potential health risks and hazards. However, the assumptions generally utilized in this assessment were selected in a manner that purposefully biases the process toward health conservatism.

6.4.1 Data Evaluation and Selection of Chemicals of Potential Concern

The selection of Site-related COPCs was based upon the results of the sampling and analytical program established for the Site. The factors that contribute to the uncertainties associated with the identification of COPCs are inherent in the data collection and data evaluation processes, including appropriate sample locations, adequate sample quantities, laboratory analyses, data validation, and treatment of validated samples.

The predominant sources of uncertainty and potential bias associated with site characterization are based on the procedures used for site investigation (including sampling plan design and the methods used for sample collection, handling, and analysis) and from the procedures used for data evaluation. A relatively comprehensive sampling program was implemented to account for the chemicals most likely to be present at the Site as a result of past Site history and activities.

The primary criterion used to identify a COPC in soil or groundwater was based on a comparison of the maximum detected concentration to a published regulatory screening level. Therefore, the selection of COPCs is a screening level assessment and can be considered quite conservative. First, comparison of the maximum detected concentration is likely to exaggerate actual human exposure and risk from the chemical in soil or groundwater, which is better represented by incorporating all Site data representing areas of both high and low concentrations of the COPC. Furthermore, groundwater at the Site is not considered a reasonably anticipated source of drinking water; however, tap water PRGs are based on the use of the water as a drinking water source. Therefore, use of this screening criterion is conservative and likely has unnecessarily identified some chemicals detected in soil or groundwater as COPCs. In some instances, the maximum concentrations were qualified as estimated values (i.e., "J" flagged) and therefore, were below the reporting limit (RL). Therefore, a detected chemical was also selected as a COPC if its maximum RL exceeded the criterion.

Background concentrations of metals were not used to distinguish site-related constituents from naturally occurring constituents in the identification of site-related COPCs (U.S. EPA, 2002b). Consequently, some chemicals selected as COPCs may actually be naturally-occurring. For example, arsenic is a naturally-occurring element; inorganic arsenic is present in many kinds of rock, especially ores that contain copper, lead, iron, nickel, and other metals. Arsenic in naturally occurring rock can leach out into groundwater, however, for the purpose of this HHRA arsenic is treated as a COPC, unrelated to naturally occurring site-background levels.

6.4.2 Exposure Assessment

Exposure Point Concentrations

For COPCs that were not detected in all samples, one-half the SQL was used as the surrogate concentration in non-detect samples for purposes of calculating the arithmetic average and 95% UCL concentrations. U.S. EPA guidance (1992b) indicates that substitution of one-half the SQL is adequate when the proportion of non-detects is less than 10 to 15 percent. If the fraction of non-detects becomes large, then assuming that the value of each non-detect is equal to one-half the SQL will generally overestimate the expected true mean concentrations, with the degree of overestimation increasing with increasing proportions of non-detects. In some cases, chemicals were detected in only 1 or 2 samples, meaning that the majority of the data used to calculate representative concentrations was conservative, relying on a single data point. For these COPCs, the representative concentrations likely are overestimated.

For example, several of the metal COPCs in shallow groundwater were only detected in one sample and the detections occurred primarily in one well (MW-2S). Specifically, six COPCs, antimony, arsenic, barium, cadmium, cobalt and copper, were detected in only one sample and the detections were reported from MW-2S. Cadmium and arsenic, detected in only one sample, are the risk-driving chemicals associated with groundwater pathways. Even risk-driving COPCs with a higher detection frequency, iron (8 out of 8 samples) and thallium (2 out of 8 samples), had maximum detected concentrations in MW-2S that were at least an order of magnitude higher than the next highest detected concentration in other samples. Because maximum detected concentrations were used for COPC selection, this conservative process may have inappropriately included these chemicals in the quantitative risk assessment if they are not actually representative of the groundwater conditions. Furthermore, consideration of these high maximum detected concentrations and infrequent detections may have overestimated the UCL, resulting in an overestimation of the risk associated with these chemicals.

As described in Section 3.2.2, monitoring well MW-2S is a very low yielding well with elevated turbidity that produced metals concentrations that are not representative of groundwater chemistry. In addition, the metals analytical results for MW-2S vary significantly between the November 2001 and April 2002 sampling events which suggests the well is not yielding representative samples. Furthermore, the metals concentrations are far higher than historical results in 1987 and 1988. Comparison of results with those from MW-2D provides further evidence that MW-2S no longer yields representative samples that could be related to the construction of the well. Therefore, the groundwater analytical results collected from MW-2S during the first and second sampling events are considered not representative of dissolved groundwater. For purposes of comparison, shallow groundwater exposure point concentrations were re-evaluated without the results from MW-2S and the associated risk from exposure to groundwater for the construction and outdoor industrial workers was calculated and presented in Appendix F.

In some cases, the maximum detected concentration was used as conservative estimates of average site concentrations. This methodology compounded with the bias sampling approach conducted at the Site likely results in an overestimation of exposures and subsequent health risks.

For chemicals detected in shallow and deep groundwater, the greater of the shallow or deeper groundwater concentration was used to represent the exposure point concentration in groundwater. This is a conservative assumption likely to overestimate risk. For example, Hexavalent chromium was not a COPC in shallow groundwater, but it was selected for deep groundwater. Although shallow groundwater most appropriately represents what type of groundwater that receptors would be exposed to, the representative concentration from deep water is used to estimate exposure.

Environmental Fate and Transport

Fate and transport models were used to estimate indoor and ambient air concentrations of COPCs volatilized from soil and groundwater. The Johnson and Ettinger (J&E) model was used to estimate chemical attenuation factors and indoor air concentrations from groundwater (U.S. EPA, 2003a). The 2002 Soil Vapor Intrusion Guidance document (U.S. EPA, 2002a) was considered for the vapor intrusion pathway. While some site-specific conditions were incorporated into the model, the model results typically are conservative, which likely overestimates risk.

When evaluating the inhalation of vapors volatilized from subsurface groundwater underlying the Site, the models assume no soil absorption, an infinite supply of affected soil and groundwater, and that more than 100 percent of the chemical vapors will be available in the breathing space of future receptors. The models do not take into consideration the potential elimination of chemicals in the vadose zone via biodegradation or other natural attenuation processes during transport. These assumptions are conservative and likely result in an overestimation of exposures and subsequent health risks.

The Johnson and Ettinger model used to estimate indoor air concentrations may underestimate or overestimate the potential indoor air risks. It has been documented that the potential migration of soil vapor into indoor air is highly variable and depends on a number of site-specific factors, including soil type within the vadose zone (e.g., air permeability), porosity, and moisture content. To account for this uncertainty, the modeling effort employed here incorporated a number of conservative assumptions, including building type, air exchange rates, areas of infiltration, and default soil properties. The use of these parameters likely leads to the overestimation of chemical exposures. It should be noted that the model was used to predict indoor air concentrations in a future building without accounting for preferential pathways, such as utility conduits and pipelines.

Exposure Assumptions and Parameters

This HHRA primarily used an RME approach for all receptors. The RME is defined by U.S. EPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site (U.S. EPA, 1989). To achieve this goal, the RME is based on exposure assumptions within the high end of the exposure distribution. For example, the evaluation assumes that an industrial worker will be present on-site for 250 days/year for 25 years. Assumptions made for these exposure parameters and other upper-bound estimates may not be representative of average exposure situations.

6.4.3 Toxicity Assessment

Uncertainty in Toxicity Criteria

One of the largest sources of uncertainty in any risk assessment is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. The majority of available toxicity data are from animal studies, which are then extrapolated using mathematical models or multiple uncertainty factors to generate toxicity criteria used to predict what might occur in humans. Sources of conservatism in the toxicity criteria used in this evaluation include:

- The use of conservative methods and assumptions to extrapolate from high dose animal studies to predict the possible response in humans at exposure levels far below those administered to animals;
- The use of dose-response data from experiments on homogeneous, sensitive animal populations to predict effects in heterogeneous human populations with a wide range of sensitivities;
- The assumption that chemicals considered to be carcinogens do not have thresholds except where data supports and alternative determination (i.e., for all doses greater than zero, some risk is assumed to be present); and

Use of single-chemical test data that do not account for multiple exposures or synergistic and antagonistic responses.

The toxicity criteria used in the HHRA are based on an evaluation of noncarcinogenic and carcinogenic health risks were developed using different methods. The noncarcinogenic criteria (i.e., oral and inhalation RfDs) incorporate multiple uncertainty factors to account for limitations in the quality or quantity of available data (e.g., animal data in lieu of human data).

The carcinogenic toxicity criteria (i.e., oral and inhalation SFs) also are developed using techniques that purposefully bias the criteria toward health protection. For example, most SFs are based on the premise that cancer data from high dose animal studies will predict cancer response in humans at dose levels thousands of times lower. The process also assumes that the carcinogenicity of a chemical in an animal model is representative of the response in humans. Finally, the statistical techniques used by regulatory agencies to extrapolate data from animals to human exposures generally assume that the dose-response curve is linear and that the 95% UCL of the slope is representative of the chemical's carcinogenic potency. In aggregate, these assumptions overestimate the actual risk estimates such that they are unlikely to be higher, but could be considerably lower and, in fact, could be non-existent.

One source of uncertainty with assessing the toxicity and risk of chemicals in the environment is that certain substances are sometimes found in mixtures. Assessing the toxicity and health risk of one or even several chemicals in a mixture and not accounting for the others can potentially lead to either overestimating or underestimating potential health effects.

Lack of Route-Specific Toxicity Criteria

Inhalation toxicity data for many chemicals was not available. As a result, the health risk estimates for these chemicals may be underestimated.

Dermal Exposure to SVOCs

The evaluation of potential cancer risks associated with dermal contact with PNAs and other SVOCs is a controversial issue. U.S. EPA (2004a) recommends a methodology to quantitatively evaluate the potential dose-response associated with dermal exposure to organic chemicals in water. The guidance provides calculated skin permeability (Kp) values based on a chemical's molecular weight and oil/water partition coefficient (log K_{ow}) and states that the predicted Kp for about 10% of the listed chemicals would be invalid. Specifically, SVOCs with high log K_{ow} values (greater than 4), like PNAs and bis(2-ethylhexyl phthalate), are likely not to have a reasonable predicted Kp value. These values are highly uncertain and likely overestimate the dermal contribution of exposure.

Weight of Evidence of Carcinogenicity

As shown in Tables 5.3 and 5.4, U.S. EPA assigns weight-of-evidence classifications to potential carcinogens. Constituents evaluated quantitatively in this assessment are classified as Group A, Group B1, or Group B2, defined as follows.

- Group A constituents (known human carcinogens) are agents for which there is sufficient evidence to support a causal association between exposure to the agents in humans and cancer.
- Group B1 constituents (probable human carcinogens) are agents for which there is limited evidence of carcinogenicity in humans.
- Group B2 constituents (probable human carcinogens) are agents for which there is sufficient evidence of carcinogenicity in animals but inadequate or no evidence in humans.

Quantitative cancer risk characterization is generally performed for all Group A, B1, and B2 and C carcinogens identified at a site. Site-related chemicals were identified as A, B1 and B2 and D (not classifiable as to carcinogenicity).

6.4.4 Uncertainty Associated with Risk Characterization

One source of uncertainty that is unique to risk characterization is the assumption that the total risk associated with exposure to multiple chemicals is equal to the sum of the individual risks for each chemical (i.e., the risks are additive). Other possible interactions include synergism, where the total risk is higher than the sum of the individual risks, and antagonism, where the total risk is lower than the sum of the individual risks. Relatively little data are available regarding potential chemical interactions following environmental exposure to chemical mixtures. Some studies have been carried out in rodents given simultaneous doses of multiple chemicals. The results of these studies indicated that no interactive effects were observed for mixtures of chemicals affecting different target organs (i.e., each chemical acted independently), whereas antagonism was observed for mixtures of chemicals affecting the same target organ, but by different mechanisms (Risk Commission, 1997).

While there are no data on chemical interactions in humans to chemical mixtures at the dose levels typically observed in environmental exposures, animal studies suggest that synergistic and antagonistic effects will not occur at levels of exposure below their individual effect levels (Seed, et al., 1995). As exposure levels approach the individual effect levels, a variety of interactions may occur, including additive, synergistic and antagonistic (Seed, et al., 1995).

Current U.S. EPA guidance for risk assessment of chemical mixtures (U.S. EPA, 2000) recommends assuming an additive effect following exposure to multiple chemicals. Subsequent recommendations by other parties, such as the National Academy of Sciences (NRC, 1988) and the Presidential/Congressional Commission on Risk Assessment and Risk Management (Risk Commission, 1997) have also advocated a default assumption of additivity. As currently practiced, risk assessments of chemical mixtures generally sum cancer risks regardless of tumor type and sum non-cancer HIs regardless of toxic endpoint or mode of action. For non-carcinogens, further evaluation was conducted where the HI was recalculated for those chemicals with similar health endpoints. Given the available experimental data, this approach likely overestimates potential risks associated with simultaneous exposure to multiple chemicals.

6.4.5 Conclusions of Uncertainty Analysis

In summary, the uncertainties in this HHRA are due, in part, to the variability in the site-specific environmental data, variability and limitations inherent in the exposure models, and the uncertainty and conservatism build into estimates of chemical toxicity and potency. An analysis of the uncertainties associated with the HHRA indicates that the noncancer adverse health effects and the theoretical excess cancer risk estimates may overestimate the actual impacts to human health. Although many factors can contribute to the potential for over- or underestimating risk, a mix of conservative, protective, and upper-bound input values were selected to estimate potential exposures. Given that the largest sources of uncertainty generally result in overestimates of exposure or risk, it is believed that the results presented in this document are based on reasonable maximum exposure estimates and that the actual impacts to human health may be less than those estimated in this assessment.

7.0 CONCLUSIONS

This baseline risk assessment was conducted to evaluate the potential human health risks as a result of potential exposure to chemicals in soil, groundwater, sediment and surface water at the Peter Cooper Markhams Superfund Site. The risk assessment is consistent with U.S. EPA guidance and policies and provides a conservative, yet reasonable, estimate of the nature and extent of the potential cancer and noncancer health hazards.

The results of the risk assessment indicate the following:

- For adult and adolescent trespassers, the HIs (0.01 and 0.03, respectively) and carcinogenic risk estimates (both $2x10^{-6}$) are below and within the acceptable risk levels.

- For the outdoor industrial worker, the HI (230) and carcinogenic risk estimate ($3x10^{-4}$) exceed the acceptable risk levels. The primary chemical contributing the most to the cancer risk is arsenic in groundwater. The primary chemicals contributing to the non cancer risk are iron and thallium in groundwater. The calculation of the Central Tendency or Average lifetime excess cancer risk and non-cancer health hazard are 5.9×10^{-5} (arsenic) and an HI = 89.5, respectively.

  The risk is primarily attributed to the unlikely pathway associated with ingestion of groundwater underlying the Site. In the event that ingestion of groundwater is not a complete pathway, the HI (0.17) and carcinogenic risk estimate of $1x10^{-5}$ are below or within the acceptable risk levels. Since results from MW-2S are considered not representative of dissolved groundwater, potential exposures and resulting risks were re-evaluated in Appendix F without considering data from MW-2S in the exposure point concentrations. Under this scenario, the predicted carcinogenic risk estimate and the HI for the outdoor industrial worker are $7x10^{-5}$ and 8.0, respectively. Although the HI still exceeds the acceptable risk level, it is approximately 30 times lower than the original RME estimate. The non-cancer HI under the Central Tendency is 1.9 based on HQs of 1 and 0.9 for hexavalent chromium and manganese, respectively.

- For the indoor industrial worker, the HI (0.00011) and carcinogenic risk estimate ($1x10^{-7}$) are below the acceptable risk levels.

- For the construction worker, the HI (5.2) exceeds the acceptable level while the carcinogenic risk estimate ($3x10^{-6}$) is within the acceptable risk range. Dermal contact of cadmium and thallium in groundwater is the primary exposure pathway contributing to the HI. Potential exposures likely are overestimated. Exposure for the construction worker was related to specific conditions during potential construction over a continuous one-year period. The risk assessment was conducted in the absence of institutional controls consistent with U.S. EPA risk assessment guidance. Appropriate health and safety precautions can be taken to protect workers during future construction, thereby mitigating any potential exposures and health risk. If exposure to groundwater is prevented based on dewatering activities, the HI from exposure to soil for the construction worker would be below the acceptable risk level at 0.4. Without consideration of results from MW-2S in the exposure calculations, the HI for the construction worker is 1 and within the risk range.

In summary, under the assumptions and conditions presented in this HHRA, the estimated HI and theoretical excess cancer risk are generally below or within the acceptable levels of concern. In those limited instances where the estimated HI and/or theoretical excess cancer risk are outside acceptable levels, the exceedance is attributable to the hypothetical assumption that future groundwater consumption is a complete pathway. Groundwater in the State of New York is classified as "GA", potential potable water supply, unless it has been designated as saline. Groundwater at the Site is not used as a potable water supply and is not likely to be used as such in the future. If the assumptions and/or conditions change, the results of this HHRA may need to be re-evaluated.

The results of the risk evaluation are based on the likely future use of the Site. Should site use, conditions, or toxicity criteria change, the information and conclusions in this report may no longer apply.

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TABLES

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TABLE 3.1
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value		COPC Flag	(6) 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	1400	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	2200	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 [7]	3.7		95.5		mg/kg	Lathe #120	50 / 50	0 – 0	95.5	NA	0.39	C	**Yes**	Grp. A
16065831	Chromium, Total [7]	13.7		65300		mg/kg	Lathe #121	62 / 62	0 – 0	65300	NA	12000	NC	**Yes**	ASL
18540299	Hexavalent Chromium[8]	2.5		63.3	J	mg/kg	Lathe #120	12 / 61	0.1 – 20:3	63.3	NA	30	NC	**Yes**	Grp. A

TABLE 3.1
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) The range of detection limits is repoted as 0 to 0 when the specific chemical was detected in all samples.
(3) Maximum value used as screening concentration.
(4) Background values not used per USEPA.
(4) Screening toxicity value – EPA Region 9 Preliminary Remediation Goals, Residential Land Use (USEPA, 2004).
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

(6) Rationale Codes

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

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 Concem
U = Not detected above the laboratory sample quantitation limit
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 3.2
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value		COPC Flag	(6) 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	1400	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	2200	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	3.7		95.5		mg/kg	Lathe #120	61 / 61	0 – 0	95.5	NA	0.39	C	Yes	Grp A
16065831	Chromium, Total	12.4		65300		mg/kg	Lathe #121	74 / 74	0 – 0	65300	NA	12000	NC	Yes	ASL
18540299	Hexavalent Chromium(7,8)	2.5		63.3		mg/kg	Lathe #113	13 / 73	0.43 – 20.3	63.3	NA	30	NC	Yes	Grp. A
7439965	Manganese	561		561		mg/kg	MW-8S; 6-10 fbgs	1 / 1	0 – 0	561	NA	180	NC	Yes	ASL

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TABLE 3.2
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) The range of detection limits is repoted as 0 to 0 when the specific chemical was detected in all samples.
(3) Maximum value used as screening concentration.
(4) Background values not used per USEPA.
(5) Screening toxicity value -- EPA Region 9 Preliminary Remediation Goals, Residential Land Use (USEPA, 2004).
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
(6) Rationale Codes

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

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
U = Not detected above the laboratory sample quantitation limit
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 3.3
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value	COPC Flag	(6) Rationale for Contaminant Deletion or Selection
67641	Acetone	21	J	21	J	µg/l	MW-2S	1 / 14	5 – 10	21	ND	550 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**	Grp. A
78933	2-Butanone	3.1	J	3.1	J	µg/l	MW-2S	1 / 14	5 – 10	3.1	ND	700 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	0.028 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) phthalata	5	J	5	J	µg/l	MW-6S	1 / 8	10 – 10	5	ND	4.8 C PRG	**Yes**	ASL
206440	Fluoranthene	0 6	J	0 6	J	µg/l	MW-8S HV	1 / 8	10 – 10	0.6	ND	150 NC PRG	No	BSL
108952	Phenol	2	J	2	J	µg/l	MW-2S	1 / 8	10 – 10	2	ND	1100 NC PRG	No	BSL
129000	Pyrene	0.5	J	0 5	J	µg/l	MW-8S HV	1 / 8	10 – 10	0.5	ND	18 NC PRG	No	BSL
7429905	Aluminum	382		36400	J	µg/l	MW-2S	5 / 8	200 – 200	36400	ND	3600 NC PRG	**Yes**	ASL
744360	Antimony	72 6	J	72 6	J	µg/l	MW-2S	1 / 8	60 – 60	72.6	ND	1 5 NC PRG	**Yes**	ASL
7440382	Arsenic	133	J	133	J	µg/l	MW-2S	1 / 15	10 – 10	133	ND	0 045 C PRG	**Yes**	Grp A
7440393	Barium	517	J	517	J	µg/l	MW-2S	1 / 8	200 – 200	517	ND	260 NC PRG	**Yes**	ASL
7440439	Cadmium	50 1	J	50 1	J	µg/l	MW-2S	1 / 8	5 – 5	50 1	ND	1 8 NC PRG	**Yes**	ASL
7440702	Calcium	26000	U	402000	EJ	µg/l	MW-6S	8 / 8	0 – 0	402000	57500	-- N/A 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	73 NC PRG	**Yes**	ASL
7440508	Copper	2220	J	2220	J	µg/l	MW-2S	1 / 8	25 – 25	2220	ND	150 NC PRG	**Yes**	ASL
7439896	Iron	218	J	3160000	J	µg/l	MW-2S	8 / 8	0 – 0	3160000	326	1100 NC PRG	**Yes**	ASL
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 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	73 NC PRG	**Yes**	ASL
7440097	Potassium	9290	NJ	9290	NJ	µg/l	MW-2S	1 / 8	5000 – 5000	9290	ND	-- N/A 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

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TABLE 3.3
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value			COPC Flag	(6) Rationale for Contaminant Deletion or Selection
7440235	Sodium	5550		27800		µg/l	MW-7S	6 / 8	5000 -- 5000	27800	11200	--	N/A	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	p	µg/l	MW-2S	3 / 8	20 – 20	146000	ND	1100	NC	PRG	**Yes**	ASL

(1) Minimum/maximum detected concentration.
(2) The range of detection limits is repoted es 0 to 0 when the specific chemicel was detected in all samples.
(3) Maximum value used for screening concentration.
(4) Background values from MW-9S. Highest value from November 2001 and April 2002 sampling events
(5) Screening toxicity value – USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2004). If unavailable the maximum contaminant level or action level for drinking water was used
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
Besed on similarities in chemical and physical structure, the following surrogete screening criteria were used:

(6) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Group A Cercinogen (Grp. A)
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 terget 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 3.4
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value			COPC Flag	(6) Rationale for Contaminant Deletion or Selection
67641	Acetone	6.3	J	74		µg/l	MW-7D	3 / 16	5 -- 10	74	ND	550	NC	PRG	No	BSL
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-2O	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	--	N/A	N/A	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	Yes	ASL
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	--	N/A	N/A	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 / 8	5000 -- 5000	19600	ND	--	N/A	N/A	No	NUT
7440235	Sodium	5850		22300		µg/l	MW-1D	6 / 8	5000 -- 5000	22300	5990	--	N/A	N/A	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(7)	321	NJ	321	NJ	µg/l	MW-5D	1 / 16	10 -- 10000	321	ND	11	NC	PRG	Yes	Grp. A

TABLE 3.4
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) The range of detection limits is repoted as 0 to 0 when the specific chemical was detected in all samples.
(3) Maximum value used for screening concentration.
(4) Background values from MW-9S. Highest value from November 2001 and April 2002 sampling events.
(5) Screening toxicity value -- USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2004).
If unavailable, the maximum contaminant level or action level for drinking water was used.
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:
- phenanthrene = pyrene

(6) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Group A Carcinogen (Grp. A)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)

(7) Hexavalent chromium is only classified as a Group A carcinogen through the inhalation route of exposure and is considered a Group D carcinogen D carcinogen via ingestion route.

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

TABLE 3.5
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 / 7	10 -- 10	13.8	N/A	5500 NC PRG	No	BSL
18540299	Hexavalent Chromium(6)	10	J	14	J	µg/l	Surface Water #2	3 / 7	10 -- 10	14	N/A	11 NC PRG	**Yes**	Grp. A

(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, 2004) If unavailable the maximum contaminant level for drinking water was used.
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
(5) Rationale Codes
Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Group A Carcinoge (Grp. A)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)
Not Historically Associated (NHIST)
(6) Hexavalent chromium Is only classified as a Group A carcinogen through the inhalation route of exposure and is considered a Group D carcinogen D carcinogen via ingestion route.

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
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

TABLE 3.6
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value		COPC Flag	(6) 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**	Grp. A
16065831	Chromium, Total	9.2	NJ	215	NJ	mg/kg	Lathe #89	16 / 17	6.6 -- 6.6	215	N/A	12000	NC	No	BSL
18540299	Hexavalent Chromium(7)	1.3		18.3		mg/kg	Lathe #89	3 / 3	0 -- 0	18	N/A	30	C	No	BSL

(1) Minimum/maximum detected concentration.
(2) The range of detection limits is repoted as 0 to 0 when the specific chemical was detected in all samples
(3) Maximum value used as screening concentration.
(4) Background values not used per USEPA.
(5) Screening toxicity value -- EPA Region 5 Preliminary Remediation Goals, Residential Land Use (USEPA, 2004).
For non-carcinogenic screening values the value was adjusted by 1/10 to account for cumulative effects.
(6) Rationale Codes

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

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

(7) Hexavalent chromium is a Group A carcinogen only via inhalation. However, it is not considered a COPC in sediment because inhalation does not represent a complete exposure pathway.

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 4.1
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/ Adolescent	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/ Adolescent	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/ Adolescent	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/ Adolescent	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/ Adolescent	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	Adult	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 Outdoor 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.	

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TABLE 4.2

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
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

Chemical of Potential Concern	Units	Arithmetic Mean	UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Benzo(a)pyrene	mg/kg	1.2E-01	2.0E-01	7.1E-02	J	mg/kg	7.1E-02	Max	(1)	1.2E-01	Mean-N	(3)
Arsenic	mg/kg	1.5E+01	2.3E+01	9.6E+01	--	mg/kg	2.3E+01	95% UCL	(2)	1.5E+01	Mean-N	(3)
Chromium, hexavalent	mg/kg	4.6E+00	1.4E+01	6.3E+01	--	mg/kg	1.4E+01	97.5% UCL	(2)	4.6E+00	Mean-N	(3)
Chromium, Total	mg/kg	6.3E+03	2.2E+04	6.5E+04	--	mg/kg	2.2E+04	99% UCL	(2)	6.3E+03	Mean-N	(3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

(1) UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(2) UCL less than the maximum detected concentration. Therefore, recommended UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(3) Normal distribution assumed.

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TABLE 4.3

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Subsurface Soil
Exposure Medium:	Soil
Exposure Point:	On-Site

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Benzo(a)pyrene	mg/kg	1.2E-01	2.0E-01	7.1E-02	--	mg/kg	7.1E-02	Max	(1)	1.2E-01	Mean-N	(4)
Arsenic	mg/kg	1.5E+01	2.4E+01	9.6E+01	--	mg/kg	2.4E+01	95% UCL	(2)	1.5E+01	Mean-N	(4)
Chromium, hexavalent	mg/kg	5.8E-01	1.2E+01	6.3E+01	--	mg/kg	1.2E+01	97.5% UCL	(2)	5.8E-01	Mean-N	(4)
Chromium, Total	mg/kg	5.6E+03	2.0E+04	6.5E+04	--	mg/kg	2.0E+04	99% UCL	(2)	5.6E+03	Mean-N	(4)
Manganese	mg/kg	5.6E+02	NA	5.6E+02	--	mg/kg	5.6E+02	Max	(3)	5.6E+02	Mean-N	(4)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

(1) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(2) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(3) Single value; UCL could not be calculated.

(4) Normal distribution assumed.

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TABLE 4.4

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

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

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	µg/L	4 8E+03	2.4E+04	3 6E+04	--	µg/L	2.4E+04	95% UCL	(1)	4 8E+03	Mean-N	(3)
Antimony	µg/L	3.5E+01	4 6E+01	7.3E+01	J	µg/L	4 6E+01	95% UCL	(1)	3.5E+01	Mean-N	(3)
Arsenic	µg/L	1.4E+01	5.1E+01	1.3E+02	J	µg/L	5.1E+01	95% UCL	(1)	1.4E+01	Mean-N	(3)
Barium	µg/L	1 5E+02	3 8E+02	5.2E+02	J	µg/L	3 8E+02	95% UCL	(1)	1 5E+02	Mean-N	(3)
Benzene	µg/L	2.5E+00	5.1E+00	1 8E+00	--	µg/L	1 8E+00	Max	(2)	2.5E+00	Mean-N	(3)
Benzo(b)fluoranthene	µg/L	4 5E+00	6.8E+00	6 0E-01	J	µg/L	6.0E-01	Max	(2)	4.5E+00	Mean-N	(3)
Bis(2-ethylhexyl) phthalate	µg/L	5 0E+00	NA	5 0E+00	J	µg/L	5 0E+00	Max	(4)	5 0E+00	Mean-N	(3)
Cadmium	µg/L	8.5E+00	3.4E+01	5.0E+01	J	µg/L	3.4E+01	95% UCL	(1)	8.5E+00	Mean-N	(3)
Cobalt	µg/L	5 3E+01	1 8E+02	2.5E+02	J	µg/L	1.8E+02	95% UCL	(1)	5 3E+01	Mean-N	(3)
Copper	µg/L	2.9E+02	1.5E+03	2 2E+03	J	µg/L	1 5E+03	95% UCL	(1)	2 9E+02	Mean-N	(3)
Iron	µg/L	4.1E+05	4.3E+06	3 2E+06	J	µg/L	3.2E+06	Max	(2)	4.1E+05	Mean-N	(3)
Lead	µg/L	1.3E+02	1 4E+03	1.0E+03	EJ	µg/L	1.0E+03	Max	(2)	1 3E+02	Mean-N	(3)
Manganese	µg/L	5.5E+03	2 9E+04	1 5E+04	EJ	µg/L	1.5E+04	Max	(2)	5 5E+03	Mean-N	(3)
Nickel	µg/L	3.8E+02	1.9E+03	2.8E+03	EJ	µg/L	1 9E+03	95% UCL	(1)	3.8E+02	Mean-N	(3)
Selenium	µg/L	7 7E+00	2.7E+01	3 9E+01	J	µg/L	2 7E+01	95% UCL	(1)	7.7E+00	Mean-N	(3)
Thallium	µg/L	1.7E+02	8.7E+02	1.3E+03	EJ	µg/L	8 7E+02	95% UCL	(1)	1.7E+02	Mean-N	(3)
Trichloroethene	µg/L	2.5E+00	5.1E+00	4.2E+00	J	µg/L	4.2E+00	Max	(2)	2.5E+00	Mean-N	(3)
Zinc	µg/L	1.9E+04	NA	1.5E+05	NJ	µg/L	1.5E+05	Max	(2)	1.9E+04	Mean-N	(3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T), Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N)

"--" = No Qualifier listed

NA = Unable to calculate 95% UCL

(1) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Normal distribution assumed.

(4) Single detection; UCL could not be calculated.

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TABLE 4.5

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

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

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	µg/L	1.2E+03	3.7E+03	5.7E+03	--	µg/L	3.7E+03	95% UCL	(1)	1.2E+03	Mean-N	(3)
Barium	µg/L	2.0E+02	4.3E+02	5.2E+02	--	µg/L	4.3E+02	95% UCL	(1)	2.0E+02	Mean-N	(3)
Hexavalent Chromium	µg/L	6.5E+02	4.9E+03	3.2E+02	NJ	µg/L	3.2E+02	Max	(2)	6.5E+02	Mean-N	(3)
Iron	µg/L	7.0E+03	1.1E+04	1.6E+04	J	µg/L	1.1E+04	95% UCL	(1)	7.0E+03	Mean-N	(3)
Manganese	µg/L	5.7E+02	1.3E+03	2.3E+03	EJ	µg/L	1.3E+03	95% UCL	(1)	5.7E+02	Mean-N	(3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

(1) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Normal distribution assumed.

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TABLE 4.6

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Peter Cooper - Markhams Site

Town of Dayton, New York

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

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Hexavalent Chromium	µg/L	8.0E+00	1.1E+01	1.4E+01	J	µg/L	1.08E+01	ProUCL	(1)	8.0E+00	Mean-N	(2)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

(1) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using U.S. EPA ProUCL 3.0 (2004); see Appendix B.

(2) Normal distribution assumed.

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TABLE 4.7

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Peter Cooper - Markhams Site

Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment
Exposure Point:	On-Site Wetlands

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	5.1E+00	6.4E+00	1.1E+01	--	mg/kg	6.4E+00	95% UCL-N	(1)	5.1E+00	Mean-N	(2)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

(1) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(2) Normal distribution assumed.

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TABLE 4.8

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Peter Cooper - Markhams Site

Town of Dayton, New York

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Air
Exposure Point:	Indoor Air

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Benzene	mg/m^3	--	--	--	--	mg/m^3	4.0E-06	--	(1)	--	--	--
Trichloroethene	mg/m^3	--	--	--	--	mg/m^3	7.4E-05	--	(1)	--	--	--

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = Calculated value; not applicable

(1) Calculated using Johnson and Ettinger (2003a); see Appendix C.

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TABLE 4.9

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Peter Cooper - Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Medium:	Groundwater
Exposure Medium:	Air
Exposure Point:	Ambient Air

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Outdoor Industrial Worker												
Benzene	mg/m^3	--	--	--	--	mg/m^3	4.3E-04	--	(1)	--	--	--
Trichloroethene	mg/m^3	--	--	--	--	mg/m^3	2.5E-06	--	(1)	--	--	--
Construction Worker												
Benzene	mg/m^3	--	--	--	--	mg/m^3	2.1E-03	--	(1)	--	--	--
Trichloroethene	mg/m^3	--	--	--	--	mg/m^3	1.2E-05	--	(1)	--	--	--
Adult Trespasser												
Benzene	mg/m^3	--	--	--	--	mg/m^3	3.9E-04	--	(1)	--	--	--
Trichloroethene	mg/m^3	--	--	--	--	mg/m^3	2.3E-06	--	(1)	--	--	--
Adolescent Trespasser												
Benzene	mg/m^3	--	--	--	--	mg/m^3	6.2E-04	--	(1)	--	--	--
Trichloroethene	mg/m^3	--	--	--	--	mg/m^3	3.6E-06	--	(1)	--	--	--

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Arithmetic Mean of Normal Data (Mean-N).

"--" = Calculated value; not applicable

(1) Calculated using VOC Emissions model and X/Q model; see Appendices C and E.

TABLE 4.10
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL AND SEDIMENT - ADULT 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 CF2 x FI x EF x ED x 1/BW x 1/AT
	FI	Fraction Ingested	unitless	1.0	(1)	0.125	(1)	
	EF	Exposure Frequency	days/year	26	(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	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	–	–	
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, 2004a	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, 2004a	0.01	EPA, 2004a	
	ABSds	Dermal Absorption Factor	unitless	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	
	EF	Exposure Frequency	days/year	26	(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. Default of 1 used for the RME; CT intake adjusted to account for actual exposure (assuming 1 out of 8 hours).

[2] 2 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 2004a, 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, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.11
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL AND SEDIMENT - ADOLESCENT 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:** Adolescent

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[4]	Cs x IRs x CF2 x FI x EF x ED x 1/BW x 1/AT
	FI	Fraction Ingested	unitless	1.0	(1)	0.125	(1)	
	EF	Exposure Frequency	days/year	39	(2)	8	(5)	
	ED	Exposure Duration	years	9	(3)	9	(3)	
	BW	Body Weight	kg	43	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	3285	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25,550	EPA, 1997	25,550	EPA, 1997	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	–	–	--	
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, 2004a	1800	EPA, 1992[6]	$\frac{Cs \times SA \times SAF \times ABSds \times EF \times ED \times CF2}{BW \times AT}$
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.07	EPA, 2004a	0.01	EPA, 2004a	
	ABSds	Dermal Absorption Factor	unitless	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	
	EF	Exposure Frequency	days/year	39	(2)	8	(5)	
	ED	Exposure Duration	years	9	(3)	9	(3)	
	BW	Body Weight	kg	43	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	3285	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. Default of 1 used for the RME; CT intake adjusted to account for actual exposure (assuming 1 out of 8 hours).

[2] 3 days/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[3] 10 to 18 year old child/adolescent.

[4] Mean value for adults.

[5] Professional judgement; 1 event/month, 8 months/year; EPA 2004a, 1997.

[6] 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, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.12
RAGS PART D - TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - ADULT 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	26	(2)	6	(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	1.36E+09	EPA, 2002a	1.36E+09	EPA, 2002a	

[1] Adults; moderate activities.

[2] 2 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.

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2004a, 1997.

Sources:

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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.13
RAGS PART D - TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - ADOLESCENT 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:** Adolescent

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	1.2	EPA, 1997[1]	1.2	EPA, 1997[1]	$\frac{Cs \times IRa \times EF \times ED \times ET}{BW \times AT \times PEF}$
	EF	Exposure Frequency	days/year	39	(2)	8	(5)	
	ED	Exposure Duration	years	9	(3)	9	(3)	
	ET	Exposure Time	hours/day	3	(4)	1	(6)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	3285	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	
	PEF	Particulate Emission Factor	m^3/kg	1.36E+09	EPA, 2002a	1.36E+09	EPA, 2002a	

[1] Children (1-18 years old); moderate activities.

[2] 3 days/week, 13 weeks of the summer. Site is located in a remote location and the surrounding area is rural and sparsely populated.

[3] 10 to 18 year old child/adolescent.

[4] U.S. EPA recommended value.

[5] Professional judgement; 1 event/month, 8 months/year; EPA 2004a, 1997.

[6] Professional judgement.

Sources:

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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

TABLE 4.14
RAGS PART D - TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - ADULT 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]	$\frac{Ca \times IRa \times EF \times ED \times ET}{BW \times AT}$
	EF	Exposure Frequency	days/year	26	(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] 2 days/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 2004a, 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.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

TABLE 4.15
RAGS PART D - TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - ADOLESCENT 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	1.2	EPA, 1997[1]	1.2	EPA, 1997[1]	$\frac{Ca \times IRa \times EF \times ED \times ET}{BW \times AT}$
	EF	Exposure Frequency	days/year	39	(2)	8	(4)	
	ED	Exposure Duration	years	9	EPA, 1997	9	EPA, 1997	
	ET	Exposure Time	hours/day	3	(2)	1	(4)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	3285	EPA, 1997	3285	EPA, 1997	
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	

[1] Children (1-18 years old); moderate activities.

[2] 3 days/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.

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2004a, 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.

TABLE 4.16
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SURFACE WATER - ADULT 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) = $\frac{DAevent \times EV \times ED \times EF \times SA}{BW \times AT}$
	SA	Exposed Skin Surface Area	cm^2	7100	EPA 1997[3]	7100	EPA 1997[3]	
	EF	Exposure Frequency	events/year	26	(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	$2 \times Kp \times Cw \times (6 \times \tau \times tevent/\pi)^{0.5}$
	tevent	Event Duration	hours/event	2	(2)	0.25	(5)	DAevent (inorganics) = Kp x Cw x tevent
	DAevent	Absorbed dose per event	mg/cm^2-event	Appendix D	Chemical-specific	Appendix D	Chemical-specific	τ = lag time (hr)
								Kp = Skin permeability constant (cm/hr)

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

[2] U.S. EPA recommended value.

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

[4] Professional judgement; 1 event/month, 8 months/year; EPA 2004a, 1997.

[5] Professional judgement.

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, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

TABLE 4.17
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SURFACE WATER - ADOLESCENT 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:** Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Dermal	Cw	Chemical Concentration in Surface Water	mg/L	–	Chemical-specific	–	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) =
Contact	SA	Exposed Skin Surface Area	cm^2	6600	EPA, 2004a[1]	6600	EPA, 2004a[1]	DAevent x EV x ED x EF x SA / BW x AT
	EF	Exposure Frequency	events/year	39	(2)	8	(4)	
	ED	Exposure Duration	years	9	EPA, 1997	9	EPA, 1997	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	
	ATnc	Averaging Time - noncancer	days	3285	EPA, 1997	3285	EPA, 1997	DAevent (organics) =
	ATca	Averaging Time - cancer	days	25550	EPA, 1997	25550	EPA, 1997	$2 \times Kp \times Cw \times (6 \times \tau \times tevent/\pi)^{0.5}$
	tevent	Event Duration	hours/event	3	(3)	0.25	(5)	DAevent (inorganics) = Kp x Cw x tevent
	DAevent	Absorbed dose per event	mg/cm^2-event	Appendix D	Chemical-specific	Appendix D	Chemical-specific	τ = lag time (hr)
								Kp = Skin permeability constant (cm/hr)

[1] Value for swimming or bathing.

[2] 3 days/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.

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

[5] Professional judgement.

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, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

TABLE 4.18
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SURFACE SOIL - OUTDOOR INDUSTRIAL 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: Surface 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 CF2 x FI x EF x ED x 1/BW x 1/AT
	IRs	Ingestion Rate of soil	mg/day	100	EPA, 2002a	50	EPA, 1997	
	EF	Exposure Frequency	days/year	225	EPA, 2002a	219	EPA, 2004a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2004a	
	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	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	--	--	
Dermal Contact	Cs	Chemical Concentration in Soil	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, 2004a	3300	EPA, 2004a	
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.2	EPA, 2004a	0.02	EPA, 2004a	
	ABSds	Dermal Absorption Factor	unitless	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	
	EF	Exposure Frequency	days/year	225	EPA, 2002a	219	EPA, 2004a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2004a	
	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	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	--	--	--	

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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.19
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
SOIL TO AMBIENT AIR - OUTDOOR INDUSTRIAL 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, 2002a	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	1.36E+09	EPA, 2002a	1.36E+09	EPA, 2002a	
	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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

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TABLE 4.20
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO AMBIENT AIR - OUTDOOR INDUSTRIAL 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, 2002a	219	EPA, 2004a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2004a	
	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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.21
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
POTABLE TAP WATER - 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 Wate	**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, 2004a	
	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	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	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, 2004a	Chem-Spec.	EPA, 2004a	if ET< t*, then: DAevent =
	KP	Permeability Coefficient from Water	cm/hr	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	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, 2004a	Chem-Spec.	EPA, 2004a	if ET> t*, then: DAevent =
	t*	Time to reach steady-state	hr	Chem-Spec.	EPA, 2004a	Chem-Spec.	EPA, 2004a	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, 2004a	Chem-Spec.	EPA, 2004a	
	EV	Event Frequency	events/day	1	EPA, 2004a	1	EPA, 2004a	
	SA	Skin Surface Area Available for Contact	cm^2	18,000	EPA, 2004a	18,000	EPA, 2004a	
	EF	Exposure Frequency	days/year	225	EPA, 2002a	219	EPA, 2004a	
	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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.22
RAGS PART D – TABLE 4

VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER TO INDOOR AIR - INDOOR COMMERCIAL 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, 2003a	Modeled concentration	EPA, 2003a	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, 2004a	
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 2004a	
	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, 2003a: User's Guide For Evaluating Subsurface Vapor Intrusion Into Buildings, June.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.23
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
SUBSURFACE SOIL AND SEDIMENT - 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	Cs	Chemical Concentration in Soil/Sediment	mg/kg	–	Chemical-specific	–	Chemical-specific	Chronic Daily Intake (CDI) (mg/kg-day) =
Ingestion	IRs	Ingestion Rate of Soil/Sediment	mg/day	330	EPA, 2002a	100	EPA, 1997	Cs x IRs x CF2 x FI x EF x ED x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	180	EPA, 2002a[1]	100	EPA, 1991, 2002a	
	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	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	0.000001	–	–	–	
Dermal	Cs	Chemical Concentration in Soil/Sediment	mg/kg	–	Chemical-specific	–	Chemical-specific	Dermally Absorbed Dose (mg/kg-day) =
Contact	SA	Skin Surface Area	cm^2	3300	EPA, 2004a	3300	EPA, 2004a	$\frac{Cs \times SA \times SAF \times ABSds \times EF \times ED \times CF2}{BW \times AT}$
	SAF	Soil-to-Skin Adherence Factor	mg/cm^2	0.3	EPA, 2004a	0.1	EPA, 2004a	
	ABSds	Dermal Absorption Factor	unitless	Appendix D	EPA, 2004a	Appendix D	EPA, 2004a	
	EF	Exposure Frequency	days/year	180	EPA, 2002a[1]	100	EPA, 1991, 2002a	
	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	
	CF2	Conversion Factor 2 - milligrams to kilograms	kg/mg	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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

EPA, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance Dermal Risk Assessment, Final, July 2004.

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TABLE 4.24
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: Subsurface 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, 2002a	Modeled concentration	EPA, 2002a	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, 2002a [2]	30	EPA, 1991, 2002a [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	2.00E+07	Appendix C	2.00E+07	Appendix C	
	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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

TABLE 4.25
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, 1996	Modeled concentration	EPA, 1996	X/Q dispersion model
	Cgw	Chemical Concentration in Groundwater	mg/L	–	Chemical-specific	--	Chemical-specific	
	IRa	Inhalation Rate	m^3/hour	2.5	EPA, 1991	1.3	EPA, 1997[1]	
	EF	Exposure Frequency	days/year	180	EPA, 2002a[1]	100	EPA, 1991, 2002a	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, 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, 2002a: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002. OSWER 9355-4-24.

TABLE 4.26
RAGS PART D – TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS
GROUNDWATER AND SURFACE WATER - CONSTRUCTION WORKER

Peter Cooper – Markhams Site
Town of Dayton, New York

Scenario Timeframe: Future	**Exposure Point:** On-Site
Medium: Surface Water/Groundwater	**Receptor Population:** Construction Worker
Exposure Medium: Surface Water/Groundwate	**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[3]	5500	EPA 1997[4]	$\frac{\text{DAevent x EV x ED x EF x SA}}{\text{BW x AT}}$
	EF	Exposure Frequency	days/year	90	(1)	50	(1)	
	ED	Exposure Duration	years	1	(2)	1	(2)	
	BW	Body Weight	kg	70	EPA, 1997	70	EPA, 1997	DAevent (organics) = 2 x Kp x Cw x $(6 \times \tau \times \text{tevent}/\pi)^{0.5}$
	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	(2)	1	(2)	τ = lag time (hr)
	tevent	Event Duration	hours/event	2	(2)	2	(2)	Kp = Skin permeability constant (cm/hr)
	DAevent	Absorbed dose per event	mg/cm^2-event	Appendix C	Chemical-specific	Appendix C	Chemical-specific	

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

[2] Professional judgement.

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

[4] Forearms, hands, lower legs, and feet (30.6% total body area of 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.

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TABLE 5.1
RAGS PART D – TABLE 5
NON-CANCER TOXICITY DATA - ORAL/DERMAL
Peter Cooper - Markhams Site
Town of Dayton, New York

Chemical of Potential Concern	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	0.9	mg/kg-day	100%	0.9	mg/kg-day	Liver, Kidney	1000	IRIS	10/18/04
Benzene	0.004	mg/kg-day	100%	0.004	mg/kg-day	Blood	N/A	IRIS	10/18/04
Bis(2-ethylhexyl) phthalate	0.02	mg/kg-day	100%	0.02	mg/kg-day	Liver	1000	IRIS	10/18/04
Trichloroethene	0.0003	mg/kg-day	100%	0.0003	mg/kg-day	N/A	N/A	PRG	10/01/04
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	1	mg/kg-day	100%	1	mg/kg-day	N/A	N/A	PRG	10/01/04
Antimony	0.0004	mg/kg-day	15%	0.00006	mg/kg-day	Blood	1000	IRIS	10/18/04
Arsenic	0.0003	mg/kg-day	100%	0.0003	mg/kg-day	Skin	3	IRIS	10/18/04
Barium	0.07	mg/kg-day	7%	0.0049	mg/kg-day	N/A	3	IRIS	10/18/04
Cadmium	0.0005	mg/kg-day	2.5%	0.000013	mg/kg-day	Kidney	10	IRIS	10/18/04
Chromium	1.5	mg/kg-day	1.3%	0.02	mg/kg-day	None	1000	IRIS	10/18/04
Hexavalent Chromium	0.003	mg/kg-day	2.5%	0.000075	mg/kg-day	N/A	900	IRIS	10/18/04
Cobalt	0.02	mg/kg-day	100%	0.02	mg/kg-day	N/A	N/A	PRG	10/01/04
Copper	0.037	mg/kg-day	100%	0.037	mg/kg-day	Gastrointestinal	N/A	HEAST	7/97
Iron(4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	0.024	mg/kg-day	4%	0.00096	mg/kg-day	CNS	1	IRIS	10/18/04
Nickel	0.02	mg/kg-day	4%	0.0008	mg/kg-day	Various	300	IRIS	10/18/04
Selenium	0.005	mg/kg-day	80%	0.004	mg/kg-day	Various	3	IRIS	10/18/04
Thallium(5)	0.000066	mg/kg-day	100%	0.000066	mg/kg-day	Blood	3000	IRIS	10/18/04
Zinc	0.3	mg/kg-day	100% (Highly Variable)	0.3	mg/kg-day	Blood	3	IRIS	10/18/04

(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) The toxicity values for iron needs to be updated with the current value supported by the Superfund Technical Support Center.

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2004
N/A = Not applicable

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TABLE 5.2
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	10/18/04
Benzene	Chronic	N/A	N/A	0.0086	mg/kg-day	N/A	N/A	IRIS	10/18/04
Bis(2-ethylhexyl) phthalate	Chronic	N/A	N/A	0.022	mg/kg-day	N/A	N/A	RE	10/18/04
Trichloroethene	Chronic	N/A	N/A	0.01	mg/kg-day	N/A	N/A	PRG	10/01/04
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	10/01/04
Antimony	Chronic	N/A	N/A	0.0004	mg/kg-day	N/A	N/A	RE	10/18/04
Arsenic	Chronic	N/A	N/A	0.0003	mg/kg-day	N/A	N/A	RE	10/18/04
Barium	Chronic	N/A	N/A	0.00014	mg/kg-day	Fetus	1000	HEAST	7/97
Cadmium	Chronic	N/A	N/A	0.0005	mg/kg-day	N/A	N/A	RE	10/18/04
Chromium	Chronic	N/A	N/A	1.5	mg/kg-day	N/A	N/A	RE	10/18/04
Hexavalent Chromium	Chronic	0.0001	mg/m^3	0.0000022	mg/kg-day	Lung	300	IRIS	10/18/04
Cobalt	Chronic	N/A	N/A	0.0000057	mg/kg-day	N/A	N/A	PRG	10/01/04
Copper	Chronic	N/A	N/A	0.037	mg/kg-day	N/A	N/A	RE	7/97
Iron(3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	Chronic	0.00005	mg/m^3	0.000014	mg/kg-day	CNS	1000	IRIS	10/18/04
Nickel	Chronic	N/A	N/A	0.02	mg/kg-day	N/A	N/A	RE	10/18/04
Selenium	Chronic	N/A	N/A	0.005	mg/kg-day	N/A	N/A	RE	10/18/04
Thallium(4)	Chronic	N/A	N/A	0.000066	mg/kg-day	N/A	N/A	RE	10/18/04
Zinc	Chronic	N/A	N/A	0.3	mg/kg-day	N/A	N/A	RE	10/18/04

(1) RfD = RfC x 20 m^3/day/70 kg or oral RfD (RE) or inhalation RfD (PRG)
(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) The toxicity values for iron needs to be updated with the current value supported by the Superfund Technical Support Center.
(4) The toxicity value for thallium was adjusted from the oral RfD of thallium sulfate (IRIS) based on the molecular weight of thallium in the thallium salt.

IRIS = Integrated Risk Informatio
HEAST= Health Effects Assessm
PRG = U.S. EPA Region 9 Prelin
RE = Route Extrapolation
N/A = Not applicable

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TABLE 5.3
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	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Benzene	0.055	100%	0.055	$(mg/kg-day)^{-1}$	A	IRIS	10/18/04
Bis(2-ethylhexyl) phthalate	0.014	100%	0.014	$(mg/kg-day)^{-1}$	B2	IRIS	10/18/04
Trichloroethene	0.4	100%	0.4	$(mg/kg-day)^{-1}$	N/A	PRG	10/01/04
Semi-Volatile Compounds							
Benzo(a)pyrene	7.3	100%	7.3	$(mg/kg-day)^{-1}$	B2	IRIS	10/18/04
Benzo(b)fluoranthene	0.73	100%	0.73	$(mg/kg-day)^{-1}$	B2	PRG	10/01/04
Metals							
Aluminum	N/A	100%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Antimony	N/A	15%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Arsenic	1.5	100%	1.5	$(mg/kg-day)^{-1}$	A	IRIS	10/18/04
Barium	N/A	7%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Cadmium	N/A	2.5%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	12/20/04
Chromium	N/A	1.3%	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Cobalt	N/A	100%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Copper	N/A	100%	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Hexavalent Chromium	N/A	2.5%	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Iron	N/A	N/A	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Lead	N/A	100%	N/A	$(mg/kg-day)^{-1}$	B2	N/A	12/20/04
Manganese	N/A	4%	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Nickel	N/A	4%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Selenium	N/A	80%	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04
Thallium	N/A	100%	N/A	$(mg/kg-day)^{-1}$	N/A	N/A	N/A
Zinc	N/A	Highly Variable	N/A	$(mg/kg-day)^{-1}$	D	IRIS	10/18/04

(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, 2004
N/A = Not applicable

(3) For IRIS values, the dete 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 humen 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

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TABLE 5.4
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	10/18/04
Benzene	0.0000078	$(\mu g/m^3)^{-1}$	3500	0.027	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/18/04
Bis(2-ethylhexyl) phthalate	N/A	N/A	N/A	0.014	$(mg/kg\text{-}day)^{-1}$	B2	RE	10/18/04
Trichloroethene	N/A	N/A	N/A	0.4	$(mg/kg\text{-}day)^{-1}$	N/A	PRG	10/01/04
Semi-Volatile Compounds								
Benzo(a)pyrene	N/A	N/A	N/A	7.3	$(mg/kg\text{-}day)^{-1}$	B2	PRG	10/01/04
Benzo(b)fluoranthene	N/A	N/A	N/A	0.73	$(mg/kg\text{-}day)^{-1}$	B2	PRG	10/01/04
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	10/18/04
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	10/18/04
Chromium	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/18/04
Hexavalent Chromium	0 012	$(\mu g/m^3)^{-1}$	3500	42	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/18/04
Cobalt	N/A	N/A	N/A	9.8	$(mg/kg\text{-}day)^{-1}$	N/A	PRG	10/01/04
Copper	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/18/04
Iron	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
Lead	N/A	$(\mu g/m^3)^{-1}$	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	B2	Cal-EPA OEHHA	12/20/04
Manganese	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	10/18/04
Nickel	N/A	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/18/04
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 (RE)

(2) IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
PRG = U.S. EPA Region 9 Preliminary Remediation Goals, 2004
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

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TABLE 6.1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
CURRENT/FUTURE TRESPASSER ADULT

Peter Cooper Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current/Future
Receptor Population:	Trespasser
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Inhalation	Dermal	Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Wetlands	Arsenic	4.2E-07	NA	5.027E-08	4.7E-07	Arsenic	Skin	2.18E-03	NA	2.61E-04	2.4E-03
						Total Risk Across Sediment	**4.7E-07**					**Total Hazard Quotient Across Sediment**	**2.4E-03**
Soil	Soil	Surface Soil	Arsenic	1.5E-06	1.3E-09	1.8E-07	1.7E-06	Arsenic	Skin	7.90E-03	6.52E-07	9.46E-04	8.9E-03
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	2.3E-08	1.9E-12	1.2E-08	3.4E-08	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	N/A	1.46E-03	1.20E-07	5.82E-05	1.52E-03
			Chromium, hexavalent	NA	2.1E-09	NA	2.1E-09	Chromium, hexavalent	Lung	4.75E-04	5.35E-05	1.89E-05	5.47E-04
						Total Risk Across Soil	**1.7E-06**					**Total Hazard Quotient Across Soil**	**1.1E-02**
Groundwater	Ambient Air	Volatile COPCs	Benzene	NA	1.8E-11	NA	1.8E-11	Benzene	Blood	NA	1.84E-07	NA	1.8E-07
			Trichloroethene	NA	1.3E-09	NA	1.3E-09	Trichloroethene	N/A	NA	7.34E-07	NA	7.3E-07
						Total Risk Across Groundwater	**1.3E-09**					**Total Hazard Quotient Across Groundwater**	**9.2E-07**
Surface Water	Surface Water	Wetlands	Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	5.20E-04	5.2E-04
						Total Risk Across Surface Water	**0.0E+00**					**Total Hazard Quotient Across Surface Water**	**5.2E-04**
						Total Risk Across All Media and All Exposure Routes	**2E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.01**

Total [Skin] HI = 0.01

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TABLE 6.2
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
CURRENT TRESPASSER ADOLESCENT
Peter Cooper Markhams Site
Town of Dayton, New York

Scenario Timeframe:	Current
Receptor Population:	Trespasser
Receptor Age:	Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Wetlands	Arsenic	3.077E-07	NA	3.683E-08	3.4E-07	Arsenic	Skin	3.99E-03	NA	4.77E-04	4.47E-03
						Total Risk Across Sediment	**3.4E-07**					**Total Hazard Quotient Across Sediment**	**4.5E-03**
Soil	Soil	Surface Soil	Arsenic	1.1E-06	6.9E-10	1.3E-07	1.3E-06	Arsenic	Skin	1.93E-02	1.19E-06	2.31E-03	2.16E-02
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	1.7E-08	1.0E-12	6.6E-09	2.5E-08	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	N/A	3.56E-03	2.20E-07	1.42E-04	3.70E-03
			Chromium, hexavalent	NA	1.2E-09	NA	1.2E-09	Chromium, hexavalent	Lung	1.16E-03	9.79E-05	4.63E-05	1.30E-03
						Total Risk Across Soil	**1.3E-06**					**Total Hazard Quotient Across Soil**	**2.7E-02**
Groundwater	Ambient Air	Volatile COPCs	Benzene	NA	2.4E-11	NA	2.4E-11	Benzene	Blood	NA	8.00E-07	NA	8.0E-07
			Trichloroethene	NA	1.6E-09	NA	1.6E-09	Trichloroethene	N/A	NA	3.19E-06	NA	3.2E-06
						Total Risk Across Groundwater	**1.7E-09**					**Total Hazard Quotient Across Groundwater**	**4.0E-06**
Surface Water	Surface Water	Wetlands	Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	8.86E-04	8.9E-04
						Total Risk Across Surface Water	**0.0E+00**					**Total Hazard Quotient Across Surface Water**	**8.9E-04**
						Total Risk Across All Media and All Exposure Routes	**2E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.03**

Total [Skin] HI = 0.02

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TABLE 6.3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUTURE OUTDOOR INDUSTRIAL WORKER
Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Arsenic	1.1E-05	1.6E-08	2.2E-06	1.3E-05	Arsenic	Skin	6.84E-02	1.01E-05	1.35E-02	8.19E-02
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	1.6E-07	2.4E-11	1.4E-07	3.0E-07	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	None Observed	1.26E-02	1.86E-06	6.25E-02	7.51E-02
			Chromium, hexavalent	NA	2.7E-08	NA	2.7E-08	Chromium, hexavalent	Lung	4.11E-03	8.26E-04	1.08E-02	1.58E-02
						Total Risk Across Soil	**1.4E-05**					**Total Hazard Quotient Across Soil**	**1.7E-01**
Groundwater	Potable Tap Water	Shower/ faucets	Aluminum	NA	NA	NA	NA	Aluminum	N/A	2.16E-01	NA	6.60E-04	2.16E-01
			Antimony	NA	NA	NA	NA	Antimony	Blood	1.02E+00	NA	2.08E-02	1.04E+00
			Arsenic	2.4E-04	NA	7.3E-07	2.4E-04	Arsenic	Skin	1.49E+00	NA	4.55E-03	1.49E+00
			Barium	NA	NA	NA	NA	Barium	Kidney	5.44E-02	NA	2.38E-03	5.68E-02
			Benzene	3.1E-07	NA	5.1E-08	3.6E-07	Benzene	Blood	5.28E-03	NA	6.54E-04	5.94E-03
			Benzo(b)fluoranthene	1.4E-06	NA	3.5E-05	3.7E-05	Benzo(b)fluoranthene	N/A	NA	NA	NA	NA
			Bis(2-ethylhexyl)phthalate	2.2E-07	NA	1.2E-05	1.3E-05	Bis(2-ethylhexyl)phthalate	Liver	2.20E-03	NA	1.23E-01	1.25E-01
			Cadmium	NA	NA	NA	NA	Cadmium	Kidney	6.06E-01	NA	3.19E+00	3.80E+00
			Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	9.42E-01	NA	2.31E-01	1.17E+00
			Cobalt	NA	NA	NA	NA	Cobalt	N/A	7.77E-02	NA	7.56E-04	7.84E-02
			Copper	NA	NA	NA	NA	Copper	Gastrointestinal	3.55E-01	NA	3.57E-03	3.58E-01
			Iron	NA	NA	NA	NA	Iron	N/A	9.28E+01	NA	8.84E-01	9.36E+01
			Lead	NA	NA	NA	NA	Lead	N/A	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA	Manganese	CNS	5.50E+00	NA	4.21E-01	5.92E+00
			Nickel	NA	NA	NA	NA	Nickel	Various	8.37E-01	NA	4.07E-02	8.77E-01
			Selenium	NA	NA	NA	NA	Selenium	Various	4.76E-02	NA	6.58E-04	4.82E-02
			Thallium	NA	NA	NA	NA	Thallium	Blood	1.16E+02	NA	2.88E+00	1.19E+02
			Trichloroethene	5.3E-06	NA	9.8E-07	6.3E-06	Trichloroethene	N/A	1.23E-01	NA	2.29E-02	1.46E-01
			Zinc	NA	NA	NA	NA	Zinc	Blood	1.13E-03	NA	NA	1.13E-03
Groundwater	Ambient Air	Volatile COPCs	Benzene	NA	9.1E-10	NA	9.1E-10	Benzene	Blood	NA	1.09E-05	NA	1.09E-05
			Trichloroethene	NA	6.2E-08	NA	6.2E-08	Trichloroethene	N/A	NA	4.35E-05	NA	4.35E-05
						Total Risk Across Groundwater	**3.0E-04**					**Total Hazard Quotient Across Groundwater**	**2.3E+02**
						Total Risk Across All Media and All Exposure Routes	**3E-04**					**Total Hazard Index Across All Media and All Exposure Routes**	**2.3E+02**
												Total [Blood] HI =	**120**

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TABLE 6.3.A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
FUTURE OUTDOOR INDUSTRIAL WORKER
Peter Cooper Markhams Site
Town of Dayton, New York.

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Potable Tap Water	Shower/Faucets	Arsenic	5.90E-05		2.6E-07	5.9E-05	Antimony	blood	0.69	NA	0.02	0.7
								Arsenic	skin	1.02	NA	0.00	1.0
								Cadmium	kidney	0.41	NA	3.09	3.5
								Chromium Hexavaler	lung	0.64	NA	0.22	0.9
								Iron	N/A	0.22	NA	0.86	1.1
								Manganese	CNS	0.04	NA	0.41	0.5
								Thallium	blood	79.09	NA	2.81	81.9
				Total Risk Across[Medium]			5.9E-05	Total Hazard Index Across All Media and All Exposure Routes					89.5
				Total Risk Across All Media and All Exposure Routes			5.9E-04						

Total [blood] HI =	82.6
Total [skin] HI =	1
Total [kidney] HI =	3.5
Total [lung] HI =	0.9
Total [CNS] HI =	0.5

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TABLE 6.4
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUTURE INDOOR WORKER

Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Medium	Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Routes		Target Organ	Ingestion	Inhalation	Dermal	Routes
Groundwater	Indoor Air	Volatile COPCs	Benzene	NA	3.0E-09	NA	3.0E-09	Benzene	Blood	NA	3.56E-05	NA	3.6E-05
			Trichloroethene	NA	1.1E-07	NA	1.1E-07	Trichloroethene	N/A	NA	7.79E-05	NA	7.8E-05
Total Risk Across Groundwater							**1.1E-07**	**Total Hazard Quotient Across Groundwater**					**1.1E-04**
Total Risk Across All Media and All Exposure Routes							**1E-07**	**Total Hazard Index Across All Media and All Exposure Routes**					**1.1E-04**

Total [Blood] HI = 3.6E-05

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TABLE 6.5
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUTURE CONSTRUCTION WORKER
Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Wetlands	Arsenic	3.198E-07	NA	2.879E-08	3.5E-07	Arsenic	Skin	4.98E-02	NA	4.48E-03	5.4E-02
						Total Risk Across Sediment	**3.5E-07**					**Total Hazard Quotient Across Sediment**	**5.4E-02**
Soil	Soil	Surface Soil	Arsenic	1.2E-06	6.0E-09	1.1E-07	1.3E-06	Arsenic	Skin	1.64E-01	9.32E-05	1.66E-02	2.0E-01
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	1.7E-08	8.7E-12	6.7E-09	2.4E-08	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	None Observed	3.02E-02	1.53E-05	6.80E-02	9.8E-02
			Chromium, hexavalent	NA	8.4E-09	NA	8.4E-09	Chromium, hexavalent	Lung	9.22E-03	6.35E-03	1.11E-02	2.66E-02
						Total Risk Across Soil	**1.3E-06**					**Total Hazard Quotient Across Soil**	**3.3E-01**
Groundwater	Groundwater	Groundwater	Aluminum	NA	NA	NA	NA	Aluminum	N/A	NA	NA	1.23E-03	1.2E-03
			Antimony	NA	NA	NA	NA	Antimony	Blood	NA	NA	3.86E-02	3.9E-02
	Ambient Air	Volatile COPCs	Arsenic	NA	NA	5.4E-08	5.4E-08	Arsenic	Skin	NA	NA	8.45E-03	8.5E-03
			Barium	NA	NA	NA	NA	Barium	Kidney	NA	NA	4.41E-03	4.4E-03
			Benzene	NA	1.4E-10	1.3E-09	1.5E-09	Benzene	Blood	NA	4.37E-05	4.23E-04	4.7E-04
			Benzo(b)fluoranthene	NA	NA	7.6E-07	7.6E-07	Benzo(b)fluoranthene	N/A	NA	NA	NA	NA
			Bis(2-ethylhexyl)phthalate	NA	NA	2.7E-07	2.7E-07	Bis(2-ethylhexyl)phthalate	Liver	NA	NA	6.66E-02	6.7E-02
			Cadmium	NA	NA	NA	NA	Cadmium	Kidney	NA	NA	1.91E+00	1.9E+00
			Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	4.28E-01	4.3E-01
			Cobalt	NA	NA	NA	NA	Cobalt	N/A	NA	NA	5.39E-04	5.4E-04
			Copper	NA	NA	NA	NA	Copper	Gastrointestinal	NA	NA	2.50E-03	2.5E-03
			Iron	NA	NA	NA	NA	Iron	N/A	NA	NA	6.40E-01	6.4E-01
			Lead	NA	NA	NA	NA	Lead	N/A	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA	Manganese	CNS	NA	NA	1.12E-01	1.1E-01
			Nickel	NA	NA	NA	NA	Nickel	Various	NA	NA	2.91E-02	2.9E-02
			Selenium	NA	NA	NA	NA	Selenium	Various	NA	NA	4.35E-04	4.4E-04
			Thallium	NA	NA	NA	NA	Thallium	Blood	NA	NA	1.56E+00	1.6E+00
			Trichloroethene	NA	9.9E-09	2.2E-08	3.2E-08	Trichloroethene	N/A	NA	1.74E-04	1.30E-02	1.3E-02
						Total Risk Across Groundwater	**1.1E-06**					**Total Hazard Quotient Across Groundwater**	**4.8E+00**
Surface Water	Surface Water	Wetlands	Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	1.8E-03	1.8E-03
						Total Risk Across Surface Water	**0.0E+00**					**Total Hazard Quotient Across Surface Water**	**1.8E-03**
						Total Risk Across All Media and All Exposure Routes	**3E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**5.2**

Total [Kidney] HI =	**1.9**
Total [Blood] HI =	**1.6**

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TABLE 6.6
CALCULATION OF BLOOD LEAD CONCENTRATIONS FROM INGESTED GROUNDWATER
FUTURE INDUSTRIAL WORKER
Peter Cooper Markhams Site
Town of Dayton, New York

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee
Version date 05/19/03

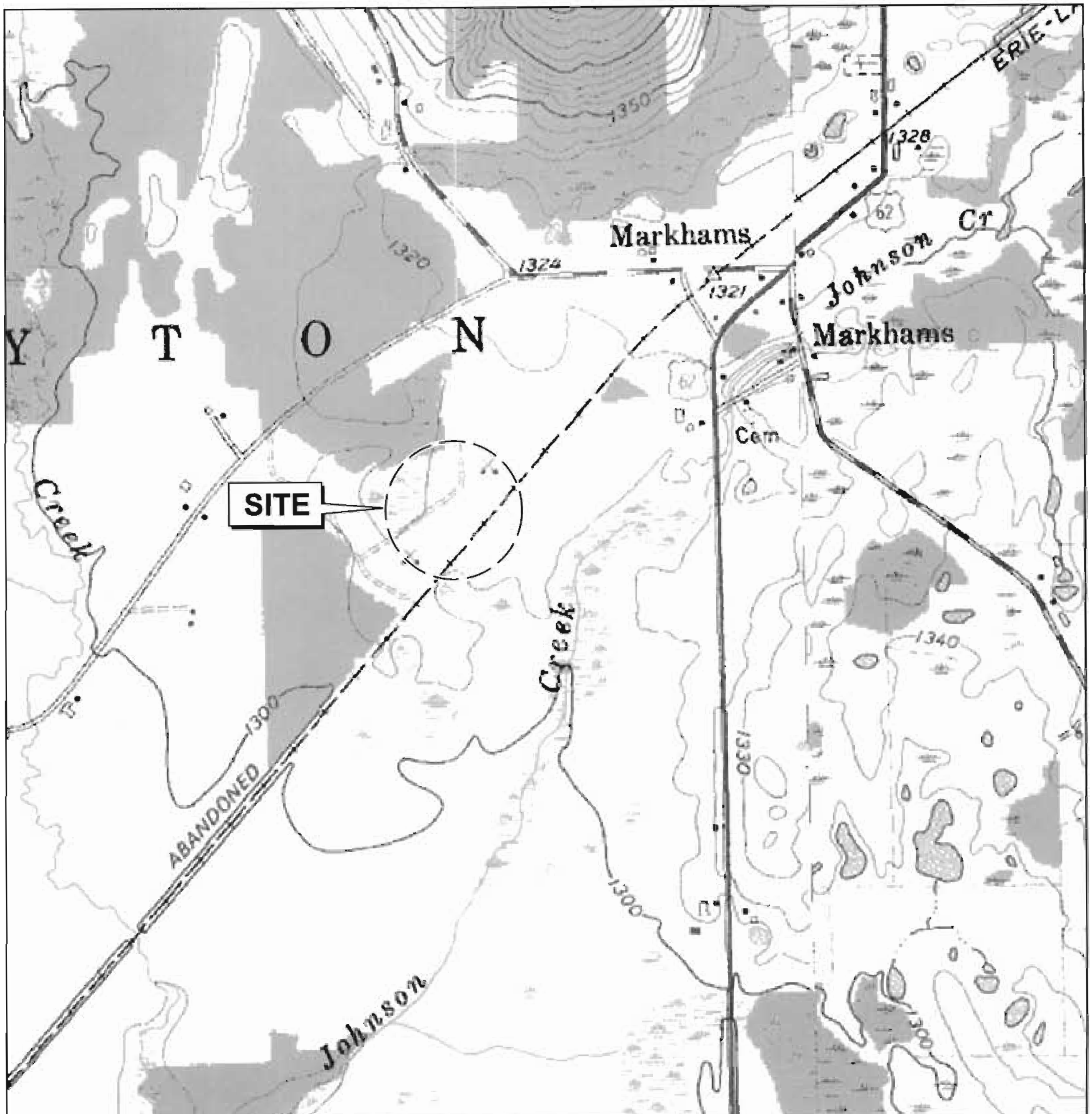
Exposure Variable	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario — U.S. EPA Default[2] — Including MW-2S: GSDi = Hom	Including MW-2S: GSDi = Het	Without MW-2S: GSDi = Hom	Without MW-2S: GSDi = Het
PbS	Groundwater lead concentration	ug/L	1020	1020	10.7	10.7
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.1	2.3	2.1	2.3
PbB_0	Baseline PbB	ug/dL	1.5	1.7	1.5	1.7
IR_S	Water ingestion rate	L/day	1.0	1.0	1.0	1.0
$AF_{S,D}$	Absorption fraction - soluble lead	--	0.20	0.20	0.20	0.20
$EF_{S,D}$	Exposure frequency	days/yr	225	225	225	225
$AT_{S,D}$	Averaging time	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**51.8**	**52.0**	**2.0**	**2.2**
$PbB_{fetal,0.95}$	**95th percentile PbB among fetuses of adult workers**	**ug/dL**	**158.0**	**184.2**	**6.2**	**7.9**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**	**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**98.1%**	**96.8%**	**1.1%**	**2.7%**

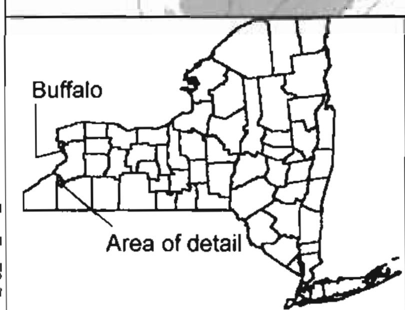
[1] Methodology adjusted from the Adult Lead Model for Exposures to Lead in Soil (U.S. EPA, 2003c).
[2] Uses EPA recommended default parameters (BKSF and AF) (U.S. EPA, 2003c).

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$
$PbB_{fetal,0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

FIGURES





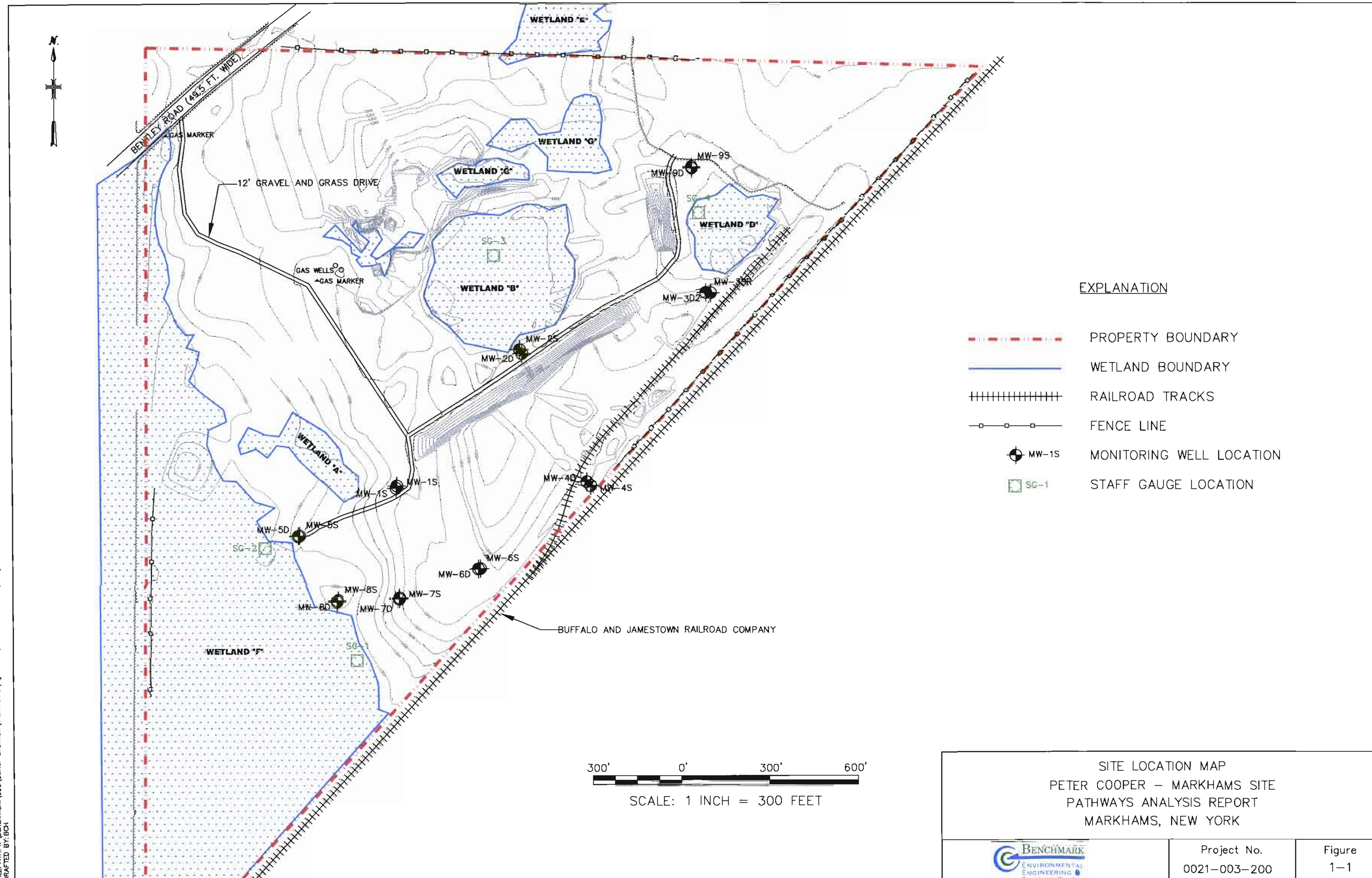
0 .25 mile

Source: USGS Topograhic maps. Topozone.com

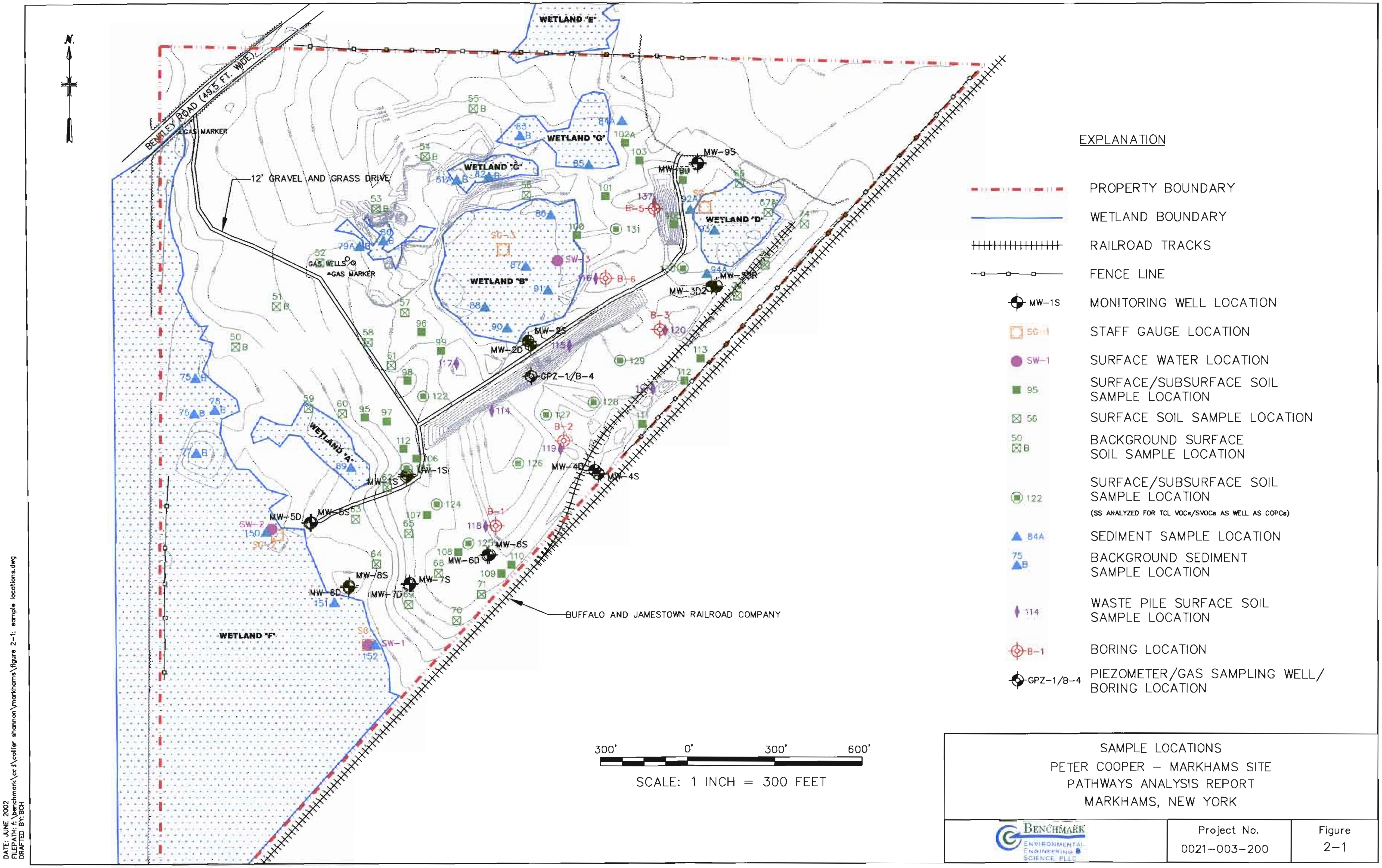
SITE VICINITY MAP
Peter Cooper – Markhams Site
Markhams, New York

By: RCH	Date: 07/12/06	Project No. 7603.001
Geomatrix		Figure 1

S:\7600s\7603\7603.001\task_HRA_fig_01_site_location.ai.ai



DATE: JUNE 2002
FILEPATH: f:\benchmark\cad\collier shannon\markhams\figure 1-1; site location map.dwg
DRAFTED BY: BCH


N
BENTLEY ROAD (49.5 FT. WIDE)
GAS MARKER
12' GRAVEL AND GRASS DRIVE
GAS WELLS
GAS MARKER
WETLAND "A"
WETLAND "B"
WETLAND "C"
WETLAND "D"
WETLAND "E"
WETLAND "F"
WETLAND "G"
MW-1S
MW-2S
MW-2D
MW-3D2
MW-4D
MW-4S
MW-5D
MW-5S
MW-6S
MW-6D
MW-7S
MW-7D
MW-8S
MW-8D
MW-9S
GPZ-1/B-4
B-1
B-2
B-3
B-5
B-6
SW-1
SW-2
SW-3
SG-1
SG-3
BUFFALO AND JAMESTOWN RAILROAD COMPANY
EXPLANATION
PROPERTY BOUNDARY
WETLAND BOUNDARY
RAILROAD TRACKS
FENCE LINE
MW-1S MONITORING WELL LOCATION
SG-1 STAFF GAUGE LOCATION
SW-1 SURFACE WATER LOCATION
95 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION
56 SURFACE SOIL SAMPLE LOCATION
50 B BACKGROUND SURFACE SOIL SAMPLE LOCATION
122 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION
(SS ANALYZED FOR TCL VOCs/SVOCs AS WELL AS COPCs)
84A SEDIMENT SAMPLE LOCATION
75 B BACKGROUND SEDIMENT SAMPLE LOCATION
114 WASTE PILE SURFACE SOIL SAMPLE LOCATION
B-1 BORING LOCATION
GPZ-1/B-4 PIEZOMETER/GAS SAMPLING WELL/ BORING LOCATION
300' 0' 300' 600'
SCALE: 1 INCH = 300 FEET
SAMPLE LOCATIONS
PETER COOPER – MARKHAMS SITE
PATHWAYS ANALYSIS REPORT
MARKHAMS, NEW YORK
BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC
Project No. 0021-003-200
Figure 2-1
DATE: JUNE 2002
FILEPATH: f:\benchmark\cr1\collier shannon\markhams\figure 2-1; sample locations.dwg
DRAFTED BY: BCH

APPENDIX A

Summary of Analytical Results Used to Calculate Exposure Point Concentrations – Soil, Groundwater, Surface Water, and Sediment

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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Sample Type	Benzo(a)pyrene	Arsenic	Chromium	Hexavalent Chromium
Lathe #129	-098	10/12/2001	Soil Surface	<0.33U	9.2	66.5	<0.45U
Lathe #128	-100	10/12/2001	Soil Surface	0.034	35.6	8990	<0.57U
Lathe #127	-102	10/12/2001	Soil Surface	0.031	55.1	11800	<0.64U
Lathe #126	-104	10/12/2001	Soil Surface	0.071	12.4	4460	<0.57U
Lathe #130	-106	10/12/2001	Soil Surface		10	3050	<0.45U
DUP of -106	-107	10/12/2001	Soil Surface	0.033			
Lathe #131	-109	10/12/2001	Soil Surface	<0.33U	8.2	36.3	<0.52U
Lathe #124	-111	10/12/2001	Soil Surface	<0.33U	9	43	<0.49U
Lathe #125	-113	10/12/2001	Soil Surface	<0.33U	9.7	13.7	<0.46U
Lathe #123	-115	10/12/2001	Soil Surface	<0.33U	9.2	85.6	<0.47U
Lathe #106	-029	10/10/2001	Soil Surface		8.3	19700	<0.93UJ
Lathe #107	-036	10/10/2001	Soil Surface		10.1	652	<0.48UJ
Lathe #108	-039	10/10/2001	Soil Surface		8.8	16.4	<0.49UJ
Lathe #109	-045	10/10/2001	Soil Surface		10.1	14	<0.48UJ
Lathe #110	-047	10/10/2001	Soil Surface		6.7	15.8	<0.5UJ
Lathe #97	-049	10/10/2001	Soil Surface		9.1	14.2	<0.48UJ
Lathe #95	-051	10/10/2001	Soil Surface		7.7	16.2	<0.5UJ
Lathe #98	-056	10/10/2001	Soil Surface		3.7	13.9	<0.53UJ
Lathe #96	-061	10/10/2001	Soil Surface		8.8	13.9	<0.63UJ
Lathe #99	-063	10/10/2001	Soil Surface		7.4	36	<0.51UJ
Lathe #105A	-070	10/10/2001	Soil Surface		19	11000	<0.58UJ
Lathe #104	-072	10/10/2001	Soil Surface		10.9	48	<0.45UJ
Lathe #103	-075	10/10/2001	Soil Surface		17.6	16.6	<0.45UJ
Lathe #102A	-077	10/10/2001	Soil Surface		9.9	14.8	<0.47UJ
Lathe #101	-079	10/10/2001	Soil Surface		8.1	16.7	<0.5UJ
Lathe #100	-081	10/10/2001	Soil Surface		7.9	60.1	<0.48UJ
Lathe #113	-089	10/10/2001	Soil Surface		12.6	4820	<1.3UJ
Lathe #112	-091	10/10/2001	Soil Surface		9.2	398	<0.66UJ
Lathe #111	-094	10/10/2001	Soil Surface		11.5	1150	<0.47UJ
DUP of -094	-095	10/10/2001	Soil Surface				
Lathe #129	-099	10/12/2001	Soil Surface		8.4	36.7	<0.45UJ
Lathe #128	-101	10/12/2001	Soil Surface		28.9	6460	<0.58UJ
Lathe #127	-103	10/12/2001	Soil Surface		26.8	12400	<0.68UJ
Lathe #126	-105	10/12/2001	Soil Surface		16.1	7850	<0.6UJ
Lathe #130	-108	10/12/2001	Soil Surface		8.4	341	<0.48UJ
Lathe #131	-110	10/12/2001	Soil Surface		11.1	30.8	<0.45UJ
Lathe #124	-112	10/12/2001	Soil Surface		9.8	17.3	<0.7UJ
Lathe #125	-114	10/12/2001	Soil Surface		7.9	15.2	<0.49UJ
Lathe #123	-116	10/12/2001	Soil Surface		9.5		
DUP of -116	-117	10/12/2001	Soil Surface			12800	<0.69UJ
Lathe #122	-119	10/12/2001	Soil Surface		6	126	<0.78UJ
Lathe #118	-037	10/10/2001	Top Fill		9.5	2840	<0.62U

APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Sample Type	Benzo(a)pyrene	Arsenic	Chromium	Hexavalent Chromium
Lathe #117	-064	10/11/2001	Top Fill		**5.8**	**35900**	<0.93UJ
Lathe #114	-065	10/11/2001	Top Fill		**30.2**	**28000**	<11.6U
Lathe #115	-066	10/11/2001	Top Fill		**18**	**18100**	<0.6U
Lathe #116	-067	10/11/2001	Top Fill		**10.3**	**13100**	<3.4U
Lathe #137	-068	10/11/2001	Top Fill		**13.1**	**1440**	<0.51U
Lathe #121	-092	10/11/2001	Top Fill		**7.1**	**65300**	<0.89U
Lathe #119	-096	10/11/2001	Top Fill		**16.9**	**2110**	<0.48U
Lathe #120	-097	10/11/2001	Top Fill		**95.5**	**29200**	<20.3U
Lathe #122	-118	10/12/2001	Soil Surface	<0.33U	**12.7**	**1150**	<2U
Lathe #113		12/3/2003	Top Fill			**4760**	**19.8**
Lathe #112		12/3/2003	Top Fill			**1230**	**3.8**
Lathe #117		12/4/2003	Top Fill			**20600**	**6.8**
Lathe #115		12/3/2003	Top Fill			**13300**	**51.8**
Lathe #137		12/3/2003	Top Fill			**1480**	**5.4**
Lathe #121		12/3/2003	Top Fill			**28000**	**18.2**
Lathe #120		12/3/2003	Top Fill			**22800**	**63.3**
Lathe #128		12/3/2003	Soil Surface			**8800**	**33**
Lathe #127		12/3/2003	Soil Surface			**2600**	**3.8**
Lathe #123		12/4/2003	Soil Surface			**58**	**2.5**
Lathe #122		12/4/2003	Soil Surface			**11600**	**7.7**
Lathe #107		12/3/2003	Soil Surface			**8970**	**29.6**
52		8/30/1988	Soil Surface		**4.7**	**46**	<0.1
S-8		6/93	Soil Surface		**7.7**	**19.8**	
			Count	10	50	62	61
			Number of Detects	4	50	62	12
			Number of Non-Detects	6	0	0	49
			Maximum Detection	0.071	95.5	65300	63.3
			Minimum Detection	0.031	3.7	13.7	2.5
			Maximum Detection Limit	0.33	0	0	20.3
			Minimum Detection Limit	0.33	0	0	0.1

Notes:
Bold values are concentrations detected about the reporting limit.
"<" indicates the chemical was not detected above the reporting limit shown.

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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Sample Type	Benzo(a)pyrene	Arsenic	Chromium	Hexavalent Chromium	Manganese
Lathe #129	-098	10/12/2001	Soil Surface	<0.33U	9.2	66.5	<0.45U	
Lathe #128	-100	10/12/2001	Soil Surface	0.034	35.6	8990	<0.57U	
Lathe #127	-102	10/12/2001	Soil Surface	0.031	55.1	11800	<0.64U	
Lathe #126	-104	10/12/2001	Soil Surface	0.071	12.4	4460	<0.57U	
Lathe #130	-106	10/12/2001	Soil Surface		10	3050	<0.45U	
DUP of -106	-107	10/12/2001	Soil Surface	0.033				
Lathe #131	-109	10/12/2001	Soil Surface	<0.33U	8.2	36.3	<0.52U	
Lathe #124	-111	10/12/2001	Soil Surface	<0.33U	9	43	<0.49U	
Lathe #125	-113	10/12/2001	Soil Surface	<0.33U	9.7	13.7	<0.46U	
Lathe #123	-115	10/12/2001	Soil Surface	<0.33U	9.2	85.6	<0.47U	
Lathe #106	-029	10/10/2001	Soil Surface		8.3	19700	<0.93UJ	
Lathe #107	-036	10/10/2001	Soil Surface		10.1	652	<0.48UJ	
Lathe #108	-039	10/10/2001	Soil Surface		8.8	16.4	<0.49UJ	
Lathe #109	-045	10/10/2001	Soil Surface		10.1	14	<0.48UJ	
Lathe #110	-047	10/10/2001	Soil Surface		6.7	15.8	<0.5UJ	
Lathe #97	-049	10/10/2001	Soil Surface		9.1	14.2	<0.48UJ	
Lathe #95	-051	10/10/2001	Soil Surface		7.7	16.2	<0.5UJ	
Lathe #98	-056	10/10/2001	Soil Surface		3.7	13.9	<0.53UJ	
Lathe #96	-061	10/10/2001	Soil Surface		8.8	13.9	<0.63UJ	
Lathe #99	-063	10/10/2001	Soil Surface		7.4	36	<0.51UJ	
Lathe #105A	-070	10/10/2001	Soil Surface		19	11000	<0.58UJ	
Lathe #104	-072	10/10/2001	Soil Surface		10.9	48	<0.45UJ	
Lathe #103	-075	10/10/2001	Soil Surface		17.6	16.6	<0.45UJ	
Lathe #102A	-077	10/10/2001	Soil Surface		9.9	14.8	<0.47UJ	
Lathe #101	-079	10/10/2001	Soil Surface		8.1	16.7	<0.5UJ	
Lathe #100	-081	10/10/2001	Soil Surface		7.9	60.1	<0.48UJ	
Lathe #113	-089	10/10/2001	Soil Surface		12.6	4820	<1.3UJ	
Lathe #112	-091	10/10/2001	Soil Surface		9.2	398	<0.66UJ	
Lathe #111	-094	10/10/2001	Soil Surface		11.5	1150	<0.47UJ	
DUP of -094	-095	10/10/2001	Soil Surface					
Lathe #129	-099	10/12/2001	Soil Surface		8.4	36.7	<0.45UJ	
Lathe #128	-101	10/12/2001	Soil Surface		28.9	6460	<0.58UJ	
Lathe #127	-103	10/12/2001	Soil Surface		26.8	12400	<0.68UJ	
Lathe #126	-105	10/12/2001	Soil Surface		16.1	7850	<0.6UJ	
Lathe #130	-108	10/12/2001	Soil Surface		8.4	341	<0.48UJ	
Lathe #131	-110	10/12/2001	Soil Surface		11.1	30.8	<0.45UJ	
Lathe #124	-112	10/12/2001	Soil Surface		9.8	17.3	<0.7UJ	
Lathe #125	-114	10/12/2001	Soil Surface		7.9	15.2	<0.49UJ	
Lathe #123	-116	10/12/2001	Soil Surface		9.5			

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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Sample Type	Benzo(a)pyrene	Arsenic	Chromium	Hexavalent Chromium	Manganese
DUP of -116	-117	10/12/2001	Soil Surface			12800	<0.69UJ	
Lathe #122	-119	10/12/2001	Soil Surface		6	126	<0.78UJ	
Lathe #118	-037	10/10/2001	Top Fill		9.5	2840	<0.62U	
Lathe #117	-064	10/11/2001	Top Fill		5.8	35900	<0.93U	
Lathe #114	-065	10/11/2001	Top Fill		30.2	28000	<11.6U	
Lathe #115	-066	10/11/2001	Top Fill		18	18100	<0.6U	
Lathe #116	-067	10/11/2001	Top Fill		10.3	13100	<3.4U	
Lathe #137	-068	10/11/2001	Top Fill		13.1	1440	<0.51U	
Lathe #121	-092	10/11/2001	Top Fill		7.1	65300	<0.89U	
Lathe #119	-096	10/11/2001	Top Fill		16.9	2110	<0.48U	
Lathe #120	-097	10/11/2001	Top Fill		95.5	29200	<20.3U	
B-4; 4-5 fbgs	-011	10/5/2001	Fill Piles					
DUP of -011	-012	10/5/2001	Fill Piles		10.5	11200	<0.69U	
B-5; 4-5 fbgs	-018	10/9/2001	Fill Piles		51.6	4490	<0.65U	
B-6; 5.5-6.5 fbgs	-022	10/9/2001	Fill Piles		65.6	6390	<0.66U	
MW-8S; 6-10 fbgs	-008	10/4/2001	mw soils					561
MW-8S; 4-6 fbgs	-007	10/4/2001	mw soils		12.7	12.6	<0.46UJ	
4 Borings/MW-8	-026	10/9/2001	mw soils					
B-1; 9-10 fbgs	-003	10/2/2001	mw soils		8.1	32.5	<0.44UJ	
B-1; 10-11 fbgs	-004	10/2/2001	mw soils		11.3	65.1	<0.43UJ	
B-5; 8-9 fbgs	-019	10/9/2001	mw soils		9.2	18.4	<0.43UJ	
B-5; 9-10 fbgs	-020	10/9/2001	mw soils		7.6	12.4	<0.45UJ	
B-6; 6.5-7.5 fbgs	-023	10/9/2001	mw soils		8	43.9	<0.46UJ	
B-6; 7.5-8.5 fbgs	-024	10/9/2001	mw soils		8.9	5860	<0.47UJ	
B-6; 9-11 fbgs	-025	10/9/2001	mw soils		11.7	36.9	<0.45UJ	
Lathe #122	-118	10/12/2001	Soil Surface	<0.33	12.7	1150	<2U	
Lathe #113		12/3/2003	Top Fill			4760	19.8	
Lathe #112		12/3/2003	Top Fill			1230	3.8	
Lathe #117		12/4/2003	Top Fill			20600	6.8	
Lathe #115		12/3/2003	Top Fill			13300	51.8	
Lathe #137		12/3/2003	Top Fill			1480	5.4	
Lathe #121		12/3/2003	Top Fill			28000	18.2	
Lathe #120		12/3/2003	Top Fill			22800	63.3	
Lathe #128		12/3/2003	Soil Surface			8800	33	
Lathe #127		12/3/2003	Soil Surface			2600	3.8	
Lathe #123		12/4/2003	Soil Surface			58	2.5	
Lathe #122		12/4/2003	Soil Surface			11600	7.7	
Lathe #107		12/3/2003	Soil Surface			8970	29.6	
B-4; 4-5 fbgs		12/3/2003	Fill Piles			31200	4.7	
52		8/30/1988	Soil Surface		4.7	46	<0.1	
S-8		6/93	Soil Surface		7.7	19.8		

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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Sample Type	Benzo(a)pyrene	Arsenic	Chromium	Hexavalent Chromium	Manganese
			Count	10	61	74	73	1
			Number of Detects	4	61	74	13	1
			Number of Non-Detects	6	0	0	60	0
			Maximum Detection	0.071	95.5	65300	63.3	561
			Minimum Detection	0.031	3.7	12.4	2.5	561
			Maximum Detection Limit	0.33	0	0	20.3	0
			Minimum Detection Limit	0.33	0	0	0.43	0

Notes:
Bold values are concentrations detected about the reporting limit.
"<" indicates the chemical was not detected above the reporting limit shown.

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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Date Collected	Sample ID	Benzene	Trichloro-ethene	Benzo(b)-fluoranthene	Bis(2-ethylhexyl) phthalate	Aluminum	Antimony	Arsenic	Barium
MW-1S	11/7/2001	-171	<10U	<10U	<10U	<10U	<200U	<60U	<10U	<200U
MW-2S	11/7/2001	-170	NA	NA	NA	NA	**36400**	**72.6**	**133**	**517**
MW-3SR	11/6/2001	-161	<10U	<10U	<10U	<10U	**654**	<60U	<10U	<200U
MW-5S	11/7/2001	-168	<10U	<10U	<10U	<10U	<200U	<60U	<10U	<200U
MW-6S	11/8/2001	-181	<10U	<10U	<10U	**5**	**499**	<60U	<10U	<200U
MW-7S	11/8/2001	-178	<10U	<10U	<10U	<10U	**382**	<60U	<10h	<200U
MW-8S HV			<10U	**4.2**	**0.6**	<10U	<200U	<60U	<10U	<200U
MW-1S	4/23/2002	-196	**0.22**	<1U	NA	NA	NA	NA	<10U	NA
MW-2S	4/23/2002	-193	**1.8**	<1U	<10U	<10U	**563**	<60U	<10U	<200U
MW-3SR	4/22/2002	-190	<1U	<1U	NA	NA	NA	NA	<10U	NA
MW-4S	4/24/2002	-202	<1U	<1U	NA	NA	NA	NA	<10U	NA
MW-5S	4/25/2002	-209	<1U	<1U	NA	NA	NA	NA	<10U	NA
MW-6S	4/24/2002	-208	<1U	<1U	NA	NA	NA	NA	<10U	NA
MW-7S	4/24/2002	-205	<1U	<1U	NA	NA	NA	NA	<10U	NA
MW-8S HV	4/23/2002	-198	<1U	**2.8**	<10U	<10U	NA	NA	<10U	NA
		Count	14	14	8	8	8	8	15	8
		Number of Detects	2	2	1	1	5	1	1	1
		Number of Non-Detects	12	12	7	7	3	7	14	7
		Maximum Detection	1.8	4.2	0.6	5	36400	72.6	133	517
		Minimum Detection	0.22	2.8	0.6	5	382	72.6	133	517
		Maximum Detection Limit	10	10	10	10	200	60	10	200
		Minimum Detection Limit	1	1	10	10	200	60	10	200

Notes:
Bold values are concentrations detected about the reporting limit.
"<" indicates the chemical was not detected above the reporting limit shown.

APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Date Collected	Sample ID	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Selenium	Thallium	Zinc
MW-1S	11/7/2001	-171	<5U	<50U	<25U	**11100**	**10.7**	**15000**	<40UE	<5U	<10UE	<20UN
MW-2S	11/7/2001	-170	**50.1**	**251**	**2220**	**3160000**	**1020**	**9800**	**2820**	**39.2**	**1300**	**146000**
MW-3SR	11/6/2001	-161	<5U	<50U	<25U	**827**	<3UE	**33.7**	<40UE	<5U	<10UE	<20UN
MW-5S	11/7/2001	-168	<5U	<50U	<25U	**267**	<3UE	**210**	<40UE	<5U	<10UE	<20UN
MW-6S	11/8/2001	-181	<5U	<50U	<25U	**1070**	**9.7**	**13500**	<40UE	<5U	<10UE	**36.1**
MW-7S	11/8/2001	-178	<5U	<50U	<25U	**11000**	<3UE	**254**	<40UE	<5U	<10UE	<20UN
MW-8S HV			<5U	<50U	<25U	**218**	<3UE	**4220**	<40UE	<5U	<10UE	<20UN
MW-1S	4/23/2002	-196	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-2S	4/23/2002	-193	<5U	<50U	<25U	**94300**	**29.1**	**804**	**83.4**	**7.2**	**13.5**	**3090**
MW-3SR	4/22/2002	-190	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-4S	4/24/2002	-202	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-5S	4/25/2002	-209	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-6S	4/24/2002	-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-7S	4/24/2002	-205	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-8S HV	4/23/2002	-198	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Count			8	8	8	8	8	8	8	8	8	8
Number of Detects			1	1	1	8	4	8	2	2	2	3
Number of Non-Detects			7	7	7	0	4	0	6	6	6	5
Maximum Detection			50.1	251	2220	3160000	1020	15000	2820	39.2	1300	146000
Minimum Detection			50.1	251	2220	218	9.7	33.7	83.4	7.2	13.5	36.1
Maximum Detection Limit			5	50	25	0	3	0	40	5	10	20
Minimum Detection Limit			5	50	25	0	3	0	40	5	10	20

Notes:
Bold values are concentrations detected about the reporting limit.
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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Date Collected	Sample ID	Benzene	Trichloro-ethene	Benzo(b)-fluoranthene	Bis(2-ethylhexyl) phthalate	Aluminum	Antimony	Arsenic	Barium
MW-1S	11/7/2001	-171	<10	<10	<10	<10	<200	<60	<10	<200
MW-3SR	11/6/2001	-161	<10	<10	<10	<10	**654**	<60	<10	<200
MW-5S	11/7/2001	-168	<10	<10	<10	<10	<200	<60	<10	<200
MW-6S	11/8/2001	-181	<10	<10	<10	**5**	**499**	<60	<10	<200
MW-7S	11/8/2001	-178	<10	<10	<10	<10	**382**	<60	<10	<200
MW-8S HV			<10	**4.2**	**0.6**	<10	<200	<60	<10	<200
MW-1S	4/23/2002	-196	**0.22**	<1	NA	NA	NA	NA	<10	NA
MW-3SR	4/22/2002	-190	<1	<1	NA	NA	NA	NA	<10	NA
MW-4S	4/24/2002	-202	<1	<1	NA	NA	NA	NA	<10	NA
MW-5S	4/25/2002	-209	<1	<1	NA	NA	NA	NA	<10	NA
MW-6S	4/24/2002	-208	<1	<1	NA	NA	NA	NA	<10	NA
MW-7S	4/24/2002	-205	<1	<1	NA	NA	NA	NA	<10	NA
MW-8S HV	4/23/2002	-198	<1	**2.8**	<10	<10	NA	NA	<10	NA
		Count	13	13	7	7	6	6	13	6
		Number of Detects	1	2	1	1	3	0	0	0
		Number of Non-Detects	12	11	6	6	3	6	13	6
		Maximum Detection	0.22	4.2	0.6	5	654	0	0	0
		Minimum Detection	0.22	2.8	0.6	5	382	0	0	0
		Maximum Detection Limit	10	10	10	10	200	60	10	200
		Minimum Detection Limit	1	1	10	10	200	60	10	200

Notes:
Bold values are concentrations detected about the reporting limit.
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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Date Collected	Sample ID	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Selenium	Thallium	Zinc
MW-1S	11/7/2001	-171	<5	<50	<25	**11100**	**10.7**	**15000**	<40	<5	<10	<20
MW-3SR	11/6/2001	-161	<5	<50	<25	**827**	<3	**33.7**	<40	<5	<10	<20
MW-5S	11/7/2001	-168	<5	<50	<25	**267**	<3	**210**	<40	<5	<10	<20
MW-6S	11/8/2001	-181	<5	<50	<25	**1070**	**9.7**	**13500**	<40	<5	<10	**36.1**
MW-7S	11/8/2001	-178	<5	<50	<25	**11000**	<3	**254**	<40	<5	<10	<20
MW-8S HV			<5	<50	<25	**218**	<3	**4220**	<40	<5	<10	<20
MW-1S	4/23/2002	-196	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-3SR	4/22/2002	-190	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-4S	4/24/2002	-202	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-5S	4/25/2002	-209	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-6S	4/24/2002	-208	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-7S	4/24/2002	-205	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-8S HV	4/23/2002	-198	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Count	6	6	6	6	6	6	6	6	6	6
		Number of Detects	0	0	0	6	2	6	0	0	0	1
		Number of Non-Detects	6	6	6	0	4	0	6	6	6	5
		Maximum Detection	0	0	0	11100	10.7	15000	0	0	0	36.1
		Minimum Detection	0	0	0	218	9.7	33.7	0	0	0	36.1
		Maximum Detection Limit	5	50	25	0	3	0	40	5	10	20
		Minimum Detection Limit	5	50	25	0	3	0	40	5	10	20

Notes:
Bold values are concentrations detected about the reporting limit.
"<" indicates the chemical was not detected above the reporting limit shown.

APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Aluminum	Barium	Iron	Manganese	Total Hexavalent Chromium
MW-1D	-173	11/7/2001	**320**	<200U	**15500**	**268**	<10UJ
MW-2D	-163	11/6/2001	**5660**	**519**	**7850**	**299**	<10000U
MW-3D2	-162	11/6/2001	<200U	<200U	**413**	**72.1**	<10UJ
MW-4D	-160	11/5/2001	<200U	<200U	**1090**	**297**	<10UJ
MW-5D	-169	11/7/2001	**232**	**230**	**14100**	**812**	**321**
MW-6D	-180	11/8/2001	<200U	<200U	**4340**	**2330**	<10UJ
MW-7D	-177	11/8/2001	**819**	<200U	**10200**	**337**	<10UJ
MW-8D	-167	11/6/2001	**2060**	**314**	**2660**	**114**	<10000U
MW-1D	-194	4/23/2002	NA	NA	NA	NA	<10UJ
MW-2D	-192	4/23/2002	NA	NA	NA	NA	<10UJ
MW-3D2	-191	4/22/2002	NA	NA	NA	NA	<10UJ
MW-4D	-201	4/24/2002	NA	NA	NA	NA	<10UJ
MW-5D	-211	4/26/2002	NA	NA	NA	NA	<10UJ
MW-6D	-207	4/24/2002	NA	NA	NA	NA	<10UJ
MW-7D	-203	4/24/2002	NA	NA	NA	NA	<10UJ
MW-8D	-200	4/23/2002	NA	NA	NA	NA	<10UJ
		Count	8	8	8	8	16
		Number of Detects	5	3	8	8	1
		Number of Non-Detects	3	5	0	0	15
		Maximum Detection	5660	519	15500	2330	321
		Minimum Detection	232	230	413	72.1	321
		Maximum Detection Limit	200	200	0	0	10000
		Minimum Detection Limit	200	200	0	0	10

Notes:
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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Chromium	Hexavalent Chromium
Surface Water #1	-186	12/3/2001	<10U	<10UJ
Surface Water #2	-184	12/3/2001	<10UJ	
Surface Water #2	-185-DUP	12/3/2001		**14**
Surface Water #1	-206	4/24/2002	<10	<10
Surface Water #2	-212	4/25/2002		
Surface Water #3	-214	4/25/2002	<10	**10**
Surface Water #4	-215	4/25/2002	<10	<10
Surface Water #2	-213 DUP	4/25/2002	**13.8**	**11.8**
Surface Water #3	-183	12/3/2001	<10U	<10UJ
		Count	7	7
		Number of Detects	1	3
		Number of Non-Detects	6	4
		Maximum Detection	13.8	14
		Minimum Detection	13.8	10
		Maximum Detection Limit	10	10
		Minimum Detection Limit	10	10

Notes:
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APPENDIX A-1
SUMMARY OF ANALYTICAL RESULTS USED TO CALCULATE EXPOSURE POINT CALCULATIONS
SURFACE SOIL
Peter Cooper - Markhams Site
Town of Dayton, NY
(Concentrations reported in mg/kg)

Sample Location	Sample ID	Date	Arsenic
Lathe #94A	-120	10/15/2001	**11.4**
Lathe #93	-121	10/15/2001	**8.6**
Lathe #92A	-122	10/15/2001	**9**
Lathe #84A	-123	10/15/2001	**3.8**
Lathe #86	-124	10/15/2001	<6.6U
Lathe #85	-125	10/15/2001	**2.3**
Lathe #87	-126	10/15/2001	**6.3**
Lathe #88	-127	10/15/2001	<6.8U
Lathe #90	-128	10/15/2001	<5.9U
Lathe #91	-129	10/15/2001	<6.7U
Lathe #150	-130	10/15/2001	**4.5**
Lathe #151	-131	10/15/2001	<3.2U
Lathe #152	-132	10/15/2001	**3.9**
Lathe #89	-133	10/15/2001	**6.4**
Lathe #93		12/3/2003	
Lathe #85		12/3/2003	
Lathe #89		12/3/2003	
Count			14
Number of Detects			9
Number of Non-Detects			5
Maximum Detection			11.4
Minimum Detection			2.3
Maximum Detection Limit			6.8
Minimum Detection Limit			3.2

Notes:
Bold values are concentrations detected about the reporting limit.
"<" indicates the chemical was not detected above the reporting limit shown.

APPENDIX B

ProUCL Output – Calculation of Exposure Point Concentrations

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APPENDIX B-1
ProUCL Output
Arsenic - Surface Soil
Peter Cooper - Markhams Site

Data File

Raw Statistics	
Number of Valid Samples	50
Number of Unique Samples	42
Minimum	3.7
Maximum	95.5
Mean	14.204
Median	9.6
Standard Deviation	14.74532
Variance	217.42447
Coefficient of Variation	1.0381104
Skewness	4.0900705

Gamma Statistics	
k hat	2.2919764
k star (bias corrected)	2.1677912
Theta hat	6.1972714
Theta star	6.5522916
nu hat	229.19764
nu star	216.77912
Approx.Chi Square Value (.05)	183.69734
Adjusted Level of Significance	0.0452
Adjusted Chi Square Value	182.79584

Log-transformed Statistics	
Minimum of log data	1.3083328
Maximum of log data	4.5591262
Mean of log data	2.4197866
Standard Deviation of log data	0.5905594
Variance of log data	0.3487604

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Variable: Arsenic

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.5321926
Shapiro-Wilk 5% Critical Value	0.947
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	17.700116

Gamma Distribution Test	
A-D Test Statistic	4.2164421
A-D 5% Critical Value	0.761154
K-S Test Statistic	0.23918
K-S 5% Critical Value	0.1266856
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	16.761977
Adjusted Gamma UCL	16.844643

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8687302
Shapiro-Wilk 5% Critical Value	0.947
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	15.768656
95% Chebyshev (MVUE) UCL	18.518836
97.5% Chebyshev (MVUE) UCL	20.763505
99% Chebyshev (MVUE) UCL	25.172724

95% Non-parametric UCLs	
CLT UCL	17.634019
Adj-CLT UCL (Adjusted for skewness)	18.922848
Mod-t UCL (Adjusted for skewness)	17.901148
Jackknife UCL	17.700116
Standard Bootstrap UCL	17.647224
Bootstrap-t UCL	21.047811
Hall's Bootstrap UCL	32.497388
Percentile Bootstrap UCL	17.906
BCA Bootstrap UCL	20.348
95% Che	23.293626
97.5% Chebyshev (Mean, Sd) UCL	27.226714
99% Chebyshev (Mean, Sd) UCL	34.952505

APPENDIX B-1
ProUCL Output
Benzo(a)pyrene - Surface Soil
Peter Cooper - Markhams Site

Data File | Variable: Benzo(a)pyrene

Raw Statistics		**Normal Distribution Test**	
Number of Valid Samples	10	Shapiro-Wilk Test Statisitic	0.6860114
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.842
Minimum	31	Data not normal at 5% significance level	
Maximum	165		
Mean	115.9	**95% UCL (Assuming Normal Distribution)**	
Median	165	Student's-t UCL	153.20278
Standard Deviation	64.350516		
Variance	4140.9889	**Gamma Distribution Test**	
Coefficient of Variation	0.5552245	A-D Test Statistic	1.5463176
Skewness	-0.579235	A-D 5% Critical Value	0.7340304
		K-S Test Statistic	0.3870175
Gamma Statistics		K-S 5% Critical Value	0.2691902
k hat	2.4557659	Data do not follow gamma distribution	
k star (bias corrected)	1.7857028	at 5% significance level	
Theta hat	47.195053		
Theta star	64.904418	**95% UCLs (Assuming Gamma Distribution)**	
nu hat	49.115318	Approximate Gamma UCL	179.6835
nu star	35.714056	Adjusted Gamma UCL	194.49719
Approx.Chi Square Value (.05)	23.036389		
Adjusted Level of Significance	0.0267	**Lognormal Distribution Test**	
Adjusted Chi Square Value	21.281844	Shapiro-Wilk Test Statisitic	0.6982376
		Shapiro-Wilk 5% Critical Value	0.842
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	3.4339872		
Maximum of log data	5.1059455	**95% UCLs (Assuming Lognormal Distribution)**	
Mean of log data	4.5355208	95% H-UCL	248.08129
Standard Deviation of log data	0.7701426	95% Chebyshev (MVUE) UCL	254.13843
Variance of log data	0.5931197	97.5% Chebyshev (MVUE) UCL	311.72188
		99% Chebyshev (MVUE) UCL	424.83343
		95% Non-parametric UCLs	
		CLT UCL	149.37182
		Adj-CLT UCL (Adjusted for skewness)	145.38903
		Mod-t UCL (Adjusted for skewness)	152.58155
		Jackknife UCL	153.20278
		Standard Bootstrap UCL	146.78617
		Bootstrap-t UCL	153.80225
RECOMMENDATION		Hall's Bootstrap UCL	143.19844
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	142.5
		BCA Bootstrap UCL	142.4
Use 95% Chebyshev (Mean, Sd) UCL		95% Che	204.60106
		97.5% Chebyshev (Mean, Sd) UCL	242.98209
		99% Chebyshev (Mean, Sd) UCL	318.37417

Recommended UCL exceeds the maximum observation

APPENDIX B-1
ProUCL Output
Chromium, Total - Surface Soil
Peter Cooper - Markhams Site

Data File

Variable: Chromium

Raw Statistics	
Number of Valid Samples	62
Number of Unique Samples	59
Minimum	13.7
Maximum	65300
Mean	6903.9113
Median	1190
Standard Deviation	11583.468
Variance	134176727
Coefficient of Variation	1.6778124
Skewness	2.7703747

Gamma Statistics	
k hat	0.2895294
k star (bias corrected)	0.2862726
Theta hat	23845.284
Theta star	24116.562
nu hat	35.901648
nu star	35.497805
Approx.Chi Square Value (.05)	22.862556
Adjusted Level of Significance	0.046129
Adjusted Chi Square Value	22.620819

Log-transformed Statistics	
Minimum of log data	2.6173958
Maximum of log data	11.086747
Mean of log data	6.4443279
Standard Deviation of log data	2.9106733
Variance of log data	8.4720189

RECOMMENDATION
Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.275978
Lilliefors 5% Critical Value	0.1125221
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	9360.9738

Gamma Distribution Test	
A-D Test Statistic	2.2551899
A-D 5% Critical Value	0.8685775
K-S Test Statistic	0.1854776
K-S 5% Critical Value	0.1229665
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	10719.435
Adjusted Gamma UCL	10833.988

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.1670484
Lilliefors 5% Critical Value	0.1125221
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	237813.33
95% Chebyshev (MVUE) UCL	118205.23
97.5% Chebyshev (MVUE) UCL	155489.17
99% Chebyshev (MVUE) UCL	228726.27

95% Non-parametric UCLs	
CLT UCL	9323.6586
Adj-CLT UCL (Adjusted for skewness)	9876.7104
Mod-t UCL (Adjusted for skewness)	9447.2387
Jackknife UCL	9360.9738
Standard Bootstrap UCL	9386.5068
Bootstrap-t UCL	10132.941
Hall's Bootstrap UCL	10477.638
Percentile Bootstrap UCL	9245.6806
BCA Bootstrap UCL	10520.977
95% Chebyshev (Mean, Sd) UCL	13316.296
97.5% Chebyshev (Mean, Sd) UCL	16090.94
99% Che	21541.19

APPENDIX B-1
ProUCL Output
Hexavalent Chromium - Surface Soil
Peter Cooper - Markhams Site

Geomatrix

Data File | Variable: Hexavalent Chromium

Raw Statistics	
Number of Valid Samples	61
Number of Unique Samples	39
Minimum	0.05
Maximum	63.3
Mean	4.5429508
Median	0.29
Standard Deviation	11.856071
Variance	140.56642
Coefficient of Variation	2.6097732
Skewness	3.618112

Gamma Statistics	
k hat	0.3515156
k star (bias corrected)	0.345157
Theta hat	12.923894
Theta star	13.161986
nu hat	42.884909
nu star	42.109148
Approx.Chi Square Value (.05)	28.231081
Adjusted Level of Significance	0.0460656
Adjusted Chi Square Value	27.955788

Log-transformed Statistics	
Minimum of log data	-2.995732
Maximum of log data	4.1478853
Mean of log data	-0.398042
Standard Deviation of log data	1.6864435
Variance of log data	2.8440916

RECOMMENDATION
Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.3715635
Lilliefors 5% Critical Value	0.1134407
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	7.0790194

Gamma Distribution Test	
A-D Test Statistic	10.223798
A-D 5% Critical Value	0.8512824
K-S Test Statistic	0.3757589
K-S 5% Critical Value	0.1227753
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	6.776212
Adjusted Gamma UCL	6.8429404

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.307604
Lilliefors 5% Critical Value	0.1134407
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	5.4149164
95% Chebyshev (MVUE) UCL	6.1365369
97.5% Chebyshev (MVUE) UCL	7.6494215
99% Chebyshev (MVUE) UCL	10.62119

95% Non-parametric UCLs	
CLT UCL	7.0398622
Adj-CLT UCL (Adjusted for skewness)	7.791266
Mod-t UCL (Adjusted for skewness)	7.1962232
Jackknife UCL	7.0790194
Standard Bootstrap UCL	7.0263727
Bootstrap-t UCL	8.8978553
Hall's Bootstrap UCL	8.3643773
Percentile Bootstrap UCL	7.2079508
BCA Bootstrap UCL	8.5863115
95% Chebyshev (Mean, Sd) UCL	11.159822
97.5% C	14.022947
99% Chebyshev (Mean, Sd) UCL	19.647003

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APPENDIX B-2
ProUCL Output
Arsenic - Subsurface Soil
Peter Cooper - Markhams Site

Data File | Variable: Arsenic

Raw Statistics	
Number of Valid Samples	61
Number of Unique Samples	50
Minimum	3.7
Maximum	95.5
Mean	15.006557
Median	9.7
Standard Deviation	15.736231
Variance	247.62896
Coefficient of Variation	1.0486236
Skewness	3.3959544

Gamma Statistics	
k hat	2.0916874
k star (bias corrected)	1.9997464
Theta hat	7.1743788
Theta star	7.5042301
nu hat	255.18586
nu star	243.96907
Approx.Chi Square Value (.05)	208.80028
Adjusted Level of Significance	0.0460656
Adjusted Chi Square Value	208.01668

Log-transformed Statistics	
Minimum of log data	1.3083328
Maximum of log data	4.5591262
Mean of log data	2.4507952
Standard Deviation of log data	0.6185476
Variance of log data	0.3826012

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.335102
Lilliefors 5% Critical Value	0.1134407
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	18.37261

Gamma Distribution Test	
A-D Test Statistic	6.1036284
A-D 5% Critical Value	0.7624765
K-S Test Statistic	0.2702667
K-S 5% Critical Value	0.1152361
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	17.534152
Adjusted Gamma UCL	17.600203

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.2121341
Lilliefors 5% Critical Value	0.1134407
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	16.39886
95% Chebyshev (MVUE) UCL	19.196753
97.5% Chebyshev (MVUE) UCL	21.449414
99% Chebyshev (MVUE) UCL	25.874332

95% Non-parametric UCLs	
CLT UCL	18.320638
Adj-CLT UCL (Adjusted for skewness)	19.256718
Mod-t UCL (Adjusted for skewness)	18.51862
Jackknife UCL	18.37261
Standard Bootstrap UCL	18.217541
Bootstrap-t UCL	20.367462
Hall's Bootstrap UCL	19.903239
Percentile Bootstrap UCL	18.429508
BCA Bootstrap UCL	20.501639
95% Chebyshev (Mean, Sd) UCL	23.788945
97.5% Chebyshev (Mean, Sd) UCL	27.589091
99% Chebyshev (Mean, Sd) UCL	35.053742

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APPENDIX B-2
ProUCL Output
Chromium, Total - Subsurface Soil
Peter Cooper - Markhams Site

Data File | Variable: Chromium

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	74	Lilliefors Test Statisitic	0.2782506
Number of Unique Samples	71	Lilliefors 5% Critical Value	0.1029954
Minimum	12.4	Data not normal at 5% significance level	
Maximum	65300		
Mean	6586.5446	95% UCL (Assuming Normal Distribution)	
Median	1150	Student's-t UCL	8751.6842
Standard Deviation	11179.641		
Variance	124984366	Gamma Distribution Test	
Coefficient of Variation	1.6973453	A-D Test Statistic	3.0703361
Skewness	2.7709755	A-D 5% Critical Value	0.8732843
		K-S Test Statistic	0.2066348
Gamma Statistics		K-S 5% Critical Value	0.1131137
k hat	0.282262	Data do not follow gamma distribution	
k star (bias corrected)	0.2798279	at 5% significance level	
Theta hat	23334.862		
Theta star	23537.837	95% UCLs (Assuming Gamma Distribution)	
nu hat	41.774774	Approximate Gamma UCL	9861.0732
nu star	41.414535	Adjusted Gamma UCL	9941.3214
Approx.Chi Square Value (.05)	27.66217		
Adjusted Level of Significance	0.0467568	Lognormal Distribution Test	
Adjusted Chi Square Value	27.438876	Lilliefors Test Statisitic	0.1852763
		Lilliefors 5% Critical Value	0.1029954
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	2.5176965		
Maximum of log data	11.086747	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	6.3253948	95% H-UCL	197672.68
Standard Deviation of log data	2.9277535	95% Chebyshev (MVUE) UCL	111193.14
Variance of log data	8.5717404	97.5% Chebyshev (MVUE) UCL	145859.89
		99% Chebyshev (MVUE) UCL	213956
		95% Non-parametric UCLs	
		CLT UCL	8724.2076
		Adj-CLT UCL (Adjusted for skewness)	9171.5182
		Mod-t UCL (Adjusted for skewness)	8821.4556
		Jackknife UCL	8751.6842
		Standard Bootstrap UCL	8717.6556
		Bootstrap-t UCL	9505.6426
RECOMMENDATION		Hall's Bootstrap UCL	9584.3466
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	8695.9108
		BCA Bootstrap UCL	10003.696
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	12251.399
		97.5% Chebyshev (Mean, Sd) UCL	14702.587
		99% Chebyshev (Mean, Sd) UCL	19517.469

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APPENDIX B-2
ProUCL Output
Hexavalent Chromium - Subsurface Soil
Peter Cooper - Markhams Site

Data File | Variable: Hexavalent Chromium

Raw Statistics	
Number of Valid Samples	73
Number of Unique Samples	43
Minimum	0.05
Maximum	63.3
Mean	3.8988356
Median	0.285
Standard Deviation	10.932932
Variance	119.52899
Coefficient of Variation	2.804153
Skewness	3.9962929

Gamma Statistics	
k hat	0.3564188
k star (bias corrected)	0.3509038
Theta hat	10.938918
Theta star	11.110838
nu hat	52.037141
nu star	51.231961
Approx.Chi Square Value (.05)	35.791127
Adjusted Level of Significance	0.0467123
Adjusted Chi Square Value	35.531357

Log-transformed Statistics	
Minimum of log data	-2.995732
Maximum of log data	4.1478853
Mean of log data	-0.520398
Standard Deviation of log data	1.6005461
Variance of log data	2.561748

RECOMMENDATION
Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Lilliefors Test Statisitic	0.3853738
Lilliefors 5% Critical Value	0.1036985
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	6.0310294

Gamma Distribution Test	
A-D Test Statistic	13.452051
A-D 5% Critical Value	0.8519004
K-S Test Statistic	0.3930937
K-S 5% Critical Value	0.1126052
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	5.5808523
Adjusted Gamma UCL	5.621654

Lognormal Distribution Test	
Lilliefors Test Statisitic	0.3282238
Lilliefors 5% Critical Value	0.1036985
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	3.6974389
95% Chebyshev (MVUE) UCL	4.4102877
97.5% Chebyshev (MVUE) UCL	5.4276527
99% Chebyshev (MVUE) UCL	7.4260693

95% Non-parametric UCLs	
CLT UCL	6.003595
Adj-CLT UCL (Adjusted for skewness)	6.6431111
Mod-t UCL (Adjusted for skewness)	6.130781
Jackknife UCL	6.0310294
Standard Bootstrap UCL	5.9742879
Bootstrap-t UCL	7.2246382
Hall's Bootstrap UCL	7.1106536
Percentile Bootstrap UCL	5.9961644
BCA Bootstrap UCL	7.2873973
95% Chebyshev (Mean, Sd) UCL	9.4764951
97.5% Chebyshev (Mean, Sd) UCL	11.889953
99% Chebyshev (Mean, Sd) UCL	16.630723

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APPENDIX B-3
ProUCL Output
Benzene - Shallow Groundwater
Peter Cooper - Markhams Site

Data File		Variable: Benzene	
Raw Statistics		**Normal Distribution Test**	
Number of Valid Samples	14	Shapiro-Wilk Test Statisitic	0.6957909
Number of Unique Samples	4	Shapiro-Wilk 5% Critical Value	0.874
Minimum	0.22	Data not normal at 5% significance level	
Maximum	5		
Mean	2.5014286	**95% UCL (Assuming Normal Distribution)**	
Median	1.15	Student's-t UCL	3.5774317
Standard Deviation	2.2733975		
Variance	5.1683363	**Gamma Distribution Test**	
Coefficient of Variation	0.9088397	A-D Test Statistic	1.7729681
Skewness	0.2540897	A-D 5% Critical Value	0.7608085
		K-S Test Statistic	0.3145088
Gamma Statistics		K-S 5% Critical Value	0.2353258
k hat	0.9801011	Data do not follow gamma distribution	
k star (bias corrected)	0.8176985	at 5% significance level	
Theta hat	2.5522149		
Theta star	3.0591088	**95% UCLs (Assuming Gamma Distribution)**	
nu hat	27.44283	Approximate Gamma UCL	4.4020341
nu star	22.895557	Adjusted Gamma UCL	4.7605532
Approx.Chi Square Value (.05)	13.010258		
Adjusted Level of Significance	0.03122	**Lognormal Distribution Test**	
Adjusted Chi Square Value	12.03045	Shapiro-Wilk Test Statisitic	0.7649906
		Shapiro-Wilk 5% Critical Value	0.874
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	-1.514128		
Maximum of log data	1.6094379	**95% UCLs (Assuming Lognormal Distribution)**	
Mean of log data	0.3265288	95% H-UCL	8.7304738
Standard Deviation of log data	1.2269362	95% Chebyshev (MVUE) UCL	6.9978215
Variance of log data	1.5053724	97.5% Chebyshev (MVUE) UCL	8.8542548
		99% Chebyshev (MVUE) UCL	12.500859
		95% Non-parametric UCLs	
		CLT UCL	3.5008269
		Adj-CLT UCL (Adjusted for skewness)	3.5449143
		Mod-t UCL (Adjusted for skewness)	3.5843085
		Jackknife UCL	3.5774317
		Standard Bootstrap UCL	N/R
		Bootstrap-t UCL	N/R
RECOMMENDATION		Hall's Bootstrap UCL	N/R
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	N/R
		BCA Bootstrap UCL	N/R
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	5.1498565
		97.5% Chebyshev (Mean, Sd) UCL	6.2958334
		99% Chebyshev (Mean, Sd) UCL	8.5468831

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

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APPENDIX B-3
ProUCL Output
Trichloroethene - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Trichloroethene

Raw Statistics	
Number of Valid Samples	14
Number of Unique Samples	4
Minimum	0.5
Maximum	5
Mean	2.5357143
Median	1.65
Standard Deviation	2.1875899
Variance	4.7855495
Coefficient of Variation	0.8627115
Skewness	0.1748678

Gamma Statistics	
k hat	1.0865707
k star (bias corrected)	0.9013532
Theta hat	2.3336855
Theta star	2.8132305
nu hat	30.42398
nu star	25.237889
Approx.Chi Square Value (.05)	14.792056
Adjusted Level of Significance	0.03122
Adjusted Chi Square Value	13.739371

Log-transformed Statistics	
Minimum of log data	-0.693147
Maximum of log data	1.6094379
Mean of log data	0.4042759
Standard Deviation of log data	1.1484458
Variance of log data	1.3189277

RECOMMENDATION
Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.7121471
Shapiro-Wilk 5% Critical Value	0.874
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	3.5711045

Gamma Distribution Test	
A-D Test Statistic	2.0155693
A-D 5% Critical Value	0.7583481
K-S Test Statistic	0.3384038
K-S 5% Critical Value	0.2347145
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	4.3263813
Adjusted Gamma UCL	4.6578606

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.6885748
Shapiro-Wilk 5% Critical Value	0.874
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	7.6668363
95% Chebyshev (MVUE) UCL	6.6819162
97.5% Chebyshev (MVUE) UCL	8.4042821
99% Chebyshev (MVUE) UCL	11.787536

95% Non-parametric UCLs	
CLT UCL	3.4973911
Adj-CLT UCL (Adjusted for skewness)	3.5265874
Mod-t UCL (Adjusted for skewness)	3.5756586
Jackknife UCL	3.5711045
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	5.0841794
97.5% Chebyshev (Mean, Sd) UCL	6.1869022
99% Chebyshev (Mean, Sd) UCL	8.3529878

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

APPENDIX B-3
ProUCL Output
Benzo(b)fluoranthene - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Benzo(b)fluoranthene

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	2
Minimum	0.6
Maximum	5
Mean	4.45
Median	5
Standard Deviation	1.5556349
Variance	2.42
Coefficient of Variation	0.3495809
Skewness	-2.828427

Gamma Statistics	
k hat	3.5249854
k star (bias corrected)	2.2864492
Theta hat	1.2624166
Theta star	1.9462492
nu hat	56.399766
nu star	36.583187
Approx.Chi Square Value (.05)	23.736333
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	21.156127

Log-transformed Statistics	
Minimum of log data	-0.510826
Maximum of log data	1.6094379
Mean of log data	1.344405
Standard Deviation of log data	0.7496264
Variance of log data	0.5619397

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	5.4920182

Gamma Distribution Test	
A-D Test Statistic	2.5453049
A-D 5% Critical Value	0.7199475
K-S Test Statistic	0.5304238
K-S 5% Critical Value	0.2957908
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	6.8584807
Adjusted Gamma UCL	7.6949428

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	11.522155
95% Chebyshev (MVUE) UCL	10.603143
97.5% Chebyshev (MVUE) UCL	13.082157
99% Chebyshev (MVUE) UCL	17.951699

95% Non-parametric UCLs	
CLT UCL	5.3546695
Adj-CLT UCL (Adjusted for skewness)	4.7669865
Mod-t UCL (Adjusted for skewness)	5.4003515
Jackknife UCL	5.4920182
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	6.8473944
97.5% Chebyshev (Mean, Sd) UCL	7.8847489
99% Chebyshev (Mean, Sd) UCL	9.9224309

Recommended UCL exceeds the maximum observation

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APPENDIX B-3
ProUCL Output
Bis(2-ethylhexyl)phthalate - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Bis(2-ethylhexyl) phthalate

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	1
Minimum	5
Maximum	5
Mean	5
Median	5

Data contains constant observations with no distinct values
There is no need to calculate lognormal statistics

Geomatrix

APPENDIX B-3
ProUCL Output
Aluminum - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Aluminum

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	8	Shapiro-Wilk Test Statisitic	0.4343099
Number of Unique Samples	6	Shapiro-Wilk 5% Critical Value	0.818
Minimum	100	Data not normal at 5% significance level	
Maximum	36400		
Mean	4849.75	95% UCL (Assuming Normal Distribution)	
Median	440.5	Student's-t UCL	13390.26
Standard Deviation	12750.177		
Variance	162567001	Gamma Distribution Test	
Coefficient of Variation	2.6290379	A-D Test Statistic	1.5437445
Skewness	2.8266969	A-D 5% Critical Value	0.7984005
		K-S Test Statistic	0.45064
Gamma Statistics		K-S 5% Critical Value	0.3171378
k hat	0.297047	Data do not follow gamma distribution	
k star (bias corrected)	0.2689877	at 5% significance level	
Theta hat	16326.542		
Theta star	18029.635	95% UCLs (Assuming Gamma Distribution)	
nu hat	4.7527518	Approximate Gamma UCL	24702.723
nu star	4.3038032	Adjusted Gamma UCL	39455.168
Approx.Chi Square Value (.05)	0.8449421		
Adjusted Level of Significance	0.01946	Lognormal Distribution Test	
Adjusted Chi Square Value	0.5290148	Shapiro-Wilk Test Statisitic	0.7631538
		Shapiro-Wilk 5% Critical Value	0.818
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	4.6051702		
Maximum of log data	10.502324	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	6.161531	95% H-UCL	273584.68
Standard Deviation of log data	1.9380212	95% Chebyshev (MVUE) UCL	7662.2451
Variance of log data	3.7559261	97.5% Chebyshev (MVUE) UCL	10125.401
		99% Chebyshev (MVUE) UCL	14963.794
		95% Non-parametric UCLs	
		CLT UCL	12264.533
		Adj-CLT UCL (Adjusted for skewness)	17078.309
		Mod-t UCL (Adjusted for skewness)	14141.112
		Jackknife UCL	13390.26
		Standard Bootstrap UCL	11578.784
		Bootstrap-t UCL	312658.21
RECOMMENDATION		Hall's Bootstrap UCL	177326.2
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	13855.5
		BCA Bootstrap UCL	18320.5
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	24499.092
		97.5% Chebyshev (Mean, Sd) UCL	33001.378
		99% Chebyshev (Mean, Sd) UCL	49702.472

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

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APPENDIX B-3
ProUCL Output
Antimony - Shallow Groundwater
Peter Cooper - Markhams Site

Data File

Variable: Antimony

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	2
Minimum	30
Maximum	72.6
Mean	35.325
Median	30
Standard Deviation	15.061374
Variance	226.845
Coefficient of Variation	0.4263659
Skewness	2.8284271

Gamma Statistics	
k hat	9.6114112
k star (bias corrected)	6.0904653
Theta hat	3.6753188
Theta star	5.8000494
nu hat	153.78258
nu star	97.447445
Approx.Chi Square Value (.05)	75.672197
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	70.831137

Log-transformed Statistics	
Minimum of log data	3.4011974
Maximum of log data	4.2849649
Mean of log data	3.5116683
Standard Deviation of log data	0.312459
Variance of log data	0.0976306

RECOMMENDATION

Data are Non-parametric (0.05)

Use Student's-t UCL
or Modified-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	45.41363

Gamma Distribution Test	
A-D Test Statistic	2.5125137
A-D 5% Critical Value	0.7152886
K-S Test Statistic	0.5244941
K-S 5% Critical Value	0.2943546
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	45.490036
Adjusted Gamma UCL	48.599121

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	45.040791
95% Chebyshev (MVUE) UCL	51.86724
97.5% Chebyshev (MVUE) UCL	59.183372
99% Chebyshev (MVUE) UCL	73.554495

95% Non-parametric UCLs	
CLT UCL	44.083846
Adj-CLT UCL (Adjusted for skewness)	49.773685
Mod-t UCL (Adjusted for skewness)	46.30113
Jackknife UCL	45.41363
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	58.536137
97.5% Chebyshev (Mean, Sd) UCL	68.579614
99% Chebyshev (Mean, Sd) UCL	88.308081

Geomatrix

APPENDIX B-3
ProUCL Output
Arsenic - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Arsenic

Raw Statistics	
Number of Valid Samples	15
Number of Unique Samples	2
Minimum	5
Maximum	133
Mean	13.533333
Median	5
Standard Deviation	33.049458
Variance	1092.2667
Coefficient of Variation	2.4420782
Skewness	3.8729833

Gamma Statistics	
k hat	0.7679924
k star (bias corrected)	0.6588384
Theta hat	17.621702
Theta star	20.541204
nu hat	23.039773
nu star	19.765151
Approx.Chi Square Value (.05)	10.676716
Adjusted Level of Significance	0.03235
Adjusted Chi Square Value	9.8619784

Log-transformed Statistics	
Minimum of log data	1.6094379
Maximum of log data	4.8903491
Mean of log data	1.8281653
Standard Deviation of log data	0.8471276
Variance of log data	0.7176252

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.2841696
Shapiro-Wilk 5% Critical Value	0.881
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	28.563179

Gamma Distribution Test	
A-D Test Statistic	5.4976274
A-D 5% Critical Value	0.7742406
K-S Test Statistic	0.5681354
K-S 5% Critical Value	0.2300545
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	25.053432
Adjusted Gamma UCL	27.123197

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.2841696
Shapiro-Wilk 5% Critical Value	0.881
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	15.727457
95% Chebyshev (MVUE) UCL	17.47853
97.5% Chebyshev (MVUE) UCL	21.303074
99% Chebyshev (MVUE) UCL	28.815651

95% Non-parametric UCLs	
CLT UCL	27.569418
Adj-CLT UCL (Adjusted for skewness)	36.687408
Mod-t UCL (Adjusted for skewness)	29.985401
Jackknife UCL	28.563179
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	50.729271
97.5% Chebyshev (Mean, Sd) UCL	66.823983
99% Chebyshev (Mean, Sd) UCL	98.438928

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Barium - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Barium

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	2
Minimum	100
Maximum	517
Mean	152.125
Median	100
Standard Deviation	147.43176
Variance	21736.125
Coefficient of Variation	0.9691488
Skewness	2.8284271

Gamma Statistics	
k hat	2.4885547
k star (bias corrected)	1.63868
Theta hat	61.12986
Theta star	92.833865
nu hat	39.816875
nu star	26.21888
Approx.Chi Square Value (.05)	15.546176
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	13.511341

Log-transformed Statistics	
Minimum of log data	4.6051702
Maximum of log data	6.2480429
Mean of log data	4.8105293
Standard Deviation of log data	0.5808432
Variance of log data	0.3373788

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	250.8799

Gamma Distribution Test	
A-D Test Statistic	2.5330866
A-D 5% Critical Value	0.7227486
K-S Test Statistic	0.5301581
K-S 5% Critical Value	0.2968933
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	256.5613
Adjusted Gamma UCL	295.19995

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	253.51881
95% Chebyshev (MVUE) UCL	270.70339
97.5% Chebyshev (MVUE) UCL	326.39544
99% Chebyshev (MVUE) UCL	435.79168

95% Non-parametric UCLs	
CLT UCL	237.863
Adj-CLT UCL (Adjusted for skewness)	293.55931
Mod-t UCL (Adjusted for skewness)	259.5674
Jackknife UCL	250.8799
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	379.33261
97.5% Chebyshev (Mean, Sd) UCL	477.64552
99% Chebyshev (Mean, Sd) UCL	670.7622

APPENDIX B-3
ProUCL Output
Cadmium - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Cadmium

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	8	Shapiro-Wilk Test Statisitic	0.4185909
Number of Unique Samples	2	Shapiro-Wilk 5% Critical Value	0.818
Minimum	2.5	Data not normal at 5% significance level	
Maximum	50.1		
Mean	8.45	95% UCL (Assuming Normal Distribution)	
Median	2.5	Student's-t UCL	19.722742
Standard Deviation	16.829141		
Variance	283.22	Gamma Distribution Test	
Coefficient of Variation	1.9916144	A-D Test Statistic	2.56563
Skewness	2.8284271	A-D 5% Critical Value	0.7475646
		K-S Test Statistic	0.5434451
Gamma Statistics		K-S 5% Critical Value	0.3047562
k hat	0.7146948	Data do not follow gamma distribution	
k star (bias corrected)	0.5300176	at 5% significance level	
Theta hat	11.823228		
Theta star	15.942867	95% UCLs (Assuming Gamma Distribution)	
nu hat	11.435117	Approximate Gamma UCL	23.763498
nu star	8.4802815	Adjusted Gamma UCL	31.792809
Approx.Chi Square Value (.05)	3.0154811		
Adjusted Level of Significance	0.01946	Lognormal Distribution Test	
Adjusted Chi Square Value	2.2539178	Shapiro-Wilk Test Statisitic	0.4185909
		Shapiro-Wilk 5% Critical Value	0.818
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	0.9162907		
Maximum of log data	3.914021	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	1.291007	95% H-UCL	27.564834
Standard Deviation of log data	1.0598577	95% Chebyshev (MVUE) UCL	15.481466
Variance of log data	1.1232984	97.5% Chebyshev (MVUE) UCL	19.669272
		99% Chebyshev (MVUE) UCL	27.895406
		95% Non-parametric UCLs	
		CLT UCL	18.236879
		Adj-CLT UCL (Adjusted for skewness)	24.59454
		Mod-t UCL (Adjusted for skewness)	20.714409
		Jackknife UCL	19.722742
		Standard Bootstrap UCL	N/R
		Bootstrap-t UCL	N/R
RECOMMENDATION		Hall's Bootstrap UCL	N/A
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	N/R
		BCA Bootstrap UCL	N/R
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	34.385449
		97.5% Chebyshev (Mean, Sd) UCL	45.607738
		99% Chebyshev (Mean, Sd) UCL	67.651753

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Cobalt - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Cobalt

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	2
Minimum	25
Maximum	251
Mean	53.25
Median	25
Standard Deviation	79.903066
Variance	6384.5
Coefficient of Variation	1.5005271
Skewness	2.8284271

Gamma Statistics	
k hat	1.2082669
k star (bias corrected)	0.8385001
Theta hat	44.071389
Theta star	63.506251
nu hat	19.33227
nu star	13.416002
Approx.Chi Square Value (.05)	6.1724315
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	4.9852736

Log-transformed Statistics	
Minimum of log data	3.2188758
Maximum of log data	5.5254529
Mean of log data	3.507198
Standard Deviation of log data	0.8154982
Variance of log data	0.6650372

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	106.77184

Gamma Distribution Test	
A-D Test Statistic	2.5533404
A-D 5% Critical Value	0.7325509
K-S Test Statistic	0.5368799
K-S 5% Critical Value	0.3003937
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	115.74079
Adjusted Gamma UCL	143.30249

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	118.82758
95% Chebyshev (MVUE) UCL	100.8671
97.5% Chebyshev (MVUE) UCL	125.37493
99% Chebyshev (MVUE) UCL	173.5158

95% Non-parametric UCLs	
CLT UCL	99.717115
Adj-CLT UCL (Adjusted for skewness)	129.90265
Mod-t UCL (Adjusted for skewness)	111.48018
Jackknife UCL	106.77184
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	176.3889
97.5% Chebyshev (Mean, Sd) UCL	229.67119
99% Chebyshev (Mean, Sd) UCL	334.33395

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Copper - Shallow Groundwater
Peter Cooper - Markhams Site

Data File

Variable: Copper

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	2
Minimum	12.5
Maximum	2220
Mean	288.4375
Median	12.5
Standard Deviation	780.46911
Variance	609132.03
Coefficient of Variation	2.7058517
Skewness	2.8284271

Gamma Statistics	
k hat	0.2799298
k star (bias corrected)	0.2582895
Theta hat	1030.3923
Theta star	1116.7219
nu hat	4.4788768
nu star	4.1326313
Approx.Chi Square Value (.05)	0.7744819
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	0.4789635

Log-transformed Statistics	
Minimum of log data	2.5257286
Maximum of log data	7.7052625
Mean of log data	3.1731704
Standard Deviation of log data	1.8312417
Variance of log data	3.3534463

RECOMMENDATION
Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	811.22275

Gamma Distribution Test	
A-D Test Statistic	2.5452001
A-D 5% Critical Value	0.8050111
K-S Test Statistic	0.5529793
K-S 5% Critical Value	0.3182265
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1539.101
Adjusted Gamma UCL	2488.7194

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4185909
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	7104.4402
95% Chebyshev (MVUE) UCL	325.68363
97.5% Chebyshev (MVUE) UCL	429.1562
99% Chebyshev (MVUE) UCL	632.40802

95% Non-parametric UCLs	
CLT UCL	742.3143
Adj-CLT UCL (Adjusted for skewness)	1037.1575
Mod-t UCL (Adjusted for skewness)	857.21234
Jackknife UCL	811.22275
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/A
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	1491.2212
97.5% Chebyshev (Mean, Sd) UCL	2011.6666
99% Chebyshev (Mean, Sd) UCL	3033.981

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

APPENDIX B-3
ProUCL Output
Iron - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Iron

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	8
Minimum	218
Maximum	3160000
Mean	409847.75
Median	6035
Standard Deviation	1111687.1
Variance	1.24E+12
Coefficient of Variation	2.7124392
Skewness	2.8238322

Gamma Statistics	
k hat	0.1779616
k star (bias corrected)	0.1945594
Theta hat	2303011.8
Theta star	2106543.5
nu hat	2.8473862
nu star	3.1129497
Approx.Chi Square Value (.05)	0.406463
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	0.2344954

Log-transformed Statistics	
Minimum of log data	5.3844951
Maximum of log data	14.966083
Mean of log data	8.713204
Standard Deviation of log data	3.2771497
Variance of log data	10.73971

RECOMMENDATION
Data are lognormal (0.05)

Use Hall's Bootstrap UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4370267
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1154494.3

Gamma Distribution Test	
A-D Test Statistic	1.0020896
A-D 5% Critical Value	0.8438491
K-S Test Statistic	0.3316614
K-S 5% Critical Value	0.3244957
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	3138872.5
Adjusted Gamma UCL	5440768.9

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.9028199
Shapiro-Wilk 5% Critical Value	0.818
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	3.45E+11
95% Chebyshev (MVUE) UCL	946736.63
97.5% Chebyshev (MVUE) UCL	1273152.4
99% Chebyshev (MVUE) UCL	1914333

95% Non-parametric UCLs	
CLT UCL	1056342.2
Adj-CLT UCL (Adjusted for skewness)	1475629.7
Mod-t UCL (Adjusted for skewness)	1219894.7
Jackknife UCL	1154494.3
Standard Bootstrap UCL	1029029.6
Bootstrap-t UCL	85574883
Hall's Bootstrap UCL	34492353
Percentile Bootstrap UCL	1188063.4
BCA Bootstrap UCL	1584296.3
95% Chebyshev (Mean, Sd) UCL	2123072.6
97.5% Chebyshev (Mean, Sd) UCL	2864386.4
99% Chebyshev (Mean, Sd) UCL	4320553.7

Recommended UCL exceeds the maximum observation
In case Hall's Bootstrap method yields an erratic,
unreasonably large UCL value, use 99% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Lead- Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Lead

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	8	Shapiro-Wilk Test Statisitic	0.4386002
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.818
Minimum	1.5	Data not normal at 5% significance level	
Maximum	1020		
Mean	134.4375	95% UCL (Assuming Normal Distribution)	
Median	5.6	Student's-t UCL	374.20207
Standard Deviation	357.9459		
Variance	128125.27	Gamma Distribution Test	
Coefficient of Variation	2.662545	A-D Test Statistic	1.3783829
Skewness	2.8245251	A-D 5% Critical Value	0.8162653
		K-S Test Statistic	0.3492891
Gamma Statistics		K-S 5% Critical Value	0.3200798
k hat	0.2507888	Data do not follow gamma distribution	
k star (bias corrected)	0.2400764	at 5% significance level	
Theta hat	536.05853		
Theta star	559.97808	95% UCLs (Assuming Gamma Distribution)	
nu hat	4.0126216	Approximate Gamma UCL	782.77196
nu star	3.8412218	Adjusted Gamma UCL	1293.4391
Approx.Chi Square Value (.05)	0.6597123		
Adjusted Level of Significance	0.01946	Lognormal Distribution Test	
Adjusted Chi Square Value	0.399249	Shapiro-Wilk Test Statisitic	0.779043
		Shapiro-Wilk 5% Critical Value	0.818
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	0.4054651		
Maximum of log data	6.9275579	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	2.0703158	95% H-UCL	50447
Standard Deviation of log data	2.2835278	95% Chebyshev (MVUE) UCL	224.57965
Variance of log data	5.2144992	97.5% Chebyshev (MVUE) UCL	298.90726
		99% Chebyshev (MVUE) UCL	444.90945
		95% Non-parametric UCLs	
		CLT UCL	342.59864
		Adj-CLT UCL (Adjusted for skewness)	477.63579
		Mod-t UCL (Adjusted for skewness)	395.26513
		Jackknife UCL	374.20207
		Standard Bootstrap UCL	328.39706
		Bootstrap-t UCL	10623.94
RECOMMENDATION		Hall's Bootstrap UCL	4888.8481
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	384.5875
		BCA Bootstrap UCL	391.4875
Use Hall's Bootstrap UCL		95% Chebyshev (Mean, Sd) UCL	686.06918
		97.5% Chebyshev (Mean, Sd) UCL	924.76064
		99% Chebyshev (Mean, Sd) UCL	1393.6238

Recommended UCL exceeds the maximum observation
In case Hall's Bootstrap method yields an erratic,
unreasonably large UCL value, use 99% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Manganese- Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Manganese

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	8
Minimum	33.7
Maximum	15000
Mean	5477.7125
Median	2512
Standard Deviation	6344.9856
Variance	40258842
Coefficient of Variation	1.1583276
Skewness	0.675823

Gamma Statistics	
k hat	0.4628482
k star (bias corrected)	0.3726135
Theta hat	11834.792
Theta star	14700.79
nu hat	7.4055719
nu star	5.9618158
Approx.Chi Square Value (.05)	1.6198903
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	1.1150604

Log-transformed Statistics	
Minimum of log data	3.5174978
Maximum of log data	9.6158055
Mean of log data	7.2194397
Standard Deviation of log data	2.2824755
Variance of log data	5.2096942

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.811023
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	9727.8037

Gamma Distribution Test	
A-D Test Statistic	0.4202894
A-D 5% Critical Value	0.7688511
K-S Test Statistic	0.1940774
K-S 5% Critical Value	0.3104686
Data follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	20160.077
Adjusted Gamma UCL	29287.303

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.902737
Shapiro-Wilk 5% Critical Value	0.818
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	8622569
95% Chebyshev (MVUE) UCL	38623.569
97.5% Chebyshev (MVUE) UCL	51405.631
99% Chebyshev (MVUE) UCL	76513.517

95% Non-parametric UCLs	
CLT UCL	9167.5981
Adj-CLT UCL (Adjusted for skewness)	9740.3335
Mod-t UCL (Adjusted for skewness)	9817.1389
Jackknife UCL	9727.8037
Standard Bootstrap UCL	8932.0936
Bootstrap-t UCL	10995.235
Hall's Bootstrap UCL	8582.0736
Percentile Bootstrap UCL	8816.75
BCA Bootstrap UCL	9423.4625
95% Chebyshev (Mean, Sd) UCL	15255.992
97.5% Chebyshev (Mean, Sd) UCL	19487.061
99% Chebyshev (Mean, Sd) UCL	27798.178

RECOMMENDATION

Data follow gamma distribution (0.05)

Use Adjusted Gamma UCL

Recommended UCL exceeds the maximum observation

Geomatrix

APPENDIX B-3
ProUCL Output
Nickel- Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Nickel

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	8	Shapiro-Wilk Test Statisitic	0.431128
Number of Unique Samples	3	Shapiro-Wilk 5% Critical Value	0.818
Minimum	20	Data not normal at 5% significance level	
Maximum	2820		
Mean	377.925	95% UCL (Assuming Normal Distribution)	
Median	20	Student's-t UCL	1039.0496
Standard Deviation	986.99668		
Variance	974162.45	Gamma Distribution Test	
Coefficient of Variation	2.6116205	A-D Test Statistic	2.0949477
Skewness	2.8256004	A-D 5% Critical Value	0.7939855
		K-S Test Statistic	0.447058
Gamma Statistics		K-S 5% Critical Value	0.3162029
k hat	0.3187704	Data do not follow gamma distribution	
k star (bias corrected)	0.2825648	at 5% significance level	
Theta hat	1185.5712		
Theta star	1337.4807	95% UCLs (Assuming Gamma Distribution)	
nu hat	5.1003263	Approximate Gamma UCL	1822.8141
nu star	4.5210373	Adjusted Gamma UCL	2868.0384
Approx.Chi Square Value (.05)	0.937349		
Adjusted Level of Significance	0.01946	Lognormal Distribution Test	
Adjusted Chi Square Value	0.5957427	Shapiro-Wilk Test Statisitic	0.5539529
		Shapiro-Wilk 5% Critical Value	0.818
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	2.9957323		
Maximum of log data	7.9444922	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	3.7928168	95% H-UCL	8196.5964
Standard Deviation of log data	1.750364	95% Chebyshev (MVUE) UCL	532.84726
Variance of log data	3.0637742	97.5% Chebyshev (MVUE) UCL	700.4502
		99% Chebyshev (MVUE) UCL	1029.6737
		95% Non-parametric UCLs	
		CLT UCL	951.90658
		Adj-CLT UCL (Adjusted for skewness)	1324.3985
		Mod-t UCL (Adjusted for skewness)	1097.1508
		Jackknife UCL	1039.0496
		Standard Bootstrap UCL	N/R
		Bootstrap-t UCL	N/R
RECOMMENDATION		Hall's Bootstrap UCL	N/R
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	N/R
		BCA Bootstrap UCL	N/R
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	1898.989
		97.5% Chebyshev (Mean, Sd) UCL	2557.1547
		99% Chebyshev (Mean, Sd) UCL	3849.9936

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Selenium - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Selenium

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	3
Minimum	2.5
Maximum	39.2
Mean	7.675
Median	2.5
Standard Deviation	12.843759
Variance	164.96214
Coefficient of Variation	1.6734539
Skewness	2.7418626

Gamma Statistics	
k hat	0.90516
k star (bias corrected)	0.6490583
Theta hat	8.4791643
Theta star	11.824824
nu hat	14.482559
nu star	10.384933
Approx.Chi Square Value (.05)	4.182889
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	3.2469283

Log-transformed Statistics	
Minimum of log data	0.9162907
Maximum of log data	3.6686767
Mean of log data	1.3925628
Standard Deviation of log data	0.9913821
Variance of log data	0.9828384

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4863379
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	16.278195

Gamma Distribution Test	
A-D Test Statistic	1.8601632
A-D 5% Critical Value	0.7391532
K-S Test Statistic	0.450223
K-S 5% Critical Value	0.3024463
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	19.054859
Adjusted Gamma UCL	24.54762

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.5816558
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	24.215956
95% Chebyshev (MVUE) UCL	15.548288
97.5% Chebyshev (MVUE) UCL	19.648105
99% Chebyshev (MVUE) UCL	27.701399

95% Non-parametric UCLs	
CLT UCL	15.144206
Adj-CLT UCL (Adjusted for skewness)	19.847783
Mod-t UCL (Adjusted for skewness)	17.011858
Jackknife UCL	16.278195
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	27.468562
97.5% Chebyshev (Mean, Sd) UCL	36.033252
99% Chebyshev (Mean, Sd) UCL	52.856927

Geomatrix

APPENDIX B-3
ProUCL Output
Thallium - Shallow Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Thallium

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	3
Minimum	5
Maximum	1300
Mean	167.9375
Median	5
Standard Deviation	457.432
Variance	209244.03
Coefficient of Variation	2.7238228
Skewness	2.8281887

Gamma Statistics	
k hat	0.2616361
k star (bias corrected)	0.2468559
Theta hat	641.87434
Theta star	680.30581
nu hat	4.1861776
nu star	3.9496943
Approx.Chi Square Value (.05)	0.7016357
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	0.4280824

Log-transformed Statistics	
Minimum of log data	1.6094379
Maximum of log data	7.1701195
Mean of log data	2.4286796
Standard Deviation of log data	1.9471031
Variance of log data	3.7912106

RECOMMENDATION
Data are Non-parametric (0.05)

Use 99% Chebyshev (Mean, Sd) UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4222423
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	474.3413

Gamma Distribution Test	
A-D Test Statistic	2.2677279
A-D 5% Critical Value	0.8120761
K-S Test Statistic	0.47403
K-S 5% Critical Value	0.3193899
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	945.36497
Adjusted Gamma UCL	1549.4723

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.5101792
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	6936.9531
95% Chebyshev (MVUE) UCL	185.99749
97.5% Chebyshev (MVUE) UCL	245.84512
99% Chebyshev (MVUE) UCL	363.40419

95% Non-parametric UCLs	
CLT UCL	433.95414
Adj-CLT UCL (Adjusted for skewness)	606.74682
Mod-t UCL (Adjusted for skewness)	501.29347
Jackknife UCL	474.3413
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	872.88755
97.5% Chebyshev (Mean, Sd) UCL	1177.92
99% Chebyshev (Mean, Sd) UCL	1777.0972

Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL

Geomatrix

APPENDIX B-3
ProUCL Output
Zinc - Shallow Groundwater
Peter Cooper - Markhams Site

Data File — Variable: Zinc

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	4
Minimum	10
Maximum	146000
Mean	18647.013
Median	10
Standard Deviation	51469.632
Variance	2.649E+09
Coefficient of Variation	2.760208
Skewness	2.8259787

Gamma Statistics	
k hat	0.1420078
k star (bias corrected)	0.1720882
Theta hat	131309.79
Theta star	108357.3
nu hat	2.2721246
nu star	2.7534112
Approx.Chi Square Value (.05)	0.3031321
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	0.1743367

Log-transformed Statistics	
Minimum of log data	2.3025851
Maximum of log data	11.891362
Mean of log data	4.3783133
Standard Deviation of log data	3.6252008
Variance of log data	13.142081

RECOMMENDATION
Data are Non-parametric (0.05)

Can't recommend Hall's Bootstrap UCL*

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4303442
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	53123.156

Gamma Distribution Test	
A-D Test Statistic	1.6293398
A-D 5% Critical Value	0.85685
K-S Test Statistic	0.4164384
K-S 5% Critical Value	0.32643
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	169374.63
Adjusted Gamma UCL	294504.18

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.6682984
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	2.36E+11
95% Chebyshev (MVUE) UCL	23161.395
97.5% Chebyshev (MVUE) UCL	31199.939
99% Chebyshev (MVUE) UCL	46990.101

95% Non-parametric UCLs	
CLT UCL	48578.847
Adj-CLT UCL (Adjusted for skewness)	68006.054
Mod-t UCL (Adjusted for skewness)	56153.407
Jackknife UCL	53123.156
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	97967.043
97.5% Chebyshev (Mean, Sd) UCL	132288.88
99% Chebyshev (Mean, Sd) UCL	199707.49

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APPENDIX B-4
ProUCL Output
Aluminum - Deep Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Aluminum

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	6
Minimum	100
Maximum	5660
Mean	1173.875
Median	276
Standard Deviation	1931.4068
Variance	3730332.1
Coefficient of Variation	1.6453258
Skewness	2.2673404

Gamma Statistics	
k hat	0.5818427
k star (bias corrected)	0.446985
Theta hat	2017.5126
Theta star	2626.2065
nu hat	9.3094835
nu star	7.1517605
Approx.Chi Square Value (.05)	2.2536094
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	1.6232833

Log-transformed Statistics	
Minimum of log data	4.6051702
Maximum of log data	8.6411792
Mean of log data	6.0012867
Standard Deviation of log data	1.5274641
Variance of log data	2.3331466

RECOMMENDATION
Data follow gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.6485755
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	2467.5982

Gamma Distribution Test	
A-D Test Statistic	0.6537952
A-D 5% Critical Value	0.7567261
K-S Test Statistic	0.2621719
K-S 5% Critical Value	0.3073761
Data follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approxir	3725.2565
Adjusted Gamma UCL	5171.7853

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.8768956
Shapiro-Wilk 5% Critical Value	0.818
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	22413.59
95% Chebyshev (MVUE) UCL	3434.7424
97.5% Chebyshev (MVUE) UCL	4479.272
99% Chebyshev (MVUE) UCL	6531.0483

95% Non-parametric UCLs	
CLT UCL	2297.0722
Adj-CLT UCL (Adjusted for skewness)	2881.9712
Mod-t UCL (Adjusted for skewness)	2558.8306
Jackknife UCL	2467.5982
Standard Bootstrap UCL	2244.2622
Bootstrap-t UCL	8420.2063
Hall's Bootstrap UCL	7354.134
Percentile Bootstrap UCL	2408.75
BCA Bootstrap UCL	2854.75
95% Chebyshev (Mean, Sd) UCL	4150.3727
97.5% Chebyshev (Mean, Sd) UCL	5438.3057
99% Chebyshev (Mean, Sd) UCL	7968.2006

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APPENDIX B-4
ProUCL Output
Barium - Deep Groundwater
Peter Cooper - Markhams Site

Data File

Variable: Barium

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	4
Minimum	100
Maximum	519
Mean	195.375
Median	100
Standard Deviation	153.75578
Variance	23640.839
Coefficient of Variation	0.7869778
Skewness	1.6384587

Gamma Statistics	
k hat	2.4604601
k star (bias corrected)	1.6211209
Theta hat	79.40588
Theta star	120.51846
nu hat	39.367362
nu star	25.937934
Approx.Chi Square Value (.05)	15.329757
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	13.311044

Log-transformed Statistics	
Minimum of log data	4.6051702
Maximum of log data	6.2519039
Mean of log data	5.0581534
Standard Deviation of log data	0.6625885
Variance of log data	0.4390236

RECOMMENDATION
Data are Non-parametric (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.7148635
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	298.36595

Gamma Distribution Test	
A-D Test Statistic	1.1013349
A-D 5% Critical Value	0.7228188
K-S Test Statistic	0.3896915
K-S 5% Critical Value	0.2969259
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	330.57431
Adjusted Gamma UCL	380.70823

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.7358696
Shapiro-Wilk 5% Critical Value	0.818
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	385.18282
95% Chebyshev (MVUE) UCL	386.66803
97.5% Chebyshev (MVUE) UCL	471.82532
99% Chebyshev (MVUE) UCL	639.10034

95% Non-parametric UCLs	
CLT UCL	284.79069
Adj-CLT UCL (Adjusted for skewness)	318.43854
Mod-t UCL (Adjusted for skewness)	303.61433
Jackknife UCL	298.36595
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	432.32857
97.5% Chebyshev (Mean, Sd) UCL	534.85857
99% Chebyshev (Mean, Sd) UCL	736.25889

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APPENDIX B-4
ProUCL Output
Barium - Deep Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Total Cr (VI)

Raw Statistics	
Number of Valid Samples	16
Number of Unique Samples	3
Minimum	5
Maximum	5000
Mean	649.125
Median	5
Standard Deviation	1700.2265
Variance	2890770.3
Coefficient of Variation	2.619259
Skewness	2.4991215

Gamma Statistics	
k hat	0.1970841
k star (bias corrected)	0.2017975
Theta hat	3293.6445
Theta star	3216.7147
nu hat	6.3066916
nu star	6.4575202
Approx.Chi Square Value (.05)	1.8774238
Adjusted Level of Significance	0.03348
Adjusted Chi Square Value	1.6103586

Log-transformed Statistics	
Minimum of log data	1.6094379
Maximum of log data	8.5171932
Mean of log data	2.7330325
Standard Deviation of log data	2.4840424
Variance of log data	6.1704666

RECOMMENDATION
Data are Non-parametric (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.4162598
Shapiro-Wilk 5% Critical Value	0.887
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1394.2706

Gamma Distribution Test	
A-D Test Statistic	4.2204295
A-D 5% Critical Value	0.8794401
K-S Test Statistic	0.5097541
K-S 5% Critical Value	0.2377248
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	2232.7073
Adjusted Gamma UCL	2602.9841

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.5017101
Shapiro-Wilk 5% Critical Value	0.887
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	10981.571
95% Chebyshev (MVUE) UCL	793.64474
97.5% Chebyshev (MVUE) UCL	1053.2474
99% Chebyshev (MVUE) UCL	1563.1864

95% Non-parametric UCLs	
CLT UCL	1348.2809
Adj-CLT UCL (Adjusted for skewness)	1632.0432
Mod-t UCL (Adjusted for skewness)	1438.5318
Jackknife UCL	1394.2706
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	2501.9039
97.5% Chebyshev (Mean, Sd) UCL	3303.6028
99% Chebyshev (Mean, Sd) UCL	4878.3851

Geomatrix

APPENDIX B-4
ProUCL Output
Barium - Deep Groundwater
Peter Cooper - Markhams Site

Data File Variable: Iron

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	8	Shapiro-Wilk Test Statisitic	0.9157255
Number of Unique Samples	8	Shapiro-Wilk 5% Critical Value	0.818
Minimum	413	Data are normal at 5% significance level	
Maximum	15500		
Mean	7019.125	95% UCL (Assuming Normal Distribution)	
Median	6095	Student's-t UCL	10923.647
Standard Deviation	5829.0828		
Variance	33978206	Gamma Distribution Test	
Coefficient of Variation	0.8304572	A-D Test Statistic	0.2605371
Skewness	0.3836979	A-D 5% Critical Value	0.7341465
		K-S Test Statistic	0.1696718
Gamma Statistics		K-S 5% Critical Value	0.3009706
k hat	1.0955838	Data follow gamma distribution	
k star (bias corrected)	0.7680732	at 5% significance level	
Theta hat	6406.7439		
Theta star	9138.6143	95% UCLs (Assuming Gamma Distribution)	
nu hat	17.529341	Approximate Gamma UCL	15923.59
nu star	12.289172	Adjusted Gamma UCL	19967.303
Approx.Chi Square Value (.05)	5.4170719		
Adjusted Level of Significance	0.01946	Lognormal Distribution Test	
Adjusted Chi Square Value	4.3200242	Shapiro-Wilk Test Statisitic	0.9101733
		Shapiro-Wilk 5% Critical Value	0.818
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	6.0234476		
Maximum of log data	9.6485953	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	8.3350036	95% H-UCL	78914.754
Standard Deviation of log data	1.2960681	95% Chebyshev (MVUE) UCL	25016.355
Variance of log data	1.6797925	97.5% Chebyshev (MVUE) UCL	32268.606
		99% Chebyshev (MVUE) UCL	46514.25
		95% Non-parametric UCLs	
		CLT UCL	10408.991
		Adj-CLT UCL (Adjusted for skewness)	10707.721
		Mod-t UCL (Adjusted for skewness)	10970.243
		Jackknife UCL	10923.647
		Standard Bootstrap UCL	10237.497
		Bootstrap-t UCL	11570.148
RECOMMENDATION		Hall's Bootstrap UCL	10624.205
Data are normal (0.05)		Percentile Bootstrap UCL	10162.5
		BCA Bootstrap UCL	10307.5
Use Approximate Gamma UCL		95% Chebyshev (Mean, Sd) UCL	16002.345
		97.5% Chebyshev (Mean, Sd) UCL	19889.391
		99% Chebyshev (Mean, Sd) UCL	27524.741

Geomatrix

APPENDIX B-4
ProUCL Output
Barium - Deep Groundwater
Peter Cooper - Markhams Site

Data File | Variable: Manganese

Raw Statistics	
Number of Valid Samples	8
Number of Unique Samples	8
Minimum	72.1
Maximum	2330
Mean	566.1375
Median	298
Standard Deviation	746.93163
Variance	557906.87
Coefficient of Variation	1.3193467
Skewness	2.3825665

Gamma Statistics	
k hat	1.0361926
k star (bias corrected)	0.7309537
Theta hat	546.36318
Theta star	774.51894
nu hat	16.579082
nu star	11.69526
Approx.Chi Square Value (.05)	5.0260132
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	3.977947

Log-transformed Statistics	
Minimum of log data	4.278054
Maximum of log data	7.7536235
Mean of log data	5.7840778
Standard Deviation of log data	1.0781601
Variance of log data	1.1624293

RECOMMENDATION
Assuming gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.6550748
Shapiro-Wilk 5% Critical Value	0.818
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	1066.4582

Gamma Distribution Test	
A-D Test Statistic	0.5864295
A-D 5% Critical Value	0.7349875
K-S Test Statistic	0.3072088
K-S 5% Critical Value	0.3012747
Data follow approximate gamma distibution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	1317.3712
Adjusted Gamma UCL	1664.4578

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.9395023
Shapiro-Wilk 5% Critical Value	0.818
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	2627.9236
95% Chebyshev (MVUE) UCL	1420.6809
97.5% Chebyshev (MVUE) UCL	1807.4274
99% Chebyshev (MVUE) UCL	2567.1159

95% Non-parametric UCLs	
CLT UCL	1000.5108
Adj-CLT UCL (Adjusted for skewness)	1238.2037
Mod-t UCL (Adjusted for skewness)	1103.5335
Jackknife UCL	1066.4582
Standard Bootstrap UCL	985.0106
Bootstrap-t UCL	3058.9481
Hall's Bootstrap UCL	3695.7648
Percentile Bootstrap UCL	1041.75
BCA Bootstrap UCL	1258.65
95% Chebyshev (Mean, Sd) UCL	1717.2365
97.5% Chebyshev (Mean, Sd) UCL	2215.3179
99% Chebyshev (Mean, Sd) UCL	3193.7024

Geomatrix

APPENDIX B-5
ProUCL Output
Hexavalent Chromium - Surface Water
Peter Cooper - Markhams Site

Data File | Variable: Cr (VI)

Raw Statistics	
Number of Valid Samples	7
Number of Unique Samples	4
Minimum	5
Maximum	14
Mean	7.97142857
Median	5
Standard Deviation	3.88231644
Variance	15.072381
Coefficient of Variation	0.48702894
Skewness	0.7122673

Gamma Statistics	
k hat	5.28132505
k star (bias corrected)	3.11313812
Theta hat	1.50936148
Theta star	2.56057658
nu hat	73.9385507
nu star	43.5839337
Approx.Chi Square Value (.05)	29.4424041
Adjusted Level of Significance	0.01584
Adjusted Chi Square Value	25.9838585

Log-transformed Statistics	
Minimum of log data	1.60943791
Maximum of log data	2.63905733
Mean of log data	1.97821337
Standard Deviation of log data	0.47008892
Variance of log data	0.22098359

RECOMMENDATION
Data are Non-parametric (0.05)

Use Student's-t UCL
or Modified-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.77490886
Shapiro-Wilk 5% Critical Value	0.803
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	10.8228069

Gamma Distribution Test	
A-D Test Statistic	0.92454311
A-D 5% Critical Value	0.70978235
K-S Test Statistic	0.37210048
K-S 5% Critical Value	0.31294923
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	11.8001986
Adjusted Gamma UCL	13.3708477

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.75289514
Shapiro-Wilk 5% Critical Value	0.803
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	12.8166215
95% Chebyshev (MVUE) UCL	14.1157113
97.5% Chebyshev (MVUE) UCL	16.7882432
99% Chebyshev (MVUE) UCL	22.0379147

95% Non-parametric UCLs	
CLT UCL	10.3850501
Adj-CLT UCL (Adjusted for skewness)	10.807151
Mod-t UCL (Adjusted for skewness)	10.8886462
Jackknife UCL	10.8228069
Standard Bootstrap UCL	N/R
Bootstrap-t UCL	N/R
Hall's Bootstrap UCL	N/R
Percentile Bootstrap UCL	N/R
BCA Bootstrap UCL	N/R
95% Chebyshev (Mean, Sd) UCL	14.3675796
97.5% Chebyshev (Mean, Sd) UCL	17.1351993
99% Chebyshev (Mean, Sd) UCL	22.5716522

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APPENDIX B-6
ProUCL Output
Arsenic - Wetland Sediments
Peter Cooper - Markhams Site

Data File | Variable: Arsenic

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	14	Shapiro-Wilk Test Statisitic	0.8859277
Number of Unique Samples	14	Shapiro-Wilk 5% Critical Value	0.874
Minimum	1.6	Data are normal at 5% significance level	
Maximum	11.4		
Mean	5.0571429	95% UCL (Assuming Normal Distribution)	
Median	3.85	Student's	6.419127
Standard Deviation	2.877623		
Variance	8.2807143	Gamma Distribution Test	
Coefficient of Variation	0.5690215	A-D Test Statistic	0.407109
Skewness	1.0356897	A-D 5% Critical Value	0.7409481
		K-S Test Statistic	0.1884108
Gamma Statistics		K-S 5% Critical Value	0.2300133
k hat	3.6576985	Data follow gamma distribution	
k star (bias corrected)	2.921525	at 5% significance level	
Theta hat	1.3826024		
Theta star	1.7309942	95% UCLs (Assuming Gamma Distribution)	
nu hat	102.41556	Approximate Gamma UCL	6.6770561
nu star	81.8027	Adjusted Gamma UCL	6.9330644
Approx.Chi Square Value (.05)	61.956637		
Adjusted Level of Significance	0.03122	Lognormal Distribution Test	
Adjusted Chi Square Value	59.668844	Shapiro-Wilk Test Statisitic	0.9657868
		Shapiro-Wilk 5% Critical Value	0.874
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	0.4700036		
Maximum of log data	2.4336134	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	1.4779199	95% H-UCL	7.123887
Standard Deviation of log data	0.5547482	95% Chebyshev (MVUE) UCL	8.4247876
Variance of log data	0.3077456	97.5% Chebyshev (MVUE) UCL	9.8848812
		99% Chebyshev (MVUE) UCL	12.752952

95% Non-parametric UCLs	
CLT UCL	6.3221621
Adj-CLT UCL (Adjusted for skewness)	6.5496278
Mod-t UCL (Adjusted for skewness)	6.4546071
Jackknife UCL	6.419127
Standard Bootstrap UCL	6.2614052
Bootstrap-t UCL	6.9572886
Hall's Bootstrap UCL	6.5309561
Percentile Bootstrap UCL	6.3321429
BCA Bootstrap UCL	6.5071429
95% Chebyshev (Mean, Sd) UCL	8.4094722
97.5% Chebyshev (Mean, Sd) UCL	9.8600278
99% Chebyshev (Mean, Sd) UCL	12.709363

RECOMMENDATION

Data are normal (0.05)

Use Student's-t UCL

APPENDIX C

Estimation of Air Concentrations and Particulate Emission Factors

APPENDIX C

ESTIMATION OF AIR CONCENTRATIONS AND PARTICULATE EMISSION FACTORS

To address the soil/groundwater-to-air pathways, the following models were used to evaluate volatilization of chemicals and fugitive dust emissions:

1. Johnson & Ettinger Model to estimate indoor air concentrations from groundwater,
2. VOC Emission Model to estimate vapor flux to ambient air from soil and groundwater,
3. X/Q dispersion model to estimate ambient air concentrations from vapor flux, and
4. PEF calculation to relate the concentration of respirable particles in the air to fugitive dust emission from soil.

These models are described in the following paragraphs. Johnson and Ettinger model output files, including the predicted indoor air chemical concentrations, are attached to this Appendix.

Johnson and Ettinger Model

Inhabitants of buildings on-site in the future could be exposed to volatile organic chemicals (VOCs) that may infiltrate the indoor environment from shallow groundwater. VOC concentrations in indoor air of future structures were estimated using the Johnson and Ettinger model, as parameterized by U.S. EPA (2003). The model incorporates both convective and diffusive mechanisms for estimating the transport of chemical vapors emanating from either subsurface soils or groundwater into indoor spaces located directly above or in close proximity to a source of chemicals. The model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source. The Johnson and Ettinger model has two levels called tiers. Tier 1 is a screening model in which most model parameters have been set equal to central tendency or upper bound values; values for the most sensitive parameters may be user-defined. In Tier 2, site-specific data may be input for all model parameters. Results from the Tier 1 model are therefore generally more conservative than results obtained from the more refined Tier 2 model. The Tier 2 model was used to estimate the indoor air concentration for the potential future receptors evaluated in this baseline RA. The predicted air concentrations for each of the COPCs were then used to estimate the dose and the resulting risks.

Inputs to the Tier 2 model used for this assessment include chemical properties, saturated and unsaturated zone soil properties, and exposure frequency and duration values. The input parameters to the model used for the scenarios evaluated are presented in Table C-1.

VOC Emissions Model

The VOC emission model presented in "Soil Screening Guidance: Users Guide and Technical Background Document" (U.S. EPA, 1996a and b) was modified to estimate vapor flux of chemicals from groundwater as follows:

$$Ei = \frac{CT \times 2 \times Da \times CF_{m2-cm2}}{\sqrt{\pi \times Da \times T}} \qquad (1)$$

Where:

Ei = Emission rate (mg/sec)

CT = Total solute concentration in soil (mg/cm^3; see below)

Da = Chemical-specific effective diffusivity in soil (cm^2/sec); calculated as follows:

$$Da = \frac{(Pa^{3.333} \times Di \times H') + (Pw^{3.333} \times Dw) / Pt^2}{(pb \times Kd) + Pw + (Pa \times H')} \qquad (2)$$

Where:
- Di = chemical-specific diffusivity in air (cm^2/sec)
- Pa = air-filled porosity (unitless)
- H' = Henry's law constant (unitless)
- Pw = water-filled porosity (unitless)
- Dw = chemical-specific diffusivity in water (cm^2/sec)
- Pt = total soil porosity (unitless)
- Pb = Soil bulk density (g/cm^3)
- Kd = Soil organic partition coefficient (cm^3/g)

CF_{m2-cm2} = Conversion factor from square meters to square centimeters

T = Exposure interval (sec) (equal to exposure duration)

The total solute concentration is derived from the concentration in groundwater and the related concentration in soil vapor based on partitioning from groundwater to vapor as predicted by Henry's law. The equation is:

$$CT = Cv \times (pb \times Kd/H' + Pw / H' + Pa) \quad (3)$$

Where:

Cv = Soil vapor concentration (g/cm^3), calculated as follows:

$$Cv = Cgw \times H' \times CF_{cm3-l} \quad (4)$$

Where: Cgw = Concentration in groundwater (mg/l)

H' = Henry's Law Constant (unitless)

CF_{cm3-l} = Conversion Factor from cubic centimeters to liters

Other parameters were defined previously.

X/Q Model

Ambient air concentrations were estimated based on the emission rate from the VOC emission model and potential dispersion in ambient air. In U.S. EPA's Soil Screening Guidance (1996a/b), there is a log-linear relationship between the inverse of the dispersion factor (Q/C;g/m^2-sec per kg/m^3) and the area of the emission source (A; acre) defined as:

$$Q / C = -29.23 \times LogA + 62.55 \quad (11)$$

This equation is based on specific measurements in Hartford, CT the location most appropriate to the subject site. The inverse dispersion factor (Q/C) is related to the dispersion factor as follows (X/Q; mg/m^3 per mg/m^2-sec):

$$X / Q = \frac{CF_{kg-mg}}{Q / C \times CF_{g-mg}} \quad (12)$$

Where:

CF_{kg-mg} = Conversion factor from kilograms to milligrams

CF_{g-mg} = Conversion factor from grams to milligrams

The concentration in ambient air was then estimated as follows:

$$Caa = Ei \times X/Q \quad (13)$$

Where:

Caa = Concentration in ambient air (mg/m^3)

Ei	=	Emission rate (mg/m^2-sec)
X/Q	=	Dispersion factor (mg/m^3 per mg/m^2-sec)

Particulate Emission Factor Calculation

Inhalation of chemicals adsorbed to respirable particles (PM10) were assessed by calculating a PEF that relates the concentration of respirable particles in the air due to fugitive dust emission from soil. The relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface chemical concentration provides a relatively continuous and constant potential for emission over an extended period of time. The following equation, as described in U.S. EPA (2002a, 1996a/b), was used:

$$PEF = \frac{Q/C \times 3600}{0.036 \times (1 - V) \times (Um/Ut)^3 \times F(x)} \qquad (14)$$

Where:

Q/C	=	Dispersion factor (g/m^2-sec per kg/m^3)
V	=	Fraction of vegetative cover (0.5; U.S. EPA, 1989)
Um	=	Mean annual windspeed (4.69 m/sec; U.S. EPA, 1996a)
Ut	=	Equivalent threshold value of windspeed at 7 meters (11.32 m/sec; U.S. EPA, 1996a)
F(x)	=	Function of Um/Ut (0.2; U.S. EPA, 1996a)

The default U.S. EPA commercial/industrial PEF of 1.36×10^9 m^3/kg was used for both the trespassers and the outdoor industrial workers. For construction workers, a default PEF of 2×10^7 m^3/kg was used to represent dusty site conditions based on U.S. EPA's national ambient air quality standard of 50 $\mu g/m^3$ for particulates (PM10). The U.S. EPA Supplemental Soil Screening Guidance (2002a) provides a detailed approach for addressing dust generated during construction that requires information that is not available for this site (e.g., number of vehicles, size of vehicles, vehicle miles traveled per day) because specific construction has not been planned. For this reason, we used the ambient air quality criteria of 50 ug/m^3, which construction projects are typically required to meet by the use of dust control measures. The PEF is the inverse of the standard adjusted for unit conversions. The PEF derived from the ambient air quality criteria is higher than the PEF derived for fugitive windblown dusts.

TABLE C-1
JOHNSON AND ETTINGER MODEL INPUT PARAMETERS
Peter Cooper Markhams Site.
Town of Dayton, New York

Parameter	Symbol	Units	Industrial Value	Rationale
Depth below grade to bottom of enclosed floor space	L_F	(cm)	15	Slab-on-grade
Depth below grade to water table	L_{WTt}	(cm)/(ft)	121.92/4	Site-specific; conservative depth to groundwater
Soil type	–	–	SC	Sandy Clay
Soil dry bulk density	ρ_b	(g/cm^3)	1.63	U.S. EPA, 2003a
Soil total porosity	P_T	(cm^3/cm^3)	0.385	U.S. EPA, 2003a
Soil water-filled porosity	P_w	(cm^3/cm^3)	0.197	U.S. EPA, 2003a
Length of building	L_B	(cm)/(ft)	1000/33	1,000 ft^2; small building
Width of building	W_B	(cm)/(ft)	1000/33	1,000 ft^2; small building
Height of building	H_B	(cm)/(ft)	457.2/15	Industrial structure
Fraction of building above plume	–	%	100	Default
Indoor air exchange rate	ER	(1/hr)	0.83	ASTM, 1997

DATA ENTRY SHEET

GW-ADV
Version 3.0; 02/03

Geomatrix Version, 1.0.1
modified by MJC, Jan 2004
includes Cal-EPA CSFs

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc below)

YES [X]

ENTER U.S. EPA or Cal-EPA: U S EPA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432	1 80E+00	Benzene
79016	4.20E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
10	15	121.92	121 92	0	0	A	SC	SC		1 00E-08

(Totals must add up to value of L_{WT} (cell G28) — applies to thickness of soil strata A, B and C.)

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-fillec porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SC	1.63	0 385	0.197	SCL	1 63	0 384	0.146	SL	1.62	0.387	0.103

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	457.2	0.1	0 83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1 0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1 79E+03	7.8E-06	3.0E-02
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	4.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	106.92	0.188	0.238	0.284	0.299	1.74E-09	0.837	ERROR	30.00	0.385	0.030	0.355	4,000
7.88E+08	106.92	0.188	0.238	0.284	0.299	1.74E-09	0.837	ERROR	30.00	0.385	0.030	0.355	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.05E+05	1.06E+06	3.77E-04	15	8,122	2.68E-03	1.15E-01	1.75E-04	2.28E-03	0.00E+00	0.00E+00	2.33E-05	8.10E-05	106.92
1.05E+05	1.06E+06	3.77E-04	15	8,557	4.78E-03	2.06E-01	1.75E-04	2.04E-03	0.00E+00	0.00E+00	1.41E-05	4.93E-05	106.92

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.07E+02	0.10	8.33E+01	2.28E-03	4.00E+02	#NUM!	7.55E-06	1.57E-03	7.8E-06	3.0E-02
15	8.64E+02	0.10	8.33E+01	2.04E-03	4.00E+02	#NUM!	4.61E-06	3.98E-03	1.1E-04	4.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.79E+06	NA
NA	NA	NA	1.47E+06	NA
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR
ERROR	ERROR	ERROR	ERROR	ERROR

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.0E-09	3.6E-05
1.1E-07	6.8E-05
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR
ERROR	ERROR

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

ERROR: Enter either an SCS soil type for stratum A OR a user-defined permeability.

END

APPENDIX D

Absorption Factors, Permeability Constants, and Dermally Absorbed Dose per Event for Chemicals of Potential Concern

APPENDIX D-1
DERMAL ABSORPTION FACTORS 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)
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	0.66
Benzo(b)fluoranthene	0.13	0.757
Bis(2-ethylhexyl)phthalate	0.1	0.677
Cadmium	0.001	0.001
Chromium, Total	0.01	0.001
Chromium, hexavalent	0.01	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, 2004a: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment, Final, September.

Geomatrix

APPENDIX D-2
DERMALLY ABSORBED DOSE PER EVENT FOR CHEMICALS OF POTENTIAL CONCERN
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)	Fraction Absorbed (FA) (--)	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 (Cgw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Industrial (mg/cm^2-event)	Dermal Absorbed Dose Per Event (DAevent) Construction (mg/cm^2-event)	Concentration Surface Water (Csw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Trespasser (mg/cm^2-event)
Aluminum	27	NA	0.001	NA	2.00E-03	1.12E-06	1.49E-01	3.04E-01	3.35E-01	0.36	2.4E-02	4.2E-06	4.9E-05	NA	NA
Antimony	122	NA	0.001	NA	4.25E-03	3 29E-07	5.07E-01	3.06E-01	3.36E-01	1.22	4.6E-05	7.9E-09	9.3E-08	NA	NA
Arsenic	75	NA	0.001	NA	3.33E-03	6.03E-07	2.77E-01	3.05E-01	3.36E-01	0.66	5.1E-05	8.6E-09	1.0E-07	NA	NA
Barium	137	NA	0.001	NA	4.50E-03	2.71E-07	6.15E-01	3.06E-01	3.36E-01	1.48	4.3E-04	7.3E-08	8.6E-07	NA	NA
Benzene	78.11	2.13	0.015	1	5.10E-02	5.79E-07	2.88E-01	3.35E-01	3.68E-01	0.70	1.8E-06	1.7E-08	6.8E-08	NA	NA
Benzo(a)pyrene	252.32	6.11	0.66	1	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	1	4.28E+00	6.12E-08	2.72E+00	1.34E+01	4.34E+00	12.03	6.0E-07	8.5E-07	2.9E-06	NA	NA
Bis(2-ethylhexyl)phthalate	390.57	7.30	0.677	1	1.82E-01	1.03E-08	1.62E+01	4.26E-01	4.64E-01	41.85	5.0E-06	1.6E-05	5.3E-05	NA	NA
Cadmium	112	NA	0.001	1	4.07E-03	3.74E-07	4.46E-01	3.06E-01	3.36E-01	1.07	3.4E-05	2.6E-08	9.9E-08	NA	NA
Chromium, trivalent	52	NA	0 001	NA	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	NA	5 55E-03	8.11E-07	2.06E-01	3.07E-01	3.37E-01	0.49	3.2E-04	1.1E-07	1.3E-06	1.1E-05	5.4E-09
Cobalt	59	NA	0.001	1	2.95E-03	7.41E-07	2.25E-01	3.05E-01	3.35E-01	0.54	1.8E-04	9.5E-08	4.3E-07	NA	NA
Copper	64	NA	0.001	1	3.08E-03	6.94E-07	2.40E-01	3.05E-01	3.35E-01	0.58	1.5E-03	8.3E-07	3.7E-06	NA	NA
Iron	55.847	NA	0.001	1	2.87E-03	7.71E-07	2.16E-01	3.05E-01	3.35E-01	0.52	3.2E+00	1.7E-03	7.7E-03	NA	NA
Lead	207	NA	0.0001	NA	5 53E-04	1.10E-07	1.52E+00	3.04E-01	3.34E-01	3.64	1.0E-03	1.7E-08	2.0E-07	NA	NA
Manganese	55	NA	0.001	NA	2.85E-03	7.80E-07	2.14E-01	3.05E-01	3.35E-01	0.51	1.5E-02	2.6E-06	3.0E-05	NA	NA
Nickel	59	NA	0.0002	1	5 91E-04	7.41E-07	2.25E-01	3.04E-01	3.34E-01	0.54	1.9E-03	2.1E-07	9.3E-07	NA	NA
Selenium -	79	NA	0.001	1	3.42E-03	5.72E-07	2.91E-01	3.05E-01	3.36E-01	0.70	2.7E-05	1.7E-08	7.0E-08	NA	NA
Thallium	204	NA	0.001	1	5.49E-03	1.14E-07	1.46E+00	3.07E-01	3.37E-01	3.50	8.7E-04	1.2E-06	4.1E-06	NA	NA
Trichloroethene	131	2.71	0.012	1	5.28E-02	2.93E-07	5.69E-01	3.36E-01	3.69E-01	1.39	4.2E-06	4.3E-08	1.6E-07	NA	NA
Zinc	65	NA	0.0006	1	1.86E-03	6.85E-07	2.43E-01	3.04E-01	3.35E-01	0.58	1.5E-01	NA	NA	NA	NA

For Organics
If tevent < t*: $DAevent = 2 \cdot FA \cdot Kp \cdot Cgw \cdot (6 \cdot tau \cdot tevent/\pi)^{1/2}$
or
If tevent > t*: $DAevent = FA \cdot Kp \cdot Cgw \cdot [\,tevent/(1+B) + 2 \cdot tau \cdot (1 + 3 \cdot B + 3 \cdot B^2)/(1+B)^2\,]$

For Inorganics
$DAevent = Kp \cdot Cgw \cdot tevent$

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

If log Kow > 4
$Kp = 10^{(-2.8 + 0.66 \cdot logKow - 0.0056 \cdot MW)}$

Source: USEPA, 2004a

$B = \frac{Kp \cdot (MW)^{1/2}}{2.6}$

t* = USEPA, 2004a Exhibit B-3, or

If B < 0.6, t* = 2.4 * tau

If B > 0.6, $t^* = \frac{(b - (b2 - c2)^{1/2}) \cdot 1E\text{-}6}{Dsc}$

$Dsc = 10^{(-5.8 - 0.0056 \cdot MW)}$

$tau = \frac{1E\text{-}6}{6 \cdot Dsc}$

$b = \frac{2 \cdot (1 + B)^2}{\pi}$

$c = \frac{1 + 3 \cdot B + 3 \cdot B^2}{3 \cdot (1 + B)}$

Parameter	Symbol	Value	Units
Event Duration - industrial worker	tevent	0.17	hr
Event Duration - construction worker	tevent	2	hr
Event Duration - trespasser	tevent	0 25	hr

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APPENDIX E

Human Health Risk Assessment Calculations RME Scenario

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RISK EQUATIONS

INCIDENTAL INGESTION OF SOIL/SEDIMENT

$$AADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFo$$

DERMAL CONTACT WITH SOIL/SEDIMENT

$$AADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFo$$

INHALATION OF VOLATILES IN AMBIENT AIR

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFi$$

INHALATION OF VOLATILES IN INDOOR AIR

$$AADD = \frac{(Cia \times IHRia \times ETia \times ABSiv \times EFia \times ED)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Cia \times IHRia \times ETia \times ABSiv \times EFia \times ED)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFi$$

INHALATION OF RESUSPENDED SOIL PARTICULATES

$$AADD = \frac{(Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED)}{(BW \times PEF \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED)}{(BW \times PEF \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFi$$

INGESTION OF GROUNDWATER/SURFACE WATER

$$AADD = \frac{(Cgw \times IRdw \times ABSow \times EFdw \times ED)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cgw \times IRdw \times ABSow \times EFdw \times ED)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFo$$

DERMAL CONTACT WITH GROUNDWATER/SURFACE WATER

$$AADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFo$$

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CONSTANTS

Parameter	Symbol	Value	Units	Source(s)
SITE-SPECIFIC PROPERTIES				
Groundwater Emission Area - industrial (ambient air)	A	33000	m^2	600 ft x 600 ft
Area Building - industrial (indoor air)	A	1,000	m^2	
Length of Area - site	LS	229	m	
Wind Speed	WS	2.5	m/sec	
Mixing Height	MH	2	m	
Particulate Emission Factor - construction	PEF	2E+07	m^3/kg	50 ug/m^3 NAAQS
SOIL PROPERTIES				
Fraction Organic Carbon	foc	0.006	unitless	
Bulk Density	pb	1.5	g/cm^3	
Water Filled Soil Porosity	Pw	0.15	unitless	
Air Filled Soil Porosity	Pa	0.28	unitless	
Total Porosity	Pt	0.43	unitless	
Temperature	T	298	K	
PHYSICAL CONSTANTS				
Universal Gas Constant	R	0.000082	atm-m^3/mole-K	--
UNITS CONVERSION FACTORS				
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1.E-06	kg/mg	--
Conversion Factor from m^2 to cm^2	$CF_{m2\text{-}cm2}$	1.E+04	cm^2/m^2	--
Conversion Factor from g to kg	$CF_{g\text{-}kg}$	1.E-03	kg/g	--
Conversion Factor from cm^3 to L	$CF_{cm3\text{-}L}$	1.E-03	L/cm^3	--
Conversion Factor from kg to mg	$CF_{kg\text{-}mg}$	1.E+06	mg/kg	--
Conversion Factor from g to mg	$CF_{g\text{-}mg}$	1.E+03	mg/g	--

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AIR DISPERSION FACTOR (X/Q)

Source	Scenario	Area of Source (acre)	Q/C (g/m^2-sec) per (kg/m^3)	X/Q (mg/m^3) per (mg/m^2-sec)
Groundwater	Industrial	8.2	46.22	21.64

$$X/Q = \frac{CF_{kg\text{-}mg}}{Q/C \times CF_{g\text{-}mg}}$$

Source: USEPA, 1996

Parameter	Symbol	Value	Units	Source(s)
Air Dispersion Factor	X/Q	see above	mg/m^3 per mg/m^2-sec	calculated
Inverse of Dispersion Factor	Q/C	see above	g/m^2-sec per kg/m^3	estimated
Area of Source	A	see above	acre	site-specific
Source Location	--	**12**	--	site-specific
Conversion Factor from kg to mg	$CF_{kg\text{-}mg}$	1.E+06	mg/kg	--
Conversion Factor from g to mg	$CF_{g\text{-}mg}$	1.E+03	mg/g	--

Location				$Q/C = A \times \exp[(\ln A_c - B)^2 \div C]$ (g/m^2-sec) / (kg/m^3)			
Selection	**Zone**	**State**	**City**	**A Constant**	**B Constant**	**C Constant**	**Commercial Groundwater**
12	**8**	**CT**	**Hartford**	**12.59**	**18.84**	**215.44**	**46.22**
1	1	--	--				
2	1	WA	Seattle	14.2253	18.84	218.18	51.37
3	1	OR	Salem	12.3783	18.97	218.21	45.61
4	2	CA	--				
5	2	CA	Fresno	10.2152	19.27	220.06	38.98
6	2	CA	Los Angeles	11.911	18.44	209.78	42.53
7	2	CA	San Francisco	13.8139	20.16	234.29	55.62
8	3	--	--				
9	3	NV	Las Vegas	13.3093	19.84	230.17	52.24
10	3	AZ	Phoenix	10.2871	18.71	212.71	37.66
11	3	NM	Albuquerque	14.9421	17.99	205.18	51.14
12	8	CT	Hartford	12.5907	18.84	215.4377	46.22

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PARTICULATE EMISSION FACTOR (PEF)

Source	Scenario	Q/C (g/m^2-sec) per (kg/m^3)	PEF (mg/kg) per (mg/m^3)
Soil	Default Industrial	93.6	1.36E+09
	Construction	NA	2.00E+07

$$PEF = \frac{Q/C \times 3600}{0.036 \times (1 - V) \times (Um/Ut)^3 \times F(x)}$$

Source: USEPA, 2002a, 1996

Parameter	Symbol	Value	Units	Source(s)
Inverse of Dispersion Factor	Q/C	see above	g/m^2-sec per kg/m^3	estimated
Fraction of Vegetative Cover	V	0.5	--	site-specific
Mean Annual Windspeed	Um	4.69	m/sec	USEPA, 1996
Equivalent Threshold Value of Windspeed at 7 m	Ut	11.32	m/sec	USEPA, 1996
Function of Um/Ut	F(x)	2.E-01	--	USEPA, 1996

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REPRESENTATIVE CONCENTRATIONS

Chemical	Sediment (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Water (mg/l)	Groundwater (mg/l)
Aluminum	NA	NA	NA	NA	24.5
Antimony	NA	NA	NA	NA	0.046
Arsenic	6.42	23.3	23.8	NA	0.051
Barium	NA	NA	NA	NA	0.43
Benzene	NA	NA	NA	NA	0.0018
Benzo(a)pyrene	NA	0.071	0.071	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	0.0006
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	0.005
Cadmium	NA	NA	NA	NA	0.034
Chromium, trivalent	NA	21500	19500	NA	NA
Chromium, hexavalent	NA	14.0	11.9	0.0108	0.321
Cobalt	NA	NA	NA	NA	0.176
Copper	NA	NA	NA	NA	1.49
Iron	NA	NA	NA	NA	3160
Lead	NA	NA	NA	NA	1.02
Manganese	NA	NA	NA	NA	15
Nickel	NA	NA	NA	NA	1.90
Selenium	NA	NA	NA	NA	0.027
Thallium	NA	NA	NA	NA	0.87
Trichloroethene	NA	NA	NA	NA	0.0042
Zinc	NA	NA	NA	NA	146

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EXPOSURE PARAMETERS

Parameter	Symbol	Units	Outdoor/Indoor Industrial Worker	Construction Worker	Trespasser - Adult	Trespasser - Adolescent
ALL PATHWAYS						
Exposure Frequency	EF	d/yr	225	180	26	39
Exposure Duration	ED	yr	25	1	30	9
Body Weight	BW	kg	70	70	70	43
Averaging Time-Non-cancer	ATnc	days	9,125	365	10,950	3,285
Averaging Time-Cancer	ATca	days	25,550	25,550	25,550	25,550
INCIDENTAL INGESTION OF SOIL						
Exposure Frequency	EFig	d/yr	225	180	26	39
Ingestion Rate	IRs	mg/d	100	330	100	100
DERMAL CONTACT WITH SOIL						
Exposure Frequency	EFdc	d/yr	225	180	26	39
Surface Area	SAs	cm^2	3,300	3,300	5,700	5,700
Soil-to-Skin Adherence Factor	SAF	mg/cm^2	0 2	0 3	0.07	0 07
INHALATION OF VOLATILES IN AMBIENT AIR						
Exposure Frequency	EFaa	d/yr	225	180	26	39
Inhalation Rate	IHRaa	m^3/hr	2 5	2 5	1 6	1 2
Exposure Time	ETaa	hr/d	8	8	2	3
INHALATION OF VOLATILES IN INDOOR AIR						
Exposure Frequency	EFia	d/yr	250	NA	NA	NA
Inhalation Rate	IHRia	m^3/hr	2 5	NA	NA	NA
Exposure Time	ETia	hr/d	8	NA	NA	NA
INHALATION OF RESUSPENDED SOIL PARTICULATES						
Exposure Frequency	EFpe	d/yr	225	30	26	39
Inhalation Rate	IHRpe	m^3/hr	2 5	2 5	1 6	1.2
Exposure Time	ETpe	hr/d	8	8	7	7
INGESTION OF GROUNDWATER						
Exposure Frequency	EFdw	d/yr	225	NA	NA	NA
Ingestion Rate	IRdw	L/d	1	NA	NA	NA
DERMAL CONTACT WITH GROUNDWATER WHILE SHOWERING						
Event Duration	tevent	hr/day	0 17	NA	NA	NA
Event Frequency	EVswr	evt/day	1	NA	NA	NA
Exposure Frequency	EFswr	d/yr	225	NA	NA	NA
Surface Area	SAswr	cm^2	18,000	NA	NA	NA
DERMAL CONTACT WITH GROUNDWATER[1]						
Event Duration	tevent	hr/day	NA	2	NA	NA
Event Frequency	EVswr	evt/day	NA	1	NA	NA
Exposure Frequency	EFswr	d/yr	NA	90	NA	NA
Surface Area	SAswr	cm^2	NA	7,100	NA	NA
DERMAL CONTACT WITH SURFACE WATER						
Event Duration	tevent	hr/event	NA	2	0 25	0.25
Event Frequency	EVswr	evt/day	NA	1	1	1
Exposure Frequency	EFswr	d/yr	NA	90	26	39
Surface Area	SAswr	cm^2	NA	7,100	7100	6,600

1) Assuming that construction workers stand in ~ 2 feet of water; thus, forearms, hands, lower legs, and feet (30 6% total body area of 23,000 cm2 - USEPA, 1997b) are exposed.

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TOXICITY CRITERIA

Chemical	Slope Factors (SF)			Reference Doses (RfD)		
	oral SFo $(mg/kg\text{-}d)^{-1}$	inhalation SFi $(mg/kg\text{-}d)^{-1}$	Adjusted Dermal SFd $(mg/kg\text{-}d)^{-1}$	chronic oral RfDo (mg/kg-d)	chronic inhalation RfDi (mg/kg-d)	Adjusted Dermal RfDd (mg/kg-d)
Acetone	NA	NA	NA	0.9	0.1	0.9
Arsenic	1.5	15	1.5	0.0003	0.0003	0.0003
Barium	NA	NA	NA	0.07	0.00014	0.0049
Benzene	0.055	0.027	0.055	0.004	0.0086	0.004
Benzo(a)pyrene	7.3	7.3	7.3	NA	NA	NA
Benzo(b)fluoranthene	0.73	0.73	0.73	NA	NA	NA
Bis(2-ethylhexyl)phthalate	0.014	0.014	0.014	0.02	0.022	0.02
Cadmium	NA	6.3	NA	0.0005	0.0005	0.0000013
Chromium, trivalent	NA	NA	NA	1.5	1.5	0.02
Chromium, hexavalent	NA	42	NA	0.003	0.0000022	0.000075
Cobalt	NA	9.8	NA	0.02	0.0000057	0.02
Copper	NA	NA	NA	0.037	0.037	0.037
Iron	NA	NA	NA	0.3	0.3	0.3
Lead	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	0.024	0.000014	0.00096
Nickel	NA	0.91	NA	0.02	0.02	0.0008
Selenium	NA	NA	NA	0.005	0.005	0.004
Thallium	NA	NA	NA	0.000066	0.000066	0.000066
Trichloroethene	0.4	0.4	0.4	0.0003	0.01	0.0003
Zinc	NA	NA	NA	0.3	0.3	0.3

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ABSORPTION FACTORS

Chemical	Oral soil ABSos (--)	Oral Water ABSow (--)	Inhalation VOC ABSiv (--)	Inhalation Dust ABSip (--)	Dermal Soil ABSds (--)	Permeability Constant Kp (USEPA) (cm/hr)	Steady-state Time t* (USEPA) (hr)
Aluminum	1	1	1	1	0.01	0.001	NA
Antimony	1	1	1	1	0.01	0.001	NA
Arsenic	1	1	1	1	0.03	0.001	NA
Barium	1	1	1	1	0.01	0.001	NA
Benzene	1	1	1	1	0.1	0.015	0.7
Benzo(a)pyrene	1	1	1	1	0.13	0.66	11.67
Benzo(b)fluoranthene	1	1	1	1	0.13	0.757	12.03
Bis(2-ethylhexyl)phthalate	1	1	1	1	0.1	0.677	41.85
Cadmium	1	1	1	1	0.001	0.001	NA
Chromium, trivalent	1	1	1	1	0.01	0.001	NA
Chromium, hexavalent	1	1	1	1	0.01	0.002	NA
Cobalt	1	1	1	1	0.01	0.001	NA
Copper	1	1	1	1	0.01	0.001	NA
Iron	1	1	1	1	0.01	0.001	NA
Lead	1	1	1	1	0.01	0.0001	NA
Manganese	1	1	1	1	0.01	0.001	NA
Nickel	1	1	1	1	0.01	0.0002	NA
Selenium	1	1	1	1	0.01	0.001	NA
Thallium	1	1	1	1	0.01	0.001	NA
Trichloroethene	1	1	1	1	0.1	0.012	1.39
Zinc	1	1	1	1	0.01	0.0006	NA

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PHYSICOCHEMICAL PROPERTIES

Chemical	Log Octanol Water Partition Coefficient (log Kow)	Henry's Law Constant (H)	Henry's Law Constant (H')	Aqueous Solubility (S)	Diffusivity in Air (Di)		Diffusivity in Water (Dw)	Organic Carbon Partition Coefficient (Koc)	Molecular Weight (MW)	VOC?
					given	calculated				
	(--)	(atm-m^3/mole)	(unitless)	(mg/l)	(cm^2/sec)	(cm^2/sec)	(cm^2/sec)	(l/kg)	(g/mole)	
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	27	No
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	122	No
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	75	No
Barium	NA	NA	NA	NA	NA	NA	NA	NA	137	No
Benzene	2.13	5.56E-03	2.28E-01	1.75E+03	8.80E-02	NA	9.80E-06	5.89E+01	78.11	Yes
Benzo(a)pyrene	6.11	1.13E-06	4.63E-05	1.62E-03	4.30E-02	NA	9.00E-06	1.02E+06	252.32	No
Benzo(b)fluoranthene	6.20	1.11E-04	4.55E-03	1.50E-03	2.26E-02	NA	5.56E-06	1.23E+06	252.32	No
Bis(2-ethylhexyl)phthalate	7.30	1.02E-07	4.18E-06	3.40E-01	3.50E-02	NA	3.66E-06	1.51E+07	390.57	No
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	112	No
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA	52	No
Chromium, hexavalent	NA	NA	NA	NA	NA	NA	NA	NA	52	No
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	59	No
Copper	NA	NA	NA	NA	NA	NA	NA	NA	64	No
Iron	NA	NA	NA	NA	NA	NA	NA	NA	55.85	No
Lead	NA	NA	NA	NA	NA	NA	NA	NA	207	No
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	55	No
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	59	No
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	79	No
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	204	No
Trichloroethene	2.71	1.03E-02	4.22E-01	1.10E+03	7.90E-02	NA	9.10E-06	1.66E+02	131	Yes
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	65	NA

$H' = H / RT$

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CALCULATION OF SOIL SATURATION CONCENTRATIONS (Csat)

Chemical	Organic Carbon Partition Coefficient (Koc) (l/kg)	Aqueous Solubility (S) (mg/l)	Henry's Law Constant (H') (unitless)	Soil-Organic Partition Coefficient (Kd) (l/kg)	Saturation Concentration (Csat) (mg/kg)	Maximum Concentration Soil (Cs) (mg/kg)	Free Phase?
Aluminum	NA	NA	NA	NA	NA	0.00E+00	NA
Antimony	NA	NA	NA	NA	NA	0.00E+00	NA
Arsenic	NA	NA	NA	NA	NA	2.38E+01	NA
Barium	NA	NA	NA	NA	NA	0.00E+00	NA
Benzene	5.89E+01	1.75E+03	2.28E-01	3.53E-01	8.68E+02	0.00E+00	No
Benzo(a)pyrene	1.02E+06	1.62E-03	4.63E-05	6.12E+03	9.91E+00	7.10E-02	No
Benzo(b)fluoranthene	1.23E+06	1.50E-03	4.55E-03	7.38E+03	1.11E+01	0.00E+00	No
Bis(2-ethylhexyl)phthalate	1.51E+07	3.40E-01	4.18E-06	9.06E+04	3.08E+04	0.00E+00	No
Cadmium	NA	NA	NA	NA	NA	0.00E+00	NA
Chromium, trivalent	NA	NA	NA	NA	NA	2.15E+04	NA
Chromium, hexavalent	NA	NA	NA	NA	NA	1.40E+01	NA
Cobalt	NA	NA	NA	NA	NA	0.00E+00	NA
Copper	NA	NA	NA	NA	NA	0.00E+00	NA
Iron	NA	NA	NA	NA	NA	0.00E+00	NA
Lead	NA	NA	NA	NA	NA	0.00E+00	NA
Manganese	NA	NA	NA	NA	NA	0.00E+00	NA
Nickel	NA	NA	NA	NA	NA	0.00E+00	NA
Selenium	NA	NA	NA	NA	NA	0.00E+00	NA
Thallium	NA	NA	NA	NA	NA	0.00E+00	NA
Trichloroethene	1.66E+02	1.10E+03	4.22E-01	9.96E-01	1.29E+03	0.00E+00	No
Zinc	NA	NA	NA	NA	NA	0.00E+00	NA

Csat = S/pb x (Kd x pb+ Pw + H' x Pa)

Kd = Koc x foc

Source: USEPA, 1996

Parameter	Symbol	Value	Units
Fraction Organic Carbon	foc	0.006	unitless
Bulk Density	pb	1.5	g/cm^3
Water Filled Soil Porosity	Pw	0.15	unitless
Air Filled Soil Porosity	Pa	0.28	unitless

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EFFECTIVE DIFFUSION COEFFICIENT IN SOIL

Chemical	Diffusivity in Air (Di) (cm^2/sec)	Diffusivity in Water (Dw) (cm^2/sec)	Henry's Law Constant (H') (unitless)	Soil-Organic Partition Coefficient (Kd) (cm^3/g)	Effective Diffusivity (Da) (cm^2/sec)
Aluminum	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA
Benzene	8.80E-02	9.80E-06	2.28E-01	3.53E-01	2.09E-03
Benzo(a)pyrene	4.30E-02	9.00E-06	4.63E-05	6.12E+03	2.64E-11
Benzo(b)fluoranthene	2.26E-02	5.56E-06	4.55E-03	7.38E+03	7.27E-10
Bis(2-ethylhexyl)phthalate	3.50E-02	3.66E-06	4.18E-06	9.06E+04	3.45E-13
Cadmium	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA
Trichloroethene	7.90E-02	9.10E-06	4.22E-01	9.96E-01	1.47E-03
Zinc	NA	NA	NA	NA	NA

$$Da = \frac{\left[\left(Pa^{10/3} \times Di \times H' + Pw^{10/3} \times Dw \right) / Pt^2 \right]}{pb \times Kd + Pw + Pa \times H'}$$

Source: USEPA, 1996

Parameter	Symbol	Value	Units
Fraction Organic Carbon	foc	0.006	unitless
Air Filled Soil Porosity	Pa	0.28	unitless
Water Filled Soil Porosity	Pw	0.15	unitless
Total Porosity	Pt	0.43	unitless
Soil Bulk Density	pb	1.5	g/cm^3

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CALCULATION OF DERMALLY ABSORBED DOSE PER EVENT (DAevent)

Chemical	Molecular Weight (MW) (g/mole)	Log Octanol Water Partition Coefficient (log Kow) (--)	Permeability Constant (Kp) (cm/hr)	Fraction Absorbed (FA) (--)	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 (Cgw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Industrial (mg/cm^2-event)	Dermal Absorbed Dose Per Event (DAevent) Construction (mg/cm^2-event)	Concentration Surface Water (Csw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Trespasser (mg/cm^2-event)
Aluminum	27	NA	0.001	NA	2.00E-03	1.12E-06	1.49E-01	3.04E-01	3.35E-01	0.36	2.4E-02	4.2E-06	4.9E-05	NA	NA
Antimony	122	NA	0.001	NA	4.25E-03	3.29E-07	5.07E-01	3.06E-01	3.36E-01	1.22	4.6E-05	7.9E-09	9.3E-08	NA	NA
Arsenic	75	NA	0.001	NA	3.33E-03	6.03E-07	2.77E-01	3.05E-01	3.36E-01	0.66	5.1E-05	8.6E-09	1.0E-07	NA	NA
Barium	137	NA	0.001	NA	4.50E-03	2.71E-07	6.15E-01	3.06E-01	3.36E-01	1.48	4.3E-04	7.3E-08	8.6E-07	NA	NA
Benzene	78.11	2.13	0.015	1	5.10E-02	5.79E-07	2.88E-01	3.35E-01	3.68E-01	0.70	1.8E-06	1.7E-08	6.8E-08	NA	NA
Benzo(a)pyrene	252.32	6.11	0.66	1	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	1	4.28E+00	6.12E-08	2.72E+00	1.34E+01	4.34E+00	12.03	6.0E-07	8.5E-07	2.9E-06	NA	NA
Bis(2-ethylhexyl)phthalate	390.57	7.30	0.677	1	1.82E-01	1.03E-08	1.62E+01	4.26E-01	4.64E-01	41.85	5.0E-06	1.6E-05	5.3E-05	NA	NA
Cadmium	112	NA	0.001	1	4.07E-03	3.74E-07	4.46E-01	3.06E-01	3.36E-01	1.07	3.4E-05	2.6E-08	9.9E-08	NA	NA
Chromium, trivalent	52	NA	0.001	NA	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	NA	5.55E-03	8.11E-07	2.06E-01	3.07E-01	3.37E-01	0.49	3.2E-04	1.1E-07	1.3E-06	1.1E-05	5.4E-09
Cobalt	59	NA	0.001	1	2.95E-03	7.41E-07	2.25E-01	3.05E-01	3.35E-01	0.54	1.8E-04	9.5E-08	4.3E-07	NA	NA
Copper	64	NA	0.001	1	3.08E-03	6.94E-07	2.40E-01	3.05E-01	3.35E-01	0.58	1.5E-03	8.3E-07	3.7E-06	NA	NA
Iron	55.847	NA	0.001	1	2.87E-03	7.71E-07	2.16E-01	3.05E-01	3.35E-01	0.52	3.2E+00	1.7E-03	7.7E-03	NA	NA
Lead	207	NA	0.0001	NA	5.53E-04	1.10E-07	1.52E+00	3.04E-01	3.34E-01	3.64	1.0E-03	1.7E-08	2.0E-07	NA	NA
Manganese	55	NA	0.001	NA	2.85E-03	7.80E-07	2.14E-01	3.05E-01	3.35E-01	0.51	1.5E-02	2.6E-06	3.0E-05	NA	NA
Nickel	59	NA	0.0002	1	5.91E-04	7.41E-07	2.25E-01	3.04E-01	3.34E-01	0.54	1.9E-03	2.1E-07	9.3E-07	NA	NA
Selenium	79	NA	0.001	1	3.42E-03	5.72E-07	2.91E-01	3.05E-01	3.36E-01	0.70	2.7E-05	1.7E-08	7.0E-08	NA	NA
Thallium	204	NA	0.001	1	5.49E-03	1.14E-07	1.46E+00	3.07E-01	3.37E-01	3.50	8.7E-04	1.2E-06	4.1E-06	NA	NA
Trichloroethene	131	2.71	0.012	1	5.28E-02	2.93E-07	5.69E-01	3.36E-01	3.69E-01	1.39	4.2E-06	4.3E-08	1.6E-07	NA	NA
Zinc	65	NA	0.0006		1.86E-03	6.85E-07	2.43E-01	3.04E-01	3.35E-01	0.58	1.5E-01	NA	NA	NA	NA

For Organics: If tevent < t* DAevent = $2 \cdot FA \cdot Kp \cdot Cgw \cdot (6 \cdot tau \cdot tevent/Pi)^{1/2}$

or

If tevent > t* DAevent = $FA \cdot Kp \cdot Cgw \cdot [\, tevent/(1+B) + 2 \cdot tau \cdot (1 + 3 \cdot B + 3 \cdot B^2) / (1+B)^2 \,]$

For Inorganics: DAevent = $Kp \cdot Cgw \cdot tevent$

If log Kow < 4

Kp = Kp USEPA, 2001a, Exhibit B-3 if available, or $10^{(-2.8 + 0.66 \cdot logKow - 0.0056 \cdot MW)}$

If log Kow >4

Kp = $10^{(-2.8 + 0.66 \cdot logKow - 0.0056 \cdot MW)}$

Source: USEPA, 2004

$B = \dfrac{Kp \cdot (MW)^{1/2}}{2.6}$

t* = USEPA, 2004 Exhibit B-3, or

If B < 0.6, t* = $2.4 \cdot tau$

If B > 0.6, t* = $\dfrac{(b - (b2 - c2)^{1/2}) \cdot 1E\text{-}6}{Dsc}$

Dsc = $10^{(-5.8 - 0.0056 \cdot MW)}$

tau = $\dfrac{1E\text{-}6}{6 \cdot Dsc}$

b = $\dfrac{2 \cdot (1 + B)^2}{Pi}$

c = $\dfrac{1 + 3 \cdot B + 3 \cdot B^2}{3 \cdot (1 + B)}$

Parameter	Symbol	Value	Units
Event Duration - industrial worker	tevent	0.17	hr
Event Duration - construction worker	tevent	2	hr
Event Duration - trespasser	tevent	0.25	hr

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TOTAL SOLUTE CONCENTRATION OF VOLATILE COPCS IN GROUNDWATER

Chemical	Concentration Groundwater (Cgw) (mg/L)	Henry's Law Constant (H') (unitless)	Soil-Organic Partition Coefficient (Kd) (l/kg)	Diffusivity in Air (Di) (cm^2/sec)	Concentration Soil Vapor (Cv) (mg/cm^3)	Concentration Soil (CT) (mg/cm^3)
Aluminum	2.45E+01	NA	NA	NA	NA	NA
Antimony	4.63E-02	NA	NA	NA	NA	NA
Arsenic	5.07E-02	NA	NA	NA	NA	NA
Barium	4.32E-01	NA	NA	NA	NA	NA
Benzene	1.80E-03	2.3E-01	3.53E-01	8.80E-02	4.1E-07	1.3E-06
Benzo(a)pyrene	NA	4.6E-05	6.12E+03	4.30E-02	NA	NA
Benzo(b)fluoranthene	6.00E-04	4.6E-03	7.38E+03	2.26E-02	NA	NA
Bis(2-ethylhexyl)phthalate	5.00E-03	4.2E-06	9.06E+04	3.50E-02	NA	NA
Cadmium	3.44E-02	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	3.21E-01	NA	NA	NA	NA	NA
Cobalt	1.76E-01	NA	NA	NA	NA	NA
Copper	1.49E+00	NA	NA	NA	NA	NA
Iron	3.16E+03	NA	NA	NA	NA	NA
Lead	1.02E+00	NA	NA	NA	NA	NA
Manganese	1.50E+01	NA	NA	NA	NA	NA
Nickel	1.90E+00	NA	NA	NA	NA	NA
Selenium	2.70E-02	NA	NA	NA	NA	NA
Thallium	8.72E-01	NA	NA	NA	NA	NA
Trichloroethene	4.20E-03	4.2E-01	9.96E-01	7.90E-02	1.8E-06	7.4E-06
Zinc	NA	NA	NA	NA	NA	NA

CT = Cv x (pb x Kd/H' + Pw/H' + Pa)

Cv = Cgw x H' x $CF_{cm3\text{-}L}$

Kd = Koc x foc

Source: USEPA, 1996

Parameter	Symbol	Value	Units
Bulk Density	pb	1.5	g/cm^3
Fraction Organic Carbon	foc	0.006	unitless
Water Filled Soil Porosity	Pw	0.15	unitless
Air Filled Soil Porosity	Pa	0.28	unitless
Conversion Factor from cm^3 to L	$CF_{cm3\text{-}L}$	1.E-03	L/cm^3

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EMISSION RATES OF VOLATILE COPCS FROM GROUNDWATER

Chemical	Concentration Soil (CT)	Effective Diffusivity (Da)	Emission Rate (Ei)			
			Industrial	Construction	Trespasser - Adult	Trespasser - Adolescent
	(mg/cm^3)	(cm^2/sec)	(mg/m^2-sec)	(mg/m^2-sec)	(mg/m^2-sec)	(mg/m^2-sec)
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Benzene	1.3E-06	2.09E-03	2.5E-08	1.2E-07	2.2E-08	3.6E-08
Benzo(a)pyrene	NA	2.64E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	7.27E-10	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	3.45E-13	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA
Trichloroethene	7.4E-06	1.47E-03	1.1E-07	5.7E-07	1.0E-07	1.6E-07
Zinc	NA	NA	NA	NA	NA	NA

$$Ei = \frac{CT \times 2 \times Da \times CF_{m2\text{-}cm2}}{(3.14 \times Da \times T)^{1/2}}$$

Source: USEPA, 1996

Parameter	Symbol .	Value	Units
Duration - Industrial	T	7.88E+08	sec
Duration - Construction	T	3.15E+07	sec
Duration - Trespasser - Adult	T	9.46E+08	sec
Duration - Trespasser - Adolescent	T	3.78E+08	sec
Conversion Factor from m^2 to cm^2	$CF_{m2\text{-}cm2}$	1.E+04	cm^2/m^2

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AMBIENT AIR CONCENTRATIONS - VOLATILE COPCS FROM GROUNDWATER - X / Q MODEL

Chemical	Emission Rate (Ei)				Concentration Air (Caa)			
	Industrial (mg/m²-sec)	Construction (mg/m²-sec)	Trespasser - Adult (mg/m²-sec)	Trespasser - Youth (mg/m²-sec)	Industrial (mg/m³)	Construction (mg/m³)	Trespasser - Adult (mg/m³)	Trespasser - Adolescent (mg/m³)
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2.5E-08	1.2E-07	2.2E-08	3.6E-08	5.3E-07	2.7E-06	4.9E-07	7.7E-07
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	1.1E-07	5.7E-07	1.0E-07	1.6E-07	2.5E-06	1.2E-05	2.3E-06	3.6E-06
Zinc	NA	NA	NA	NA	NA	NA	NA	NA

Caa =	Ei x X/Q
Source:	USEPA, 1996

Parameter	Symbol	Value	Units
Air Dispersion Factor - industrial	X/Q	21.64	mg/m³ per mg/m²-sec

Geomatrix

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INDOOR AIR CONCENTRATIONS DUE TO VOLATILE COPCS FROM GROUNDWATER: JOHNSON AND ETTINGER

Chemical	Concentration Air from Groundwater
	Industrial (mg/m^3)
Aluminum	NA
Antimony	NA
Arsenic	NA
Barium	NA
Benzene	1.57E-06
Benzo(a)pyrene	NA
Benzo(b)fluoranthene	NA
Bis(2-ethylhexyl)phthalate	NA
Cadmium	NA
Chromium, trivalent	NA
Chromium, hexavalent	NA
Cobalt	NA
Copper	NA
Iron	NA
Lead	NA
Manganese	NA
Nickel	NA
Selenium	NA
Thallium	NA
Trichloroethene	3.98E-06
Zinc	NA

Notes:
[1] DTSC's Johnson & Ettinger Model; please refer to Appendix C.
NA = Not Available

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INGESTION OF GROUNDWATER: OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Groundwater (Cgw) (mg/L)	Oral Absorption Factor-Water (ABSow) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	2.45E+01	1	2.2E-01	1	2.2E-01	7.7E-02	NA	NA
Antimony	4.63E-02	1	4.1E-04	0.0004	1.0E+00	1.5E-04	NA	NA
Arsenic	5.07E-02	1	4.5E-04	0.0003	1.5E+00	1.6E-04	1.5	2.4E-04
Barium	4.32E-01	1	3.8E-03	0.07	5.4E-02	1.4E-03	NA	NA
Benzene	1.80E-03	1	1.6E-05	0.003	5.3E-03	5.7E-06	0.055	3.1E-07
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	6.00E-04	1	5.3E-06	NA	NA	1.9E-06	0.73	1.4E-06
Bis(2-ethylhexyl)phthalate	5.00E-03	1	4.4E-05	0.02	2.2E-03	1.6E-05	0.014	2.2E-07
Cadmium	3.44E-02	1	3.0E-04	0.0005	6.1E-01	1.1E-04	NA	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	3.21E-01	1	2.8E-03	0.003	9.4E-01	1.0E-03	NA	NA
Cobalt	1.76E-01	1	1.6E-03	0.02	7.8E-02	5.5E-04	NA	NA
Copper	1.49E+00	1	1.3E-02	0.037	3.5E-01	4.7E-03	NA	NA
Iron	3.16E+03	1	2.8E+01	0.3	9.3E+01	9.9E+00	NA	NA
Lead	1.02E+00	1	9.0E-03	NA	NA	3.2E-03	NA	NA
Manganese	1.50E+01	1	1.3E-01	0.024	5.5E+00	4.7E-02	NA	NA
Nickel	1.90E+00	1	1.7E-02	0.02	8.4E-01	6.0E-03	NA	NA
Selenium	2.70E-02	1	2.4E-04	0.005	4.8E-02	8.5E-05	NA	NA
Thallium	8.72E-01	1	7.7E-03	0.000066	1.2E+02	2.7E-03	NA	NA
Trichloroethene	4.20E-03	1	3.7E-05	0.0003	1.2E-01	1.3E-05	0.4	5.3E-06
Zinc	1.46E+02	1	3.4E-04	0.3	1.1E-03	4.8E-06	NA	NA
					2E+02			2E-04

$$AADD = \frac{Cgw \times IRdw \times ABSow \times EFdw \times ED}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cgw \times IRdw \times ABSow \times EFdw \times ED}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	225	d/yr
Exposure Duration	ED	25	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	9,125	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	1	L/day

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
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DERMAL CONTACT WITH GROUNDWATER: OUTDOOR INDUSTRIAL WORKER

Chemical	Dermal Absorbed Dose Per Event (DAevent)	Annual Average Daily Dose (AADD)	Adjusted Dermal Chronic Reference Dose (RfDd)	Hazard Quotient	Lifetime Average Daily Dose (LADD)	Adjusted Dermal Slope Factor (SFd)	Excess Cancer Risk
	(mg/cm^2-event)	(mg/kg-d)	(mg/kg-d)	(--)	(mg/kg-d)	$(mg/kg\text{-}d)^{-1}$	(--)
Aluminum	4.16E-06	6.6E-04	1	6.6E-04	2.4E-04	NA	NA
Antimony	7.87E-09	1.2E-06	0.00006	2.1E-02	4.5E-07	NA	NA
Arsenic	8.62E-09	1.4E-06	0.0003	4.6E-03	4.9E-07	1.5	7.3E-07
Barium	7.35E-08	1.2E-05	0.0049	2.4E-03	4.2E-06	NA	NA
Benzene	1.65E-08	2.6E-06	0.004	6.5E-04	9.3E-07	0.055	5.1E-08
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	8.54E-07	1.4E-04	NA	NA	4.8E-05	0.73	3.5E-05
Bis(2-ethylhexyl)phthalate	1.55E-05	2.5E-03	0.02	1.2E-01	8.8E-04	0.014	1.2E-05
Cadmium	2.62E-08	4.1E-06	0.0000013	3.2E+00	1.5E-06	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	1.09E-07	1.7E-05	0.000075	2.3E-01	6.2E-06	NA	NA
Cobalt	9.54E-08	1.5E-05	0.02	7.6E-04	5.4E-06	NA	NA
Copper	8.33E-07	1.3E-04	0.037	3.6E-03	4.7E-05	NA	NA
Iron	1.67E-03	2.7E-01	0.3	8.8E-01	9.5E-02	NA	NA
Lead	1.73E-08	2.7E-06	NA	NA	9.8E-07	NA	NA
Manganese	2.55E-06	4.0E-04	0.00096	4.2E-01	1.4E-04	NA	NA
Nickel	2.05E-07	3.3E-05	0.0008	4.1E-02	1.2E-05	NA	NA
Selenium	1.66E-08	2.6E-06	0.004	6.6E-04	9.4E-07	NA	NA
Thallium	1.20E-06	1.9E-04	0.000066	2.9E+00	6.8E-05	NA	NA
Trichloroethene	4.33E-08	6.9E-06	0.0003	2.3E-02	2.5E-06	0.4	9.8E-07
Zinc	NA	NA	0.3	NA	NA	NA	NA
				7.8E+00			4.9E-05

AADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	225
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Skin Surface Area	SAswr	cm2	18,000

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Air (Caa) (mg/m^3)	Inhalation Absorption Factor-Volatiles (ABSiv) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) (mg/kg-d)$^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	5.3E-07	1	9.4E-08	0.0086	1.1E-05	3.4E-08	0.027	9.1E-10
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	2.5E-06	1	4.3E-07	0.01	4.3E-05	1.6E-07	0.4	6.2E-08
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					5E-05			6E-08

AADD = (Caa x IHRaa x ETaa x ABSiv x EFaa x ED) / (BW x ATnc)

LADD = (Caa x IHRaa x ETaa x ABSiv x EFaa x ED) / (BW x ATca)

Hazard Quotient = AADD / RfDi

Excess Cancer Risk = LADD x SFi

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	225
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	2.5
Exposure Time	ETaa	hr/d	8

Geomatrix

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
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INCIDENTAL INGESTION OF SOIL - OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	1	2.1E-05	0.0003	6.8E-02	7.3E-06	1.5	1.1E-05
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	1	6.3E-08	NA	NA	2.2E-08	7.3	1.6E-07
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	1	1.9E-02	1.5	1.3E-02	6.8E-03	NA	NA
Chromium, hexavalent	1.40E+01	1	1.2E-05	0.003	4.1E-03	4.4E-06	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	1	NA	0.0009	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Mercury	NA	1	NA	0.000086	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					8.5E-02			1E-05

$$AADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Value	Units
Exposure Frequency	EFig	225	d/yr
Exposure Duration	ED	25	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	9,125	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	100	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

Geomatrix

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DERMAL CONTACT WITH SOIL - OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.00006	NA	NA	NA	NA
Arsenic	2.33E+01	0.03	4.1E-06	0.0003	1.4E-02	1.5E-06	1.5	2.2E-06
Barium	NA	0.01	NA	0.0049	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	0.13	5.4E-08	NA	NA	1.9E-08	7.3	1.4E-07
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	0.01	1.2E-03	0.02	6.2E-02	4.5E-04	NA	NA
Chromium, hexavalent	1.40E+01	0.01	8.1E-07	0.000075	1.1E-02	2.9E-07	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.00096	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.0008	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.004	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					9E-02			2E-06

$$AADD = \frac{Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	225	d/yr
Exposure Duration	ED	25	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	9,125	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	3,300	cm^2
Soil-to-Skin Adherence Factor	SAF	0.2	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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INHALATION OF RESUSPENDED PARTICULATES FROM SOIL - OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Inhalation Absorption Factor-Dusts (ABSip) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	23.3	1	3.0E-09	0.0003	1.0E-05	1.1E-09	15	1.6E-08
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	NA	1	NA	0.0086	NA	NA	0.027	NA
Benzo(a)pyrene	0.071	1	9.2E-12	NA	NA	3.3E-12	7.3	2.4E-11
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	21500	1	2 8E-06	1.5	1.9E-06	1.0E-06	NA	NA
Chromium, hexavalent	14	1	1.8E-09	0.0000022	8.3E-04	6.5E-10	42	2.7E-08
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.01	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					8E-04			4E-08

AADD = (Cs x IHRaa x ETaa x ABSip x EFaa x ED) / (BW x PEF x ATnc)

Hazard Quotient = AADD / RfDi

LADD = (Cs x IHRaa x ETaa x ABSip x EFaa x ED) / (BW x PEF x ATca)

Excess Cancer Risk = LADD x SFi

Parameter	Symbol	Units	Values
Exposure Frequency	EFpe	d/yr	225
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRpe	m^3/hr	2.5
Exposure Time	ETpe	hr/d	8
Particulate Emission Factor	PEF	m^3/kg	1.36E+09

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SUMMARY RISK CHARACTERIZATION: OUTDOOR INDUSTRIAL WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Ingestion of Groundwater	Dermal Contact with Groundwater while Bathing	Inhalation of Volatiles in Ambient Air from Groundwater	Excess Cancer Risk
Aluminum	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	**1.1E-05**	**2.2E-06**	1.6E-08	**2.4E-04**	7.3E-07	NA	**2.5E-04**
Barium	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	3.1E-07	5.1E-08	9.1E-10	3.6E-07
Benzo(a)pyrene	1.6E-07	1.4E-07	2.4E-11	NA	NA	NA	3.0E-07
Benzo(b)fluoranthene	NA	NA	NA	**1.4E-06**	**3.5E-05**	NA	**3.7E-05**
Bis(2-ethylhexyl)phthalate	NA	NA	NA	2.2E-07	**1.2E-05**	NA	**1.3E-05**
Cadmium	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	2.7E-08	NA	NA	NA	2.7E-08
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	**5.3E-06**	9.8E-07	6.2E-08	**6.3E-06**
Zinc	NA	NA	NA	NA	NA	NA	NA
Total	1.1E-05	2.3E-06	4.3E-08	2.5E-04	4.9E-05	6.3E-08	3.1E-04

NA = not applicable

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SUMMARY RISK CHARACTERIZATION: OUTDOOR INDUSTRIAL WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Ingestion of Groundwater	Dermal Contact with Groundwater while Bathing	Inhalation of Volatiles in Ambient Air from Groundwater	Hazard Index
Aluminum	NA	NA	NA	2.2E-01	6.6E-04	NA	2.2E-01
Antimony	NA	NA	NA	**1.0E+00**	2.1E-02	NA	**1.0E+00**
Arsenic	6.8E-02	1.4E-02	1.0E-05	**1.5E+00**	4.6E-03	NA	**1.6E+00**
Barium	NA	NA	NA	5.4E-02	2.4E-03	NA	5.7E-02
Benzene	NA	NA	NA	5.3E-03	6.5E-04	1.1E-05	5.9E-03
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	2.2E-03	1.2E-01	NA	1.3E-01
Cadmium	NA	NA	NA	6.1E-01	**3.2E+00**	NA	**3.8E+00**
Chromium, trivalent	1.3E-02	6.2E-02	1.9E-06	NA	NA	NA	7.5E-02
Chromium, hexavalent	4.1E-03	1.1E-02	8.3E-04	9.4E-01	2.3E-01	NA	**1.2E+00**
Cobalt	NA	NA	NA	7.8E-02	7.6E-04	NA	7.8E-02
Copper	NA	NA	NA	3.5E-01	3.6E-03	NA	3.6E-01
Iron	NA	NA	NA	**9.3E+01**	8.8E-01	NA	**9.4E+01**
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	**5.5E+00**	4.2E-01	NA	**5.9E+00**
Nickel	NA	NA	NA	8.4E-01	4.1E-02	NA	8.8E-01
Selenium	NA	NA	NA	4.8E-02	6.6E-04	NA	4.8E-02
Thallium	NA	NA	NA	**1.2E+02**	**2.9E+00**	NA	**1.2E+02**
Trichloroethene	NA	NA	NA	1.2E-01	2.3E-02	4.3E-05	1.5E-01
Zinc	NA	NA	NA	1.1E-03	NA	NA	1.1E-03
Total	8.5E-02	8.7E-02	8.4E-04	2.2E+02	7.8E+00	5.4E-05	2.3E+02

NA = not applicable

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INHALATION OF VOCS IN INDOOR AIR FROM GROUNDWATER EMISSIONS: INDOOR INDUSTRIAL WORKER

Chemical	Concentration Air (Cia)	Inhalation Absorption Factor-Volatiles (ABSiv)	Annual Average Daily Dose (AADD)	Inhalation Chronic Reference Dose (RfDi)	Hazard Quotient	Lifetime Average Daily Dose (LADD)	Inhalation Slope Factor (SFi)	Excess Cancer Risk
	(mg/m^3)	(--)	(mg/kg-d)	(mg/kg-d)	(--)	(mg/kg-d)	$(mg/kg\text{-}d)^{-1}$	(--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	1.6E-06	1	3.1E-07	0.0086	3.6E-05	1.1E-07	0.027	3.0E-09
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	4.0E-06	1	7.8E-07	0.01	7.8E-05	2.8E-07	0.4	1.1E-07
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					1E-04			1E-07

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFia	d/yr	250
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRia	m^3/hr	2.5
Exposure Time	ETia	hr/d	8

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APPENDIX E
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME
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SUMMARY RISK CHARACTERIZATION: INDOOR INDUSTRIAL WORKER

Chemical	Inhalation of Volatiles in Indoor Air from Groundwater	Excess Cancer Risk
Aluminum	NA	NA
Antimony	NA	NA
Arsenic	NA	NA
Barium	NA	NA
Benzene	3.0E-09	3.0E-09
Benzo(a)pyrene	NA	NA
Benzo(b)fluoranthene	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA
Cadmium	NA	NA
Chromium, trivalent	NA	NA
Chromium, hexavalent	NA	NA
Cobalt	NA	NA
Copper	NA	NA
Iron	NA	NA
Lead	NA	NA
Manganese	NA	NA
Nickel	NA	NA
Selenium	NA	NA
Thallium	NA	NA
Trichloroethene	1.1E-07	1.1E-07
Zinc	NA	NA
Total	1E-07	1E-07

NA = not applicable

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME
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SUMMARY RISK CHARACTERIZATION: INDOOR INDUSTRIAL WORKER

Chemical	Inhalation of Volatiles in Indoor Air from Groundwater	Hazard Index
Aluminum	NA	NA
Antimony	NA	NA
Arsenic	NA	NA
Barium	NA	NA
Benzene	3.6E-05	3.6E-05
Benzo(a)pyrene	NA	NA
Benzo(b)fluoranthene	NA	NA
Benzo(k)fluoranthene	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA
Cadmium	NA	NA
Chromium, trivalent	NA	NA
Chromium, hexavalent	NA	NA
Cobalt	NA	NA
Copper	NA	NA
Iron	NA	NA
Lead	NA	NA
Manganese	NA	NA
Nickel	NA	NA
Selenium	NA	NA
Thallium	NA	NA
Trichloroethene	7.8E-05	7.8E-05
Zinc	NA	NA
Total	1.1E-04	1.1E-04

NA = not applicable

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DERMAL CONTACT WITH GROUNDWATER: CONSTRUCTION WORKER

Chemical	Dermal Absorbed Dose Per Event (DAevent) (mg/cm^2-event)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	4.90E-05	1.2E-03	1	1.2E-03	1.8E-05	NA	NA
Antimony	9.26E-08	2.3E-06	0.00006	3.9E-02	3.3E-08	NA	NA
Arsenic	1.01E-07	2.5E-06	0.0003	8.5E-03	3.6E-08	1.5	5.4E-08
Barium	8.65E-07	2.2E-05	0.0049	4.4E-03	3.1E-07	NA	NA
Benzene	6.77E-08	1.7E-06	0.004	4.2E-04	2.4E-08	0.055	1.3E-09
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	2.93E-06	7.3E-05	NA	NA	1.0E-06	0.73	7.6E-07
Bis(2-ethylhexyl)phthalate	5.32E-05	1.3E-03	0.02	6.7E-02	1.9E-05	0.014	2.7E-07
Cadmium	9.93E-08	2.5E-06	0.0000013	1.9E+00	3.5E-08	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	1.28E-06	3.2E-05	0.000075	4.3E-01	4.6E-07	NA	NA
Cobalt	4.31E-07	1.1E-05	0.02	5.4E-04	1.5E-07	NA	NA
Copper	3.69E-06	9.2E-05	0.037	2.5E-03	1.3E-06	NA	NA
Iron	7.67E-03	1.9E-01	0.3	6.4E-01	2.7E-03	NA	NA
Lead	2.04E-07	5.0E+00	NA	NA	7.3E-08	NA	NA
Manganese	3.00E-05	1.1E-04	0.00096	1.1E-01	1.1E-05	NA	NA
Nickel	9.31E-07	2.3E-05	0.0008	2.9E-02	3.3E-07	NA	NA
Selenium	6.96E-08	1.7E-06	0.004	4.4E-04	2.5E-08	NA	NA
Thallium	4.12E-06	1.0E-04	0.000066	1.6E+00	1.5E-06	NA	NA
Trichloroethene	1.56E-07	3.9E-06	0.0003	1.3E-02	5.6E-08	0.4	2.2E-08
Zinc	NA	NA	0.3	NA	NA	NA	NA
				4.8E+00			1.1E-06

AADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	90
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25550
Skin Surface Area	SAswr	cm2	7100

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: CONSTRUCTION WORKER

Chemical	Concentration Air (Caa) (mg/m^3)	Inhalation Absorption Factor-Volatiles (ABSiv) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	2.67E-06	1	3.8E-07	0.0086	4.4E-05	5.4E-09	0.027	1.4E-10
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	1.23E-05	1	1.7E-06	0.01	1.7E-04	2.5E-08	0.4	9.9E-09
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					2E-04			1E-08

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	180
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	2.5
Exposure Time	ETaa	hr/d	8

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INCIDENTAL INGESTION OF SOIL - CONSTRUCTION WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.38E+01	1	5.5E-05	0.0003	1.8E-01	7.9E-07	1.5	1.2E-06
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.003	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	1	1.7E-07	NA	NA	2.4E-09	7.3	1.7E-08
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	1.95E+04	1	4.5E-02	1.5	3.0E-02	6.5E-04	NA	NA
Chromium, hexavalent	1.19E+01	1	2.8E-05	0.003	9.2E-03	4.0E-07	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					2E-01			1E-06

$$AADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	180	d/yr
Exposure Duration	ED	1	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	365	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	330	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SOIL - CONSTRUCTION WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.00006	NA	NA	NA	NA
Arsenic	2.38E+01	0.03	5.0E-06	0.0003	1.7E-02	7.1E-08	1.5	1.1E-07
Barium	NA	0.01	NA	0.0049	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	0.13	6.4E-08	NA	NA	9.2E-10	7.3	6.7E-09
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	1.95E+04	0.01	1.4E-03	0.02	6.8E-02	1.9E-05	NA	NA
Chromium, hexavalent	1.19E+01	0.01	8.3E-07	0.000075	1.1E-02	1.2E-08	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.00096	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.0008	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.004	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					1E-01			1E-07

AADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	180	d/yr
Exposure Duration	ED	1	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	365	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	3,300	cm^2
Soil-to-Skin Adherence Factor	SAF	0.3	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
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INHALATION OF RESUSPENDED PARTICULATES FROM SOIL - CONSTRUCTION WORKER

Chemical	Concentration Soil (Cs) (mg/kg)	Inhalation Absorption Factor-Dusts (ABSip) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.38E+01	1	2.8E-08	0.0003	9.3E-05	4.0E-10	15	6.0E-09
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	NA	1	NA	0.0086	NA	NA	0.027	NA
Benzo(a)pyrene	7.10E-02	1	8.3E-11	NA	NA	1.2E-12	7.3	8.7E-12
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	1.95E+04	1	2.3E-05	1.5	1.5E-05	3.3E-07	NA	NA
Chromium, hexavalent	1.19E+01	1	1.4E-08	0.0000022	6.4E-03	2.0E-10	42	8.4E-09
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.01	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					6E-03			1E-08

$$AADD = \frac{Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED}{BW \times PEF \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED}{BW \times PEF \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFpe	d/yr	30
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRpe	m^3/hr	2.5
Exposure Time	ETpe	hr/d	8
Particulate Emission Factor	PEF	m^3/kg	2E+07

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DERMAL CONTACT WITH SURFACE WATER: CONSTRUCTION WORKER

Chemical	Dermal Absorbed Dose Per Event (DAevent) $(mg/cm^2\text{-event})$	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	NA	1	NA	NA	NA	NA
Antimony	NA	NA	0.00006	NA	NA	NA	NA
Arsenic	NA	NA	0.0003	NA	NA	1.5	NA
Barium	NA	NA	0.0049	NA	NA	NA	NA
Benzene	NA	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	5.40E-09	1.4E-07	0.000075	1.8E-03	1.9E-09	NA	NA
Cobalt	NA	NA	0.02	NA	NA	NA	NA
Copper	NA	NA	0.037	NA	NA	NA	NA
Iron	NA	NA	0.3	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	0.00096	NA	NA	NA	NA
Nickel	NA	NA	0.0008	NA	NA	NA	NA
Selenium	NA	NA	0.004	NA	NA	NA	NA
Thallium	NA	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	NA	0.3	NA	NA	NA	NA
				1.8E-03			0.0E+00

$$AADD = \frac{DAevent \times SAswr \times EVswr \times EFswr \times ED}{BW \times ATnc}$$

$$LADD = \frac{DAevent \times SAswr \times EVswr \times EFswr \times ED}{BW \times ATca}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Units	Value
Exposure Frequency	EFswr	d/yr	90
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25,550
Skin Surface Area	SAswr	cm2	7,100

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INCIDENTAL INGESTION OF SEDIMENT: CONSTRUCTION WORKER

Chemical	Concentration Sediment (Csd) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	6.42E+00	1	1.5E-05	0.0003	5.0E-02	2.1E-07	1.5	3.2E-07
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.003	NA	NA	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					5E-02			3E-07

$$AADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	180	d/yr
Exposure Duration	ED	1	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	365	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	330	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SEDIMENT: CONSTRUCTION WORKER

Chemical	Concentration Sediment (Csd) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.00006	NA	NA	NA	NA
Arsenic	6.42E+00	0.03	1.3E-06	0.0003	4.5E-03	1.9E-08	1.5	2.9E-08
Barium	NA	0.01	NA	0.0049	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	0.13	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	0.01	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	NA	0.01	NA	0.000075	NA	NA	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.00096	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.0008	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.004	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					4E-03			3E-08

AADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	180	d/yr
Exposure Duration	ED	1	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	365	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	3,300	cm^2
Soil-to-Skin Adherence Factor	SAF	0.3	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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SUMMARY RISK CHARACTERIZATION: CONSTRUCTION WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Volatiles in Ambient Air from Soil	Inhalation of Particulates	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Dermal Contact with Surface Water	Dermal Contact with Groundwater	Inhalation of Volatiles in Ambient Air from Groundwater	Excess Cancer Risk
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	**1.2E-06**	1.1E-07	NA	6.0E-09	3.2E-07	2.9E-08	NA	5.4E-08	NA	**1.7E-06**
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	NA	NA	NA	NA	1.3E-09	1.4E-10	1.5E-09
Benzo(a)pyrene	1.7E-08	6.7E-09	NA	8.7E-12	NA	NA	NA	NA	NA	2.4E-08
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	7.6E-07	NA	7.6E-07
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	2.7E-07	NA	2.7E-07
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	8.4E-09	NA	NA	NA	NA	NA	8.4E-09
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	2.2E-08	9.9E-09	3.2E-08
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	1.2E-06	1.1E-07	0.0E+00	1.4E-08	3.2E-07	2.9E-08	0.0E+00	**1.1E-06**	1.0E-08	2.8E-06

NA = Not applicable

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SUMMARY RISK CHARACTERIZATION: CONSTRUCTION WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Volatiles in Ambient Air from Soil	Inhalation of Particulates	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Dermal Contact with Surface Water	Dermal Contact with Groundwater	Inhalation of Volatiles in Ambient Air from Groundwater	Hazard Index
Aluminum	NA	NA	NA	NA	NA	NA	NA	1.2E-03	NA	1.2E-03
Antimony	NA	NA	NA	NA	NA	NA	NA	3.9E-02	NA	3.9E-02
Arsenic	1.8E-01	1.7E-02	NA	9.3E-05	5.0E-02	4.5E-03	NA	8.5E-03	NA	2.6E-01
Barium	NA	NA	NA	NA	NA	NA	NA	4.4E-03	NA	4.4E-03
Benzene	NA	NA	NA	NA	NA	NA	NA	4.2E-04	4.4E-05	4.7E-04
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	6.7E-02	NA	6.7E-02
Cadmium	NA	NA	NA	NA	NA	NA	NA	**1.9E+00**	NA	**1.9E+00**
Chromium, trivalent	3.0E-02	6.8E-02	NA	1.5E-05	NA	NA	NA	NA	NA	9.8E-02
Chromium, hexavalent	9.2E-03	1.1E-02	NA	6.4E-03	NA	NA	1.8E-03	4.3E-01	NA	4.6E-01
Cobalt	NA	NA	NA	NA	NA	NA	NA	5.4E-04	NA	5.4E-04
Copper	NA	NA	NA	NA	NA	NA	NA	2.5E-03	NA	2.5E-03
Iron	NA	NA	NA	NA	NA	NA	NA	6.4E-01	NA	6.4E-01
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	1.1E-01	NA	1.1E-01
Nickel	NA	NA	NA	NA	NA	NA	NA	2.9E-02	NA	2.9E-02
Selenium	NA	NA	NA	NA	NA	NA	NA	4.4E-04	NA	4.4E-04
Thallium	NA	NA	NA	NA	NA	NA	NA	**1.6E+00**	NA	**1.6E+00**
Trichloroethene	NA	NA	NA	NA	NA	NA	NA	1.3E-02	1.7E-04	1.3E-02
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	2.2E-01	9.6E-02	0.0E+00	6.5E-03	5.0E-02	4.5E-03	1.8E-03	**4.8E+00**	2.2E-04	**5.2E+00**

NA = Not applicable

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: ADULT TRESPASSER

Chemical	Concentration Air (Caa) (mg/m^3)	Inhalation Absorption Factor-Volatiles (ABSiv) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	4.87E-07	1	1.6E-09	0.0086	1.8E-07	6.8E-10	0.027	1.8E-11
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	2.25E-06	1	7.3E-09	0.01	7.3E-07	3.1E-09	0.4	1.3E-09
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					9E-07			1E-09

AADD = (Caa x IHRaa x ETaa x ABSiv x EFaa x ED) / (BW x ATnc)

Hazard Quotient = AADD / RfDi

LADD = (Caa x IHRaa x ETaa x ABSiv x EFaa x ED) / (BW x ATca)

Excess Cancer Risk = LADD x SFi

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	26
Exposure Duration	ED	yr	30
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	10,950
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	1.6
Exposure Time	ETaa	hr/d	2

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DERMAL CONTACT WITH SURFACE WATER: ADULT TRESPASSER

Chemical	Dermal Absorbed Dose Per Event (DAevent) (mg/cm²-event)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	NA	1	NA	NA	NA	NA
Antimony	NA	NA	0.00006	NA	NA	NA	NA
Arsenic	NA	NA	0.0003	NA	NA	1.5	NA
Barium	NA	NA	0.0049	NA	NA	NA	NA
Benzene	NA	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	5.40E-09	3.9E-08	0.000075	5.2E-04	1.7E-08	NA	NA
Cobalt	NA	NA	0.02	NA	NA	NA	NA
Copper	NA	NA	0.037	NA	NA	NA	NA
Iron	NA	NA	0.3	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	0.00096	NA	NA	NA	NA
Nickel	NA	NA	0.0008	NA	NA	NA	NA
Selenium	NA	NA	0.004	NA	NA	NA	NA
Thallium	NA	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	NA	0.3	NA	NA	NA	NA
				5.2E-04			0.0E+00

AADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	26
Exposure Duration	ED	yr	30
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	10,950
Averaging Time-Cancer	ATca	days	25,550
Skin Surface Area	SAswr	cm2	7,100

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INCIDENTAL INGESTION OF SEDIMENT: ADULT TRESPASSER

Chemical	Concentration Sediment (Csd) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	6.42E+00	1	6.5E-07	0.0003	2.2E-03	2.8E-07	1.5	4.2E-07
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.003	NA	NA	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					2E-03			4E-07

AADD = $\frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$ Hazard Quotient = $\frac{AADD}{RfDo}$

LADD = $\frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$ Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Values	Units
Exposure Frequency	Efig	26	d/yr
Exposure Duration	ED	30	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	10,950	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	100	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SEDIMENT: ADULT TRESPASSER

Chemical	Concentration Sediment (Csd) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.00006	NA	NA	NA	NA
Arsenic	6.42E+00	0.03	7.8E-08	0.0003	2.6E-04	3.4E-08	1.5	5.0E-08
Barium	NA	0.01	NA	0.0049	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	0.13	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	0.01	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	NA	0.01	NA	0.000075	NA	NA	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.00096	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.0008	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.004	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					3E-04			5E-08

AADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (Cs x SAs x SAF x ABSds x EFdc x ED x CFmg-kg) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	26	d/yr
Exposure Duration	ED	30	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	10,950	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	5,700	cm^2
Soil-to-Skin Adherence Factor	SAF	0.07	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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INCIDENTAL INGESTION OF SOIL - ADULT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	1	2.4E-06	0.0003	7.9E-03	1.0E-06	1.5	1.5E-06
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	1	7.2E-09	NA	NA	3.1E-09	7.3	2.3E-08
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	1	2.2E-03	1.5	1.5E-03	9.4E-04	NA	NA
Chromium, hexavalent	1.40E+01	1	1.4E-06	0.003	4.7E-04	6.1E-07	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					1E-02			2E-06

AADD = (Cs x IRs x ABSos x EFig x ED x CFmg-kg) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (Cs x IRs x ABSos x EFig x ED x CFmg-kg) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Exposure Duration	ED	30	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	10,950	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	100	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SOIL - ADULT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	0.03	2.8E-07	0.0003	9.5E-04	1.2E-07	1.5	1.8E-07
Barium	NA	0.01	NA	0.07	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	0.13	3.7E-09	NA	NA	1.6E-09	7.3	1.2E-08
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	0.01	8.7E-05	1.5	5.8E-05	3.7E-05	NA	NA
Chromium, hexavalent	1.40E+01	0.01	5.7E-08	0.003	1.9E-05	2.4E-08	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.024	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.02	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.005	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	ND	NA	NA
					1E-03			2E-07

$$AADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Exposure Duration	ED	30	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	10,950	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	5,700	cm^2
Soil-to-Skin Adherence Factor	SAF	0.07	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

Geomatrix

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INHALATION OF RESUSPENDED PARTICULATES FROM SOIL - ADULT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Inhalation Absorption Factor-Dusts (ABSip) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	1	2.0E-10	0.0003	6.5E-07	8.4E-11	15	1.3E-09
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	NA	1	NA	0.0086	NA	NA	0.027	NA
Benzo(a)pyrene	7.10E-02	1	6.0E-13	NA	NA	2.6E-13	7.3	1.9E-12
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	2.15E+04	1	1.8E-07	1.5	1.2E-07	7.7E-08	NA	NA
Chromium, hexavalent	1.40E+01	1	1.2E-10	0.0000022	5.3E-05	5.0E-11	42	2.1E-09
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.01	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					5E-05			3E-09

$$AADD = \frac{Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED}{BW \times PEF \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED}{BW \times PEF \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Exposure Duration	ED	yr	30
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	10,950
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRpe	m^3/hr	1.6
Exposure Time	ETpe	hr/d	7
Particulate Emission Factor	PEF	m^3/kg	1.36E+09

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SUMMARY RISK CHARACTERIZATION: ADULT TRESPASSER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Inhalation of Volatiles in Ambient Air from Groundwater	Dermal Contact With Surface Water	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Excess Cancer Risk
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	**1.5E-06**	1.8E-07	1.3E-09	NA	NA	4.2E-07	5.0E-08	**2.2E-06**
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	1.8E-11	NA	NA	NA	1.8E-11
Benzo(a)pyrene	2.3E-08	1.2E-08	1.9E-12	NA	NA	NA	NA	3.4E-08
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	2.1E-09	NA	NA	NA	NA	2.1E-09
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	1.3E-09	NA	NA	NA	1.3E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA
Total	**1.5E-06**	1.9E-07	3.4E-09	1.3E-09	0.0E+00	4.2E-07	5.0E-08	**2.2E-06**

NA = not applicable

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SUMMARY RISK CHARACTERIZATION: ADULT TRESPASSER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Inhalation of Volatiles in Ambient Air from Groundwater	Dermal Contact With Surface Water	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Hazard Index
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	7.9E-03	9.5E-04	6.5E-07	NA	NA	2.2E-03	2.6E-04	1.1E-02
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	1.8E-07	NA	NA	NA	1.8E-07
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	1.5E-03	5.8E-05	1.2E-07	NA	NA	NA	NA	1.5E-03
Chromium, hexavalent	4.7E-04	1.9E-05	5.3E-05	NA	5.2E-04	NA	NA	1.1E-03
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	7.3E-07	NA	NA	NA	7.3E-07
Zinc	NA	NA	NA	NA	NA	NA	NA	NA
Total	9.8E-03	1.0E-03	5.4E-05	9.2E-07	5.2E-04	2.2E-03	2.6E-04	1.4E-02

NA = not applicable

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: ADOLESCENT TRESPASSER

Chemical	Concentration Air (Caa)	Inhalation Absorption Factor-Volatiles (ABSiv)	Annual Average Daily Dose (AADD)	Inhalation Chronic Reference Dose (RfDi)	Hazard Quotient	Lifetime Average Daily Dose (LADD)	Inhalation Slope Factor (SFi)	Excess Cancer Risk
	(mg/m^3)	(--)	(mg/kg-d)	(mg/kg-d)	(--)	(mg/kg-d)	$(mg/kg\text{-}d)^{-1}$	(--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	7.69E-07	1	6.9E-09	0.0086	8.0E-07	8.8E-10	0.027	2.4E-11
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	3.56E-06	1	3.2E-08	0.01	3.2E-06	4.1E-09	0.4	1.6E-09
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					4E-06			2E-09

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	39
Exposure Duration	ED	yr	9
Body Weight	BW	kg	43
Averaging Time-Non-cancer	ATnc	days	3,285
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	1.2
Exposure Time	ETaa	hr/d	3

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DERMAL CONTACT WITH SURFACE WATER: ADOLESCENT TRESPASSER

Chemical	Dermal Absorbed Dose Per Event (DAevent) (mg/cm^2-event)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) (mg/kg-d)$^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	NA	1	NA	NA	NA	NA
Antimony	NA	NA	0.00006	NA	NA	NA	NA
Arsenic	NA	NA	0.0003	NA	NA	1.5	NA
Barium	NA	NA	0.0049	NA	NA	NA	NA
Benzene	NA	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	5.40E-09	6.6E-08	0.000075	8.9E-04	1.1E-08	NA	NA
Cobalt	NA	NA	0.02	NA	NA	NA	NA
Copper	NA	NA	0.037	NA	NA	NA	NA
Iron	NA	NA	0.3	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	0.00096	NA	NA	NA	NA
Nickel	NA	NA	0.0008	NA	NA	NA	NA
Selenium	NA	NA	0.004	NA	NA	NA	NA
Thallium	NA	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	NA	0.3	NA	NA	NA	NA
				8.9E-04			0.0E+00

AADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (DAevent x SAswr x EVswr x EFswr x ED) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	39
Exposure Duration	ED	yr	9
Body Weight	BW	kg	43
Averaging Time-Non-cancer	ATnc	days	4,380
Averaging Time-Cancer	ATca	days	25,550
Skin Surface Area	SAswr	cm^2	6,600

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INCIDENTAL INGESTION OF SEDIMENT: ADOLESCENT TRESPASSER

Chemical	Concentration Sediment (Csd) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	6.42E+00	1	1.2E-06	0.0003	4.0E-03	2.1E-07	1.5	3.1E-07
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.003	NA	NA	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					4E-03			3E-07

$$AADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	39	d/yr
Exposure Duration	ED	9	yr
Body Weight	BW	43	kg
Averaging Time-Non-cancer	ATnc	4,380	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	100	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SEDIMENT: ADOLESCENT TRESPASSER

Chemical	Concentration Sediment (Csd) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.00006	NA	NA	NA	NA
Arsenic	6.42E+00	0.03	1.4E-07	0.0003	4.8E-04	2.5E-08	1.5	3.7E-08
Barium	NA	0.01	NA	0.0049	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	NA	0.13	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	0.01	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	NA	0.01	NA	0.000075	NA	NA	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.00096	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.0008	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.004	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					5E-04			4E-08

$$AADD = \frac{Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg}{BW \times ATnc}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg}{BW \times ATca}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	39	d/yr
Exposure Duration	ED	9	yr
Body Weight	BW	43	kg
Averaging Time-Non-cancer	ATnc	4,380	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	5,700	cm^2
Soil-to-Skin Adherence Factor	SAF	0.07	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
PETER COOPER MARKHAMS SITE
TOWN OF DAYTON, NEW YORK
7603.001
Final

INCIDENTAL INGESTION OF SOIL: ADOLESCENT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	1	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	1	5.8E-06	0.0003	1.9E-02	7.4E-07	1.5	1.1E-06
Barium	NA	1	NA	0.07	NA	NA	NA	NA
Benzene	NA	1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	1	1.8E-08	NA	NA	2.3E-09	7.3	1.7E-08
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	1	5.3E-03	1.5	3.6E-03	6.9E-04	NA	NA
Chromium, hexavalent	1.40E+01	1	3.5E-06	0.003	1.2E-03	4.5E-07	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.024	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					2E-02			1E-06

AADD = (Cs x IRs x ABSos x EFig x ED x CFmg-kg) / (BW x ATnc)

Hazard Quotient = AADD / RfDo

LADD = (Cs x IRs x ABSos x EFig x ED x CFmg-kg) / (BW x ATca)

Excess Cancer Risk = LADD x SFo

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	39	d/yr
Exposure Duration	ED	9	yr
Body Weight	BW	43	kg
Averaging Time-Non-cancer	ATnc	3,285	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	100	mg/d
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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DERMAL CONTACT WITH SOIL: ADOLESCENT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Dermal Absorption Factor-Soil (ABSds) (–)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (–)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	0.01	NA	1	NA	NA	NA	NA
Antimony	NA	0.01	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	0.03	6.9E-07	0.0003	2.3E-03	8.9E-08	1.5	1.3E-07
Barium	NA	0.01	NA	0.07	NA	NA	NA	NA
Benzene	NA	0.1	NA	0.004	NA	NA	0.055	NA
Benzo(a)pyrene	7.10E-02	0.13	9.2E-09	NA	NA	1.2E-09	7.3	8.6E-09
Benzo(b)fluoranthene	NA	0.13	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	0.1	NA	0.02	NA	NA	0.014	NA
Cadmium	NA	0.001	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	2.15E+04	0.01	2.1E-04	1.5	1.4E-04	2.7E-05	NA	NA
Chromium, hexavalent	1.40E+01	0.01	1.4E-07	0.003	4.6E-05	1.8E-08	NA	NA
Cobalt	NA	0.01	NA	0.02	NA	NA	NA	NA
Copper	NA	0.01	NA	0.037	NA	NA	NA	NA
Iron	NA	0.01	NA	0.3	NA	NA	NA	NA
Lead	NA	0.01	NA	NA	NA	NA	NA	NA
Manganese	NA	0.01	NA	0.024	NA	NA	NA	NA
Nickel	NA	0.01	NA	0.02	NA	NA	NA	NA
Selenium	NA	0.01	NA	0.005	NA	NA	NA	NA
Thallium	NA	0.01	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	0.1	NA	0.0003	NA	NA	0.4	NA
Zinc	NA	0.01	NA	0.3	NA	NA	NA	NA
					2E-03			1E-07

$$AADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFdc	39	d/yr
Exposure Duration	ED	9	yr
Body Weight	BW	43	kg
Averaging Time-Non-cancer	ATnc	3,285	days
Averaging Time-Cancer	ATca	25,550	days
Surface Area	SAs	5,700	cm^2
Soil-to-Skin Adherence Factor	SAF	0.07	mg/cm^2
Conversion Factor from mg to kg	$CF_{mg\text{-}kg}$	1E-06	kg/mg

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INHALATION OF RESUSPENDED PARTICULATES FROM SOIL: ADOLESCENT TRESPASSER

Chemical	Concentration Soil (Cs) (mg/kg)	Inhalation Absorption Factor-Dusts (ABSip) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	2.33E+01	1	3.6E-10	0.0003	1.2E-06	4.6E-11	15	6.9E-10
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	NA	1	NA	0.0086	NA	NA	0.027	NA
Benzo(a)pyrene	7.10E-02	1	1.1E-12	NA	NA	1.4E-13	7.3	1.0E-12
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	2.15E+04	1	3.3E-07	1.5	2.2E-07	4.3E-08	NA	NA
Chromium, hexavalent	1.40E+01	1	2.2E-10	0.0000022	9.8E-05	2.8E-11	42	1.2E-09
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	NA	1	NA	0.01	NA	NA	0.4	NA
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					1E-04			2E-09

$$AADD = \frac{(Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED)}{(BW \times PEF \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Cs \times IHRaa \times ETaa \times ABSip \times EFaa \times ED)}{(BW \times PEF \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFpe	d/yr	39
Exposure Duration	ED	yr	9
Body Weight	BW	kg	43
Averaging Time-Non-cancer	ATnc	days	3,285
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRpe	m^3/hr	1.2
Exposure Time	ETpe	hr/d	7
Particulate Emission Factor	PEF	m^3/kg	1.36E+09

APPENDIX E
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
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SUMMARY RISK CHARACTERIZATION: ADOLESCENT TRESPASSER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Inhalation of Volatiles in Ambient Air from Groundwater	Dermal Contact With Surface Water	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Excess Cancer Risk
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	**1.1E-06**	1.3E-07	6.9E-10	NA	NA	3.1E-07	3.7E-08	**1.6E-06**
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	2.4E-11	NA	NA	NA	2.4E-11
Benzo(a)pyrene	1.7E-08	8.6E-09	1.0E-12	NA	NA	NA	NA	2.5E-08
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	1.2E-09	NA	NA	NA	NA	1.2E-09
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	1.6E-09	NA	NA	NA	1.6E-09
Zinc	NA	NA	NA	NA	NA	NA	NA	NA
Total	**1.1E-06**	1.4E-07	1.9E-09	1.7E-09	0.0E+00	3.1E-07	3.7E-08	**1.6E-06**

NA = not applicable

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HUMAN HEALTH RISK ASSESSMENT CALCULATIONS RME SCENARIO
PETER COOPER MARKHAMS SITE
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SUMMARY RISK CHARACTERIZATION: ADOLESCENT TRESPASSER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Inhalation of Volatiles in Ambient Air from Groundwater	Dermal Contact With Surface Water	Incidental Ingestion of Sediment	Dermal Contact with Sediment	Hazard Index
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.9E-02	2.3E-03	1.2E-06	NA	NA	4.0E-03	4.8E-04	2.6E-02
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	8.0E-07	NA	NA	NA	8.0E-07
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	3.6E-03	1.4E-04	2.2E-07	NA	NA	NA	NA	3.7E-03
Chromium, hexavalent	1.2E-03	4.6E-05	9.8E-05	NA	8.9E-04	NA	NA	2.2E-03
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	3.2E-06	NA	NA	NA	3.2E-06
Zinc	NA	NA	NA	NA	NA	NA	NA	NA
Total	2.4E-02	2.5E-03	9.9E-05	4.0E-06	8.9E-04	4.0E-03	4.8E-04	3.2E-02

NA = not applicable

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APPENDIX E-1

RAGS D Tables 7 and 8

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tapwater
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	2.45E+01	mgL	2.45E+01	mgL	M	2.2E-01	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	2.2E-01
	Antimony	4.63E-02	mg/L	4.63E-02	mg/L	M	4.1E-04	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	1.0E+00
	Arsenic	5.07E-02	mg/L	5.07E-02	mg/L	M	4.5E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.5E+00
	Barium	4.32E-01	mg/L	4.32E-01	mg/L	M	3.8E-03	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	5.4E-02
	Benzene	1.80E-03	mg/L	1.80E-03	mg/L	M	1.6E-05	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	5.3E-03
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	5.00E-03	mg/L	M	4.4E-05	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.2E-03
	Chromium, hexavalent	3.21E-01	mg/L	3.21E-01	mg/L	M	2.8E-03	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	9.4E-01
	Cobalt	1.76E-01	mg/L	1.76E-01	mg/L	M	1.6E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	7.8E-02
	Copper	1.49E+00	mg/L	1.49E+00	mg/L	M	1.3E-02	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	3.5E-01
	Iron	3.16E+03	mg/L	3.16E+03	mg/L	M	2.8E+01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	9.3E+01
	Manganese	1.50E+01	mg/L	1.50E+01	mg/L	M	1.3E-01	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	5.5E+00
	Nickel	1.90E+00	mg/L	1.90E+00	mg/L	M	1.7E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	8.4E-01
	Selenium	2.70E-02	mg/L	2.70E-02	mg/L	M	2.4E-04	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	4.8E-02
	Thallium	8.72E-01	mg/L	8.72E-01	mg/L	M	7.7E-03	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	1.2E+02
	Trichloroethene	4.20E-03	mg/L	4.20E-03	mg/L	M	3.7E-05	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.2E-01
	Zinc	1.46E+02	mg/L	1.46E+02	mg/L	M	3.4E-04	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	1.1E-03
Dermal	Aluminum	2.45E+01	mg/L	4.2E-06	mg/cm^2-event	R	6.6E-04	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	6.6E-04
	Antimony	4.63E-02	mg/L	7.9E-09	mg/cm^2-event	R	1.2E-06	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	2.1E-02
	Arsenic	5.07E-02	mg/L	8.6E-09	mg/cm^2-event	R	1.4E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	4.6E-03
	Barium	4.32E-01	mg/L	7.3E-08	mg/cm^2-event	R	1.2E-05	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	2.4E-03
	Benzene	1.80E-03	mg/L	1.7E-08	mg/cm^2-event	R	2.6E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	6.5E-04

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tapwater
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal (cont'd)	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	1.6E-05	mg/cm^2-event	R	2.5E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.2E-01
	Chromium, hexavalent	3.21E-01	mg/L	1.1E-07	mg/cm^2-event	R	1.7E-05	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	2.3E-01
	Cobalt	1.76E-01	mg/L	9.5E-08	mg/cm^2-event	R	1.5E-05	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	7.6E-04
	Copper	1.49E+00	mg/L	8.3E-07	mg/cm^2-event	R	1.3E-04	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	3.6E-03
	Iron	3.16E+03	mg/L	1.7E-03	mg/cm^2-event	R	2.7E-01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	8.8E-01
	Manganese	1.50E+01	mg/L	2.6E-06	mg/cm^2-event	R	4.0E-04	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	4.2E-01
	Nickel	1.90E+00	mg/L	2.1E-07	mg/cm^2-event	R	3.3E-05	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	4.1E-02
	Selenium	2.70E-02	mg/L	1.7E-08	mg/cm^2-event	R	2.6E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	6.6E-04
	Thallium	8.72E-01	mg/L	1.2E-06	mg/cm^2-event	R	1.9E-04	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	2.9E+00
	Trichloroethene	4.20E-03	mg/L	4.3E-08	mg/cm^2-event	R	6.9E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.3E-02
	Zinc	1.46E+02	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tapwater
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Arsenic	5.07E-02	mg/L	5.07E-02	mg/L	M	1.6E-04	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	2.4E-04
	Benzene	1.80E-03	mg/L	1.80E-03	mg/L	M	5.7E-06	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	3.1E-07
	Benzo(b)fluoranthene	6.00E-04	mg/L	6.00E-04	mg/L	M	1.9E-06	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	1.4E-06
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	5.00E-03	mg/L	M	1.6E-05	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	2.2E-07
	Cadmium	3.44E-02	mg/L	3.44E-02	mg/L	M	1.1E-04	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	1.02E+00	mg/L	M	3.2E-03	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	4 20E-03	mg/L	M	1.3E-05	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	5.3E-06
Dermal	Arsenic	5.07E-02	mg/L	8.62E-09	mg/cm^2-event	R	4.9E-07	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	7.3E-07
	Benzene	1.80E-03	mg/L	1.65E-08	mg/cm^2-event	R	9.3E-07	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	5.1E-08
	Benzo(b)fluoranthene	6.00E-04	mg/L	8.54E-07	mg/cm^2-event	R	4.8E-05	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	3.5E-05
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	1.55E-05	mg/cm^2-event	R	8.8E-04	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	1.2E-05
	Cadmium	3.44E-02	mg/L	2.62E-08	mg/cm^2-event	R	1.5E-06	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	1.73E-08	mg/cm^2-event	R	9.8E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	4.33E-08	mg/cm^2-event	R	2.5E-06	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	9.8E-07

APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Ambient Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	1.80E-03	mg/L	5.33E-07	mg/m^3	R	9.39E-08	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	1.1E-05
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	4.20E-03	mg/L	2.47E-06	mg/m^3	R	4.35E-07	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	4.3E-05
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1

TABLE 8.1.RME

CALCULATION OF CANCER RISKS

REASONABLE MAXIMUM EXPOSURE

Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Ambient Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	5.33E-07	mg/m^3	R	3.4E-08	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	9.1E-10
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	2.47E-06	mg/m^3	R	1.6E-07	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	6.2E-08
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	2.1E-05	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	6.8E-02
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	6.3E-08	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	1.9E-02	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	1.3E-02
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.2E-05	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	4.1E-03
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.3E+01	mg/kg	M	4.1E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.4E-02
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.1E-02	mg/kg	M	5.4E-08	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.2E+04	mg/kg	M	1.2E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	6.2E-02
	Chromium, hexavalent	1.40E+01	mg/kg	1.4E+01	mg/kg	M	8.1E-07	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	1.1E-02
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	2.1E-05	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	3.08E-05
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	6.3E-08	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	4.56E-07
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	1.9E-02	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.2E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	1.5E-06	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	2.2E-06
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.9E-08	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.4E-07
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	4.5E-04	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.9E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	3.02E-09	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.0E-05
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	9.22E-12	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	2.79E-06	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	1.9E-06
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.82E-09	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	8.3E-04
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	1.08E-09	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	1.6E-08
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	3.29E-12	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	2.4E-11
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	9.97E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	6.49E-10	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	2.7E-08
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Indoor Air
Receptor Population: Indoor Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	1.80E-03	mg/L	1.57E-06	mg/m^3	R	3.06E-07	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	3.6E-05
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	4.20E-03	mg/L	3.98E-06	mg/m^3	R	7.79E-07	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	7.8E-05
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Indoor Air
Receptor Population: Indoor Industrial Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+01	$(mg/kg-day)^{-1}$	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	1.57E-06	mg/m^3	R	3.56E-05	mg/kg-day	2.7E-02	$(mg/kg-day)^{-1}$	9.62E-07
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E+00	$(mg/kg-day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E-01	$(mg/kg-day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-02	$(mg/kg-day)^{-1}$	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.2E+01	$(mg/kg-day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.8E+00	$(mg/kg-day)^{-1}$	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.1E-01	$(mg/kg-day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	3.98E-06	mg/m^3	R	7.79E-05	mg/kg-day	4.0E-01	$(mg/kg-day)^{-1}$	3.12E-05
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Exposed Groundwater
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	2.45E+01	mg/L	4.90E-05	mg/cm^2-event	R	1.23E-03	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	1.2E-03
	Antimony	4.63E-02	mg/L	9.26E-08	mg/cm^2-event	R	2.32E-06	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	3.9E-02
	Arsenic	5.07E-02	mg/L	1.01E-07	mg/cm^2-event	R	2.54E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	8.5E-03
	Barium	4.32E-01	mg/L	8.65E-07	mg/cm^2-event	R	2.16E-05	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	4.4E-03
	Benzene	1.80E-03	mg/L	6.77E-08	mg/cm^2-event	R	1.69E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	4.2E-04
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	2.93E-06	mg/cm^2-event	R	7.33E-05	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	5.32E-05	mg/cm^2-event	R	1.33E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	6.7E-02
	Cadmium	3.44E-02	mg/L	9.93E-08	mg/cm^2-event	R	2.48E-06	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	1.9E+00
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	1.28E-06	mg/cm^2-event	R	3.21E-05	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	4.3E-01
	Cobalt	1.76E-01	mg/L	4.31E-07	mg/cm^2-event	R	1.08E-05	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	5.4E-04
	Copper	1.49E+00	mg/L	3.69E-06	mg/cm^2-event	R	9.23E-05	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	2.5E-03
	Iron	3.16E+03	mg/L	7.67E-03	mg/cm^2-event	R	1.92E-01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	6.4E-01
	Lead	1.02E+00	mg/L	2.04E-07	mg/cm^2-event	R	5.00E+00	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	3.00E-05	mg/cm^2-event	R	1.07E-04	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	1.1E-01
	Nickel	1.90E+00	mg/L	9.31E-07	mg/cm^2-event	R	2.33E-05	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	2.9E-02
	Selenium	2.70E-02	mg/L	6.96E-08	mg/cm^2-event	R	1.74E-06	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	4.4E-04
	Thallium	8.72E-01	mg/L	4.12E-06	mg/cm^2-event	R	1.03E-04	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	1.6E+00
	Trichloroethene	4.20E-03	mg/L	1.56E-07	mg/cm^2-event	R	3.91E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.3E-02
	Zinc	1.46E+02	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Exposed Groundwater
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	2.45E+01	mg/L	4.90E-05	mg/cm^2-event	R	1.8E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	9.26E-08	mg/cm^2-event	R	3.3E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	1.01E-07	mg/cm^2-event	R	3.6E-08	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	5.4E-08
	Barium	4.32E-01	mg/L	8.65E-07	mg/cm^2-event	R	3.1E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	6.77E-08	mg/cm^2-event	R	2.4E-08	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	1.3E-09
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	2.93E-06	mg/cm^2-event	R	1.0E-06	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	7.6E-07
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	5.32E-05	mg/cm^2-event	R	1.9E-05	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	2.7E-07
	Cadmium	3.44E-02	mg/L	9.93E-08	mg/cm^2-event	R	3.5E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	1.28E-06	mg/cm^2-event	R	4.6E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	4.31E-07	mg/cm^2-event	R	1.5E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	1.49E+00	mg/L	3.69E-06	mg/cm^2-event	R	1.3E-06	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	3.16E+03	mg/L	7.67E-03	mg/cm^2-event	R	2.7E-03	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	2.04E-07	mg/cm^2-event	R	7.3E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	3.00E-05	mg/cm^2-event	R	1.1E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	9.31E-07	mg/cm^2-event	R	3.3E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	6.96E-08	mg/cm^2-event	R	2.5E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	4.12E-06	mg/cm^2-event	R	1.5E-06	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	1.56E-07	mg/cm^2-event	R	5.6E-08	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	2.2E-08
	Zinc	1.46E+02	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

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

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	1.80E-03	mg/L	2 67E-06	mg/m^3	R	3.76E-07	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	4.4E-05
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	4.20E-03	mg/L	1.23E-05	mg/m^3	R	1.74E-06	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	1.7E-04
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

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

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	2.67E-06	mg/m^3	R	5.37E-09	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	1.4E-10
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	1.23E-05	mg/m^3	R	2.48E-08	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	9.9E-09
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil
Exposure Point: Subsurface Soil
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.38E+01	mg/kg	2.38E+01	mg/kg	M	5.5E-05	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.8E-01
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.7E-07	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	1.95E+04	mg/kg	1.95E+04	mg/kg	M	4.5E-02	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	3.0E-02
	Chromium, hexavalent	1.19E+01	mg/kg	1.19E+01	mg/kg	M	2.8E-05	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	9.2E-03
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil
Exposure Point: Subsurface Soil
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	2.38E+01	mg/kg	2.4E+01	mg/kg	M	5.0E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.7E-02
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.1E-02	mg/kg	M	6.4E-08	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	1.95E+04	mg/kg	2.0E+04	mg/kg	M	1.4E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	6.8E-02
	Chromium, hexavalent	1.19E+01	mg/kg	1.2E+01	mg/kg	M	8.3E-07	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	1.1E-02
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil
Exposure Point: Subsurface Soil
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	5.5E-05	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	8.30E-05
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.7E-07	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.20E-06
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	4.5E-02	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.8E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil
Exposure Point: Subsurface Soil
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	1.5E-06	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	2.2E-06
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.9E-08	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.4E-07
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	4.5E-04	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.9E-07	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

Geomatrix

APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.38E+01	mg/kg	2.38E+01	mg/kg	M	2.8E-08	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	9.3E-05
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	8.3E-11	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	1.95E+04	mg/kg	1.95E+04	mg/kg	M	2.3E-05	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	1.5E-05
	Chromium, hexavalent	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.4E-08	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	6.4E-03
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Subsurface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Arsenic	2.38E+01	mg/kg	2.38E+01	mg/kg	M	4.0E-10	mg/kg-day	1.5E+01	$(mg/kg-day)^{-1}$	6.0E-09
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.7E-02	$(mg/kg-day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.2E-12	mg/kg-day	7.3E+00	$(mg/kg-day)^{-1}$	8.7E-12
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg-day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg-day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, trivalent	1.95E+04	mg/kg	1.95E+04	mg/kg	M	3.3E-07	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, hexavalent	1.19E+01	mg/kg	1.19E+01	mg/kg	M	2.0E-10	mg/kg-day	4.2E+01	$(mg/kg-day)^{-1}$	8.4E-09
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.8E+00	$(mg/kg-day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.1E-01	$(mg/kg-day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg-day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	1.35E-07	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	1.8E-03
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	5.5E-02	$(mg/kg-day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E+00	$(mg/kg-day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E-01	$(mg/kg-day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.4E-02	$(mg/kg-day)^{-1}$	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-01	$(mg/kg-day)^{-1}$	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA

Geomatrix

APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	1.80E-03	mg/L	4.87E-07	mg/m^3	R	1.58E-09	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	1.8E-07
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	4.20E-03	mg/L	2.25E-06	mg/m^3	R	7.34E-09	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	7.3E-07
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	4.87E-07	mg/m^3	R	6.8E-10	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	1.8E-11
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	2.25E-06	mg/m^3	R	3.1E-09	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	1.3E-09
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	3.90E-08	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	5.2E-04
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	5.5E-02	$(mg/kg-day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E+00	$(mg/kg-day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E-01	$(mg/kg-day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.4E-02	$(mg/kg-day)^{-1}$	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-01	$(mg/kg-day)^{-1}$	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg-day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	6.5E-07	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.2E-03
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	6.42E+00	mg/kg	6.4E+00	mg/kg	M	7.8E-08	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.6E-04
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	NA	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	3.4E-08	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	5.0E-08
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	2.4E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	7.9E-03
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	7.2E-09	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	2.2E-03	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	1.5E-03
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.4E-06	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	4.7E-04
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.3E+01	mg/kg	M	2.8E-07	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	9.5E-04
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.1E-02	mg/kg	M	3.7E-09	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.2E+04	mg/kg	M	8.7E-05	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	4.4E-03
	Chromium, hexavalent	1.40E+01	mg/kg	1.4E+01	mg/kg	M	5.7E-08	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	7.6E-04
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	NA	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	1.2E-07	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1.8E-07
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.6E-09	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.2E-08
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	3.7E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.4E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	ND	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	1.96E-10	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	6.5E-07
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	5.96E-13	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	1.81E-07	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	1.2E-07
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.18E-10	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	5.3E-05
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	8.39E-11	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	1.3E-09
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	2.56E-13	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.9E-12
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	7.74E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	5.04E-11	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	2.1E-09
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	1.80E-03	mg/L	7.69E-07	mg/m^3	R	6.88E-09	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	8.0E-07
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	4.20E-03	mg/L	3.56E-06	mg/m^3	R	3.19E-08	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	3.2E-06
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	2.45E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	4.63E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	5.07E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	4.32E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	1.80E-03	mg/L	7.69E-07	mg/m^3	R	8.8E-10	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	2.4E-11
	Benzo(a)pyrene	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	6.00E-04	mg/L	NA	mg/m^3	R	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	5.00E-03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	3.44E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	3.21E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	1.76E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	1.49E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	3.16E+03	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	1.02E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	1.50E+01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	1.90E+00	mg/L	NA	mg/m^3	R	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	2.70E-02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	8.72E-01	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	4.20E-03	mg/L	3.56E-06	mg/m^3	R	4.1E-09	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	1.6E-09
	Zinc	1.46E+02	mg/L	NA	mg/m^3	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	6.64E-08	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	8.9E-04
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.08E-02	mg/L	1.08E-05	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/L	NA	mg/cm^2-event	R	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	1.2E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	4.0E-03
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	6.42E+00	mg/kg	6.4E+00	mg/kg	M	1.4E-07	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	4.8E-04
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	NA	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Wetlands
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	6.42E+00	mg/kg	6.42E+00	mg/kg	M	2.5E-08	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	3.7E-08
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	5.8E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.9E-02
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.8E-08	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	5.3E-03	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	3.6E-03
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	3.5E-06	mg/kg-day	3.0E-03	mg/kg-day	NA	NA	1.2E-03
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.4E-02	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 7.1 RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.0E-05	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.3E+01	mg/kg	M	6.9E-07	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.3E-03
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.9E-03	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.1E-02	mg/kg	M	9.2E-09	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.3E-06	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.2E+04	mg/kg	M	2.1E-04	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.1E-02
	Chromium, hexavalent	1.40E+01	mg/kg	1.4E+01	mg/kg	M	1.4E-07	mg/kg-day	7.5E-05	mg/kg-day	NA	NA	1.9E-03
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.6E-04	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.0E-04	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	NA	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	NA	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil
Exposure Point: Surface Soil
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2 33E+01	mg/kg	2.33E+01	mg/kg	M	8.9E-08	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1.3E-07
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.5E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.2E-09	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	8.6E-09
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	2.7E-05	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	1.8E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX E-1
TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-03	mg/kg-day	NA	NA	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	3.58E-10	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.2E-06
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-04	mg/kg-day	NA	NA	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	8.6E-03	mg/kg-day	NA	NA	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.09E-12	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.2E-02	mg/kg-day	NA	NA	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	3.31E-07	mg/kg-day	1.5E+00	mg/kg-day	NA	NA	2.2E-07
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.15E-10	mg/kg-day	2.2E-06	mg/kg-day	NA	NA	9.8E-05
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.7E-06	mg/kg-day	NA	NA	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.7E-02	mg/kg-day	NA	NA	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	mg/kg-day	NA	NA	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-05	mg/kg-day	NA	NA	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	5.0E-03	mg/kg-day	NA	NA	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	6.6E-05	mg/kg-day	NA	NA	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	NA

APPENDIX E-1
TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Peter Cooper Markhams Site

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Fugitive Dusts
Exposure Point: Ambient Air
Receptor Population: Trespasser
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Aluminum	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Antimony	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Arsenic	2.33E+01	mg/kg	2.33E+01	mg/kg	M	4.61E-11	mg/kg-day	1.5E+01	$(mg/kg\text{-}day)^{-1}$	6.9E-10
	Barium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Benzene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	2.7E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Benzo(a)pyrene	7.10E-02	mg/kg	7.10E-02	mg/kg	M	1.40E-13	mg/kg-day	7.3E+00	$(mg/kg\text{-}day)^{-1}$	1.0E-12
	Benzo(b)fluoranthene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	7.3E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Bis(2-ethylhexyl)phthalate	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	1.4E-02	$(mg/kg\text{-}day)^{-1}$	NA
	Cadmium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, trivalent	2.15E+04	mg/kg	2.15E+04	mg/kg	M	4.25E-08	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Chromium, hexavalent	1.40E+01	mg/kg	1.40E+01	mg/kg	M	2.77E-11	mg/kg-day	4.2E+01	$(mg/kg\text{-}day)^{-1}$	1.2E-09
	Cobalt	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.8E+00	$(mg/kg\text{-}day)^{-1}$	NA
	Copper	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Iron	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Lead	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Manganese	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Nickel	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	9.1E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Selenium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Thallium	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA
	Trichloroethene	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	4.0E-01	$(mg/kg\text{-}day)^{-1}$	NA
	Zinc	NA	mg/kg	NA	mg/kg	M	NA	mg/kg-day	NA	$(mg/kg\text{-}day)^{-1}$	NA

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APPENDIX F

Human Health Risk Assessment Calculations Revised Exposure to Groundwater

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TABLE F-1
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	(2) Range of Detection Limits	(3) Concentration Used for Screening	(4) Background Value	(5) Screening Toxicity Value			COPC Flag	(6) Rationale for Contaminant Deletion or Selection
71432	Benzene	0 22	J	0.22		µg/l	MW-1S	2 / 13	1 – 10	0.22	ND	0.35	C	PRG	No	Grp. A
108907	Chlorobenzene	0.27	J	0.27	J	µg/l	MW-1S	1 / 13	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 / 13	1 – 10	1.4	ND	6.1	NC	PRG	No	BSL
79016	Trichloroethene	2.8	J	4 2	J	µg/l	MW-8S HV	2 / 13	1 – 10	4.2	ND	0.028	C	PRG	**Yes**	ASL
205992	Benzo(b)fluoranthene	0.6	J	0.6	J	µg/l	MW-8S HV	1 / 7	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 / 7	10 – 10	5	ND	4 8	C	PRG	**Yes**	ASL
206440	Fluoranthene	0.6	J	0.6	J	µg/l	MW-8S HV	1 / 7	10 – 10	0.8	ND	150	NC	PRG	No	BSL
129000	Pyrene	0.5	J	0.5	J	µg/l	MW-8S HV	1 / 7	10 – 10	0.5	ND	18	NC	PRG	No	BSL
7429905	Aluminum	382		654		µg/l	MW-3SR	3 / 6	200 – 200	654	ND	3600	NC	PRG	No	ASL
7439896	Iron	218	J	11100	J	µg/l	MW-1S	6 / 6	0 – 0	11100	326	1100	NC	PRG	**Yes**	ASL
7439921	Lead	9.7	E	10 7	EJ	µg/l	MW-1S	2 / 6	3 – 3	10.7	ND	15	C	AL	No	ASL
7439954	Magnesium	9520		96400		µg/l	MW-6S	7 / 6	5000 – 5000	96400	9050	--	N/A	N/A	No	NUT
7439965	Manganese	33.7	EJ	15000	EJ	µg/l	MW-1S	6 / 6	0 – 0	15000	112	88	NC	PRG	**Yes**	ASL
7440235	Sodium	5550		27800		µg/l	MW-7S	5 / 6	5000 – 5000	27800	11200	–	N/A	N/A	No	NUT
7440666	Zinc	36.1		36 1		µg/l	MW-6S	1 / 6	20 – 20	36.1	ND	1100	NC	PRG	No	ASL

(1) Minimum/maximum detected concentration.

(2) The range of detection limits is repoted as 0 to 0 when the specific chemical was detected in all samples.

(3) Maximum value used for screening concentration.

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

(5) Screening toxicity value – USEPA Region 9 Preliminary Remediation Goals for tap water (USEPA, 2004). If unavailable the maximum contaminant level or action level for drinking water was used.
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:

(6) Rationale Codes

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

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 F-2

RAGS PART D - TABLE 3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

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

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	µg/L	2.7	5.3	654.0	--	µg/L	5.3	Max	(1)	2.7	Mean-N	(3)
Antimony	µg/L	30.0	NA	ND	--	µg/L	NA	Max	(1)	30.0	Mean-N	(3)
Arsenic	µg/L	5.0	NA	ND	--	µg/L	NA	Max	(1)	5.0	Mean-N	(3)
Barium	µg/L	100.0	NA	ND	--	µg/L	NA	Max	(1)	100.0	Mean-N	(3)
Benzene	µg/L	2.6	9.1	0.2	J	µg/L	0.2	Max	(1)	2.6	Mean-N	(3)
Benzo(b)fluoranthene	µg/L	2.4	5.4	0.6	J	µg/L	0.6	Max	(1)	2.4	Mean-N	(3)
Bis(2-ethylhexyl) phthalate	µg/L	2.7	5.8	5.0	J	µg/L	5.0	Max	(1)	3	Mean-N	(3)
Cadmium	µg/L	2.5	NA	ND	--	µg/L	NA	Max	(1)	2.5	Mean-N	(3)
Cobalt	µg/L	25.0	NA	ND	--	µg/L	NA	Max	(1)	25.0	Mean-N	(3)
Copper	µg/L	12.5	NA	ND	--	µg/L	NA	Max	(1)	12.5	Mean-N	(3)
Iron	µg/L	4080.3	18739.3	11100	J	µg/L	11100	Max	(1)	4080.3	Mean-N	(3)
Lead	µg/L	4.4	12.4	10.7	E	µg/L	10.7	Max	(1)	4.4	Mean-N	(3)
Manganese	µg/L	5536.3	70218.4	15000	EJ	µg/L	15000	Max	(1)	5536.3	Mean-N	(3)
Nickel	µg/L	20.0	NA	ND	UE	µg/L	NA	Max	(1)	20.0	Mean-N	(3)
Selenium	µg/L	2.5	NA	ND	--	µg/L	NA	Max	(1)	2.5	Mean-N	(3)
Thallium	µg/L	5.0	NA	ND	UE	µg/L	NA	Max	(1)	5.0	Mean-N	(3)
Trichloroethene	µg/L	2.7	5.3	4.2	J	µg/L	4.2	Max	(1)	2.7	Mean-N	(3)
Zinc	µg/L	14	33.3	36.1	N	µg/L	33.3	95%UCL	(2)	14	Mean-N	(3)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T);
Arithmetic Mean of Normal Data (Mean-N).

"--" = No Qualifier listed

NA = Unable to calculate 95% UCL

(1) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(2) 95% UCL less than the maximum detected concentration. Therefore, 95% UCL used for EPC. Calculated using US EPA ProUCL 3.0 (2004); see Appendix B.

(3) Normal distribution assumed.

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TABLE F-3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE WITHOUT MW-2S
FUTURE OUTDOOR INDUSTRIAL WORKER

Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Arsenic	1.1E-05	1.7E-08	2.2E-06	1.3E-05	Arsenic	Skin	6.84E-02	1.04E-05	1.35E-02	8.19E-02
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	1.6E-07	2.5E-11	1.4E-07	3.0E-07	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	None Observed	1.26E-02	1.92E-06	6.26E-02	7.52E-02
			Chromium, hexavalent	NA	2.8E-08	NA	2.8E-08	Chromium, hexavalent	Lung	4.12E-03	8.50E-04	1.09E-02	1.58E-02
						Total Risk Across Soil	**1.4E-05**					**Total Hazard Quotient Across Soil**	**1.7E-01**
Groundwater	Potable Tap Water	Shower/ faucets	Aluminum	NA	NA	NA	NA	Aluminum	N/A	3.26E-02	NA	9.97E-05	3.27E-02
			Antimony	NA	NA	NA	NA	Antimony	Blood	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Arsenic	Skin	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	Barium	Kidney	5.41E-02	NA	2.36E-03	5.65E-02
			Benzene	3.8E-08	NA	6.3E-09	4.4E-08	Benzene	Blood	6.46E-04	NA	8.00E-05	7.26E-04
			Benzo(b)fluoranthene	1.4E-06	NA	3.5E-05	3.7E-05	Benzo(b)fluoranthene	N/A	NA	NA	NA	NA
			Bis(2-ethylhexyl)phthalate	2.2E-07	NA	1.2E-05	1.3E-05	Bis(2-ethylhexyl)phthalate	Liver	2.20E-03	NA	1.23E-01	1.25E-01
			Cadmium	NA	NA	NA	NA	Cadmium	Kidney	NA	NA	NA	NA
			Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	9.42E-01	NA	2.31E-01	1.17E+00
			Cobalt	NA	NA	NA	NA	Cobalt	N/A	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Copper	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Iron	N/A	3.26E-01	NA	3.11E-03	3.29E-01
			Lead	NA	NA	NA	NA	Lead	N/A	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA	Manganese	CNS	5.50E+00	NA	4.21E-01	5.92E+00
			Nickel	NA	NA	NA	NA	Nickel	Various	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Selenium	Various	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	Thallium	Blood	NA	NA	NA	NA
			Trichloroethene	5.3E-06	NA	9.8E-07	6.3E-06	Trichloroethene	N/A	1.23E-01	NA	2.29E-02	1.46E-01
			Zinc	NA	NA	NA	NA	Zinc	Blood	NA	NA	NA	NA
Groundwater	Ambient Air	Volatile COPCs	Benzene	NA	1.1E-10	NA	1.1E-10	Benzene	Blood	NA	1.33E-06	NA	1.33E-06
			Trichloroethene	NA	6.2E-08	NA	6.2E-08	Trichloroethene	N/A	NA	4.35E-05	NA	4.35E-05
						Total Risk Across Groundwater	**5.6E-05**					**Total Hazard Quotient Across Groundwater**	**7.8E+00**
						Total Risk Across All Media and All Exposure Routes	**7E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**8.0E+00**

Total [CNS] HI = **6**

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TABLE F.3.A
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
FUTURE OUTDOOR INDUSTRIAL WORKER
Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Potable Tap Water	Shower/Faucets						Chromium Hexavaler	lung	0.64	NA	0.39	1.0
								Manganese	CNS	0.48	NA	0.41	0.9
						Total Risk Across[Medium]					Total Hazard Index Across All Media and All Exposure Routes		1.9
						Total Risk Across All Media and All Exposure Routes							
												Total [lung] HI =	1
												Total [manganese] HI =	0.9

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TABLE F-4
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE WITHOUT MW-2S
FUTURE CONSTRUCTION WORKER
Peter Cooper Markhams Site
Town of Dayton, New York

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

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Inhalation	Dermal	Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Wetlands	Arsenic	3 198E-07	NA	2.879E-08	3.5E-07	Arsenic	Skin	4.98E-02	NA	4 48E-03	5.4E-02
						Total Risk Across Sediment	**3.5E-07**					**Total Hazard Quotient Across Sediment**	**5.4E-02**
Soil	Soil	Surface Soil	Arsenic	1.2E-06	6.0E-09	1.1E-07	1.3E-06	Arsenic	Skin	1.84E-01	9 31E-05	1.66E-02	2.0E-01
	Ambient Air	Fugitive Dust	Benzo(a)pyrene	1.7E-08	8.7E-12	6.7E-09	2 4E-08	Benzo(a)pyrene	N/A	NA	NA	NA	NA
			Chromium, trivalent	NA	NA	NA	NA	Chromium, trivalent	None Observed	3 02E-02	1.53E-05	6 81E-02	9.8E-02
			Chromium, hexavalent	NA	8 4E-09	NA	8 4E-09	Chromium, hexavalent	Lung	9.21E-03	6.35E-03	1.11E-02	2.66E-02
						Total Risk Across Soil	**1.3E-06**					**Total Hazard Quotient Across Soil**	**3.3E-01**
Groundwater	Groundwater	Groundwater	Aluminum	NA	NA	NA	NA	Aluminum	N/A	NA	NA	1.85E-04	1.9E-04
			Antimony	NA	NA	NA	NA	Antimony	Blood	NA	NA	NA	NA
	Ambient Air	Volatile COPCs	Arsenic	NA	NA	NA	NA	Arsenic	Skin	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	Barium	Kidney	NA	NA	4.39E-03	4.4E-03
			Benzene	NA	1.8E-11	1.6E-10	1.8E-10	Benzene	Blood	NA	5 34E-06	5.17E-05	5.7E-05
			Benzo(b)fluoranthene	NA	NA	7.6E-07	7 6E-07	Benzo(b)fluoranthene	N/A	NA	NA	NA	NA
			Bis(2-ethylhexyl)phthalate	NA	NA	2.7E-07	2.7E-07	Bis(2-ethylhexyl)phthalate	Liver	NA	NA	6.66E-02	6.7E-02
			Cadmium	NA	NA	NA	NA	Cadmium	Kidney	NA	NA	NA	NA
			Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	4.28E-01	4 3E-01
			Cobalt	NA	NA	NA	NA	Cobalt	N/A	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Copper	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Iron	N/A	NA	NA	2.25E-03	2 2E-03
			Lead	NA	NA	NA	NA	Lead	N/A	NA	NA	NA	NA
			Manganese	NA	NA	NA	NA	Manganese	CNS	NA	NA	1.12E-01	1.1E-01
			Nickel	NA	NA	NA	NA	Nickel	Various	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Selenium	Various	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	Thallium	Blood	NA	NA	NA	NA
			Trichloroethene	NA	9.9E-09	2.2E-08	3 2E-08	Trichloroethene	N/A	NA	1.74E-04	1.30E-02	1.3E-02
						Total Risk Across Groundwater	**1.1E-06**					**Total Hazard Quotient Across Groundwater**	**8.3E-01**
Surface Water	Surface Water	Wetlands	Chromium, hexavalent	NA	NA	NA	NA	Chromium, hexavalent	Lung	NA	NA	1.8E-03	1.8E-03
						Total Risk Across Surface Water	**0.0E+00**					**Total Hazard Quotient Across Surface Water**	**1.8E-03**
						Total Risk Across All Media and All Exposure Routes	**3E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**1.0**

Total [Lung] HI =	**0.5**
Total [Skin] HI =	**0.2**

APPENDIX F
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS REVISED GROUNDWATER EXPOSURE
PETER COOPER MARKHAMS SITE
TOWN OF DAYTON, NEW YORK
7603.001
Final

REPRESENTATIVE CONCENTRATIONS

Chemical	Sediment (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Water (mg/l)	Groundwater (mg/l)	Source(s)
Aluminum	NA	NA	NA	NA	3.7	
Antimony	NA	NA	NA	NA	NA	
Arsenic	6.42	23.29	23.79	NA	NA	
Barium	NA	NA	NA	NA	0.43	
Benzene	NA	NA	NA	NA	0.00022	
Benzo(a)pyrene	NA	0.071	0.071	NA	NA	
Benzo(b)fluoranthene	NA	NA	NA	NA	0.0006	
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	0.005	
Cadmium	NA	NA	NA	NA	NA	
Chromium, trivalent	NA	21541	19517	NA	NA	
Chromium, hexavalent	NA	14.02	11.89	0.0108	0.321	
Cobalt	NA	NA	NA	NA	NA	
Copper	NA	NA	NA	NA	NA	
Iron	NA	NA	NA	NA	11.1	
Lead	NA	NA	NA	NA	NA	
Manganese	NA	NA	NA	NA	15	
Nickel	NA	NA	NA	NA	NA	
Selenium	NA	NA	NA	NA	NA	
Thallium	NA	NA	NA	NA	NA	
Trichloroethene	NA	NA	NA	NA	0.0042	
Zinc	NA	NA	NA	NA	NA	

APPENDIX F
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS REVISED GROUNDWATER EXPOSURE
PETER COOPER MARKHAMS SITE
TOWN OF DAYTON, NEW YORK
7603.001
Final

CALCULATION OF DERMALLY ABSORBED DOSE PER EVENT (DAevent)

Chemical	Molecular Weight (MW) (g/mole)	Log Octanol Water Partition Coefficient (log Kow) (--)	Permeability Constant (Kp) (cm/hr)	Fraction Absorbed (FA) (--)	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 (Cgw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Industrial (mg/cm^2-event)	Dermal Absorbed Dose Per Event (DAevent) Construction (mg/cm^2-event)	Concentration Surface Water (Csw) (mg/cm^3)	Dermal Absorbed Dose Per Event (DAevent) Trespasser (mg/cm^2-event)
Aluminum	27	NA	0.001	NA	2.00E-03	1.12E-06	1.49E-01	3.04E-01	3.35E-01	0.36	3.7E-03	6.3E-07	7.4E-06	NA	NA
Antimony	122	NA	0.001	NA	4.25E-03	3.29E-07	5.07E-01	3.06E-01	3.36E-01	1.22	NA	NA	NA	NA	NA
Arsenic	75	NA	0.001	NA	3.33E-03	6.03E-07	2.77E-01	3.05E-01	3.36E-01	0.66	NA	NA	NA	NA	NA
Barium	137	NA	0.001	NA	4.50E-03	2.71E-07	6.15E-01	3.06E-01	3.36E-01	1.48	4.3E-04	7.3E-08	8.6E-07	NA	NA
Benzene	78.11	2.13	0.015	1	5.10E-02	5.79E-07	2.88E-01	3.35E-01	3.68E-01	0.70	2.2E-07	2.0E-09	8.3E-09	NA	NA
Benzo(a)pyrene	252.32	6.11	0.66	1	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	1	4.28E+00	6.12E-08	2.72E+00	1.34E+01	4.34E+00	12.03	6.0E-07	8.5E-07	2.9E-06	NA	NA
Bis(2-ethylhexyl)phthalate	390.57	7.30	0.677	1	1.82E-01	1.03E-08	1.62E+01	4.26E-01	4.64E-01	41.85	5.0E-06	1.6E-05	5.3E-05	NA	NA
Cadmium	112	NA	0.001	1	4.07E-03	3.74E-07	4.46E-01	3.06E-01	3.36E-01	1.07	NA	NA	NA	NA	NA
Chromium, trivalent	52	NA	0.001	NA	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	NA	5.55E-03	8.11E-07	2.06E-01	3.07E-01	3.37E-01	0.49	3.2E-04	1.1E-07	1.3E-06	1.1E-05	5.4E-09
Cobalt	59	NA	0.001	1	2.95E-03	7.41E-07	2.25E-01	3.05E-01	3.35E-01	0.54	NA	NA	NA	NA	NA
Copper	64	NA	0.001	1	3.08E-03	6.94E-07	2.40E-01	3.05E-01	3.35E-01	0.58	NA	NA	NA	NA	NA
Iron	55.847	NA	0.001	1	2.87E-03	7.71E-07	2.16E-01	3.05E-01	3.35E-01	0.52	1.1E-02	5.9E-06	2.7E-05	NA	NA
Lead	207	NA	0.0001	NA	5.53E-04	1.10E-07	1.52E+00	3.04E-01	3.34E-01	3.64	NA	NA	NA	NA	NA
Manganese	55	NA	0.001	NA	2.85E-03	7.80E-07	2.14E-01	3.05E-01	3.35E-01	0.51	1.5E-02	2.6E-06	3.0E-05	NA	NA
Nickel	59	NA	0.0002	1	5.91E-04	7.41E-07	2.25E-01	3.04E-01	3.34E-01	0.54	NA	NA	NA	NA	NA
Selenium	79	NA	0.001	1	3.42E-03	5.72E-07	2.91E-01	3.05E-01	3.36E-01	0.70	NA	NA	NA	NA	NA
Thallium	204	NA	0.001	1	5.49E-03	1.14E-07	1.46E+00	3.07E-01	3.37E-01	3.50	NA	NA	NA	NA	NA
Trichloroethene	131	2.71	0.012	1	5.28E-02	2.93E-07	5.69E-01	3.36E-01	3.69E-01	1.39	4.2E-06	4.3E-08	1.6E-07	NA	NA
Zinc	65	NA	0.0006		1.86E-03	6.85E-07	2.43E-01	3.04E-01	3.35E-01	0.58	NA	NA	NA	NA	NA

For Organics: If tevent < t* DAevent = $2 * FA * Kp * Cgw * (6 * tau * tevent/Pi)^{1/2}$

or

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

For Inorganics: DAevent = Kp * Cgw * tevent

If log Kow < 4

Kp = Kp USEPA, 2001a, Exhibit B-3 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)

Source: USEPA, 2004

$$B = \frac{Kp * (MW)^{1/2}}{2.6}$$

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

$$tau = \frac{1E\text{-}6}{6 * Dsc}$$

t* = USEPA, 2004 Exhibit B-3, or

If B < 0.6, t* = 2.4 * tau

$$\text{If } B > 0.6,\ t^* = \frac{(b - (b2 - c2)^{1/2}) * 1E\text{-}6}{Dsc}$$

$$b = \frac{2*(1 + B)^2}{Pi}$$

$$c = \frac{1 + 3*B + 3*B^2}{3*(1 + B)}$$

Parameter	Symbol	Value	Units
Event Duration - industrial worker	tevent	0.17	hr
Event Duration - construction worker	tevent	2	hr
Event Duration - trespasser	tevent	0.25	hr

TOTAL SOLUTE CONCENTRATION OF VOLATILE COPCS IN GROUNDWATER

Chemical	Concentration Groundwater (Cgw) (mg/L)	Henry's Law Constant (H') (unitless)	Soil-Organic Partition Coefficient (Kd) (l/kg)	Diffusivity in Air (Di) (cm^2/sec)	Concentration Soil Vapor (Cv) (mg/cm^3)	Concentration Soil (CT) (mg/cm^3)
Aluminum	3.70E+00	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	4.30E-01	NA	NA	NA	NA	NA
Benzene	2.20E-04	2.3E-01	3.53E-01	8.80E-02	5.0E-08	1.6E-07
Benzo(a)pyrene	NA	4.6E-05	6.12E+03	4.30E-02	NA	NA
Benzo(b)fluoranthene	6.00E-04	4.6E-03	7.38E+03	2.26E-02	NA	NA
Bis(2-ethylhexyl)phthalate	5.00E-03	4.2E-06	9.06E+04	3.50E-02	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	3.21E-01	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Iron	1.11E+01	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Manganese	1.50E+01	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA
Trichloroethene	4.20E-03	4.2E-01	9.96E-01	7.90E-02	1.8E-06	7.4E-06
Zinc	NA	NA	NA	NA	NA	NA

CT =	Cv x (pb x Kd/H' + Pw/H' + Pa)
Cv =	Cgw x H' x $CF_{cm3\text{-}L}$
Kd =	Koc x foc
Source:	USEPA, 1996

Parameter	Symbol	Value	Units
Bulk Density	pb	1.5	g/cm^3
Fraction Organic Carbon	foc	0.006	unitless
Water Filled Soil Porosity	Pw	0.15	unitless
Air Filled Soil Porosity	Pa	0.28	unitless
Conversion Factor from cm^3 to L	$CF_{cm3\text{-}L}$	1.E-03	L/cm^3

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EMISSION RATES OF VOLATILE COPCS FROM GROUNDWATER

Chemical	Concentration Soil (CT) (mg/cm³)	Effective Diffusivity (Da) (cm²/sec)	Emission Rate (Ei) Industrial (mg/m²-sec)	Emission Rate (Ei) Construction (mg/m²-sec)	Emission Rate (Ei) Trespasser - Adult (mg/m²-sec)	Emission Rate (Ei) Trespasser - Adolescent (mg/m²-sec)
Aluminum	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA
Benzene	1.6E-07	2.09E-03	3.0E-09	1.5E-08	2.7E-09	4.3E-09
Benzo(a)pyrene	NA	2.64E-11	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	7.27E-10	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	3.45E-13	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA
Trichloroethene	7.4E-06	1.47E-03	1.1E-07	5.7E-07	1.0E-07	1.6E-07
Zinc	NA	NA	NA	NA	NA	NA

$$Ei = \frac{CT \times 2 \times Da \times CF_{m2\text{-}cm2}}{(3.14 \times Da \times T)^{1/2}}$$

Source: USEPA, 1996

Parameter	Symbol	Value	Units
Duration - Industrial	T	7.88E+08	sec
Duration - Construction	T	3.15E+07	sec
Duration - Trespasser - Adult	T	9.46E+08	sec
Duration - Trespasser - Adolescent	T	3.78E+08	sec
Conversion Factor from m² to cm²	$CF_{m2\text{-}cm2}$	1 E+04	cm²/m²

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AMBIENT AIR CONCENTRATIONS - VOLATILE COPCS FROM GROUNDWATER - X / Q MODEL

Chemical	Emission Rate (Ei)				Concentration Air (Caa)			
	Industrial (mg/m²-sec)	Construction (mg/m²-sec)	Trespasser - Adult (mg/m²-sec)	Trespasser - Youth (mg/m²-sec)	Industrial (mg/m³)	Construction (mg/m³)	Trespasser - Adult (mg/m³)	Trespasser - Adolescent (mg/m³)
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	3.0E-09	1.5E-08	2.7E-09	4.3E-09	6.5E-08	3.3E-07	5.9E-08	9.4E-08
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	1.1E-07	5.7E-07	1.0E-07	1.6E-07	2.5E-06	1.2E-05	2.3E-06	3.6E-06
Zinc	NA	NA	NA	NA	NA	NA	NA	NA

Caa =	Ei x X/Q
Source:	USEPA, 1996

Parameter	Symbol	Value	Units
Air Dispersion Factor - commercial	X/Q	21.64	mg/m³ per mg/m²-sec

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INGESTION OF GROUNDWATER: OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Groundwater (Cgw) (mg/L)	Oral Absorption Factor-Soil (ABSos) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Oral Chronic Reference Dose (RfDo) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Oral Slope Factor (SFo) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	3.70E+00	1	3.3E-02	1	3.3E-02	1.2E-02	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	1.5	NA
Barium	4.30E-01	1	3.8E-03	0.07	5.4E-02	1.4E-03	NA	NA
Benzene	2.20E-04	1	1.9E-06	0.003	6.5E-04	6.9E-07	0.055	3.8E-08
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	6.00E-04	1	5.3E-06	NA	NA	1.9E-06	0.73	1.4E-06
Bis(2-ethylhexyl)phthalate	5.00E-03	1	4.4E-05	0.02	2.2E-03	1.6E-05	0.014	2.2E-07
Cadmium	NA	1	NA	0.0005	NA	NA	NA	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	3.21E-01	1	2.8E-03	0.003	9.4E-01	1.0E-03	NA	NA
Cobalt	NA	1	NA	0.02	NA	NA	NA	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	1.11E+01	1	9.8E-02	0.3	3.3E-01	3.5E-02	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	1.50E+01	1	1.3E-01	0.024	5.5E+00	4.7E-02	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	NA	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	4.20E-03	1	3.7E-05	0.0003	1.2E-01	1.3E-05	0.4	5.3E-06
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					7E+00			7E-06

$$AADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)} \qquad \text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(Cs \times IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}{(BW \times ATca)} \qquad \text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Values	Units
Exposure Frequency	EFig	225	d/yr
Exposure Duration	ED	25	yr
Body Weight	BW	70	kg
Averaging Time-Non-cancer	ATnc	9,125	days
Averaging Time-Cancer	ATca	25,550	days
Ingestion Rate	IRs	1	L/day

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DERMAL CONTACT WITH GROUNDWATER: OUTDOOR INDUSTRIAL WORKER

Chemical	Dermal Absorbed Dose Per Event (DAevent) (mg/cm²-event)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) $(mg/kg\text{-}d)^{-1}$	Excess Cancer Risk (--)
Aluminum	6.29E-07	1.0E-04	1	1.0E-04	3.6E-05	NA	NA
Antimony	NA	NA	0.00006	NA	NA	NA	NA
Arsenic	NA	NA	0.0003	NA	NA	1.5	NA
Barium	7.31E-08	1.2E-05	0.0049	2.4E-03	4.1E-06	NA	NA
Benzene	2.02E-09	3.2E-07	0.004	8.0E-05	1.1E-07	0.055	6.3E-09
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	8.54E-07	1.4E-04	NA	NA	4.8E-05	0.73	3.5E-05
Bis(2-ethylhexyl)phthalate	1.55E-05	2.5E-03	0.02	1.2E-01	8.8E-04	0.014	1.2E-05
Cadmium	NA	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	1.09E-07	1.7E-05	0.000075	2.3E-01	6.2E-06	NA	NA
Cobalt	NA	NA	0.02	NA	NA	NA	NA
Copper	NA	NA	0.037	NA	NA	NA	NA
Iron	5.88E-06	9.3E-04	0.3	3.1E-03	3.3E-04	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	2.55E-06	4.0E-04	0.00096	4.2E-01	1.4E-04	NA	NA
Nickel	NA	NA	0.0008	NA	NA	NA	NA
Selenium	NA	NA	0.004	NA	NA	NA	NA
Thallium	NA	NA	0.000066	NA	NA	NA	NA
Trichloroethene	4.33E-08	6.9E-06	0.0003	2.3E-02	2.5E-06	0.4	9.8E-07
Zinc	NA	NA	0.3	NA	NA	NA	NA
				8.0E-01			4.9E-05

$$AADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	225
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Skin Surface Area	SAswr	cm2	18,000

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: OUTDOOR INDUSTRIAL WORKER

Chemical	Concentration Air (Caa) (mg/m^3)	Inhalation Absorption Factor-Volatiles (ABSiv) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) $(mg/kg-d)^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	6.5E-08	1	1.1E-08	0.0086	1.3E-06	4.1E-09	0.027	1.1E-10
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	2.5E-06	1	4.3E-07	0.01	4.3E-05	1.6E-07	0.4	6.2E-08
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					4E-05			6E-08

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	225
Exposure Duration	ED	yr	25
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	9,125
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	2.5
Exposure Time	ETaa	hr/d	8

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DERMAL CONTACT WITH GROUNDWATER: CONSTRUCTION WORKER

Chemical	Dermal Absorbed Dose Per Event (DAevent) (mg/cm^2-event)	Annual Average Daily Dose (AADD) (mg/kg-d)	Adjusted Dermal Chronic Reference Dose (RfDd) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Adjusted Dermal Slope Factor (SFd) (mg/kg-d)$^{-1}$	Excess Cancer Risk (--)
Aluminum	7.40E-06	1.9E-04	1	1.9E-04	2.6E-06	NA	NA
Antimony	NA	NA	0.00006	NA	NA	NA	NA
Arsenic	NA	NA	0.0003	NA	NA	1.5	NA
Barium	8.60E-07	2.2E-05	0.0049	4.4E-03	3.1E-07	NA	NA
Benzene	8.28E-09	2.1E-07	0.004	5.2E-05	3.0E-09	0.055	1.6E-10
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	2.93E-06	7.3E-05	NA	NA	1.0E-06	0.73	7.6E-07
Bis(2-ethylhexyl)phthalate	5.32E-05	1.3E-03	0.02	6.7E-02	1.9E-05	0.014	2.7E-07
Cadmium	NA	NA	0.0000013	NA	NA	NA	NA
Chromium, trivalent	NA	NA	0.02	NA	NA	NA	NA
Chromium, hexavalent	1.28E-06	3.2E-05	0.000075	4.3E-01	4.6E-07	NA	NA
Cobalt	NA	NA	0.02	NA	NA	NA	NA
Copper	NA	NA	0.037	NA	NA	NA	NA
Iron	2.69E-05	6.7E-04	0.3	2.2E-03	9.6E-06	NA	NA
Lead	NA	5.0E+00	NA	NA	NA	NA	NA
Manganese	3.00E-05	1.1E-04	0.00096	1.1E-01	1.1E-05	NA	NA
Nickel	NA	NA	0.0008	NA	NA	NA	NA
Selenium	NA	NA	0.004	NA	NA	NA	NA
Thallium	NA	NA	0.000066	NA	NA	NA	NA
Trichloroethene	1.56E-07	3.9E-06	0.0003	1.3E-02	5.6E-08	0.4	2.2E-08
Zinc	NA	NA	0.3	NA	NA	NA	NA
				6.3E-01			1.1E-06

$$AADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDo}$$

$$LADD = \frac{(DAevent \times SAswr \times EVswr \times EFswr \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFo$$

Parameter	Symbol	Units	Value
Event Frequency	EVswr	evt/day	1
Exposure Frequency	EFswr	d/yr	90
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25550
Skin Surface Area	SAswr	cm2	7100

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INHALATION OF VOCS IN AMBIENT AIR FROM GROUNDWATER EMISSIONS: CONSTRUCTION WORKER

Chemical	Concentration Air (Caa) (mg/m^3)	Inhalation Absorption Factor-Volatiles (ABSiv) (--)	Annual Average Daily Dose (AADD) (mg/kg-d)	Inhalation Chronic Reference Dose (RfDi) (mg/kg-d)	Hazard Quotient (--)	Lifetime Average Daily Dose (LADD) (mg/kg-d)	Inhalation Slope Factor (SFi) (mg/kg-d)$^{-1}$	Excess Cancer Risk (--)
Aluminum	NA	1	NA	0.0014	NA	NA	NA	NA
Antimony	NA	1	NA	0.0004	NA	NA	NA	NA
Arsenic	NA	1	NA	0.0003	NA	NA	15	NA
Barium	NA	1	NA	0.00014	NA	NA	NA	NA
Benzene	3.26E-07	1	4.6E-08	0.0086	5.3E-06	6.6E-10	0.027	1.8E-11
Benzo(a)pyrene	NA	1	NA	NA	NA	NA	7.3	NA
Benzo(b)fluoranthene	NA	1	NA	NA	NA	NA	0.73	NA
Bis(2-ethylhexyl)phthalate	NA	1	NA	0.022	NA	NA	0.014	NA
Cadmium	NA	1	NA	0.0005	NA	NA	6.3	NA
Chromium, trivalent	NA	1	NA	1.5	NA	NA	NA	NA
Chromium, hexavalent	NA	1	NA	0.0000022	NA	NA	42	NA
Cobalt	NA	1	NA	0.0000057	NA	NA	9.8	NA
Copper	NA	1	NA	0.037	NA	NA	NA	NA
Iron	NA	1	NA	0.3	NA	NA	NA	NA
Lead	NA	1	NA	NA	NA	NA	NA	NA
Manganese	NA	1	NA	0.000014	NA	NA	NA	NA
Nickel	NA	1	NA	0.02	NA	NA	0.91	NA
Selenium	NA	1	NA	0.005	NA	NA	NA	NA
Thallium	NA	1	NA	0.000066	NA	NA	NA	NA
Trichloroethene	1.23E-05	1	1.7E-06	0.01	1.7E-04	2.5E-08	0.4	9.9E-09
Zinc	NA	1	NA	0.3	NA	NA	NA	NA
					2E-04			1E-08

$$AADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATnc)}$$

$$\text{Hazard Quotient} = \frac{AADD}{RfDi}$$

$$LADD = \frac{(Caa \times IHRaa \times ETaa \times ABSiv \times EFaa \times ED)}{(BW \times ATca)}$$

$$\text{Excess Cancer Risk} = LADD \times SFi$$

Parameter	Symbol	Units	Values
Exposure Frequency	EFaa	d/yr	180
Exposure Duration	ED	yr	1
Body Weight	BW	kg	70
Averaging Time-Non-cancer	ATnc	days	365
Averaging Time-Cancer	ATca	days	25,550
Inhalation Rate	IHRaa	m^3/hr	2.5
Exposure Time	ETaa	hr/d	8

APPENDIX F
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS REVISED GROUNDWATER EXPOSURE
PETER COOPER MARKHAMS SITE
TOWN OF DAYTON, NEW YORK
Final

SUMMARY RISK CHARACTERIZATION: OUTDOOR INDUSTRIAL WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Ingestion of Groundwater	Dermal Contact with Groundwater while Bathing	Inhalation of Volatiles in Ambient Air from Groundwater	Excess Cancer Risk
Aluminum	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	**1.1E-05**	**2.2E-06**	1.7E-08	NA	NA	NA	**1.3E-05**
Barium	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	NA	3.8E-08	6.3E-09	1.1E-10	4.4E-08
Benzo(a)pyrene	1.6E-07	1.4E-07	2.5E-11	NA	NA	NA	3.0E-07
Benzo(b)fluoranthene	NA	NA	NA	**1.4E-06**	**3.5E-05**	NA	**3.7E-05**
Bis(2-ethylhexyl)phthalate	NA	NA	NA	2.2E-07	**1.2E-05**	NA	**1.3E-05**
Cadmium	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	NA	NA	NA	NA	NA	NA	NA
Chromium, hexavalent	NA	NA	2.8E-08	NA	NA	NA	2.8E-08
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	**5.3E-06**	9.8E-07	6.2E-08	**6.3E-06**
Zinc	NA	NA	NA	NA	NA	NA	NA
Total	1.1E-05	2.3E-06	4.5E-08	6.9E-06	4.9E-05	6.2E-08	6.9E-05

NA = not applicable

Geomatrix

APPENDIX F
HUMAN HEALTH RISK ASSESSMENT CALCULATIONS REVISED GROUNDWATER EXPOSURE
PETER COOPER MARKHAMS SITE
TOWN OF DAYTON, NEW YORK
Final

SUMMARY RISK CHARACTERIZATION: OUTDOOR INDUSTRIAL WORKER

Chemical	Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	Ingestion of Groundwater	Dermal Contact with Groundwater while Bathing	Inhalation of Volatiles in Ambient Air from Groundwater	Hazard Index
Aluminum	NA	NA	NA	3.3E-02	1.0E-04	NA	3.3E-02
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	6.8E-02	1.4E-02	1.0E-05	NA	NA	NA	8.2E-02
Barium	NA	NA	NA	5.4E-02	2.4E-03	NA	5.6E-02
Benzene	NA	NA	NA	6.5E-04	8.0E-05	1.3E-06	7.3E-04
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	2.2E-03	1.2E-01	NA	1.3E-01
Cadmium	NA	NA	NA	NA	NA	NA	NA
Chromium, trivalent	1.3E-02	6.3E-02	1.9E-06	NA	NA	NA	7.5E-02
Chromium, hexavalent	4.1E-03	1.1E-02	8.5E-04	9.4E-01	2.3E-01	NA	**1.2E+00**
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	3.3E-01	3.1E-03	NA	3.3E-01
Lead	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	**5.5E+00**	4.2E-01	NA	**5.9E+00**
Nickel	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	1.2E-01	2.3E-02	4.3E-05	1.5E-01
Zinc	NA	NA	NA	NA	NA	NA	NA
Total	8.5E-02	8.7E-02	8.6E-04	7.0E+00	8.0E-01	4.5E-05	8.0E+00

NA = not applicable