UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

November 13, 1997

de maximis, inc.

REPLY TO THE ATTENTION OF:

SR-6J

Via Express Mail

NOV 14 1997
RECEIVED

Robert W. Rule
De Maximis, Inc.
301 Gallaher View Road
Suite 227
Knoxville, TN 37919

Re: Streamlined Risk Evaluation for the Garland Road Landfill Site
near West Milton, Miami County, Ohio

Dear Mr. Rule:

Thank you for the opportunity to discuss the Garland Road Landfill at the site on November 6, 1997. Your offer to provide a description of site geology and groundwater flow within two weeks after the meeting is also appreciated. As you know, the presumptive remedy for municipal landfills is containment. The United States Environmental Protection Agency (U.S. EPA) and the Ohio Environmental Protection Agency will utilize the information you are preparing in evaluating the containment alternatives proposed in the Engineering Evaluation/Cost Analysis (EE/CA) Report.

During the meeting, several participants expressed concern that the discussion of geology and groundwater flow may further delay progress at the site. U.S. EPA is also concerned about delays and believes the preparation of the EE/CA Report, while issues regarding geology and groundwater flow are resolved, is in the interest of all parties concerned. To prevent further delays in the EE/CA process, U.S. EPA is transmitting with this letter the Streamlined Risk Evaluation (SRE). Pursuant to the Consent Order (Docket No. V-W-95-C-296), U.S. EPA requests General Motors Corporation submit a draft EE/CA Report which incorporates the enclosed SRE within sixty (60) days of receipt.

If you have any questions regarding this matter, please feel free to call me at (312) 886-4442.

Sincerely,

Matthew J. Ohl

Matthew J. Ohl
Remedial Project Manager

enclosure

STREAMLINED RISK EVALUATION
FOR
GARLAND ROAD LANDFILL
WEST MILTON/MIAMI COUNTY/OHIO
TDD: S05-9609-002
PAN: 6P0201TR

November 13, 1997

Prepared for:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Emergency and Enforcement Response Branch
77 West Jackson Boulevard
Chicago, Illinois 60604

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1. INTRODUCTION

Ecology and Environment, Inc. (E & E) was tasked by the United States Environmental Protection Agency (U.S. EPA) under Technical Direction Document (TDD) No. S05-9609-002 to prepare a streamlined risk evaluation (SRE) for the Garland Road Landfill (GRL) site in West Milton, Miami County, Ohio (U.S. EPA 1996a). This SRE is prepared in support of an Engineering Evaluation/Cost Analysis EE/CA being conducted by the potentially responsible parties (PRPs) for the site. The purpose of the SRE is to evaluate the potential risks posed to human and environmental receptors from contamination at the site in the event that no further action is taken at the site.

The SRE has been prepared and organized in general accordance with U.S. EPA's *Risk Assessment Guidance for Superfund* (RAGS), *Volume I: Human Health Evaluation Manual* (U.S. EPA 1989a); *RAGS, Volume II. Environmental Evaluation Manual, EPA/540/1-89/001* (U.S. EPA 1989b); and other related guidance, including but not limited to, *Guidance for Conducting Non-Time Critical Removal Actions* (U.S. EPA 1993a), and *Presumptive Remedy for CERCLA Municipal Landfill Sites* (U.S. EPA 1993b). Descriptions of the site history, previous investigations, and the nature and extent of contamination are presented in the EE/CA work plan prepared by the PRP Contractor (Conestoga, Rovers, and Associates [CRA]), in previous reports prepared for the site by the Ohio Environmental Protection Agency (OEPA) and U.S. EPA, and in the EE/CA report (to be prepared by CRA). A brief discussion of these items is presented in Section 2.

1.1 Purpose and Scope of the Streamlined Risk Evaluation

EPA guidance on conducting non-time-critical removal actions (U.S. EPA 1993a) requires that a Streamlined Risk Evaluation (SRE) be included as a component of the EE/CA in order to assist in determining whether a removal action is required, and to identify the potential current and future exposures

that should be prevented. The SRE is intermediate in scope between the limited risk evaluation performed for a removal action and the conventional baseline risk assessment conducted for remedial actions. The SRE is intended to evaluate the existing and potential risks posed by the specific problem that the removal action is intended to address, and can be both qualitative and quantitative in nature (U.S. EPA 1993a).

The purpose of this SRE is to evaluate potential risks to humans and the environment as a result of exposure to contaminants present in groundwater and surface soil at the site. Due to the lack of analytical data for off-site media (soil, surface water, and groundwater), the SRE focuses on contaminants detected at the landfill, and thus is intended to evaluate on-site contamination relative to a presumptive remedy for a municipal landfill (U.S. EPA 1993b).

2. BACKGROUND

2.1 Site Description

The GRL site is a 15-acre property located along the west bank of the Stillwater River south of Frederick-Garland Road, just outside the city limits of West Milton, Miami County, Ohio (see Figure 2-1). The property is approximately 2,500 feet long and varies between 300 and 500 feet in width. The site is bounded on the north by Frederick-Garland Road, on the east by the Stillwater River, a State Scenic River, and on the south and west by farmland. The City of West Milton is located less than 1 mile northwest of the site. The City of Union is located approximately 2 miles to the south. The landfill covers most of the surface of the site, except for the southeast end. The site is located within the 100-year flood plain of the Stillwater River, and the southern portion of the site floods annually (FEMA 1983).

2.2 Site History

The GRL site was initially used as a landfill during the early 1960s, by then property owner Harold Ostrov. Landfill operations were interrupted for a brief period when Ostrov sold the property to B & W Realty in 1966, but resumed in 1967 under lease by B & W Landfill. Between 1967 and 1970, the landfill reportedly received large amounts of liquid and sludge wastes from General Motors Inland Division of Vandalia, Ohio, Wastes were reported to have been dumped into trenches 15 to 20 feet deep. It is not known if the trenches were lined. The landfill also received household waste. Operations ceased at the landfill in 1970, and B & W sold the property to the current owners, Paul and Martha Theis, in 1973.

Anonymous citizen complaints prompted an inspection by OEPA on March 21, 1991. OEPA noted numerous drums protruding from the ground surface and the river bank, and estimated that at least 400 drums were present at the site. A follow-up visit was conducted by OEPA on July 15, 1992, to collect samples of drum materials and surrounding soil for analysis. Results of the analysis of 4 drum and 4 soil

samples indicated the presence of chlorinated and non-chlorinated organic solvents, semi-volatile organic compounds, polychlorinated biphenyls (PCB), and heavy metals.

EPA's Field Investigation Team (FIT) conducted a site assessment on January 28, 1993 and collected six soil samples, four sediment samples, and one groundwater sample from a nearby residential well on April 7, 1993 (PRC Environmental Management, Inc. [PRC] 1993). On March 23, 1993, U.S. EPA's Technical Assistance Team (TAT) contractor collected samples of drum contents, and surface soil from the site. The results of analysis of samples collected during both the FIT and TAT assessments revealed the presence of organic solvents, metals, PCB, and semivolatile organic compounds in soil and waste samples.

EPA initiated a time-critical removal action at the site on November 8, 1993. Activities have included excavation of approximately 13,000 drums, and over 11,000 tons of soil and debris associated with the drum removal. Excavated soil has been stockpiled on site until final treatment options are determined. Debris containing vinyl chloride above TCLP regulatory limits was placed in an excavation pit (#P-9) on-site, and comes into direct contact with shallow groundwater at the site.

2.3 Summary of Nature And Extent of Contamination

This section summarizes the nature and extent of contamination detected at the GRL site based on investigations by OEPA, U.S. EPA, and CRA. Groundwater, surface soil, sediment, and fish sampling locations are shown in Figures 2-2 through 2-4. Summaries of analytical results are presented in Appendix A.

On-Site Surface Soil

On-site surface soil samples were collected during investigations by OEPA and U.S. EPA prior to the removal action, and by CRA subsequent to the removal. Pre-removal soil samples were collected judgementally from areas next to drums, or other areas where contamination was suspected. Contaminants detected in surface soil on site include metals, PCBs, PAHs, pesticides, phthalates, and volatile organics.

Post-removal surface soil samples collected by CRA from soil borings and monitoring well borings indicate that residual surface soil contamination exists at the site. Contaminants detected in surface soil on site include metals (detected in all samples), Aroclor 1248 (one out of 12 samples), Aroclor 1254 (6 of 12 samples), PAHs, 4,4'-DDD (2 samples), dieldrin (4 of 12 samples), phthalates, and volatile organics. Due to the limited number of background samples, a statistical comparison could not be made between off-site

and on-site concentrations of inorganics and other compounds. Concentrations of metals detected off-site appear to be in the same general range as those detected on-site. Concentrations of arsenic, beryllium, cobalt, manganese, and vanadium were actually higher in the background samples than in the on-site samples. Dieldrin was also detected at a higher concentration in one of the background samples.

With the exception of the two background samples, analytical data are not available for off-site surface soil in the areas adjacent to the site. The south end of the site is often flooded, and a possibility exists that contaminants may migrate off-site to the farmland south of the site (which also experiences flooding).

Groundwater

A total of four rounds of monitoring well sampling were conducted at the GRL site between July 1995 and October 1996. The latest round of sampling, conducted during the summer of 1996, includes all 9 of the monitoring wells at the site. Analytical results from the latest sampling round reveal the presence of 10 inorganic compounds, as well as volatile organic compounds acetone, benzene, 1,2-dichloroethene, methyl-isobutyl ketone (MIBK), toluene, trichloroethene, and vinyl chloride. Bis(2-ethylhexyl)phthalate and three phenolic compounds were also detected in one well. Of the detected compounds, only calcium, and magnesium were detected in the well considered upgradient of the site. Previous rounds of groundwater sampling (July and December, 1995) also detected the presence of methyl ethyl ketone, chlorobenzene, 1,1-dichloroethene, ethylbenzene, 2-hexanone; methylene chloride, 4-methyl-2-pentanone, 1,1,2-trichlorobenzene, di-n-butylphthalate, and several PAHs in groundwater at the site. One residential well sample was collected at the Theis residence (located approximately 3,000 feet southwest of the landfill) by the U.S. EPA FIT team during the screening site inspection in 1993. Site related contamination was not detected in the well sample at that time; however, it should be noted that the well is hydraulically upgradient of the site.

Stillwater River Sediment

Sediment samples were collected from the Stillwater River by U.S. EPA (one upstream and three adjacent samples), OEPA (one upstream sample, one adjacent sample, and four downstream samples), and the PRP contractor (one upstream, one adjacent sample , and three downstream samples).

Results of analysis indicates the presence of metals, polycyclic aromatic hydrocarbons (PAHs), aldrin, Aroclor 1221, bis (2-ethylhexyl) phthalate, and methylene chloride in sediment upstream of the site.

Samples collected adjacent to the site were found to contain PAHs and metals. Downstream samples contained acetone, Aroclor 1221, PAHs, and metals.

Detected concentrations of acetone, Aroclor 1221, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, and fluorene were higher in samples upstream of the site than in adjacent and downstream samples, suggesting that an upgradient source of these compounds may exist.

Stillwater River

Surface water samples were not collected from the Stillwater River. A potential exists, however, that VOCs detected in sediment and groundwater are being released into surface water.

3. HUMAN HEALTH EVALUATION

This section describes the general approach used to evaluate the potential risks to human health at the GRL site. In accordance with U.S. EPA guidance for streamlined risk evaluation, a quantitative evaluation was not performed for every potential exposure pathway and receptor possible at the site. The focus of the quantitative evaluation is to assess potential risks to residual contamination in surface soils at the site, and to evaluate potential risk to recreational users of the Stillwater River. Risks associated with groundwater ingestion and fish consumption were evaluated by comparison of detected contaminant concentrations to federal health-based criteria. Exposure to soil excavated and stockpiled on site during the removal action was not assessed based on the assumption that the material will be treated or removed from the site. Risks associated with surface water also were not evaluated in this assessment.

The human health portion of the SRE is organized using the general approach outlined in RAGS Volume I. Section 3.1 reviews the data evaluation and selection of chemicals of potential concern (COPC) for quantitative evaluation of on-site surface soils and sediment in the Stillwater River. Section 3.2 assesses potential exposure of receptors to the COPC. Section 3.3 presents a qualitative comparison of chemicals detected in groundwater and fish to health-based levels. Section 3.4 presents values used in the quantitative exposure estimates. Toxicity assessments for the COPC at the site are presented in Section 3.5. Section 3.6 integrates the exposure and toxicity assessments from previous sections into an overall risk evaluation. A discussion of uncertainties associated with the risk assessment is presented in Section 3.7.

3.1 Identification of Chemicals of Potential Concern

Chemicals of potential concern (COPC) for groundwater, soil, sediment, and fish were selected based on a review of the existing data and site history, evaluation of the frequency and range of detection,

distribution of media-specific chemical concentrations, and toxicity screening. The COPC selection process and results are described below.

Data Collection, Evaluation, and Validation

The EE/CA sampling conducted by CRA consisted of one round of river sediment sampling, surface and subsurface soil sampling, and monitoring well installation, and sampling. Surface soil data collected by CRA from 8 soil borings and 4 monitoring well installation borings was used in the SRE to evaluate on-site surface soil. Historical soil data collected by OEPA and U.S. EPA were not used for quantitative evaluation because soil removal has occurred at the site since the collection of those samples, and the results are no longer representative of site conditions. Sediment data collected by U.S. EPA, OEPA, and CRA were used in the evaluation of sediment exposure. Fish samples collected by OEPA were also included in this assessment.

Data evaluation qualifiers were reviewed in order to determine if the data are appropriate for use in a quantitative risk evaluation. Data qualified as rejected ("R" qualifier) were not included in the SRE. Results for one fish tissue sample were rejected based on quality control criteria. Data qualified as estimated ("J") are considered acceptable for use in the risk evaluation. Bis(2-ethylhexyl)phthalate (a common laboratory artifact) was detected in laboratory blank samples. Consequently, bis(2-ethylhexyl)phthalate results with an associated "B" qualifier were considered to be lab artifacts if the concentrations were less than 10 times the blank concentration.

Evaluation of Frequency of Detection of Chemicals

Analytical data were segregated by environmental medium (i.e., surface soil and sediment) and evaluated for frequency of detection of chemicals. The frequency of detection for a chemical is the number of samples in which the chemical was positively detected divided by the total number of samples analyzed for that chemical. Chemicals are generally eliminated as COPC if they were positively detected in less than 5% of the total number of samples analyzed (for sample sets of 20 or more). None of the chemicals detected in groundwater, soil, and/or sediment samples collected from the site during the EE/CA support sampling were detected at a frequency below 5% (due to the limited number of samples for each of the environmental media) and, therefore, no detected chemicals were eliminated from consideration based on this criterion.

Comparison to Background

Concentrations of inorganic compounds detected in on-site soil are normally compared to background concentrations to determine if the concentrations detected on-site are similar to normal constituent concentrations for the area. As stated in Section 2, the limited number of background samples collected at the site are not sufficient to perform a statistical comparison; therefore, only a qualitative comparison can be made to detected concentrations of chemicals detected off-site. Consequently, compounds detected in surface soil were not eliminated from consideration in the SRE based on comparison to background.

For sediments, the mean concentrations of the upstream samples were used for a background comparison. If a chemical was not detected in one of the samples, one-half of the detection limit was used for the determination of the mean. Concentrations of acetone, Aroclor 1221, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, and fluorene were present in upstream samples at higher concentrations than downstream samples. Arsenic was detected at similar levels in upstream samples. These compounds were not excluded as COPC because they are also associated with on-site soils; however, the possibility exists that another source of these contaminants exists upstream of the site, or, in the case of arsenic, that concentrations detected adjacent to and downstream of the site are representative of local conditions.

Toxicity Screen

The next step in the COPC selection process was to compare the maximum concentrations of chemicals detected in surface soil and sediment to a risk-based concentration (RBC) in order to eliminate those chemicals from the quantitative risk evaluation that are unlikely to contribute significantly to overall risks. The analytical data were compared to RBCs generated by U.S. EPA Region 9 (U.S. EPA 1996b) for residential exposure to soil (via incidental ingestion). Although a residential exposure scenario is not anticipated for the GRL site, RBCs based on a residential exposure scenario were used as a health-protective screen. In general, chemicals classified as Group A or B carcinogens were not excluded based on toxicity screening because cancer risks are assessed cumulatively. Certain inorganic compounds considered to be essential nutrients, and/or toxic only at high concentrations were also excluded as COPC. Aluminum, iron, calcium, magnesium, cobalt, copper, selenium, sodium, and zinc were excluded based on this criteria. Tables 3-1 and 3-2 present the results of toxicity screening of COPC in soil and sediment with Risk Based Concentrations developed using U.S. EPA, Region 9 guidance (U.S. EPA 1996b).

3.1.2 Summary of Analytical Results and Chemicals of Potential Concern

COPC selected for surface soil and sediment are presented in Table 3-3. Based on the criteria discussed above, chemicals selected as COPC in surface soil at the GRL site include metals (arsenic, beryllium, lead, and mercury), PCBs (Aroclor 1248 and 1254), 7 PAH compounds, dieldrin, bis(2-ethylhexyl)phthalate, methylene chloride, and trichloroethene. COPC selected for sediment include arsenic, beryllium, lead, mercury, bis(2-ethylhexyl)phthalate, Aroclor 1221, and 3 PAH compounds. Chemicals detected in groundwater and fish will be retained as COPC for the qualitative evaluation.

3.2 Exposure Assessment

This section evaluates the potential for human contact with the COPC selected for the site. The routes, duration, frequency, and magnitude of these potential exposures are estimated in this section. Exposure scenarios evaluated for a site generally depend on the populations potentially exposed and the types of land use at the site.

The exposure assessment includes the following steps:

- Characterization of the exposure setting;
- Identification of potential exposure pathways;
- Identification of potentially complete exposure pathways; and
- Quantification of exposure.

The following subsections present the exposure assessment according to the above steps.

3.2.1 Characterization of the Exposure Setting

This section presents a brief description of the site setting as it relates to potential human exposure to COPC identified at the site. Descriptions of the site and the nature and extent of contamination are presented in Section 2 of this report.

The site is located in a rural area of Miami County, Ohio. PRC (1993) estimated that 164 persons reside within a one-mile radius of the site, and 3,938 persons reside within 2 miles of the site. Residences, all having private water supply wells, are located within one quarter-mile northeast and southwest of the site. These private wells are mostly developed in thin beds of shale and limestone bedrock. The residential well

sampled during the FIT investigation draws water from sand and gravel at approximately 32 feet below ground surface (BGS) (PRC 1993). Community wells for the City of Union are located along the west bank of the river, approximately 2.5 miles south of the site. Farmland surrounds the site to the south, west, and across Garland Road to the north. A six-foot fence topped with barbed wire surrounds the site, except for a section along the river. The entire site is located within the 100-year floodplain of the Stillwater River, and the site is also located in the flood control easement of the Miami Conservancy District (Brandewie 1996).

The Stillwater River (designated as a state scenic river) forms the eastern boundary of the GRL site, and is approximately 200 feet wide and relatively shallow in the area of the site. Recreational fishing occurs in the area of the site. The site topography slopes down from west to east towards the River. The center of the site is sparsely vegetated due to the drum excavation activities. Most of the river bank is steep and is heavily vegetated with trees and brush, except for a section where drums had been excavated from the bank. The south end of the site is also heavily vegetated and slopes down to the southwest towards an intermittent stream that runs through the adjacent field to the Stillwater River. Leaves and vegetation were observed lodged in the top of the six-foot high fence in the low lying southeast corner of the site as the result of flooding.

The climate of Miami County is continental and is marked by wide range of temperatures. Summers are relatively warm and humid, with an average daily maximum temperature of 85 degrees Fahrenheit (°F) in July, and an average daily minimum of 65°F. Winters are typically cold and cloudy, with an average daily maximum of 37°F in January and an average daily minimum of 22 F. Precipitation also varies, but is normally considerable and well-distributed throughout the year. The yearly precipitation average is approximately 36 inches, with the lowest amount of rainfall occurring in the Fall months. The average last spring freeze occurs on May 1st, and the average first Fall freeze occurs on October 15th (SCS 1978).

3.2.2 Potential Exposure Pathways

Figure 3-1 presents a schematic depiction of the conceptual model for the GRL site. Wastes deposited at the site have contaminated surface and subsurface soils, and groundwater at the site by migration of wastes to soil and subsequently to groundwater, and by direct contact with wastes and groundwater. Wastes in groundwater may potentially migrate into, beneath, and parallel to the Stillwater River. Under current conditions, persons trespassing at the site (hunters, teenagers) may be exposed to COPC in surface

soil via incidental-ingestion, dermal contact, and inhalation of airborne dust or vapors. Off-site migration of COPC in surface soil may occur to adjacent farmlands, and possibly be absorbed by food crops. Off-site receptors may therefore be exposed to COPC in off-site soil by direct contact (i.e., ingestion and dermal contact), inhalation, or food crop consumption. People using the Stillwater River for fishing or wading may be exposed to COPC in sediment via dermal contact or incidental ingestion. Sport fishers and their families may consume fish from the river that have bioaccumulated COPC from surface water, sediment or food chain exposure. Although surface water data is not available, a possibility exists that COPC in sediment or groundwater may be released to surface water. Exposure to COPC in surface water could occur by incidental ingestion and dermal contact with water.

Current and future off-site residents using groundwater in the area may potentially be exposed to COPC via ingestion, dermal contact, and inhalation of vapors from groundwater; however, data is not currently available to assess these potential pathways.

In the future, the site area could potentially be used as a recreation area (e.g., a park). If the site is used as a recreation area, adults and children using the site may be exposed to COPC in soil via incidental ingestion, inhalation of vapors or dust, and dermal contact. Exposures to recreational users of Stillwater River are anticipated to remain the same as under the current scenario.

It is not anticipated that the site will be used in the future as a residential property. As stated earlier, the site is located in the 100-year flood plain of the Stillwater River, and also is located in the Miami Conservancy District flood control easement. In addition, wastes are still present in the landfill, making the land unstable for building construction.

3.2.3 Potentially Complete Exposure Pathways

The Stillwater River is utilized for canoeing and other recreational uses. U.S. EPA has observed men wading onto the island on the Stillwater River adjacent to the site, and sport fishing has been observed in the site area. The site is only partially fenced and trespassers could access the site by scaling the steep riverbank in the unfenced area. U.S. EPA encountered a trespasser who was on site to hunt in the early stages of the time-critical removal action. Evidence of game animals such as deer have also been found on-site. Most containment alternatives that may be considered for the site would reduce the potential exposure to game animals and subsequently to those that prey upon them. Therefore, consumption of game from the site was not assessed in the SRE.

Other evidence of trespassing included piles of beer and soft drink cans at the south end of the site and the apparent wear on barb wire strands on the top a gate at the southern end of the site. On a site visit during October 1996, a section of fence on the south end of the site appeared to have been pried up at the south end of the site.

Although a future on-site residential scenario is not anticipated, ingestion of COPC in groundwater at the site was qualitatively evaluated in the SRE in addition to the scenarios listed above by comparison of detected concentrations in groundwater to health-based criteria. This evaluation was conducted to evaluate potential risks from consumption of groundwater from the site. Currently available information for off-site wells is limited to one residential well located hydraulically upgradient of the site that is not impacted by COPCs from the site.

The exposure pathways discussed above were further evaluated to determine which pathways were most likely occurring and therefore potentially complete, and if analytical data are available to assess the pathway. These pathways will be further evaluated in the SRE. Potentially complete pathways evaluated in the SRE include:

- Direct contact with sediment and surface water in the Stillwater River by recreational users of the Stillwater River and fish consumption by anglers and their families using the Stillwater River for fishing.

- Direct contact (ingestion and dermal contact) with surface soil and inhalation of dust and vapors by site trespassers.

- Direct contact with surface soil and inhalation of dust and vapors by future recreational users of the site.

Off-site pathways identified as potentially complete were not assessed (with the exception of Stillwater river sediment) due to lack of analytical data.

3.3 Qualitative Evaluation of Groundwater and Fish Data

Groundwater and fish data were compared to federal health-based criteria established for drinking water and fish consumption in order to determine if potential risks exist for users of groundwater, and

recreational fishers using the Stillwater River in the vicinity of the site. Toxicity profiles of the chemicals of concern identified in groundwater and fish are presented in Section 3.5. A discussion of potential risks posed by the chemicals of concern in groundwater and fish is included in Section 3.6. Uncertainties associated with the potential risks are discussed in Section 3.7.

Groundwater

The latest round of groundwater data collected by CRA were compared to Maximum Contaminant Levels (MCLs), non-zero Maximum Contaminant Level Goals (MCLGs), or other health-based criteria in order to estimate potential risks posed to a hypothetical resident using groundwater from the site as a source of drinking water. The results of the comparison and chemicals of concern for groundwater from the September 1996 sampling event are presented in Table 3-4.

As shown in the table, concentrations of 1,2-dichloroethene, trichloroethene (TCE), vinyl chloride, and bis(2-ethylhexyl)phthalate exceed their respective MCLs. The highest detected concentration of 1,2-dichloroethene (total) is greater than 10 times the MCL for cis-1,2-dichloroethene, and more than 9 times greater than the MCL for trans-1,2-dichloroethene (an MCL is not listed for total 1,2-dichloroethene). The highest detected concentration of TCE is 10 times higher than the MCL. For vinyl chloride, the lowest detected concentration is 10 times the MCL, and the maximum detected value is 60 times higher than the MCL.

Benzene was not detected in the latest round of samples at concentrations above the MCL; however, it should be noted that the sample quantitation limits for non-detects ranged from one to ten times the MCL. Benzene was detected in well S-3 at 5.01 μg/l in the December 1995 sampling, which is slightly above the MCL of 5 μg/l. Although not detected in the latest round of sampling, 1,1-dichloroethene (in wells S-4, S-5, D-1, and D-2) and 4-methyl-2-pentanone (well S-5) were detected in the July and December 1995 sampling events at concentrations above MCLs (5 μg/l and 160 μg/l, respectively). Benzo(a)pyrene was also detected in well S-5 during the July 1995 sampling at a concentration of 7.6 J μg/l, which is above the MCL of 0.2 μg/l. MCLs have not been promulgated for the other PAH compounds detected.

Fish

Fish samples were collected by OEPA from locations upstream, adjacent to, and downstream from the site (see Figure 2-4). Information on fish exposure time in the area of concern was not provided. Results

of analysis of fish tissue were evaluated to assess potential food chain exposure to recreational fishers in the area. Mercury and several pesticides were detected in fish collected upstream, adjacent to, and downstream of the site. Given that the site is adjacent to farmland, and pesticides were detected in fish samples upstream, downstream, and adjacent to the site, pesticides detected in fish samples are believed to be associated with surface runoff from area farmlands to the Stillwater River, and are not considered attributable to the site. PCBs were not detected in any of the fish samples; however, E & E performed a screening calculation, using standard exposure parameters for recreational fish consumption, and the detection limit for Aroclor 1254 as the exposure point concentration in fish tissue in order to assess the adequacy of the detection limits for PCBs in fish. The results of the screening (presented in Table 3-5) show that adverse health effects are possible from consumption of fish containing PCBs at the detection limit by recreational fishermen and their families. Consequently, the detection limit for PCBs in fish tissue are not completely adequate for use in a quantitative risk assessment.

Mercury was detected in 16 of 17 fish samples collected from the Stillwater River. Mercury concentrations detected in fish fillets were compared to the FDA maximum level of methyl mercury in edible portions of seafood products (ATSDR 1994). Although the form of mercury (i.e., inorganic, or organic) detected in fish tissue was not reported, studies indicate that methyl mercury constitutes over 99% of the total mercury detected in fish muscle tissue (ATSDR 1994). One sample (channel catfish collected upstream at River Mile 23.4) contained mercury at 1.04 mg/kg, slightly above the FDA maximum level of 1 part per million (ppm). This sample was collected approximately 7 miles upstream of the site, and the mercury concentrations detected in the fish tissue can not be attributed to the site.

3.4 Quantification of Exposure

This section describes the rationale used to determine quantitative exposure estimates. First, the methodology for deriving exposure point concentrations is presented. Secondly, the exposure estimation equations are presented along with the rationale for the selection of input parameters for the equations.

Exposure Point Calculations

The exposure media of concern for quantitative evaluation in this SRE are surface soil and sediment. Exposure point concentrations (EPCs) for surface soil and sediment were estimated directly from measured concentrations. The EPCs for surface soil were based on the maximum detected concentrations from 12

surface soil samples collected during the EE/CA support sampling. The EPCs for COPC in sediment were based on maximum detected values for 7 sediment samples for inorganics (12 for lead and 9 for mercury), 4 samples for volatile organics, and 12 samples for semivolatile organics collected by OEPA, U.S. EPA, and CRA. Maximum detected values were used due to the limited number of samples for each medium (small sample sets with few detections often lead to poor estimates of the 95% upper confidence level of the mean). The EPCs determined for COPC at the GRL site are presented in Table 3-6.

Exposure Estimation Methods

The exposure estimates described in this section combine the following:

- Estimates of exposure media contaminant concentrations developed in the previous section;
- Estimates of contact rate and frequency and duration of exposure that receptor populations are likely to experience; and
- Estimates of various physiological parameters (e.g., body weight and average life expectancy).

The equations used to estimate the exposure for each pathway and route of exposure evaluated in this SRE are presented in Tables 3-7 through 3-16. The parameter values used in the equations and the rationale for their selection are also provided.

The exposure scenarios quantitatively evaluated in the SRE are direct contact with soil and inhalation of vapors and dust for site trespassers and future recreational users of the site, and direct contact exposure to sediment for current recreational users. Exposure to surface water, was not evaluated due to the lack of actual chemical data. Uncertainties associated with the exclusion of the surface water exposure pathways will be discussed in Section 3.7.

Site trespassers are most likely a subset of the local adolescent population. The site is partially fenced and likely not a focal point for local recreational activities. However, open areas do exist which could attract adolescents and evidence of trespassing has been observed at the site.

Parameter values were selected to correspond to a reasonable maximum exposure (RME) that an individual in the receptor group might experience. In some cases standard default exposure factors from U.S. EPA's *Supplemental Guidance: Standard Default Exposure Factors* (U.S. EPA 1991a) or other U.S. EPA

guidance were used. Exposure factors not specified in guidance documents were based on professional judgment. A description of the parameters used in the exposure estimation is presented below. For the first exposure route, all of the parameters will be described and discussed in the text; for the subsequent routes only the key parameters for that route not previously mentioned will be discussed.

Pathway 1: Incidental Ingestion of Soil and Sediment

Ingestion Rate of Soil

The ingestion rate (IR) is the amount of soil a person might incidentally ingest through hand-to-mouth contact. The default value for age groups beyond 6 years old (100 mg/day) was used to assess adolescents between 8 and 16 years of age and adults (U.S. EPA 1991a). For children, the default value of 200 mg/day was used.

Fraction of Soil Ingested From the Contaminated Source (FI)

The FI is the estimated proportion of total soil ingested from the contaminated source. No default exposure factors exist for this variable. U.S. EPA (1991a) recommends that estimates of FI be made on site-specific information, or, in the absence of specific information, best professional judgment. For this assessment, E & E assumed that all of the soil ingested was from the contaminated source.

Exposure Frequency

For site trespassers, an exposure frequency (EF) of 48 days was used based on the assumption that adolescents visit the site two times per week during the summer months and once per week during the six nonwinter months when school is in session. For children exposed to the Stillwater River sediments, an exposure frequency of 72 days per year was used (4 days per week during Summer months and 2 days per week during the Spring and Fall months). Adults were assumed to frequent the site for 48 days per year (2 days per week during the non-winter months).

Exposure Duration

The exposure duration (ED) is the total number of years in which the exposure is expected to occur. An ED of 8 years was used in the exposure estimate to correspond to the age range assumed for a site trespasser (i.e., 8 to 16 years). The ED of 6 years for children corresponds to the duration of the childhood (0

to 6 years). An ED of 24 years for adults, corresponds to the adult portion of the 90th percentile amount of time spent living at one residence.

Body Weight

The body weight (BW) is the average body weight over the exposure period. An average body weight of 42 kilograms (kg) for young adult males (ages 8 to 16) was determined by averaging the mean body weights reported for those age groups (U.S. EPA 1989a). For current and future children and adults, the average body weights for children aged 1-6, and adults (15 kg and 70 kg, respectively) were used.

Averaging Time

The averaging time (AT) selected is dependent on the type of toxic effect being assessed. For chronic and subchronic noncarcinogenic effects, the AT is equal to the ED. For carcinogenic effects, the exposure is averaged over a lifetime (estimated 70 years) (U.S. EPA 1989a).

Pathway 2: Dermal Contact with Soil and Sediment

Absorption Factor

The absorption factor (ABS) is the rate of absorption of a chemical through the skin from the environmental medium. Limited data are available to assess this variable. An ABS of 1% was assumed for metals and 10% for organic compounds. A value of 6% was used for the ABS for PCBs (U.S. EPA 1992).

Soil to Skin Adherence Factor

The soil to skin adherence factor (AF) is the fraction of soil that will adhere to the skin surface following contact. The default upper-bound value of 1 milligram per square centimeter (mg/cm^2) per event (U.S. EPA 1992) was used as a health-protective estimate.

Skin Surface Area

For trespassers, the skin surface area (SA) available for contact was assumed to be 3,313 cm^2 per event. This assumes that 25% of the total skin area (head, hands, arms, and lower legs) of an average adolescent (age 8 to 16) will be exposed to soil or sediment (U.S. EPA 1992). The assumption that 25% of the total skin area would be available for contact with sediment was also used for children and adults to derive SA values of 1,750

and 5,000 cm^2, respectively.

Pathway 3: Inhalation of Vapors and Particulates

Inhalation Rate

The inhalation rate (IR_{air}) of 20 m^3/day is the default respiration rate for moderate to heavy outdoor activity (U.S. EPA 1991a).

Particulate Emission Factor

The particulate emission factor (PEF) relates the COPC concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from sites with surface contamination (U.S. EPA 1991b). The equation and input parameters used in the calculation of the PEF are shown in Attachment B.

Volatilization Factor

The volatilization factor (VF) is a chemical-specific value used to define the relationship between concentrations of volatile COPC in soil and volatilized COPC in air (U.S. EPA 1991b). The equation and input parameters used in the calculation of the VF are shown in Attachment B.

Exposure Frequency

Because inhalation rates are expressed as cubic meters per day, the EF for inhalation exposures, was adjusted for the anticipated number of hours per day spent on site. A site trespasser was assumed to spend a maximum of 4 hours per day on site (16% of a 24-hour day). Children and adults under a future on-site recreational use scenario were assumed to spend up to 6 hours on site per visit (25% of a 24-hour day). The resulting proportions were multiplied by the EF assumed for each receptor to determine an equivalent number of days on site for inhalation exposure.

Exposure Estimates

The exposure estimates derived using the input parameters described above are given as lifetime average daily intakes (LADIs) for carcinogenic effects and as chronic daily intakes (CDIs) for noncarcinogenic effects for each exposure case. The exposure estimates are combined with toxicity estimates for the COPC discussed in Section 3.5 to obtain risk estimates.

3.5. Toxicity Assessment

The purpose of the toxicity assessment is to review toxicity and carcinogenicity data for the COPC, and to provide an estimate of the relationship between the extent of exposure to these contaminants and the likelihood and/or severity of adverse effects. The toxicity assessment is accomplished in two steps: hazard identification and dose-response assessment.

The hazard identification is a qualitative description of the potential toxic effects of the COPC. The toxicological profiles presented in the following section describe the toxic effects that have been observed in humans and/or animals following exposure to the COPC identified at the GRL site.

The dose-response evaluation is a process that results in a quantitative estimate or index of toxicity for each COPC at the site. For carcinogenic effects, the index is the slope factor (SF), and for noncarcinogenic effects, it is the reference dose (RfD). Practices and procedures used to develop quantitative indices of toxicity and to incorporate toxicological information into the risk estimation process, and the quantitative indices of toxicity are presented in Section 3.5.2.

3.5.1. Health Effects Summaries

The health effects summaries describe the potential toxic properties of the COPC at the GRL site. For carcinogens, the weight-of-evidence category is also included (see Table 3-17 for a description of the U.S. EPA weight-of-evidence categories). In most cases, the information in the summaries has been drawn from the Public Health Statement in the Agency for Toxic Substances and Disease Registry's (ATSDR's) toxicological profile for the chemical.

Arsenic

Arsenic is a naturally occurring element and is usually found combined with one or more elements, such as oxygen, chlorine, or sulfur. This element is widely distributed in the environment from natural sources, but higher concentrations have been found to occur in association with chemical waste, smelting of copper and other metals, fossil fuel combustion, and pesticide use. The primary use of arsenic is as a wood preservative, but it is also used to make insect and weed killers and pharmaceutical.

All people are exposed to low levels of arsenic because it is naturally occurring, and low levels are present in food, water, soil, and air. Workers in several industries (nonferrous smelting, wood preservation,

arsenical pesticides) may be exposed to significantly higher levels. Arsenic has been recognized as a human poison since ancient times. Large oral doses are lethal. Chronic arsenic overexposure may cause many adverse health effects including body weight changes, changes in blood, and liver and kidney damage. The critical or most sensitive effects, based on chronic oral exposure to humans, are hyper-pigmentation, keratosis, and possible vascular complications.

Arsenic is considered a Group A human carcinogen by U.S. EPA. Epidemiological studies and case reports have found evidence that arsenic exposure is associated with increased risk of cancer of the skin, lungs, bladder, and kidneys. Workers exposed by the inhalation pathway demonstrate an increased risk of lung cancer. Oral exposure leads to an increased risk of skin cancer.

Beryllium

Pure beryllium is a hard gray metal. In nature it occurs as a chemical component of certain rocks. The minerals bertrandite and beryl are mined commercially for the recovery of beryllium.

Most beryllium ore mined is processed into pure metal, alloys, or beryllium oxide. Beryllium metal and alloys are used in electronics, aircraft and space craft structures, X-ray machines, nuclear weapons, and nuclear reactors. Beryllium oxide is used in the manufacture of specialty ceramics.

Although beryllium is released into the air by natural sources such as volcanic dust, the major emission source to the environment is the burning of fossil fuels. Beryllium compounds are naturally present in soils, but deposition of atmospheric beryllium and disposal of beryllium-containing wastes can increase the levels in localized areas. The general population is exposed to low levels of beryllium in air, food, and water. Beryllium occurs naturally in tobacco and can be inhaled in cigarette smoke.

Industrial workers have the highest exposure to beryllium in the mining, milling, and processing of beryllium to alloys or beryllium oxide. In general, the primary route of exposure to beryllium is inhalation, since relatively little beryllium is absorbed from the GI tract or through the skin.

The respiratory tract is the major target of inhalation exposure to beryllium. Short-term exposure can produce lung inflammation and pneumonia-like symptoms. Long-term exposure can cause berylliosis, an immune reaction characterized by noncancerous growths on the lungs. Similar growths can appear on the skin of sensitive individuals exposed by dermal contact.

Epidemiological studies have found that an increased risk of lung cancer may result from exposure to beryllium in industrial settings. In addition, laboratory studies have shown that breathing beryllium causes

lung cancer in animals. However, it is not clear what cancer risk, if any, is associated with ingestion of beryllium.

EPA has classified beryllium as a Group B2 probable human carcinogen based on limited human evidence and the animal data.

Bis(2-ethylhexyl)phthalate (BEHP, DEHP)

DEHP is a man-made liquid widely used to make plastics more flexible. Plastics may contain up to 40% DEHP and may be used in a variety of consumer products including food packaging material, rainwear, upholstery, and shower curtains. DEHP does not evaporate easily and does not dissolve easily in water. DEHP has been found in groundwater near waste landfills, but when DEHP is released to soil it usually does not migrate far from where it was released.

DEHP can enter the body following exposure by breathing air or eating food or water that contain DEHP. The most likely route of human exposure is through food. DEHP leaches into foods from plastics used in food processing and storage.

Most of what is known about the health effects of DEHP comes from studies of laboratory mice and rats. The very low levels to which humans may be routinely exposed have not been shown to cause adverse effects; however, liver disease and reproductive effects have been associated with DEHP exposure to laboratory animals.

DEHP has been shown to cause liver cancer in rats and mice. However, because there have been no studies of the carcinogenic effects of DEHP in humans, DEHP is classified as a Group B2 probable human carcinogen.

1,2-Dichloroethene (1,2-DCE)

1,2-DCE is a man-made flammable liquid with a sharp, harsh odor. 1,2-DCE is primarily used in the production of solvents and as an additive to dyes, lacquer solutions, perfumes, and thermoplastics. There are two forms of 1,2-DCE; cis-1,2-DCE, and trans-1,2-DCE, which may occur separately or as a mixture.

In the environment, 1,2-DCE evaporates rapidly. When 1,2-DCE is released to either surface soil or surface water, almost all of the chemical will evaporate into air. When 1,2-DCE occurs in the subsurface, such as in landfills and chemical waste sites, it can dissolve in water and migrate into groundwater. In groundwater,

1,2-DCE breaks down to vinyl chloride, which ultimately breaks down to water, carbon dioxide, and chloride ions. Vinyl chloride, the initial breakdown product, is more toxic than 1,2-DCE.

1,2-DCE can enter the body by drinking water, eating food, or breathing air that contains 1,2-DCE. Because 1,2-DCE evaporates readily, inhalation is the most likely route of human exposure. Inhalation of high levels of 1,2-DCE can cause nausea, drowsiness, dizziness, and may result in death. Liver, heart, and lung damage were observed in laboratory animals after short or long term exposure to 1,2-DCE in air. Liver and lung damage was reported in animals fed 1,2-DCE. Death can also occur in animals fed large amounts of 1,2-DCE. Changes in blood chemistry are the critical or most sensitive effect and serves as the basis for the RfD used in the SRE.

The long term health effects resulting from exposure to 1,2-DCE are not known. Increased risk of cancer has not been reported in humans or animals exposed to 1,2-DCE.

Dieldrin

Dieldrin was used extensively as an agricultural pesticide for over 20 years until the United States Department of Agriculture (USDA) suspended its use in 1970. The use of Dieldrin to control termites continued until 1987, when the manufacturer voluntarily canceled the registration.

Dieldrin persists in the environment and can be found tightly bound to soils and sediment. It is not expected to leach to groundwater. Plants can take up dieldrin from soil, and fish and livestock can accumulate high concentrations through the food chain. In animals, dieldrin accumulates in fat. Dieldrin can be absorbed into the body through skin contact, ingestion, and inhalation. The most likely route of human exposure to dieldrin is through eating contaminated food. Foods most likely to be contaminated include fish, shellfish, root crops, meat, and dairy products.

Human poisoning from dieldrin is characterized by major involuntary muscle convulsions or kidney damage that can be fatal. Other effects include lack of coordination, headache, dizziness, and gastrointestinal disturbances.

Animal studies show effects of dieldrin on the nervous system and kidneys to be similar to the effects in humans. In addition, exposure to dieldrin has resulted in increases in liver enzymes and liver weight, decreased immune response, and high mortality in nursing rat pups. Liver damage is the critical or most sensitive effect in animals according to U.S. EPA. It is unknown whether exposed humans have similar health effects.

Dieldrin is a carcinogen to mice, with the liver being the site of increased tumor incidence. However, it is not known if dieldrin is a human carcinogen. Dieldrin is classified as Group B2, probable human carcinogen, by U.S. EPA.

Lead

Lead is a naturally occurring metal that is used in the manufacture of storage batteries and the production of ammunition and miscellaneous metal products (e.g., sheet lead, solder, and pipes). Other uses for lead are in the manufacturing of lead compounds including gasoline additives and pigments. In recent years, the quantity of lead used in paints, gasoline additives, ammunition, and solder has been reduced due to its toxic effects.

Lead can enter the body via ingestion and inhalation. Although it may also enter the body through the skin, dermal absorption of inorganic lead compounds is less significant than absorption through other routes. Children appear to be the segment of the population at greatest risk from toxic effects of lead. Children absorb about 50% of ingested lead whereas adults absorb only 5% to 15%. Initially, lead travels in the blood to the soft tissues (heart, liver, kidney, brain, etc.), and then gradually redistributes to the bones and teeth where it tends to remain. Children retain a larger fraction of the absorbed lead, about 57%, in the blood and soft tissue compartments whereas in adults roughly 95% of the total body burden of lead is found in bones and teeth.

The most serious effects associated with markedly elevated blood lead levels include neurotoxic effects such as irreversible brain damage. Health effects are the same for inhaled and ingested lead. At blood lead levels of 40 to 100 micrograms per deciliter (µg/dL), children have exhibited nerve damage, permanent mental retardation, colic, anemia, brain damage, and death. Chronic kidney disease is also evident at these levels. For most adults, such damage does not occur until blood lead levels exceed 100 µg/dL to 120 µg/dL. At these levels, damage to the male reproductive system; miscarriages; anemia; severe digestive system symptoms; decreased reaction time; weakness in fingers, wrists, or ankles; and some increased risk of heart and circulatory system disease may be exhibited. Pregnant women are at increased risk from exposure to lead because of the inherent susceptibility of the fetus from transplacental transfer of maternal lead.

None of the epidemiology studies conducted to explore the relationship between lead exposure and increased cancer risk in humans found any relationship. However, animal studies have shown increased kidney cancer and central nervous system (CNS) cancer in rats and mice orally exposed to lead. U.S. EPA has classified lead as Group B2, probable human carcinogen.

Mercury

Mercury is a naturally occurring element that exists in three oxidation states - metallic mercury (Hg^{o}), mercurous mercury (Hg_2^{++}), and mercuric mercury (Hg^{++}) and a variety of chemical forms. The most important with respect to human exposure are compounds of methyl mercury, mercuric mercury, and elemental mercury vapor.

Uptake of inorganic mercury and methyl mercury compounds is primarily through ingestion, with the major source of human exposure to methyl mercury being through the consumption of fish and shellfish. Mercury can also readily enter the body through inhalation of mercury vapor.

All forms of mercury, once absorbed, are distributed to tissues throughout the body via the bloodstream. The critical, or most sensitive effect of inorganic mercury is kidney damage and CNS damage. Long-term exposure to all forms of mercury can permanently damage the brain, kidneys, and developing fetus. The form of mercury and route of exposure determine which health effects will be most severe. Mercury vapor and methyl mercury readily cross the blood-brain and placental barriers.

Prenatal life is very sensitive to methyl mercury poisoning, with effects in infants ranging from slowed mental and coordination development to a severe from of cerebral palsy. To date, these effects have been found to be irreversible. Depending upon the form, level of mercury taken in, and duration of exposure, effects on the adult nervous system can range from reversible feeling of burning, or pins and needles, and feeling "out of sorts"; to irreversible brain damage leading to permanent tremors and shakiness, and constriction of the visual field. Mercury has not been found to be carcinogenic in humans.

Methylene Chloride (MC)

MC is a man-made liquid chemical that is widely used as an industrial solvent and as a paint stripper. Because MC evaporates easily, most MC released into the environment will end up in the air, where it is broken down by sunlight. MC released to water or soil tends to volatilize to air, but may migrate to groundwater. MC is formed during water chlorination, and small amounts of MC may be found in public drinking water supplies.

Absorption into the body occurs readily following exposure by breathing vapors or accidental ingestion. Occupational exposure to MC in air has resulted in drowsiness, fatigue, lack of appetite, and light-headedness. Other effects include impaired reaction time and coordination, numbness or tingling of fingers

and toes, and intoxication. The critical, or most sensitive effect of MC exposure is liver damage observed in rats exposed to MC.

Chronic exposure of laboratory animals to high concentrations of MC by inhalation resulted in an increased incidence of liver and lung cancer in mice and rats. MC has not been shown to cause cancer in occupationally exposed humans. Based on the results from animal studies, MC is classified as a Group B2 probable human carcinogen. Uncertainties remain regarding the pharmacokinetics, pharmacodynamics, and mechanisms of carcinogenicity for MC.

Polychlorinated Biphenyls (PCBs)

PCBs are a class of compounds with varying degrees of chlorine substitution on two phenyl rings joined by a single bond between the 1 and 1' positions. Because of their thermal stability and resistance, low water solubility, and favorable dielectric properties, PCBs were widely used in hydraulic fluids, compressor lubricants, heat transfer fluids, paints, lacquers, and ink (U.S. EPA 1987a).

Commercial PCB products consist of various complex mixtures of many of the 209 possible individual PCB isomers and congeners and have been marketed under trade names that vary with manufacturer and country of origin. The term "Aroclor" is the trade name of a series of PCB products formerly manufactured by Monsanto in the United States. The various Aroclor products were identified by a four-digit number. The first two digits identified the type of compound and the last two digits indicated the average weight percentage of chlorine. The only exception is Aroclor 1016, which retained the 1016 designation by which it was known during development. The chlorine percentage in Aroclor 1016 is similar to that of Aroclor 1242.

The uptake, distribution, metabolism, excretion, and toxicity of the individual congeners are all affected to a greater or lesser degree by the number and position of chlorine substituents on the biphenyl molecule. In general, a greater degree of chlorination increases absorption, favors deposition in the body's lipid stores, and slows metabolism and excretion. Higher chlorinated biphenyls with chlorine substituents in the para- (4,4') and at least two meta- (3,3', 5,5') positions on the biphenyl nucleus, but lacking substituents in the ortho- (2,2', 6,6') positions (i.e. the "coplanar" PCBs), tend to be the most toxic. This group of congeners has been shown to bind specifically to the AH receptor protein (which also binds dioxin) and to mimic many of the toxic effects of dioxin.

PCB mixtures released to the environment change through partitioning, transformation, and bioaccumulation and differ considerably from commercial mixtures. Environmental mixtures are often

characterized as Aroclors. This can lead to qualitative and quantitative errors when interpreting gas chromatography/mass spectrometry (GC/MS) results. For environmentally altered mixtures, an absence of the characteristic Aroclor patterns can suggest the absence of Aroclors, even if some PCB congeners are present at high concentrations (U.S. EPA 1996c).

The liver is the target organ most frequently associated with the toxic effects of PCBs. Hepatic effects have been seen in rats, mice, guinea pigs, rabbits, dogs, and monkeys. The toxic manifestations typically include liver enlargement, fat deposition, enzyme induction, and tissue necrosis. Hepatic effects, including liver enlargement and increases in hepatic enzyme levels, have also been reported in humans occupationally exposed to PCBs (Maroni *et al.* 1981a, b; Fishbein 1985; Alvares *et al.* 1977).

Exposure to PCBs both by dermal contact and by oral exposure has led to skin lesions in animals. Exudative lesions have been seen in rats, and monkeys exhibit chloracne-like lesions (U.S. EPA 1988a). Various skin lesions, including rashes, burning sensations, acne, hyper-pigmentation of the skin, and other manifestations, have been seen in humans occupationally exposed to PCBs, and in victims of two accidental poisoning episodes in which PCBs were ingested (U.S. EPA 1988a).

Developmental effects have also been reported in humans following PCB exposures. In a series of studies (Fein *et al.* 1984a, 1984b; Jacobson *et al.* 1990a, 1990b), neuro-developmental effects were reported in children of women who consumed PCB-contaminated fish from Lake Michigan before and during pregnancy. Intrauterine exposure was associated with lower birth weight, deficits in visual recognition memory in infancy, and short-term memory deficits at age 4. Exposure to PCBs in breast milk was associated with reduced activity levels at age 4. As often occurs in epidemiological studies, methodologies including the validity of the exposure assessment, selection of the exposed and control samples, and comparability of the exposed and control samples have been criticized (Paneth 1991).

PCB exposure has resulted in decreased reproductive success and reproductive failure in mink, monkeys, and rats. Few studies on reproductive effects in humans have been conducted; however, the weight of evidence from animal studies suggests that PCBs cause adverse reproductive effects in humans.

A number of studies have found PCBs (specifically Aroclor 1260 and 1254, and Clophen A-30 and Clophen A-60) to be carcinogenic in rats and mice. In the animal studies, the carcinogenic effects were much more pronounced in females exposed to PCBs with higher levels of chlorination (Aroclor 1254 and 1260).

The possible carcinogenicity of PCBs in humans has been investigated in several epidemiological studies of individuals occupationally exposed to PCBs in the capacitor and electrical equipment manufacturing

industries (Brown and Jones 1981; Brown 1986; Bertazzi *et al.* 1987; and Gustavsson, Hogstedt, and Rappe 1986) and in individuals who accidentally ingested PCBs in Japan (Yusho incident) (Kuratsune *et al.* 1987). To date, the occupational studies have not shown a consistent tumorigenic effect due to PCB exposures. A statistically significant increase in liver cancers was found in victims of the Yusho incident, but only among individuals living in one prefecture. The PCBs ingested by these individuals also contained polychlorinated dibenzofurans (PCDFs) and polychlorinated quatraphenyls, which also could have been responsible for or contributed to the effects. The Yusho results are therefore inconclusive.

EPA's Carcinogen Assessment Group has classified PCBs in weight-of-evidence group B2: probable human carcinogen based on sufficient evidence in animals and insufficient evidence in humans.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular, or cluster arrangements. PAHs are formed during the incomplete burning of fossil fuel, garbage, or any organic matter. PAHs produced by burning may be carried into the air on dust particles and distributed into water and soil. In general, PAHs do not evaporate easily, and do not dissolve in water.

Exposure to PAHs may occur by inhaling airborne particles, drinking water, or accidentally ingesting soil or dust containing PAHs. In addition, smoking tobacco or eating charcoal-broiled food are common routes of exposure to PAHs.

Some PAHs are known carcinogens, and potential health effects caused by PAHs are usually discussed in terms of an individual PAH compound's carcinogenic or noncarcinogenic effects. Little attention has been paid to non-cancer effects of PAHs. Rapidly growing tissues, such as the intestinal lining, bone marrow, lymphoid organs, blood cells, and testes seem to be especially susceptible targets to non-cancer effects. Concentrations of 150 mg/kg or more administered to laboratory animals have been shown to inhibit body growth.

Exposure to benzo(a)pyrene (B(a)P) and other carcinogenic PAHs can cause cancer at the point of exposure. However, only B(a)P has been assigned a slope factor (SF) by U.S. EPA. In the past, other group B2 carcinogenic PAHs were assumed to be equipotent to B(a)P; however, it has been shown in animal studies that some are less carcinogenic than B(a)P. U.S. EPA has adopted relative potency factors (RPFs) that account for differences in the carcinogenic potencies of individual PAHs relative to that of B(a)P (U.S. EPA 1993c). The RPFs are to be used only for the oral route of exposure. In this SRE, the oral SF for each carcinogenic

PAH has been estimated by multiplying the oral SF for B(a)P by the compound-specific RPF.

Animals exposed to high levels of B(a)P in air develop lung tumors; when exposed via the dietary route they develop stomach tumors; and when B(a)P is painted on skin, animals develop skin tumors. Although RfDs and SFs for dermal exposure to many chemicals are routinely extrapolated from oral route values, it is inappropriate to use the oral SF for B(a)P to evaluate carcinogenic risks from dermal exposure because direct dermal exposure to B(a)P can cause skin cancer at the point of contact.

Trichloroethene (TCE)

TCE is a man-made chemical widely used as a cleaning agent and solvent for degreasing operations. Most TCE released into surface water or surficial soil will rapidly evaporate into the air. In the subsurface, TCE is moderately to highly mobile and can migrate to groundwater. TCE biodegrades very slowly in subsurface soils and groundwater. Microbial degradation products include dichloroethylene and vinyl chloride.

Humans are most likely to be exposed to TCE in air. TCE also may occur in drinking water supplies and consumer products including metal cleaners, spot removers, rug cleaning fluids, paints, and paint removers. TCE may cause adverse health effects following exposure via inhalation, ingestion, or skin or eye contact. Exposure to high levels of TCE can cause central nervous system effects including drowsiness, dizziness, headache, blurred vision, lack of coordination, mental confusion, flushed skin, tremors, nausea, vomiting, fatigue, irregular heartbeat, and, in some cases, death. In the past, TCE was used as an anesthetic, but that use was discontinued when it was found to cause irregular heartbeats. Chronic exposure to TCE can cause liver damage and skin reactions, as well as central nervous system effects.

Exposure of laboratory animals to TCE has been associated with an increased incidence of a variety of tumors, including kidney, liver, and lung cancers. However, it is uncertain whether people exposed to TCE have a higher risk of cancer. TCE is considered a Group B2 probable human carcinogen.

Vinyl Chloride (VC)

VC, which is a gas or pressurized liquid at ambient temperature, is primarily used in the chemical manufacturing industry in the production of polymeric chemicals that are in turn used to manufacture a variety of plastic products. In addition, VC is a known degradation product of many chlorinated solvents including tetra-, tri-, and dichloro-ethenes. Most of the VC in the environment comes from the plastic industry's releases to air or water. In surface water or surface soil, VC evaporates readily. Once in the air, VC breaks down

rapidly to nonhazardous chemicals. VC can dissolve in water and migrate to groundwater. Once in the groundwater, VC can persist for many years.

People are most likely to be exposed to VC in the air, although it is also possible to be exposed to VC in drinking water. Levels of VC have not been detected in background air samples, but it has been detected in the air near some plastics factories, landfills, and chemical waste sites. VC has also been detected in tobacco smoke.

VC may cause adverse health effects following exposure by inhalation, ingestion, or dermal or eye contact. VC inhalation can cause dizziness or sleepiness. Breathing very high levels of VC can cause unconsciousness and in some cases, death. On skin, exposure to liquid VC can cause burns. Non cancer effects associated with long-term occupational VC exposure include hepatitis-like changes in the liver, immune reactions, and nerve damage.

VC has been shown to cause liver and lung cancer in rats, and liver cancer in workers occupationally exposed to air concentrations in the range of 25 parts per million (ppm) to greater than 200 ppm. Based on this evidence, U.S. EPA has classified VC as a Group A human carcinogen.

3.5.2 Quantitative Indices of Toxicity

Quantitative indices of toxicity from the dose-response assessment are used in estimating the relationship between the extent of exposure to a contaminant and the potential increased likelihood and/or severity of adverse effects. The methods for deriving indices of toxicity, the toxicity indices for the COPC, and the procedures for estimating potential adverse effects are presented below.

Categorization of Chemicals as Carcinogens or Noncarcinogens

For the purpose of risk assessment, chemicals are divided into two groups: known or suspected carcinogens, and noncarcinogens. The risks posed by these two groups are assessed differently because non-carcinogenic effects generally exhibit a threshold dose below which no adverse effects occur, whereas no such threshold has been shown to exist for carcinogenicity.

As used here, the term "carcinogen" means any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or animals. Chemicals are classified as carcinogens or noncarcinogens based on weight-of-evidence criteria assigned by U.S. EPA Guidelines for Carcinogenic Risk Assessment (U.S. EPA 1986a). Table 3-17 summarizes the five U.S. EPA

weight-of-evidence categories. According to these U.S. EPA guidelines, chemicals classified in Groups A and B (B1 and B2) are considered human carcinogens or probable human carcinogens based on sufficient evidence, and should be the subject of non-threshold carcinogenic risk estimation procedures. These classifications are dynamic; chemicals may be reclassified at any time as additional evidence becomes available that shifts the weight-of-evidence one way or the other.

Assessment of Carcinogens

In contrast to noncarcinogenic effects, for which thresholds are thought to exist, scientists generally have been unable to demonstrate experimentally a threshold for carcinogenic effects. This has led to the assumption by federal regulatory agencies (e.g., U.S. EPA, Food and Drug Administration [FDA], and Occupational Safety and Health Administration [OSHA]) that any exposure to a carcinogen theoretically entails some finite risk of cancer. However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be practically negligible.

Scientists have developed several mathematical models to estimate low-dose carcinogenic risks from observed high-dose risks. Consistent with current theories of carcinogenesis, U.S. EPA has selected the linearized multistage model based on prudent public health policy (U.S. EPA 1986a). In addition to using the linearized multistage model, U.S. EPA uses the upper 95th percentile confidence limit for doses or concentrations in animal or human studies to estimate a low-dose SF. By using these procedures, the regulatory agencies are unlikely to underestimate the actual SF (formerly called carcinogenic potency factor) for humans.

Using the SF, lifetime excess cancer risks can be estimated by:

$$\text{Risk} = \Sigma \text{LADI}_j \times \text{SF}_j$$

where:

LADI_j = Exposure route-specific lifetime average daily intake; and

SF_j = Route-specific slope factor.

Using the multistage model, the carcinogenic risks for the oral and dermal routes of exposure are calculated as follows:

$$\text{Risk} = LADI_o\ SF_o + LADI_d\ SF_o$$

where subscript "o" indicates the oral route, and subscript "d" the dermal route. SFs for the COPC are presented in Table 3-18. U.S. EPA's weight-of-evidence classification for the chemical and the type of cancer that may be associated with exposure to the chemical are also included in the table.

Assessment of Noncarcinogens

Risks associated with noncarcinogenic effects (e.g., organ damage, immunological effects, birth defects, skin irritation) are usually assessed by comparing the estimated average exposure to the acceptable daily dose, now called the reference dose (RfD) by U.S. EPA. The RfD is selected by identifying the lowest reliable no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature, then applying a suitable uncertainty factor (usually ranging from 10 to 1,000) to allow for differences between the study conditions and the human exposure situation to which the RfD is to be applied. NOAELs and LOAELs can be derived from either human epidemiological studies or animal studies; however, they are usually based on laboratory experiments on animals in which relatively high doses are used. Consequently, uncertainty or safety factors are applied when deriving RfDs to compensate for data limitations inherent in the underlying experiments and for the lack of precision created by extrapolating from high doses in animals to lower doses in humans.

To calculate the RfD, the appropriate NOAEL or the LOAEL is divided by the product of all of the applicable uncertainty factors and the modifying factor. That is:

$$\text{RfD} = \text{NOAEL or LOAEL}/(UF_1 \times UF_2 \ldots \times MF)$$

Oral RfDs are typically expressed as one significant figure in units of mg/kg-day.
The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime, in the case of a subchronic RfD, or during the entire lifetime, in the case of a chronic RfD. The RfD is used as a reference point for gauging the potential effects of other exposures. Usually, exposures that are less than the RfD are not likely to be associated with health risks. As the frequency of exposures exceeding the RfD increases and as the size of the excess increases, the probability increases that

adverse health effects may be observed in a human population. Nonetheless, a clear distinction that would categorize all exposures below the RfD as "acceptable" (risk-free) and all exposures in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made. Noncarcinogenic risks are usually assessed by calculating a hazard quotient, which is the ratio of the estimated exposure to the RfD as follows:

where:

$$HQ = \frac{CDI}{RfD}$$

HQ = Hazard Quotient;
CDI = Chronic Daily Intake (exposure); and
RfD = Reference Dose (acceptable daily intake).

A hazard quotient greater than 1 indicates that adverse effects may be possible, whereas a value less than 1 means that adverse effects would not be expected. The higher the hazard index is above 1, the more likely it is that adverse effects could occur. Table 3-19 summarizes the RfDs for COPC at the GRL site.

3.6. Risk Characterization

This section combines the information developed in the exposure and toxicity assessment sections to obtain estimates of the risks posed to human health by exposure to COPC at the GRL site.

According to U.S. EPA's policy for developing Superfund remedial alternatives (U.S. EPA 1991b), when the cumulative carcinogenic site risk to an individual, based on reasonable maximum exposure for both current and future land use, is less than 10^{-4}, and the noncarcinogenic hazard quotient is less than 1, action is generally not warranted unless there are adverse environmental impacts; Maximum Contaminant Levels (MCLs) or non-zero Maximum Contaminant Level Guidelines (MCLGs) are exceeded; or unless certain site conditions lead the risk manager to determine that a baseline risk less than 10^{-4} is unacceptable. Other chemical-specific applicable, relevant and appropriate requirements (ARARs) (e.g., state or federal water quality standards based on a 10^{-5} risk) may also be used to determine whether a site warrants remediation. U.S. EPA uses the general 10^{-4} to 10^{-6} risk range as a "target range" within which the Agency strives to manage risks as part of a Superfund cleanup. Once a decision has been made to undertake an action at a site, the Agency has expressed a preference for cleanups achieving the more protective end of the range, although

strategies achieving reductions in site risks anywhere within the risk range may be deemed acceptable by the U.S. EPA risk manager.

The excess cancer risk and chronic hazard quotients were estimated for an RME case for the exposure scenarios identified in Section 3.2. Section 3.6.1 presents the risk estimates. Section 3.6.2 summarizes the risk estimation results and identifies the COPC and pathway(s) that account for the most significant risks at the GRL site. Uncertainties associated with the risk estimates are presented in Section 3.7.

3.6.1 Risk Estimates

Tables 3-20 and 3-21 summarize the total cancer risks and non-cancer hazard indices posed to potential receptors, and show which exposure pathway and which chemicals are responsible for the most risk. The calculations used in the risk estimates are presented in Appendix B. A summary discussion of the risk estimates is presented below.

Carcinogenic Risk Estimate

Potential carcinogenic risk is assessed by multiplying the estimated LADI of a carcinogen by its SF to obtain the estimated risk, expressed as a probability of that exposure resulting in an excess incidence of cancer (i.e., more cancers than would normally be expected in that population). The excess cancer risk for exposure to each chemical by each route of exposure, category of receptor, and exposure case is initially estimated separately. The risk estimates are then summed across chemicals and across all exposure routes and pathways applicable to the same population to obtain a total cancer risk for that population.

Site Trespasser

As shown in Table 3-20, a cancer risk of 3.9×10^{-6} was estimated for an adolescent trespasser at the site. Dermal contact with soil accounted for 50.5% of the total risk, and incidental ingestion of soil accounted for 49.4%. PCBs were the only COPC with estimated risks greater than 1×10^{-6}, and were responsible for 61% of the estimated risks.

Current Recreational Users of Stillwater River

Risks estimated for a current user of Stillwater River exposed to sediment totaled 5×10^{-6}. Of this total, incidental ingestion of sediment accounted for 85% of the risk. Arsenic was responsible for 79% of the

estimated risk, and was the only COPC that had an estimated risk greater than 1×10^{-6}.

Future On-Site Recreational Users

Risks posed to future recreational users by on-site soil totaled 2.4×10^{-5}. Incidental ingestion of soil was the principal pathway of exposure (64.3% of total risk). The COPC accounting for the bulk of the risk were PCBs (56%), arsenic (24%), and benzo(a)pyrene (10%).

Noncarcinogenic Risk Estimation

The potential for adverse effects resulting from exposure to systemic toxicants (noncarcinogens) is assessed by comparing the estimated CDI of a substance to its chronic RfD. This comparison is performed by calculating the ratio of the CDI to its corresponding RfD, which is the HQ. HQs should be summed across chemicals that produce the same type of adverse effects (e.g., liver damage), but should be kept separate if their critical effects are different. However, for screening purposes, HQs are commonly summed across all chemicals, exposure routes, and pathways applicable to a given population to obtain an HI for that population.

For noncarcinogens, U.S. EPA defines acceptable exposure levels as those to which the human population, including sensitive subpopulations, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. This acceptable exposure level is approximately an HI of 1.0. If the HI is less than 1.0, adverse effects usually would not be expected. As the HI increases beyond 1.0, the possibility of adverse effects occurring also increases. HI estimated for the receptors at the GRL site are presented below.

Site Trespasser

The HI estimated for a site trespasser was below 1. Estimated HQ for a site trespasser did not exceed 1 for any of the COPC.

Current Recreational Users of Stillwater River

The HI estimated for a current user of Stillwater River exposed to sediment was below 1. None of the HQ calculated for adult or child receptors were greater than or equal to 1.

Future On-Site Recreational Users

The HI estimated for a potential child receptor totaled 1.1, with PCBs accounting for 93% of the total risk (HQ = 1.02). Incidental ingestion of soil (67.5%) and dermal contact (31.2%) accounted for the majority of the risk,. Risks estimated for an adult receptor were less than 1; however, an HI of 1.3 would result from lifetime (i.e., child and adult combined) exposure to soil at the site.

3.6.2 Summary Discussion of the Risk Characterization

Nature of Potential Adverse Health Effects

Potential cancer risks greater than 1×10^{-6} are associated with current and future exposures to PCBs arsenic, and B(a)P in on-site soil, and arsenic in sediment adjacent to the site. As previously discussed, PCBs are classified as a Group B, probable human carcinogen, based on carcinogenicity in animals. Chronic exposures to arsenic in sediment via incidental ingestion may lead to an increased risk of skin, bladder, and kidney cancers. Chronic exposure to arsenic via inhalation of airborne particulates may cause an increased risk of developing lung cancer. Overexposure to B(a)P via incidental ingestion and dermal contact may increase the risk of developing stomach and skin cancers.

Chronic exposure to PCBs in soils are also associated with potential non-cancer health effects for future recreational users of the site. Long-term human exposures to PCBs may cause adverse hepatic, immunological, and reproductive effects.

Lead was also detected in soils above the risk-based concentration; however, the RBC for lead is based on residential exposure. Although exposure to soil at the site is not anticipated to be as great as for a residential receptor, concentrations of lead in soil may be of concern for exposure of sensitive receptors (i.e., children) that visit the site on a frequent basis.

A qualitative evaluation of groundwater data from the site indicates that significant potential risks exist from ingestion of groundwater at the site, due to the presence of TCE, VC, 1,2-DCE, and DEHP at levels well above their respective MCLs. Persons ingesting groundwater from the site appear to be at an increased risk of developing several adverse health effects, including changes in blood chemistry (1,2-DCE), cancer of the liver (VC, TCE, and DEHP), liver damage (DEHP, TCE, and VC), immune reactions, and nerve damage (VC). TCE and DEHP are classified as Group B2 probable human carcinogens by U.S. EPA, and VC is classified as a Group A known human carcinogen. Although not detected in the most recent round of sampling, benzene and 1,1-dichloroethene were also detected at concentrations above health-based criteria in

earlier sampling rounds. A potential exists that contaminants in groundwater are migrating from the site; however, data is not available to assess off-site migration of COPC in groundwater.

Major Factors Driving Risks

The major factors driving the risks at the site are:

- The presence of PCBs, arsenic, and benzo(a)pyrene in surface soils on-site
- Arsenic in sediment of the Stillwater River adjacent to the site, and
- Volatile organic compounds present in site groundwater above MCLs

Exposures to COPC in soil could reasonably be expected for a site trespasser under current conditions, and for recreational users for future scenarios at the site. The health-protective assumptions used for COPC concentrations may overestimate actual exposures for a segment of the receptor population evaluated; however, it is possible that higher concentrations of the COPC are present at the site but were not sampled. In addition, arsenic levels detected in soil may be equal to area background concentrations (the limited number of background samples did not allow a statistical comparison).

No drinking water wells currently exist at the site. Available data for the one off-site well sampled (which is upgradient of the site) is not sufficient to determine whether site-related contamination is migrating off-site to nearby residential wells in the area.

3.7 Discussion of Uncertainty

In order to evaluate the meaning of a risk assessment, uncertainties in the assumptions made, the potential impact of quantitative changes in those assumptions on the risk estimates, and the relevance of the findings to the real world exposures and risks must be considered. Due to the number of assumptions, data points, and calculations, a degree of uncertainty is necessarily associated with the exposure values and numerical toxicity values used in any risk assessment. The following sections discuss the uncertainties associated with the exposure and toxicity assessments, and with the resultant risk characterization calculations.

3.7.1 Uncertainties Related to the Exposure Assessment

Environmental Sampling and Analysis

The EE/CA support sampling conducted at the site was designed to characterize the areas that present the highest potential risk at the site. The locations of the samples were selected in a directed fashion to investigate specific features of the site and to identify "hot spots" of contamination. A detailed characterization of the site is often not required for the EE/CA; however, due to the biased nature of the sampling locations, the resultant chemical concentrations used in the exposure and risk estimates most likely reflect high-end estimates of the actual exposure that may occur at the site. Maximum detected concentrations of the COPC were used in the exposure estimates. As discussed earlier, this health-protective assumption may lead to an overestimate of the true exposures occurring at the site and resultant risk. However, it should be noted that only 12 soil samples were collected to assess a 15-acre site. The limited number of samples may result in areas of higher contamination being missed, which would result in an underestimate of risk posed by the site. In addition, the characterization of PCBs as Aroclors may result in an underestimate of the actual PCB congeners at the site, due to the fact that environmentally altered mixtures may not be detected as Aroclors, even if PCB congeners are present. This could result in an underestimate of PCB concentrations and subsequently an underestimate of risks posed to receptors at the site.

Due to the focused nature of the SRE, chemicals at levels below risk-based screening criteria were not carried through the quantitative risk evaluation. The results of toxicity screening indicate that the chemicals that were not included in the SRE would not pose a significant risk to a residential receptor, which is not anticipated for the site; therefore, the impacts of not including these chemicals in the evaluation of risk for site trespassers and recreational users (whose anticipated exposure is much lower than that of a potential on-site resident) is anticipated to be insignificant.

The lack of analytical information for surface water, groundwater, and off-site soil precludes a quantitative assessment of risks posed to off-site receptors. Further characterization of conditions surrounding the site would be needed in order to identify contaminant migration pathways and potential off-site receptors.

Exposure Scenarios

As stated in guidance for conducting non-time-critical removal actions, the SRE is intended to address risks associated with the particular area that the removal action is intended to address, and may be quantitative or qualitative in nature. This SRE concentrated on quantitative evaluation of exposure for the populations that

are anticipated to be at the greatest risk of exposure to contamination on site. Potential off-site exposure pathways such as exposure to COPC in surface water, and off-site residential exposure to groundwater and contaminated soils from the site via surface run-off were not evaluated in this SRE due to lack of data. Further, more expanded investigations of the site area would be required in order to completely assess risks associated with these pathways.

Exposure Estimation Calculations

The primary uncertainty regarding the exposure estimation calculations is that associated with the selection of appropriate parameter values. Individual parameter values were selected so that the overall pathway exposure estimates would approximate high-end (RME) exposures, thereby overestimating rather than underestimating risks for the potentially exposed population.

3.7.2 Uncertainties Related to the Toxicity Assessment

Evaluation of Carcinogenic Toxicity Assessment Assumptions

SF for carcinogens are often estimated from high-dose animal studies using very conservative assumptions about the dose-response relationship for carcinogens. Although there are practical reasons for doing this, the procedures used to derive SFs tend to overestimate the actual cancer potency of a chemical at low doses.

Because the increased incidence of cancer from low doses of a carcinogen may be very small relative to the incidence in unexposed populations, and because the cancer may appear long after the exposure, there is usually not sufficient low-dose data from animal bioassay or human epidemiological studies to directly estimate SFs at low doses.

Therefore, by necessity, agencies such as U.S. EPA use carcinogenic extrapolation models for estimating low-dose SFs from the responses seen at high doses. Based upon prudent public policy, these agencies assume that there is no threshold dose below which carcinogenic risks will not occur. This is equivalent to the assumption that every dose above zero, no matter how low, carries with it a small but finite risk of cancer. They also assume that the dose-response relationship is linear at low doses. This differs from the approach used for non-cancer effects, for which thresholds are assumed to exist.

The current model favored by U.S. EPA and certain other federal regulatory agencies is the linearized multistage model. The agency uses the statistically derived upper 95th percentile confidence limit of the slope

of the dose-response curve, rather than a maximum likelihood value, for the SF. The agency has concluded, based on theoretical grounds consistent with human epidemiological and animal data, that cancer follows a series of discrete stages (i.e., initiation, promotion, and progression) that ultimately can result in the uncontrolled cell proliferation known as cancer. Consistent with this conclusion, the use of the linearized multistage model permits an estimation of SF that is not likely to be exceeded if the real slope could be measured.

Evaluation of Noncarcinogenic Toxicity Assessment Assumptions

Key assumptions used in assessing the likelihood of noncarcinogenic effects are that threshold doses exist below which various noncarcinogenic effects do not occur and that the occurrence or absence of noncarcinogenic effects can be extrapolated between species and occasionally between routes of exposure and over varying exposure durations. The threshold assumption appears to be sound for most noncarcinogens based on reasonably good fits of experimental data to the usual dose-response curves.

The other assumptions generally appear to be true to varying degrees. The effects observed in one species or by one route of exposure may not occur in another species or by another route, or they may occur at a higher or lower dose due to differences in the biokinetics of a compound in different species or when exposure occurs by different routes. The uncertainty in these assumptions is taken into account in the development of RfDs through the use of safety or uncertainty factors. These factors reflect uncertainty associated with species-to-species extrapolation and data limitations, and include safety factors to protect sensitive individuals. The uncertainty factors used by the U.S. EPA are health-protective in nature in that they tend to overestimate the uncertainties so that the RfDs obtained are unlikely to be too high. Use of the resulting RfDs tends to overestimate the potential for noncarcinogenic effects occurring at a given exposure level.

RfDs do not exist for some COPC (such as lead). The maximum lead concentration detected at the site is well above the level of concern for residential exposure. Although exposures at the site are anticipated to be lower than those of a residential receptor, the exclusion of risks associated with lead exposure results in an underestimate of potential risks posed by the site.

3.7.3 Uncertainty Associated with the Risk Characterization

The risk characterization combines and integrates the information developed in the exposure and

toxicity assessments; therefore, uncertainties associated with these assessments also affect the degree of confidence that can be placed in risk characterization results. The previous sections provide full discussions of the factors causing uncertainty in the exposure and toxicity assessments, respectively.

For the exposure assessment, the use of maximum detected concentrations for exposure point concentrations of COPC is likely to cause overestimation of the true exposures. The limited amount of analytical data and the use of average and default values in lieu of site-specific data for critical variables in the exposure assessment could lead to either overestimation or underestimation of the exposures, depending on actual conditions at the site.

The basic uncertainties underlying the assessment of the toxicity of a chemical include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of the assessment; and
- Uncertainties involved in extrapolating from the underlying scientific studies to the exposure situation being evaluated, including variable responses to chemical exposures within human and animal populations and between species.

These basic uncertainties could result in a toxicity estimate, based directly on the underlying studies, that either under- or overestimates the true toxicity of a chemical in the circumstances of interest.

Several additional factors should be considered when discussing uncertainties associated with the overall risk characterization. These include the cumulative effect of using health-protective assumptions throughout the process, uncertainties associated with exclusion of COPC from the quantitative estimates due to lack of toxicity information, and the likelihood of the exposures postulated and estimated in the exposure assessment actually occurring.

3.7.4 Summary of Uncertainty

The cumulative effect of using health-protective assumptions throughout the risk estimation process is that the resulting estimates could overstate the true risks. RAGS recommends that individual parameter values be selected so that the overall estimate of exposure represents reasonable maximum exposures. The actual statistical distributions of exposure parameters used in the evaluation of the GRL site are not known. As a result, best professional judgment was used to select values that are sufficiently conservative to avoid underestimating the true risk, yet not so conservative that the resulting risk estimate turns out to be

unreasonably high. The postulated exposures presented in this SRE are very likely occurring to some degree at the GRL site. Overall, the parameters used in the SRE represent a reasonable maximum estimate of those exposures.

3.8 Conclusions

The lack of analytical information for surface water, groundwater, and off-site soil precludes a quantitative assessment of risks posed to off-site receptors. Further characterization of conditions surrounding the site would be needed in order to identify contaminant migration pathways and potential off-site receptors. However, in accordance with U.S. EPA guidance (U.S. EPA 1993b), it is not necessary to conduct a quantitative risk assessment that addresses all exposure pathways to determine whether a response action is needed when contaminant concentration levels exceed standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. Where established standards for one or more contaminants in a given medium are clearly exceeded, remedial action is generally warranted. In this case, both groundwater and soils at the site exhibit concentration levels that exceed potential ARARs and/or risk based criteria. Containment alternatives should be evaluated in the EE/CA Report. Some practical considerations in developing containment alternatives include the following: regular flooding of the site; inundation of source materials by shallow groundwater during high river stage; and the location of the site immediately adjacent to a designated State Scenic River.

4. STREAMLINED ECOLOGICAL RISK EVALUATION

The purpose of the streamlined ecological risk evaluation (SERE) for the GRL site is to identify the chemicals of concern associated with the site; to evaluate the pathways and the extent to which ecological receptors might be exposed to these chemicals; and to assess the environmental effects associated with exposures to the chemicals. The focus of this SERE is on the potential impacts of chemicals of concern from the GRL site on the ecology of the Stillwater River and the site itself.

4.1 Scope of the SERE

According to U.S. EPA guidance (U.S. EPA 1989b), the ecological risk assessment process is divided into five major components: problem formulation; ecological data acquisition and review; exposure assessment; ecological effects assessment; and risk characterization. Because this is a *streamlined* risk evaluation, not a complete baseline risk assessment, several components of the risk assessment process are treated in a combined fashion, and some process steps that are usually quantitative in nature are addressed qualitatively.

To satisfy the goals of the SERE, it was necessary to collect data beyond the scope of the ecological investigations that had previously been conducted at the site. START utilized existing sampling data and existing reports on the GRL site and the Stillwater River as part of this investigation. In addition, START reviewed wetlands maps, topographic quadrangles, soils maps, and state and federal lists and reviews of species of potential concern. START also conducted limited ecological field reconnaissance activities to confirm and supplement the findings of the literature review and previously obtained site information. The field activities conducted for the SERE at the GRL site included:

- Documentation of physical characteristics of habitats identified as potential receptors;
- Confirmation of identifiable resource boundaries;
- Observations of dominant vegetation and wildlife species or communities;
- Documentation of species of potential regulatory concern;

- Identification of surface water drainage patterns;
- Observation of general land use in the vicinity of the site; and
- Identification of potential sources of contamination not related to the site.

The environmental resources identified in the literature review and field reconnaissance are presented in Section 4.2. The potential risks to the environmental resources are presented in Section 4.3.

4.2 Environmental Resources Inventory

The literature review and limited field reconnaissance documented the following environmental resources at the GRL site and the adjacent Stillwater River:

- Surface Water Resources (river, wetlands, floodplain, and surface water drainage);
- Habitats;
- Species of Concern;
- Geology and Hydrogeology;
- Soils;
- Topography;
- Land use; and
- Climate.

4.2.1 Surface Water Resources

To assess the surface water resources on and adjacent to the site, START reviewed the following resources: United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) map of West Milton, Ohio, quadrangle; the Ohio Environmental Protection Agency (OEPA) report entitled, *Biological and Sediment Quality Study of the Stillwater River, Garland Road Landfill, Miami and Montgomery Counties, Ohio* (OEPA 1995); and Ohio Department of Natural Resources (ODNR) memorandum entitled, Designation of the Stillwater River from Beamsville to Englewood Dam as a Scenic River (ODNR 1974). START also performed limited field reconnaissance activities to verify surface water resources and habitat types. Wetland types have been classified in accordance with *Classification of Wetlands and Deepwater Habitats* (Cowardin *et al.* 1979) and are described in Section 4.2.1.2.

4.2.1.1 Stillwater River

The Stillwater River, designated as a state scenic river, forms the eastern boundary of the GRL site. The Stillwater River is approximately 67 miles in length and empties into the Great Miami River in Dayton. The total watershed of the Stillwater River is 673 square miles (ODNR 1974). The portion of the Stillwater River adjacent to the site is approximately 200 feet wide, is relatively shallow, and has an average flow of 450 cubic feet per second (ft^3/sec.)(PRC 1993). Pool habitats comprise the majority of the river within the area of the site but there are also short, well developed riffle and run habitats as well. The substrate is dominated by cobble, gravel, and sand. The Stillwater River is currently designated as Exceptional Warmwater Habitat for aquatic life use (OEPA 1995).

On August 1, 1995, the OEPA published a report entitled, *Biological and Sediment Quality Study of the Stillwater River, Garland Road Landfill, Miami and Montgomery Counties, Ohio*. The purpose of the study, and similar studies in 1982 and 1990 fish tissue, fish biomarker, and sediment sampling of the Stillwater River in the vicinity of the GRL site from August to November 1994 (OEPA 1995). A summary of OEPA's findings and conclusions is presented below:

- The stream and riparian zone were found to provide excellent physical habitat for aquatic life and were found to be capable of supporting Exceptional Warmwater Habitat stream fish communities (OEPA 1995).
- "Based upon the 1994 sampling results, the Garland Road Landfill was not impacting the macroinvertebrate communities of the Stillwater River" (OEPA 1995).
- With regard to sediment samples, the report states that, "all results are below the Lowest Effect Level" (OEPA 1995).
- "The Garland Road Landfill was not impacting the fish communities of the Stillwater River, based upon 1994 sampling results" (OEPA 1995).
- "Fish tissue results showed only mercury as being of concern...." (OEPA 1995).
- "A significant improvement in the fish communities occurred during 1994" and "... appears associated with reduced effluent loadings of ammonia-N [ammonia as nitrogen] and oxygen-demanding material from the West Milton WWTP [wastewater treatment plant]" (OEPA 1995)(see Section 4.3.8).

OEPA collected a high number of fish species at each sampling location, including significant numbers of pollution-sensitive Golden Redhorse (*Moxostoma erythrurum*), Black Redhorse (*Moxostoma duquesnei*), Shorthead Redhorse (*Moxostoma macrolepidotum*), Northern Hog Sucker (*Hypentelium*

nigricans), Smallmouth Bass (*Micropterus dolomieui*), and River Redhorse (*Moxostoma carinatum*), a species that is listed by ODNR as Special Interest. Pollution-intolerant fish represented approximately 10.5 percent of the total catch in the Stillwater River (OEPA 1995). A list of the 39 fish species and two hybrids collected in the Stillwater River by OEPA, as published in their 1995 report, is presented in Table 4-1.

The NWI map of West Milton, Ohio, quadrangle identifies the aquatic habitat of the Stillwater River main channel in the area adjacent to the site as Riverine Lower Perennial Unconsolidated Bottom Permanently Flooded (R2UBH). R2UBH wetlands consist of habitats that are contained within a channel and with a salinity less than 0.5 parts per thousand. R2UBH wetlands are bounded on the landward side by uplands or by wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. R2UBH wetlands have a low gradient and a slow water velocity. These wetland areas remain flooded throughout the year in all years. A well developed floodplain is also characteristic of this wetland type (Cowardin *et al.* 1979).

4.2.1.2 Wetlands

The NWI map designates a total of six wetland areas on or in the vicinity of the GRL site: three wetland areas on the GRL site; one adjacent to the site within the Stillwater River; and two areas immediately downgradient of the site along the Stillwater River. As described below, START believes that jurisdictional wetlands, as defined by the United States Army Corps of Engineers (USACE 1987), do not exist on site. The wetlands and wetland types in the vicinity of the GRL site, as identified by the NWI map, are described below and are shown in Figure 4-1.

GRL Site

Approximately 0.7-acre or 5 percent of the 15-acre site in the southeastern corner of the site is designated on the NWI map as Palustrine Forested Broad-Leaved Deciduous Temporarily Flooded (PFO1A)(USFWS 1985). Palustrine wetland systems are nontidal wetland systems dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. Palustrine wetlands possess all of the following four characteristics: are less than 20 acres in size; lack active wave-formed or bedrock shoreline features; have a water depth in the deepest part of the basin less than 6 feet at low water; and have salinity due to ocean-derived salts less than 0.5 parts per thousand. PFO1A wetlands flood for less

than two weeks during the growing season most years and are usually dry by mid-growing season. They are characterized by woody vegetation that is 20 feet or taller. These wetlands normally possess an overstory of trees covering at least 30 percent of the ground, an understory of young trees or shrubs, and a herbaceous layer (Cowardin *et al.* 1979).

Two small wetland areas on the NWI map near the southwestern tip of the site are designated as Palustrine Unconsolidated Bottom Semipermanently Flooded Excavated (PUBFx). The total size of the two wetlands is approximately 0.3 acre or 2 percent of the 15-acre site, as determined from the NWI map. PUBFx wetlands are described as freshwater wetlands that are less than 20 acres in size and less than two meters deep at low water. These wetlands remain flooded throughout the growing season in most years and have been created or modified by excavation and removal of existing substrate (Cowardin *et al.* 1979).

NWI maps are prepared primarily by stereoscopic analysis of high altitude aerial photographs, and are generally not "ground-truthed". The wetlands designated on NWI maps are identified from photographs based on vegetation, visible hydrology, and geography. The identification of wetlands on an NWI map does not indicate the existence of jurisdictional wetlands (USFWS 1985). The USACE, which has authority over wetlands, defines wetlands in, *Wetlands Delineation Manual, Technical Report Y-87-1*. This manual defines regulated wetlands as having each of three characteristics:

1) a predominance of hydrophytic vegetation;
2) saturated soil conditions; and
3) inundated or saturated groundwater at or near the surface (USACE 1987).

Although START did not delineate boundaries or establish the jurisdictional or regulatory status of the habitats on site, START believes that jurisdictional wetlands do not exist on the GRL site based on the lack of visual evidence to support the presence of all three jurisdictional wetland characteristics. NWI maps categorize wetlands as areas having just one of the above characteristics.

Off Site

A relatively small island exists within the Stillwater River adjacent to the GRL site. The NWI map designates this island as PFO1A habitat. The NWI map also identified two PFO1A wetland areas on

either bank of the Stillwater River, approximately 350 feet downstream of the southern portion of the site (USFWS 1985).

4.2.1.3 Floodplains

The 100-year floodplain is defined by state and local regulations as those areas mapped by the Federal Emergency Management Agency (FEMA) National Flood Insurance Program, Flood Insurance Rate Maps (FIRM). In general, FEMA maps identify all land within reach of a flood with a one percent probability of occurring in any given year; also referred to as the base flood (Kusler and Platt 1988). Floodplains occur in areas along or adjacent to a stream or body of water that are capable of storing or conveying floodwater.

The FEMA maps for Miami County, Ohio, designate the entire GRL site as Zone A, indicating that it is within the 100-year floodplain of the Stillwater River. The boundary between the Zone A floodplain and Zone C (areas of minimal flooding) is approximately 3,000 feet to the west of the GRL site. FEMA has not determined base flood elevations and flood hazards within the Zone A floodplain in this area (FEMA 1983).

Englewood dam is located approximately six miles south of the GRL site and was constructed in 1922 to protect Dayton and other cities to the south along the Great Miami River from flooding. The dam only stores water during flood events. The dam has stored water on 443 occasions since its construction was completed in 1922 (Rinehart 1996).

The spillway of Englewood dam is at elevation 876. Prior to constructing the dam, the Miami Conservancy District, which has authority over Englewood dam, acquired certain rights on all properties situated below the spillway elevation. One of these rights is to back water over all properties below the spillway elevation. The maximum elevation on the GRL site is approximately 824 feet above sea level, well below the elevation of the Englewood dam spillway (Rinehart 1996).

Evidence of flooding was observed on the site during reconnaissance activities on November 21, 1996. In the low-lying southeast corner of the site, leaves from vegetation were observed lodged into the entire height of the approximately 6-foot high fence along the Stillwater River. The steep slope of the river bank along the eastern side of the GRL site indicates that flooding of the Stillwater River happens relatively infrequently but with sharp peaks (Mitsch and Gosselink 1993), however, the southern portion of the site floods annually (FEMA 1993).

4.2.1.4 Surface Water Drainage Patterns

Based on field observations and on topographic mapping of the site, START has estimated surface runoff patterns on and adjacent to the site (Figure 4-2). Surface water drainage on the site is generally west to east, towards the Stillwater River. At the southern end of the site, most of the surface water drainage flows into the center of the site and then to the southeast towards the Stillwater River. At the extreme southwestern tip of the site, surface water drains to the southwest towards an intermittent stream that runs through the adjacent agricultural field before entering the Stillwater River.

4.2.2 Habitats

Terrestrial habitats were identified based on field observations and have been classified according to *Eastern Forests* (Kricher and Morrison 1988). Figure 4-3 shows the locations of the habitat types on the site.

The major habitat types identified within and adjacent to the GRL site include:

- River
- Northern Riverine Forest
- Old Field
- Barren Land

The vegetation observed in each habitat is listed in Table 4-2. The birds, mammals, and reptiles and amphibians that may potentially exist on the site and their probable habitats are listed in Tables 4-3, 4-4, and 4-5, respectively.

4.2.2.1 River

As discussed in Section 4.2.1.1, the Stillwater River flows adjacent to the site. In the vicinity of the site, the Stillwater River is designated as R2UBH (Cowardin *et al.* 1979).

Based on the findings of the Stillwater River study done by OEPA (1995), the Stillwater River habitat is considered to be of high ecological importance. The fish and benthic macroinvertebrate communities appear to be healthy upstream and downstream of the GRL site and sediment and biotic

contamination appear to be minimal (OEPA 1995).

4.2.2.2 Northern Riverine Forest

On the site, a narrow strip of northern riverine forest habitat exists along the bank of the Stillwater River (Figure 4-3). This habitat comprises approximately two acres or 13 percent of the 15-acre site. The northern riverine forest is approximately 50 to 100 feet wide and exists on a steep slope between the landfill and the river. The topography of this habitat slopes down approximately 16 feet to the edge of the river.

Northern riverine forest communities are those that occupy moist sites along rivers and floodplains. Spring flooding is an annual occurrence in this type of community. Herbaceous cover is generally minimal (Kricher and Morrison 1988).

The vegetation in this community is comprised mostly of large, old trees with little understory. Heavy flooding tends to keep understory vegetation to a minimum. Tree leaves observed lodged in the top of the six-foot high site fence provide evidence of flooding of this habitat. Observations of the vegetation in this habitat during the ecological field reconnaissance included: Eastern Sycamore (*Platanus occidentalis*); Silver Maple (*Acer saccharinum*); Eastern Cottonwood (*Populus deltoides*); Black Willow (*Salix nigra*); Red Maple (*Acer rubrum*); Sugar Maple (*Acer saccharum*); Swamp White Oak (*Quercus bicolor*); and Northern Hackberry (*Celtis occidentalis*). Animals observed in this forest community included: Belted Kingfisher (*Ceryle alcyon*); Pileated Woodpecker (*Dryocopus pileatus*); and Downy Woodpecker (*Picoides pubescens*). In addition, START field personnel have observed several small (one inch diameter) burrow holes in this river bank soil.

This habitat is considered to be of high importance to the ecology of the Stillwater River and the local area. Although the northern riverine habitat on the site is not very large and is not capable of supporting a large number of plant and animal species, it does provide many important functions to the Stillwater River and to the surrounding terrestrial habitats.

This northern riverine forest habitat is the riparian zone of the Stillwater River. A riparian zone is the land adjacent to a body of water that is, at least periodically, influenced by flooding. The northern riverine forest habitat at the GRL site is at the interface between the aquatic ecosystem of the Stillwater River and the upland ecosystem of the majority of the site. Mitsch and Gosselink (1993) describe riparian ecosystems, such as this one, as being characterized by a combination of high species diversity,

high species densities, and high productivity. Diversity and abundance of species tend to be greatest at the ecotone between two distinct ecosystems such as a river and uplands. Riparian ecosystems are generally home to productive and diverse plant communities and are valuable for many animals that seek its bit erosion of the steep river bank slope at the GRL site. This habitat may also help to inhibit erosion of GRL site surface soils into the Stillwater River by trapping the runoff. The inhibition of erosion into the river likely helps to promote the existence of silt-sensitive fish and benthic macroinvertebrate organisms in the Stillwater River.

The northern riverine habitat is important for the stream-shading that the large trees provide. This stream shading provides important escape cover for fish. Stream shading also helps to keep important water quality parameters of rivers from changing drastically, such as temperature and dissolved oxygen. The clearance of streamside vegetation increases water temperature and, together with the loss of tree root habitat, can cause dramatic reductions and alterations in fish and benthic macroinvertebrate populations (Goldman and Horne, 1983). This riparian vegetation also provides coarse particulate organic matter (CPOM) to the Stillwater River this is important food to a portion of the benthic macroinvertebrate community (U.S. EPA 1989c).

Goldman and Horne (1983) state that it is a wise stream management practice to leave a buffer strip of original vegetation about 30 meters wide. Mitsch and Gosselink (1993) state that:

> "... the importance of the river to the floodplain and the floodplain to the river... cannot be overemphasized. If either is altered, the other will change over time because floodplains and their rivers are in a continuous dynamic balance..." (Mitsch an Gosselink 1993).

OEPA, in its 1995 report on the Stillwater River, made the following recommendation about the northern riverine forest habitat of the GRL site:

> "Every attempt should be made at the Garland Road landfill to preserve the mature trees lining the river bank to stabilize the stream bank and provide riparian habitat. It would take decades for newly planted trees to provide the same functions that the trees currently provide the aquatic community. Erosion controls and bank stabilization need to be of primary concern in all actions taken during remediation activities" (OEPA 1995).

4.2.2.3 Old Field

Old field habitat comprises approximately 7.5 acres or 50 percent of the 15-acre site. Old field habitat exists at the southern and northern ends of the site (Figure 4-3).

An old field is defined as an abandoned field or disturbed terrestrial habitat that has a well-developed soil base. Old field succession begins soon after a field is abandoned or a disturbed terrestrial habitat is left alone. Many fields are abandoned with bare ground. When bare ground is available, it is quickly colonized by herbaceous plants whose seeds were present in the soil. The plants that originally colonize an area are called pioneer species, and develop quickly in the abundant sunlight available due to the removal of the overstory (Kricher and Morrison 1988).

Two types of successional old field habitats can be found on the GRL site: perennial herbaceous plant community and perennial herbaceous woody plant community. Each type is described in further detail below.

Perennial Herbaceous Plant Community

Fields that range in age from 3 to 10 years post-disturbance are usually dominated by perennial herbaceous plant communities. The majority of the southern end of the site can be characterized as a perennial herbaceous plant community. The perennial herbaceous plant community that is between 3 and 10 years post-disturbance has established in an old field. This community often has an abundance of perennial herbaceous and grass species. The goldenrods and asters that usually dominate a two to three year post-disturbance field no longer uniformly cover the field and seedlings of shrub and tree species begin to grow (Kricher and Morrison 1988).

Observations of the vegetation in this community on site included the following species: Common Mullein *(Verbascum thapsis)*; Goldenrods (*Solidago* species); Queen Anne's Lace (*Daucus carota*); Beggar Ticks (*Bidens frondosa*); Tree-of-Heaven (*Ailanthus altissima*); and various species of grasses. Animal species that were observed in this habitat included: American Crow (*Corvus brachyrhynchos*); Song Sparrow (*Melospiza melodia*); and Northern Cardinal (*Cardinalis cardinalis*). In addition, START personnel have noted Raccoon (*Procyon lotor*) tracks and several rodent burrows that were between six and eight inches in diameter within the old field habitat at the south end of the site.

Perennial Herbaceous Woody Plant Community

Fields that range in age from 10 to 60 years post-abandonment are usually dominated by perennial herbaceous woody plant communities. Much of the northeastern corner of the site can be characterized as a perennial herbaceous woody plant community. In these communities, herbs and grasses are much less obvious compared to the younger communities. Clumps of trees and shrubs shade the ground. Large patches of trees and shrubs are interrupted by areas of grass. The habitat is very patchy in appearance. Very old fields begin to look like woodlands, with dense clumps of slender trees (Kricher and Morrison 1988).

Observations of the vegetation in this community included the following species: Goldenrods; Beggar Ticks; Tartarian Honeysuckle (*Lonicera tatarica*); Eastern Redcedar (*Juniperus virginiana*); Eastern Sycamore; Red Maple; Sugar Maple; Flowering Dogwood (*Cornus florida*); Tree-of-Heaven; Eastern Cottonwood; Paper Birch (*Betula papyrifera*); and Black Willow (*Salix nigra*). Animals species observed in this habitat included: American Crow, Dark-eyed Junco (*Junco hyemalis*), Song Sparrow, Northern Cardinal, Northern Mockingbird (*Mimus polyglottos*), Tufted Titmouse (*Parus bicolor*), Rufous-sided Towhee (*Pipilo erythrophthalmus*), Purple Finch (*Carpodacus purpureus*), White-breasted Nuthatch (*Sitta carolinensis*), and Carolina Chickadee (*Parus carolinensis*).

Both types of old field habitats are considered to be of low ecological importance. Due to the fence surrounding the majority of the site, few mammals are potentially able to utilize this site habitat. Birds that are common to disturbed areas would likely find this habitat to be of moderate value for foraging and nesting. This site habitat is small in size and there are many other old field habitats available in the local area that are less disturbed than the GRL site.

4.2.2.4 Barren Land

Barren land on the site includes the driveway, the area in the northwestern corner of the site where the work trailers are set up, and the area in the center of the site where soil excavation has occurred (Figure 4-3). Barren land comprises approximately 5.5 acres or 37 percent of the 15-acre site.

Barren land areas are mostly devoid of habitat for ecological receptors. There are few, if any, plants and animals inhabiting these areas. There are a few grasses in the soil excavation area, but little else. If this area is left undisturbed, old field succession will begin shortly.

Due to the soil excavation, this area is not considered to be of ecological importance. This area is not considered to be suitable habitat for wildlife species. The barren land of the site is not considered to be an ecosystem of concern. Barren land areas may develop into habitats of low to moderate ecological importance if left undisturbed in the future. Barren lands often take 60 or more years to develop into forest communities (Kricher and Morrison 1988). As a forest community, this habitat would not rival the ecological importance of the northern riverine forest habitat.

4.2.3 Species of Potential Concern

To identify species of potential concern in the vicinity of the GRL site, START reviewed current lists of threatened and endangered plants and animals in the vicinity of the site from ODNR and USFWS. USFWS lists the Indiana Bat (*Myotis sodalis*) as the only federally endangered species existing in Miami County, Ohio (USFWS 1996). The Indiana Bat is discussed in further detail below. One species on the ODNR list of threatened and endangered species, the Dark-eyed Junco (*Junco hyemalis*), is also discussed in further detail below (ODNR 1992).

At the request of START, ODNR, Division of Natural Areas and Preserves, conducted a file search for an approximately seven square mile area (1.5-mile radius) surrounding the GRL site (see Attachment C). The results of the file search indicate the following:

- No records of rare species were found for the 1.5-mile radius area;
- There are no existing or proposed state nature preserves at the site; and
- The site is located along the Stillwater River, which is a designated component of the State Scenic River system.

Based on the habitat requirements of the identified species-of-concern and the disturbed nature of the majority of the site, no federal or state species-of-concern are likely to occur in these areas. The northern riverine forest habitat provides the most likely area for the potential existence of threatened or endangered species. No species-of-concern were observed during the November 1996 field reconnaissance, but their potential occurrence can not be ruled out at this time.

Indiana Bat (*Myotis sodalis*)

USFWS identified the Indiana Bat as the only federally endangered species known to be present within Miami County, Ohio. No federally threatened or proposed threatened species were identified by

USFWS as being present within Miami County (USFWS 1996).

START contracted 3D/Environmental of Cincinnati, Ohio, to assess the site for suitable Indiana Bat habitat. On August 11, 1995, 3D/Environmental submitted a report entitled, *Assessment of Garland Road Landfill for Suitable Indiana Bat Summer Habitat*. The study concentrated on the northern riverine forest habitat and found that the GRL site has no value for Indiana Bat roosting habitat and has minimal value for foraging habitat. The report concluded that the overall suitability of the habitat to the Indiana Bat was negligible.

Dark-eyed Junco (*Junco hyemalis*)

Between 40 and 50 dark-eyed juncos were observed on the GRL site during START's limited ecological assessment on November 21, 1996. The Dark-eyed Junco is listed as endangered by ODNR, Division of Wildlife (ODNR 1992). Debbie Woischke of ODNR, Division of Natural Areas and Preserves, stated in a telephone conversation that the Dark-eyed Junco is listed as endangered in the State of Ohio for nesting habitat only. She stated that there are many Dark-eyed Juncos that inhabit Ohio in the winter that are migrants and are not of concern (Woischke 1996b).

Dark-eyed Juncos prefer coniferous and mixed woodlands for nesting (National Geographic Society 1987). In winter, they inhabit open woods, undergrowth, woodsides, and brush (Peterson 1980). There are 17 records of nesting Dark-eyed Juncos during spring and summer in Ohio and all are in the northeast portion of the state within Cuyahoga, Lake, Geauga, and Ashtabula counties (Peterjohn and Rice 1991). Ms. Woischke also stated that the GRL site is not appropriate habitat for nesting of the Dark-eyed Junco (Woischke 1996b).

4.2.4 Geology and Hydrogeology

The following information is based on a general description of geologic conditions in the Stillwater River Basin (ODNR 1960). Site-specific descriptions of the geologic conditions at the site may be found in the EE/CA prepared by CRA. The landfill material in the area of the GRL site is underlain by glacial deposits covering shale and limestone bedrock. The glacial deposits are comprised largely of clay till, sand, and gravel. Groundwater at the site is generally encountered at about 10 feet below ground surface. Groundwater movement in the vicinity of the site is assumed to be southeast towards the Stillwater River.

4.2.5 Soils

The soils within Miami County, Ohio were mapped by the United States Department of Agriculture, Soil Conservation Service (SCS) in the *Soil Survey of Miami County, Ohio* (SCS 1978). The soils mapped by the SCS (Figure 4-4) identified the following five soil types within the site boundaries:

- Made Land
- Gravel Pits
- Eldean silt loam, 0 to 2 percent slopes
- Eldean loam, 2 to 6 percent slopes
- Genesee silt loam

None of these soil types are identified on the Miami County hydric soils list (SCS 1996). A description of each soil type is presented below.

Made Land

The majority of the site is mapped as made-land. Made-land consists mostly of former pits and depressions that have been filled or covered with trash, bricks and stones, cinders, industrial waste, and other non-soil material (SCS 1978).

Gravel Pits

A gravel pit area is mapped at the southern tip of the site. Gravel pits are open excavations where the soil material has been removed and the underlying sand and gravel has been mined (SCS 1978).

Eldean silt loam, 0 to 2 percent slopes

On the site, this soil type is found as a narrow strip along the western boundary. This soil is level to nearly level and is found on high stream terraces. Nearly all of the original surface layer remains, and there is little or no evidence of erosion (SCS 1978).

Eldean loam, 2 to 6 percent slopes

A small area of this soil type is mapped at the southern tip of the site. This soil type is gently

sloping and is found along drainageways, on stream terraces, and on gravelly knolls and ridges in uplands. Slopes are about 50 to 75 feet long and there is some evidence of erosion (SCS 1978).

Genesee silt loam

A small area of this soil type exists in the northeast corner of the site. This is a level to nearly-level soil found on broad floodplains (SCS 1978).

4.2.6 Topography

The general topography of the site slopes down from west to east towards the Stillwater River. The western boundary of the site has an elevation of approximately 824 feet above sea level. From west to east, elevations decrease slowly to a ridge that exists approximately 40 to 75 feet from the Stillwater River. From this ridge, elevations decrease rapidly down to the river. The elevation of the Stillwater River is approximately 800 feet above sea level.

At the southern end of the site, the topography slopes down into the center of the site and then slopes east/southeast towards the Stillwater River. At the extreme southern end of the site, the topography slopes down to the southwest towards an intermittent stream that runs through the adjacent agricultural field to the Stillwater River.

4.2.7 Land Use

Land use adjacent to the site was identified by observations made during visual field reconnaissance on November 21, 1996. Land-use types have been categorized according to *A Land Use and Land Cover Classification System For Use With Remote Sensor Data* (Anderson *et al.* 1976). The following land-use types were identified within the vicinity of the site and are shown in Figure 4-5:

- Open Space
- Agricultural Land
- Streams and Canals
- Transportation, Communications, and Utilities
- Forest Land

A description of each land-use type and the location of each is presented below.

Open Space

The entire 15-acre GRL site is characterized as open space. The site was used for industrial purposes in the past, but no longer has that land use. The site is surrounded by a 6-foot high fence that keeps it from being influenced by surrounding land uses. The site land use is not expected to change in the future.

Agricultural Land

Agricultural land is described as land used primarily for production of food and fiber (Anderson *et al.* 1976). The land surrounding the site to the west and south is agricultural land. At the time that field reconnaissance was performed, the agricultural land surrounding the site had been used for growing corn.

Streams and Canals

This category includes rivers, creeks, canals, and other linear water bodies (Anderson *et al.* 1976). The Stillwater River is categorized as this land use.

Transportation, Communications, and Utilities

This category includes highways, railways, and areas associated with these uses (Anderson *et al.* 1976). Frederick-Garland Road, which borders the site to the north, can be categorized as this land use.

Forest Land

Forest land has a tree-crown areal density of 10 percent or more, is stocked with trees capable of producing timber or other wood products, and exerts an influence on the climate or water regime (Anderson *et al.* 1976). Forest land exists south of the site, along the Stillwater River.

4.2.8 Non-Site Related Conditions of Potential Environmental Concern

This section describes conditions in the vicinity of the site that are not related to the site, but may have, or may have recently had, an impact on the physical characteristics or ecology of the Stillwater River. The sites listed below will need to be considered when evaluating current and/or past analytical results from the Stillwater River sampling data.

Wastewater Treatment Plant

The West Milton wastewater treatment plant (WWTP) is located on the Stillwater River, approximately two miles north and upstream of the site. According to OEPA (1995), Stillwater River loadings data showed a marked decrease in ammonia, total nonfilterables, and carbonaceous biochemical oxygen demand following a plant upgrade that was completed in November 1992. A marked improvement in the fish communities also appeared with the reduced effluent loadings from the West Milton WWTP (OEPA 1995).

Agricultural Operations

Agricultural fields exist adjacent to the west and south of the site and are prevalent along the Stillwater River upstream and downstream of the site. Runoff from these agricultural fields is a potential source of sediments, pesticides, herbicides, and fertilizers to the Stillwater River.

4.2.9 Climate

The climate of Miami County is continental and is marked by wide annual, daily, and day-to-day ranges of temperature. Summers are moderately warm and humid, and winters are reasonably cold and cloudy. The average daily maximum for July is 85 degrees Fahrenheit (°F) and the average daily minimum is 65°F. The average daily maximum for January is 37°F and the average daily minimum is 22°F. Precipitation varies widely from year to year but is normally abundant and well-distributed throughout the year. The yearly precipitation average is approximately 36 inches, with the least amount of precipitation occurring in the Fall months. The average length of the growing season is approximately 168 days, with the average last Spring freeze on May 1 and the average first Fall freeze on October 15 (SCS 1978).

4.3 Identification of Contaminants of Potential Ecological Concern

In this section, sampling results have been compared to media-specific screening criteria to determine the extent of potential ecological concern associated with contaminants at the GRL site. Ecological characteristics of the site and the Stillwater River described in Section 4.2 have been used in combination with screening criteria to determine overall ecological risk. Due to the small size of the site,

the relatively small number of samples collected, and the likelihood that soil particles from all portions of the site may potentially wash into the Stillwater River, the different habitats identified in Section 4.5 could not be evaluated separately.

On-site surface soils and Stillwater River sediments have been screened for contaminants of ecological concern. Groundwater samples were not screened for contaminants of ecological concern because direct contact with subsurface groundwater is likely to be minimal for ecological receptors. START was unable to screen Stillwater River surface water for contaminants of ecological concern because no surface water data was collected in site investigations. Surface water contamination, however, is believed to be much lower than sediment contamination.

4.3.1 Inorganic Contaminants

The eight surface soil samples (all taken within one foot of the surface) collected and analyzed at the GRL site have been compared to screening benchmark concentrations. Toxicological benchmarks were obtained from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision* (Will and Suter 1995; *Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Will and Suter 1995); *Toxicological Benchmarks for Wildlife: 1995 Revision* (Opresko et al. 1995); and various other toxicological profiles.

Sediments

Stillwater River sediment sampling results from 1993, 1994, and 1996 were screened against inorganic ecotoxicity values for sediments. The ecotoxicity values used for screening purposes were taken from *Eco Update: Ecotox Thresholds* (U.S. EPA 1996g), when available, and suggested values from *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1994 Revision* (Hull and Suter 1994) for contaminants without screening benchmark values in the U.S. EPA document.

Background concentrations for inorganic analytes were determined by taking the mean of the three upstream sediment samples (one from each sampling event). In the event that an analyte was not detected in a given upstream sample, the value used for calculating the background concentration was one-half of the sample quantitation limit for that particular sampling event.

Table 4-6 lists the analytes detected in Stillwater River sediments, the range of detected concentrations, background concentrations, and the sediment screening benchmarks used. For the majority of the inorganic analytes, a total of seven sediment samples from the three sampling events were able to be screened to identify contaminants of potential ecological concern. No inorganic analytes exceeded both the sediment screening benchmark and three times the background level. Therefore, no inorganic contaminants of potential ecological concern were identified in the Stillwater River sediment samples.

Surface Soils

Eight surface soil samples (all taken within one foot of the surface) collected and analyzed at the GRL site have been compared to screening benchmark concentrations for the toxicity of chemicals to vegetation from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision* (Will and Suter 1995) and other various toxicological profiles.

Background levels for soils were obtained from, *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States* (Shacklette and Boerngen 1984) and *Background Levels of Heavy Metals in Ohio Farm Soils* (Logan and Miller 1983). Background levels were taken from these sources because there were only two site-specific background samples available for comparison to site surface soil samples.

Table 4-7 lists the analytes detected in GRL site soils, the range of detected concentrations, background concentrations, and the ecological screening benchmark values. The following analytes were detected at levels greater than ecological screening benchmarks and greater than three times background: barium, cadmium, chromium, lead, mercury, nickel, and zinc. Calcium and magnesium were detected at concentrations greater than three times background but have been eliminated because they are considered essential nutrients. In addition, no background concentration or ecological screening level was available for cyanide.

4.3.2 Organic Contaminants

As with inorganic contaminants in soil, the eight surface soil samples that were collected and analyzed at the GRL site have been compared to screening benchmark concentrations taken from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial*

Plants; 1995 Revision (Will and Suter 1995); *Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Will and Suter 1995); *Toxicological Benchmarks for Wildlife: 1995 Revision* (Opresko et al. 1995); and various other toxicological profiles.

Sediment

As with inorganic contaminants, ecological screening values for organic contaminants in sediment were taken from *Eco Update: Ecotox Thresholds* (U.S. EPA 1996g), when available, and from *Toxicological Benchmarks For Screening Contaminants of Potential Concern For Effects On Sediment-Associated Biota: 1994 Revision* (Hull and Suter 1994) for contaminants without screening benchmark values in the U.S. EPA document.

Table 4-6 lists the analytes detected in Stillwater River sediments, the range of detected concentrations, background concentrations, and the sediment screening benchmarks used. All organic contaminants detected in sediment samples were below the sediment quality screening values, except benzo(a)anthracene. The sediment screening benchmark for benzo(a)anthracene is 108 micrograms per kilogram (ug/kg) and the maximum concentration detected in the sediment samples was estimated at 120 ug/kg.

Surface Soils

As with inorganic contaminants in soil, the eight surface soil samples (all taken within one foot of the surface) that were collected and analyzed at the GRL site have been compared to screening benchmark concentrations for the toxicity of chemicals to vegetation from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision* (Will and Suter 1995) and other various toxicological profiles.

Table 4-7 lists the analytes detected in GRL site soils, the range of detected concentrations, background concentrations, and the ecological screening benchmark values. The following organic analytes were detected at concentrations greater than ecological screening benchmarks: bis(2-ethylhexyl)phthalate, Aroclor 1248, and Aroclor 1254.

4.3.3 Summary of Contaminants of Potential Ecological Concern

Contamination of potential ecological concern in Stillwater River sediments includes only benzo(a)anthracene. Contamination of potential ecological concern in GRL site soils includes: barium, cadmium, chromium, cyanide, lead, mercury, nickel, zinc, bis(2-ethylhexyl)phthalate, Aroclor 1248, and Aroclor 1254.

4.3.4 Unavailable Screening Benchmark Values

Little data exists in literature on the threshold toxicity of organic compounds to ecological receptors in soils. As a consequence, no ecological screening benchmark values were able to be identified for the following organic compounds: acetone; 1,2-dichloroethene; acenaphthylene; benzoic acid; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(ghi)perylene; isophorone; and 2-methylnaphthalene. These analytes can not be ruled out or included as contaminants of concern without ecological screening criteria for comparisons. Where possible, toxicological information for some of these contaminants is provided in Section 4.4.3.

4.4 Ecological Significance of Contamination

4.4.1 Contaminant Source, Fate, and Transport

Benzo(a)anthracene

The major source of benzo(a)anthracene is natural and man-made combustion. It is very persistent in sediment. Benzo(a)anthracene has a low water solubility and has a high propensity for binding to particulate or organic matter. Sediment adsorption or biotic uptake are the primary transport processes for the removal of waterborne benzo(a)anthracene. Desorption into water from soil is very unlikely. Erosion of contaminated soils by surficial runoff is the most probable process for the transport of soil-bound benzo(a)anthracene to aquatic systems. The major fate of sediment-bound benzo(a)anthracene is most likely to be biodegradation. Many organisms metabolize and excrete PAHs rapidly, so bioaccumulation is a short-term process (U.S. EPA 1987b).

The surface soil contaminants of ecological concern are located in close proximity to and upgradient of the Stillwater River. Surface water flow from the site discharges to the Stillwater River. Consequently, there is a potential pathway for migration of these soil contaminants to the Stillwater River. Migration potential would be expected to increase during periods of heavy precipitation, during

snowmelt, and/or during flooding of the Stillwater River.

All contaminants of concern in soil (except bis(2-ethylhexyl)phthalate) are particle-reactive contaminants, it is expected that their transport would occur primarily in particulate form. They are naturally occurring in the earth's crust (except cyanide). Specific source, fate, and migration information is presented below for several of these contaminants.

Chromium

Man-made sources of chromium include coal and oil combustion, steel production, chemical manufacture, primary metal production, and chrome plating (U.S. EPA 1987c).

Cyanide

The major sources of cyanide in soil are disposal of cyanide wastes in landfills and the use of cyanide-containing road salts. In surface soils with a pH of less than 9.2, volatilization of HCN is expected to be an important loss mechanism for cyanides (U.S. EPA 1988b).

Lead

Atmospheric deposition is the largest source of lead in soils and solid waste disposal is the second largest source. Very little transport of lead occurs because it is strongly retained by soils (U.S. EPA 1988c).

Nickel

The primary man-made sources of nickel in soils is the application of nickel-containing sewage sludge, the use of certain fertilizers, and the deposition of aerosol particles. Nickel is extremely persistent in soils (U.S. EPA 1987d).

Although the potential pathway exists for migration of site soil contaminants of concern to the Stillwater River, sediment data for the Stillwater River does not appear to support this hypothesis. Fish and benthic macroinvertebrate studies of the Stillwater River also do not lend support to the hypothesis that site contaminants are currently impacting the Stillwater River.

4.4.2 Ecological Effects Assessment

This section presents a discussion of ecological effects associated with contaminants of potential concern.

Chromium

Chromium is usually found in biological materials in the +3 oxidation state, where it acts as an essential nutrient to mammals. Hexavalent chromium is more toxic than the +3 form due to its high oxidation potential and its ability to easily penetrate biological membranes (Steven *et al.* 1976; Taylor and Parr 1978; Langard and Norseth 1979). Absorbed chromium is excreted from the body rapidly. The target organs following high exposures to chromium include the kidneys, immune system, nervous system, and liver. Long-term exposure of animals to relatively low levels of chromium has not resulted in effects (U.S. EPA 1987c).

Cadmium

Cadmium, like many other metals, can adversely affect organisms as a result of its ability to bind with enzymes and other cellular proteins and render them ineffective. Toxic effects resulting from cadmium exposure in rats include testicular damage and teratogenic effects, anemia, ovarian damage, and fetal death. In other test animals, testicular hemorrhages, necrosis, and fetal facial development defects.

Cyanide

Cyanide is readily absorbed by animals by inhalation, oral, and dermal routes of exposure. Inhalation of hydrogen cyanide is the most dangerous. Following absorption, it is distributed throughout the body and the effects include neurotoxicity, cardiac/repiratory effects, and thyrotoxicity (U.S. EPA 1988b).

Lead

Bioaccumulation of lead has been demonstrated for a variety of organisms, with bioconcentration factors typically ranging from 42 to 1,700 (U.S. EPA 1988c). Lead bonds with amino acids contained in proteins (including enzymes) or polypeptides. This characteristic increases bioaccumulation and inhibits excretion. High levels of lead exposure can have neurobehavioral effects. Lead is readily absorbed by

plants and can be toxic (U.S. EPA 1988c).

Mercury

Mercury is strongly adsorbed to humic and clay soils. Mercury compounds are known to be readily taken up by plants (Kabata-Pendias and Pendias 1992).

Nickel

Nickel is rapidly and readily taken up by plants from soils, and until certain nickel concentrations in plant tissues are reached, the adsorption is positively correlated with the soil nickel concentrations. Nickel toxicity symptoms in plants include chlorosis, retarded nutrient absorption, retarded root development, and retarded metabolism (Kabata-Pendias and Pendias 1992). Nickel toxicity symptoms in animals include lung and reproductive effects. Nickel has a short half-life in the bodies of most animals and there is little evidence of tissue accumulation (U.S. EPA 1987d).

Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs), such as Aroclor 1248 and Aroclor 1254, are known to biomagnify through the food chain and have considerable effects upon higher trophic-level organisms such as fish-eating birds and carnivorous mammals. PCBs are lipophilic and, thus, are readily passed up the food chain. Numerous species of biota have been shown to be susceptible to the chronic and acute effects of PCB exposure (Eisler 1986). Relatively low levels of PCBs in the diet of a variety of wildlife species have been shown to cause reproductive impairment, behavioral changes, and mortality in sensitive species (Boucher 1993).

Zinc

Zinc is readily transported in most natural waters and is one of the most mobile of heavy metals. Zinc levels of 30 to 21,600 ug/L have been shown to reduce the growth of various plant species. Symptoms of zinc toxicity in animals include hypertrophy in the adrenal cortex, changes in the pancreatic islets and the pituitary gland, weight gain, gastrointestinal hemorrhages, brain damage, swollen joints, anemia, low levels of hemoglobin, low hematocrit values, decreased numbers of leukocytes, morphological changes in red blood cells, reduced fetal weight, hair loss, and copper deficiency

(Dadiiska *et al.* 1985).

Benzo(a)anthracene

Benzo(a)anthracene was detected above the ecological screening criteria in sediments. Benzo(a)anthracene is a polycyclic aromatic hydrocarbon (PAH). PAHs are readily accumulated by most aquatic species at low concentrations in the environment, although uptake of PAHs is highly species specific. For instance, uptake is much higher in algae, mollusks, and other species incapable of metabolizing PAHs.

In sediments, PAHs may be biotransformed and biodegraded by benthic macroinvertebrate organisms in an oxygen-rich environment such as the Stillwater River. PAHs usually remain close to sites of deposition in aquatic environments.

PAHs have been shown to capable of causing liver neoplasia, tumors, hyperplastic diseases, destruction of hematopoietic and lymphoid tissues, ovotoxicity, antispermatogonic effects, adrenal necrosis, and changes in intestinal and respiratory epithelia in aquatic organisms (U.S. EPA 1980; Lee and Grant 1981).

4.4.3 Ecological Effects Assessment for Contaminants Without Screening Values

This section presents a discussion of ecological effects associated with contaminants for which no screening benchmark values were identified.

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) include the following contaminants for which no screening benchmarks were identified: acenaphthylene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, and 2-methylnaphthalene.

PAHs are persistent in the environment. PAHs are rapidly metabolized by most organisms and therefore do not biomagnify in food chains (Eisler 1987). Several species of organisms have been observed to have adverse biological effects on their survival, growth, metabolism, and tumor formation as a result of PAH exposure.

Plant leaves may absorb or assimilate PAHs, which can then enter the food chain. PAHs assimilated by plants may be translocated, metabolized, and possibly subjected to photodegradation

within a plant. In highly contaminated areas, assimilation can exceed metabolism and degradation, resulting in an accumulation in the plant tissues. Plants can also absorb PAHs from soils through their roots and translocate them to other parts of the plant such as developing shoots (Edwards 1983).

Inhalation, skin contact, and ingestion are all routes of exposure for PAHs into mammals. PAHs are poorly absorbed from the gastrointestinal tract. Elimination of PAHs and their metabolites is through the hepatobiliary system and the gastrointestinal tract (Simms and Overcash 1983). The cytochrome P-450-dependent mixed function oxidase system is responsible for initiating the metabolism of lipophilic organic compounds like PAHs. This enzyme is present in rodent tissues, human liver, skin, placenta, fetal liver, macrophages, lymphocytes, and monocytes and the intermediates it produces can be highly toxic, mutagenic, or carcinogenic to the host (Lo and Sandi 1978).

PAHs have been shown to be capable of causing tumors in the skin and most epithelial tissues of many animal species. Acute and chronic effects of PAH exposures include: destruction of hematopoietic and lymphoid tissues; ovotoxicity; antispermatogonic effects; adrenal necrosis; and changes in intestinal and respiratory epithelia (U.S. EPA 1980; Lee and Grant 1981).

4.4.4 Risk Characterization

The ecological risk associated with the low level of benzo(a)anthracene in sediment is likely low. The value detected in Stillwater River sediments (120 ug/kg) is only slightly above the ecological screening benchmark value of 108 ug/kg.

The levels of the inorganics, PCBs, and organic contaminant of ecological concern likely present a moderate risk to ecological receptors. While levels of these contaminants are high in certain areas on site, the greatest concentrations are believed to be associated with the barren land areas of the center of the site. These barren land areas are of little ecological importance, especially when compared to the adjacent northern riverine forest and Stillwater River. The greatest ecological risk associated with site soil contaminants is not contact with land receptors, but the potential migration of the contaminants to the Stillwater River where they may potentially impact its high-value ecological system. Many of the soil contaminants of ecological concern are particulate-bound and may migrate to the Stillwater River via runoff.

4.4.5 Uncertainty Assessment

There are several factors that contribute to the uncertainty related to the overall assessment of risk at the GRL site. These factors are discussed in detail below.

The surface water of the Stillwater River was not sampled and therefore, the pathway of site contaminants to surface water could not be evaluated in the SRE. based on the low levels of contaminants detected in sediment samples and the large volume of water in the Stillwater River, it is unlikely that high levels of COPC would be detected in surface water. However, the level of impact from the site to the Stillwater River can not be accurately assessed without actual sampling and analysis of surface water.

Nine of the COPC detected in surface soil samples do not have screening benchmark values available in literature. Therefore, the levels of these contaminants could not be screened to determine if the detected concentrations are above levels of ecological concern. This risk evaluation was unable to determine if these nine contaminants detected in soil are contaminants of ecological concern at the GRL site.

Only eight surface soil samples were collected on-site, and two background surface soil samples were collected in the vicinity of the site. The GRL site is approximately 15 acres. It is likely that the eight surface soil samples have not adequately characterized soil contamination at the site. As two site-specific background samples are not a sufficient number of samples to conduct statistical analysis, literature values were used for background comparisons of inorganic analytes. The values obtained from the literature apply to broad general areas, which introduces uncertainty. For most of the inorganic analytes, the general background values are lower than the site-specific values. Therefore, it is unlikely that the use of general background levels for inorganics in soil is less stringent than using the actual data from the two samples.

Future land use at the GRL site is not known, and, therefore, the future of site habitats is not known. It is possible that the old field and barren land areas could revert to habitats of moderate ecological value if left undisturbed for a long period of time.

4.5 Conclusions

Although several contaminants in soil are present above ecological concern levels, the low contaminant concentrations in sediments and the high quality fish and benthic macroinvertebrate analysis

results from the Stillwater River indicate that GRL site soil contaminants are not negatively impacting the ecology of the Stillwater River. The Stillwater River is an ecologically significant habitat and preventing site impacts to it should be made a top priority for the selection of remedial alternatives for the GRL site.

It is important to prevent the contaminants in soils from reaching the Stillwater River. Future actions at the site should take into account the ecological importance of the northern riverine forest as a crucial riparian zone to the Stillwater River and every effort should be made to limit the disturbance to this crucial habitat.

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TABLES

Table 3-1

CONTAMINANT SCREENING OF SURFACE SOILS
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for Non-detects	Range of Detected Concentrations	Reported Off-Site Sample Concentrations	Risk-Based Concentration (RBC)	Number of Samples Exceeding RBC
Metals and Cyanide (mg/kg)							
Aluminum	12/12	100	--	3,500-14,000	11,300/13,000	77,000	0
Arsenic	12/12	100	--	3.9-11	1.09/15.6	0.38	12
Barium	12/12	100	--	41-2,400	72.5/80.2	5,300	--
Beryllium	12/12	100	--	0.19-0.67	0.77 B/0.74 B	0.14	12
Cadmium	12/12	100	--	0.33-14	2.8/2.0	38	0
Calcium	12/12	100	--	24,000-130,000	1,850/3,260	--	--
Chromium	12/12	100	--	6.1-79	14.4/15.5	210	0
Cobalt	12/12	100	--	2.4-7.9	9.4 B/10.3 B	4,600	0
Copper	12/12	100	--	11-70	ND/ND	2,800	0
Cyanide	7/12	58	0.1	0.1-12	NA	1,300	0
Iron	12/12	100	--	8,000-29,000	18,200/19,200	--	--
Lead	12/12	100	--	15-1,100	29.8/35.3	400	8
Magnesium	12/12	100	--	13,000-62,000	2,200/2,270	--	--
Manganese	12/12	100	--	190-600	745/820	3,200	0
Mercury	4/12	33	0.10-0.20	0.19-0.66	ND/ND	--	--
Nickel	12/12	100	--	11-190	17.1/17.4	1,500	0
Potassium	12/12	100	--	500-2,100	844 B/977 B	--	--
Selenium	3/12	25	0.28-0.54	0.36-0.56	NA	380	0

End of table.

Table 3-1

CONTAMINANT SCREENING OF SURFACE SOILS
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for Non-detects	Range of Detected Concentrations	Reported Off-Site Sample Concentrations	Risk-Based Concentration (RBC)	Number of Samples Exceeding RBC
Sodium	12/12	100	--	110-230	ND/133 B	--	--
Vanadium	12/12	100	--	7.3-27	28.4/33.2	540	--
Zinc	12/12	100	--	42-1,000	63.2 EJ/76.2 EJ	23,000	0
Volatile Organics (ug/kg)							
Acetone	8/12	75	10	10,500-125,000	ND/ND	2,100,000	0
1,2-Dichloroethene (total)	2/12	16	5-20	48.4-1,280	ND/ND	35,000	0
Methylene chloride	5/12	42	5	4.4-40	ND/ND	78,000	0
Toluene	2/12	16	5-20	2.9-3.4	ND/ND	7,900,000	0
Trichloroethene	6/12	50	5-20	2.9-51.0	ND/ND	32,000	0
Semivolatile Organics (ug/kg)							
Acenaphthene	1/12	8	330-3,300	280	ND/ND	1,100,000	0
Acenaphthylene	1/12	8	330-3,300	270	ND/ND	--	--
Anthracene	2/12	16	330-3,300	290-620	ND/ND	57,000	0
Benzoic acid	1/12	8	660-6,600	4,420	ND/ND	1,100,000	0
Benzo(a)anthracene	3/12	25	330-3,300	230J-1460	ND/ND	610	1
Benzo(b)fluoranthene	3/12	25	330-3,300	170-1,020	ND/ND	610	1
Benzo(k)fluoranthene	3/12	25	330-3,300	210-1,210	ND/ND	6,100	0
Benzo(a)pyrene	3/12	25	330-3,300	200-1,160	ND/ND	61	3

Key at end of table.

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CONTAMINANT SCREENING OF SURFACE SOILS
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for Non-detects	Range of Detected Concentrations	Reported Off-Site Sample Concentrations	Risk-Based Concentration (RBC)	Number of Samples Exceeding RBC
Benzo(ghi)perylene	2/12	16	330-3,300	110-570	ND/ND	--	--
Bis(2-ethylhexyl)phthalate	7/12	58	330	310J-18,700	ND/ND	32,000	0
Butyl benzylphthalate	1/12	8	330-3,300	700	ND/ND	9,300,000	0
Chrysene	3/12	25	330-3,300	230J-1,540	ND/ND	72,000	0
Di-n-butylphthalate	5/12	42	330-3,300	450-4,620	ND/ND	6,500,000	0
Fluoranthene	3/12	25	330-3,300	490-3,610	ND/ND	2,600,000	0
Fluorene	1/12	8	330-3,300	280	ND/ND	900,000	0
Indeno(1,2,3-cd) pyrene	2/12	16	330-3,300	100J-560	ND/ND	610	0
Isophorone	1/12	8	330	9,140	ND/ND	470,000	0
2-Methylnaphthalene	2/12	16	330-3,300	200-340	ND/120J	2,400,000[b]	0
Phenanthrene	3/12	25	330-3,300	300J-2,630	ND/ND	--	--
Pyrene	5/12	42	330-3,300	110-3,330	ND/ND	100,000	0
Pesticides/PCBs							
Aroclor 1248	1/12	8	80-400	6,100	ND/ND	--	--
Aroclor 1254	6/12	50	80	110-5,000	ND/ND	--	--
4,4'-DDD	2/12	16	8-40	48-90	ND/12.5	1,900	0
Dieldrin	4/12	33	8-40	13-64	ND/150	28	2

end of table.

[a] Reported off-site soil sample data are from samples collected by PRC during FIT investigation in 1993 (SS-05 and SS-06).

Key:

B = For inorganics, indicates that reported result is estimated. For organics, indicates that compound was also detected in blank sample.
mg/kg = Milligrams per kilogram.
ug/kg = Micrograms per kilogram.
ND = Not detected at method detection limit.
NA = Not analyzed.
PCB = Polychlorinated biphenyl.
-- = Not applicable
b = RBC for naphthalene used as a surrogate.

Key at end of table.

Table 3-2

CONTAMINANT SCREENING OF RIVER SEDIMENT
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for non-detects	Range of Detected Concentrations	Average Upstream Sample Concentration[a]	Risk-Based Concentration (RBC)	Number of Samples Exceeding RBC
Metals and Cyanide (mg/kg)							
Aluminum	7/7	100	--	1,250-11,000	8,220	77,000	0
Arsenic	7/7	100	--	2.5-7.7	6.5	0.37	7
Barium	5/7	71	20.0	34.3-135	78	5,300	0
Beryllium	3/7	43	1	0.37-0.64 B	0.33	0.14	3
Cadmium	2/7	29	0.5-1	0.58B-0.71B	0.38	38	0
Calcium	7/7	100	1,000	38,000-81,700	37,700	-	-
Chromium	7/7	100	2	3-14.6	11.2	210	0
Cobalt	3/7	43	5-10	5.0 B-6.8 B	3.1	4,600	0
Copper	6/7	86	2.5-5	2.8-28.0	15.1	2,800	0
Cyanide	3/7	43	0.50-10	26.7-80.1	40.1	1,300	0
Iron	7/7	100	20	3,410 B-16,600	12,295	-	-
Lead	12/12	100	0.6	2.2-34.3	11.6	400	0
Magnesium	7/7	100	1,000	10,000-35,600	12,100	-	-
Manganese	7/7	100	3	149-560	350	3,200	3
Mercury	1/9	11	0.08-0.1	0.08	0.045	--	--
Nickel	5/7	71	4.0-8	5.6-16.4	13.4	1,500	0
Potassium	4/7	57	500-1,000	508-1,560	1,057	-	-
Silver	3/7	43	1-2	0.7 B-1.2 B	0.65	380	0

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Table 3-2

CONTAMINANT SCREENING OF RIVER SEDIMENT
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for non-detects	Range of Detected Concentrations	Average Upstream Sample Concentration[a]	Risk-Based Concentration (RBC)	Number of Samples Exceeding RBC
Sodium	3/7	43	500-1,000	235 B-277 B	199	-	-
Vanadium	6/7	86	5-10	5.2-24.1	18.2	540	0
Zinc	7/7	100	4	13.6-66.3	51.7	23,000	0
Volatile Organics (µg/kg)							
Acetone	1/4	25	50	15 J	25	2,100,000	0
Semivolatile Organics (µg/kg)							
Benzo(a)anthracene	1/12	8	330	120 J	193	610	0
Benzo(b)fluoranthene	1/12	8	330	210 J	153	610	0
Bis(2-ethylhexyl)phthalate	1/9	11	330	200 J	217	32,000	0
Chrysene	1/12	8	330	110 J	193	7,200	0
Fluoranthene	4/12	33	330	36 J-340 J	172	2,600,000	0
Fluorene	1/12	8	330	150 J	193	90,000	0
Phenanthrene	3/12	25	330	48 J-390 J	193	--	--
Pyrene	4/12	33	330	35 J-380 J	178	100,000	0
Pesticides/PCBs (µg/kg)							
Aroclor 1221	1/9	11	33-66	36	42	--	0

[a] Background values are expressed as the mean of the upstream samples from each of the three sets of data. For non-detects, half the quantitation limit was used.

Key at end of table.

Key:

mg/kg = Milligrams per kilogram.
µg/kg = Micrograms per kilogram.
PCB = Polychlorinated biphenyl.
b = RBC for naphthalene used.

Ke[illegible]nd of table.

Table 3-3

CHEMICALS OF POTENTIAL CONCERN IN SOIL AND SEDIMENT
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Chemical	Media	
	Surface Soil	Sediment
Aroclor 1221		X
Aroclor 1248	X	
Aroclor 1254	X	
Arsenic	X	X
Beryllium	X	X
Benzo(a)anthracene	X	X
Benzo(a)pyrene	X	
Benzo(b)fluoranthene	X	X
Benzo(k)fluoranthene	X	
Bis(2-ethylhexyl)phthalate	X	X
Benzo(g,h,i)perylene	X	
Dieldrin	X	
Indeno(1,2,3-cd)pyrene	X	
Lead	X	X
Mercury	X	X
Methylene Chloride	X	
Phenanthrene	X	X
Trichloroethene	X	

Table 3-4

CONTAMINANT SCREENING OF GROUNDWATER
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Parameter	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for Non-detects	Range of Detected Concentrations	Upgradient Well Concentration[a]	Health-Based Criteria for Drinking Water	Number of Samples Exceeding Criteria
Metals (mg/L)							
Arsenic	1/9	11	0.10	0.0422	ND	0.05[b]	0
Barium	2/9	22	0.20	0.69-0.78	ND	2[b]	0
Calcium	9/9	100	--	73.1-138	87	--	-
Iron	2/9	22	0.10	4.9-23.5	ND	--	-
Magnesium	9/9	100	--	25.2-82.2	32.6	--	-
Manganese	7/9	78	0.015	0.012-0.56	ND	0.2[c]	2
Nickel	1/9	11	0.040	0.065	ND	0.10[b]	0
Potassium	1/9	11	5.0	30.0	ND	--	-
Sodium	8/9	89	5.0	5.1-44.9	ND	--	-
Zinc	1/9	11	0.50	0.10	ND	3[e]	0
Volatile Organics (ug/L)							
Acetone	2/9	22	50-500	27-31	ND	3,500[c]	0
Benzene	1/9	11	5-50	3.3	ND	5[b]	0
1,2-Dichloroethene (total)	7/9	78	5.0	3.0-960	ND	cis - 70[b] trans - 100[b]	4
4-Methyl-2-pentanone	1/9	11	50-500	15	ND	160[f]	0
Toluene	1/9	11	5-50	21	ND	1,000[b]	0
Trichloroethene	6/9	67	5-10	11-500	ND	5[b]	6
Vinyl chloride	3/9	33	57-120	27-120	ND	2[b]	3
Semivolatile Organics (ug/L)							
Bis(2-ethylhexyl)phthalate	1/9	11	10	8.2	ND	4.8[b]	1

Table 3-4

CONTAMINANT SCREENING OF GROUNDWATER
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Parameter	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits for Non-detects	Range of Detected Concentrations	Upgradient Well Concentration[a]	Health-Based Criteria for Drinking Water	Number of Samples Exceeding Criteria
2,4-Dimethylphenol	1/9	11	10	4.6	ND	730[b]	0
4-Methylphenol	1/9	11	10	19	ND	180[b]	0
Phenol	1/9	11	10	3.2	ND	6[e]	0

a Upgradient well concentration taken from well S-1.

Key:

mg/L = Milligrams per liter.
ug/L = Micrograms per liter
b = Maximum Contaminant Level
c = Drinking Water Equivalent Level
d = Maximum Contaminant Level Goal
e = Longer-term Health Advisory (Child)
f = Risk Based Concentration (equivalent to 1×10^{-6} cancer risk or hazard quotient of 1)

Table 3-5

CANCER RISKS AND HAZARD INDICES CORRESPONDING TO SAMPLE QUANTITATION LIMIT FOR AROCLOR 1254 IN FISH TISSUE SAMPLES FROM THE STILLWATER RIVER

Intake Equation:

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

where:

Cf = Chemical concentration in fish (mg/kg)
IR = Ingestion Rate (kg/day) Average Daily Fish Consumption
FI = Fraction of fish consumption from contaminated source (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (events/year)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
Cf	Child/Adult	RME	0.049 mg/kg (sample quantitation limit for Aroclor 1254)
IR	Child/Adult	RME	0.054 kg/day (Average daily consumption; EPA 1991a)
FI	Child/Adult	RME	0.5 (assumed)
EF	Child/Adult	RME	350 days/year (EPA 1991a)
ED	Child Adult	RME RME	6 years (entire duration of age group) 24 years (adult portion of time spent at one residence)
BW	Child Adult	RME RME	15 kg (average body weight for age group; EPA 1989a) 70 kg (average; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)
Cancer Slope Factor (SF)	Child/Adult	–	2.0 (mg/kg-day)
Oral Reference Dose (RfD)	Child/Adult	–	2.0 E-5 (mg/kg-day)
Estimated Cancer Risk (Intake x SF)	Child Adult Cumulative	RME	**1.4 E-5** **1.2 E-5** **2.6 E-5**
Estimated Non-cancer Risk (Intake/RfD)	Child Adult Cumulative	RME	**4.2** **0.91** **5.11**

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-6

EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL AND SEDIMENT STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Chemical	EPC (mg/kg)	
	Surface Soil	Sediment
Aroclor 1221	–	36
Aroclor 1248	6.1	–
Aroclor 1254	5	–
Arsenic	11	7.7
Beryllium	0.67	0.64
Benzo(a)anthracene	1.5	0.12
Benzo(a)pyrene	1.2	–
Benzo(b)fluoranthene	1	0.21
Benzo(k)fluoranthene	1.2	–
Bis(2-ethylhexyl)phthalate	19	0.21
Benzo(g,h,i)perylene	0.57	–
Dieldrin	0.064	–
Indeno(1,2,3-cd)pyrene	0.56	–
Lead	1,100	34
Mercury	0.66	0.08
Methylene Chloride	0.04	–
Phenanthrene	2.6	0.39
Trichloroethene	0.051	–

Key:

— = Not applicable.

Table 3-7

CURRENT TRESPASSER SCENARIO: INCIDENTAL INGESTION OF ON-SITE SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
IR = Ingestion Rate (mg soil/day)
FI = Fraction ingested from contaminated source (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Exposure point concentration in soil.
IR	Adolescent	RME	100 mg/day (age groups greater than 6 years old; EPA 1991a)
FI	Adolescent	RME	1.0 (assumes all of ingested soil is from the site).
EF	Adolescent	RME	48 days/year (see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989a)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-8

CURRENT TRESPASSER SCENARIO: DERMAL CONTACT WITH SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Soil to skin adherence factor (mg/cm^2)
ABS = Absorption factor (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Exposure point concentration in soil
SA	Adolescent	RME	3,313 (average total skin area for males ages 8-16, × 25%; EPA 1992)
AF	Adolescent	RME	1.0 mg/cm^2 (EPA 1992)
ABS	Adolescent	RME	Chemical-specific value (see text) (EPA 1992)
EF	Adolescent	RME	48 days/year (see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989a)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-9

CURRENT TRESPASSER SCENARIO: INHALATION OF PARTICULATES FROM SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times ED \times EF \times IR_{air} \times (1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
IR_{air} = Inhalation rate (m^3/day)
PEF = Particulate Emission Factor (mg^3/kg)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Chemical concentration in soil
IR_{air}	Adolescent	RME	20 m^3/day (EPA 1991a)
PEF	Adolescent	RME	1.3×10^{-9} m^3/kg (calculated: EPA 1991b)
EF	Adolescent	RME	8 days/year (48 days per year adjusted for portion of day spent on site [16%] see text)
ED	Adolescent	RME	8 years (entire duration of age group: see text)
BW	Adolescent	RME	42 kg (average body weight for age group: EPA 1989a)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-10

CURRENT TRESPASSER SCENARIO: INHALATION OF VAPORS FROM SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times ED \times EF \times IR_{air} \times (1/VF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
IR_{air} = Inhalation rate (m^3/day)
VF = Soil-to-Air volatilization factor (mg^3/kg)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Adolescent	RME	Chemical concentration in soil
IR_{air}	Adolescent	RME	20 m^3/day (EPA 1991a)
VF	Adolescent	RME	Chemical specific
EF	Adolescent	RME	8 days/year (48 days per year adjusted for portion of day spent on site [16%] see text)
ED	Adolescent	RME	8 years (entire duration of age group; see text)
BW	Adolescent	RME	42 kg (average body weight for age group; EPA 1989a)
AT	Adolescent	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-11

CURRENT RECREATIONAL SCENARIO: INCIDENTAL INGESTION OF SEDIMENT STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in sediment (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
IR = Ingestion Rate (mg soil/day)
FI = Fraction ingested from contaminated source (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Exposure point concentration in sediment.
IR	Child	RME	200 mg/day (children 0-6 years old; EPA 1991a)
	Adult	RME	100 mg/day (age groups greater than 6 years old: EPA 1991a)
FI	Child/Adult	RME	1.0 (assumes all of ingested sediment is from the site).
EF	Child	RME	72 days/year (see text)
	Adult	RME	48 days/year
ED	Child	RME	6 years (entire duration of age group; see text)
	Adult	RME	24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult	RME	70 kg (average: EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-12

CURRENT RECREATIONAL SCENARIO: DERMAL CONTACT WITH SEDIMENT STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in sediment (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Soil to skin adherence factor (mg/cm^2)
ABS = Absorption factor (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Exposure point concentration in sediment
SA	Child	RME	1,750 cm^2 (average total skin area for child ages 2-6, × 25%; EPA 1992)
	Adult		5,000 cm^2 (average total skin area for an adult, × 25%; EPA 1992)
AF	Child/Adult	RME	1.0 mg/cm^2 (EPA 1992)
ABS	Child/Adult	RME	Chemical-specific value (see text) (EPA 1992)
EF	Child	RME	72 days/year (see text)
	Adult		48 days/year
ED	Child	RME	6 years (entire duration of age group; see text)
	Adult	RME	24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult	RME	70 kg (average; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-13

FUTURE RECREATIONAL USE SCENARIO: INCIDENTAL INGESTION OF ON-SITE SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
IR = Ingestion Rate (mg soil/day)
FI = Fraction ingested from contaminated source (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Exposure point concentration in soil.
IR	Child	RME	200 mg/day (children 0 to 6 years old; EPA 1991a)
	Adult	RME	100 mg/day (age groups greater than 6 years old; EPA 1991a)
FI	Child/Adult	RME	1.0 (assumes all of ingested soil is from the source).
EF	Child	RME	72 days/year (see text)
	Adult	RME	48 days/year
ED	Child	RME	6 years (entire duration of age group; see text)
	Adult		24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult	RME	70 kg (average; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-14

FUTURE RECREATIONAL USE SCENARIO: DERMAL CONTACT WITH SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

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

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Soil to skin adherence factor (mg/cm^2)
ABS = Absorption factor (unitless)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Exposure point concentration in soil
SA	Child	RME	1,750 cm^2 (average total skin area for child ages 2-6, × 25%; EPA 1992)
	Adult	RME	5,000 cm^2 (average total skin area for an adult, × 25%; EPA 1992)
AF	Child/Adult	RME	1.0 mg/cm^2 (EPA 1992)
ABS	Child Adult	RME	Chemical-specific value (see text) (EPA 1992)
EF	Child	RME	72 days/year (see text)
	Adult	RME	48 days/year
ED	Child	RME	6 years (entire duration of age group; see text)
	Adult	RME	24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult	RME	70 kg (average; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-15

FUTURE RECREATIONAL USE SCENARIO: INHALATION OF PARTICULATES FROM SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times ED \times EF \times IR_{air} \times (1/PEF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
IR_{air} = Inhalation rate (m^3/day)
PEF = Particulate Emission Factor (mg^3/kg)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Chemical concentration in soil
IR_{air}	Child/Adult	RME	20 m^3/day (EPA 1991a)
PEF	Child/Adult	RME	1.3×10^{-9} m^3/kg (calculated)
EF	Child	RME	18 days/year (see text)
	Adult	RME	12 days/year
ED	Child	RME	6 years (entire duration of age group; see text)
	Adult	RME	24 years (adult portion of time spent at one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult	RME	70 kg (average; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-16

FUTURE RECREATIONAL USE SCENARIO: INHALATION OF VAPORS FROM SOIL STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Equation:

$$Intake\ (mg/kg\text{-}day) = \frac{CS \times ED \times EF \times IR_{air} \times (1/VF)}{BW \times AT}$$

where:

CS = Chemical concentration in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
IR_{air} = Inhalation rate (m^3/day)
VF = Soil-to-Air volatilization factor (mg^3/kg)
BW = Body weight (kg)
AT = Averaging time (days)

Variable	Receptor	Case	Value (Rationale/Source)
CS	Child/Adult	RME	Chemical concentration in soil
IR_{air}	Child/Adult	RME	20 m^3/day (EPA 1991a)
VF	Child/Adult	RME	Chemical specific
EF	Child	RME	18 days/year (see text)
	Adult		12 days/year
ED	Child	RME	6 years (entire duration of age group)
	Adult		24 years (adult portion of time spent a t one residence)
BW	Child	RME	15 kg (average body weight for age group; EPA 1989a)
	Adult		70 kg (average body weight; EPA 1989a)
AT	Child/Adult	RME	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED × 365 days/year) and 70-year lifetime for carcinogenic effects (i.e., 70 years × 365 days/year) (EPA 1989a)

Key:

EPA = United States Environmental Protection Agency.
RME = Reasonable maximum exposure.

Table 3-17

WEIGHT-OF-EVIDENCE CATEGORIES FOR CHEMICAL CARCINOGENICITY STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Group	Description
A	Human Carcinogen
B	Probable Human Carcinogen: B1: Limited human data are available. B2: Sufficient evidence in animals or no evidence in humans.
C	Possible Human Carcinogen
D	Not Classifiable
E	Evidence of Noncarcinogenicity for Humans

Source: EPA 1986c.

Table 3-18

SUMMARY OF TOXICITY INFORMATION FOR CARCINOGENS
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
GARLAND ROAD LANDFILL SITE

Chemical	Carcinogenicity Classification	Route	Slope Factor (mg/kg/day)	Target Organ	Tumor Type	Species	Exposure Route	Source
PCBs	B2	Oral/Inhalation	2.0 E+0[a] 4.0 E-1[b]	Liver	Tubercular carcinomas	Rat	Diet	IRIS
Arsenic	A	Oral Inhalation	1.5 E+0 1.5 E+1	Skin Lung	Tumors Lung cancer	Human	Drinking water Inhalation	IRIS
Beryllium	B2	Inhalation Oral	8.4 E+0 4.3 E+0	Lung Whole body	Lung tumors gross-all sites	Human Rat	Inhalation Drinking water	IRIS IRIS
Benzo(b)fluoranthene	B2	Inhalation Oral	6.1 E+0 7.3 E-1	-- --	--	--	--	HEAST NCEA
Benzo(k)fluoranthene	B2	Inhalation Oral	6.1 E+0 7.3 E-2	-- --	--	--	--	HEAST NCEA
Benzo(a)pyrene	B2	Inhalation Oral	6.1 E+0 7.3 E+0	Respiratory Tract Forestomach	-- Squamous cell carcinoma	Hamster Mice	Inhalation Diet	HEAST IRIS
Bis(2-ethylhexyl)phthalate	B2	Inhalation Oral	1.4 E-2 1.4 E-2	-- Liver	-- hepatocellular carcinoma and adenoma	Mouse Mouse	-- Diet	Oral SF IRIS

Table 3-18

SUMMARY OF TOXICITY INFORMATION FOR CARCINOGENS
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
GARLAND ROAD LANDFILL SITE

Chemical	Carcinogenicity Classification	Route	Slope Factor (mg/kg/day)	Target Organ	Tumor Type	Species	Exposure Route	Source
Dieldrin	B2	Inhalation	1.6 E+1	Liver	--	--	--	IRIS
		Oral	1.6 E+1	Liver	Carcinoma	Mouse	Diet	IRIS
Indeno(1,2,3-cd)pyrene	B2	Inhalation	6.1 E+0	--	--	--	--	NCEA
		Oral	7.3 E-1	--	--	--	--	NCEA
Methylene Chloride	B2	Inhalation	1.6 E-3	Lung	--	Rat	Inhalation	IRIS
		Oral	7.5 E-3	Liver	--	Rat	Diet	IRIS
Trichloroethene	B2	Inhalation	6.0 E-3	Lung	--	Rat	Inhalation	NCEA
		Oral	1.1 E-2	Liver, Kidney	--	Rat	Diet	NCEA

[a]
[b] Upper end SF used for soil, sediment, and food chain exposure, and dermal contact (when absorption factors are used).
SF used for inhalation exposures, ingestion of water soluble congeners, or dermal exposure when no absorption factor is used.

Key:

IRIS = United States Environmental Protection Agency, Integrated Risk Information System, entries on line as of July 1995.
HEAST = EPA's Health Effects Assessment Summary Tables
NCEA = EPA's National Center for Environmental Assessment
mg/kg/day = Milligrams per kilogram per day.

Table 3-19

SUMMARY OF TOXICITY INFORMATION FOR NONCARCINOGENS
STREAMLINED HUMAN HEALTH RISK ASSESSMENT
GARLAND ROAD LANDFILL SITE

Chemical	Route	RfD Type	RfD (mg/kg/day)	Uncertainty Factor	Modifying Factor	Confidence Level	Target Organ	Critical Effect	Source
Aroclor 1254	Inhalation	Chronic	2.0 E-05	--	--	--	--	Decreased antibody response	Oral RfD
	Oral		2.0 E-05	300	1	Medium	--	Decreased antibody response	IRIS
Arsenic	Inhalation	Chronic	3.0 E-04	--	--	--	Skin	Hyperpigmentation, keratosis, and possible vascular complications	Oral RfD
	Oral		3.0 E-04	3	1	Medium	Skin		IRIS
Beryllium	Inhalation	Chronic	5.0 E-3	--	--	--	--	No adverse effects	Oral RfD
	Oral	Chronic	5.0 E-3	100	1	Low	--	No adverse effects	IRIS
Bis(2-ethylhexyl) phthalate	Inhalation	Chronic	5.7 E-2	100	--	Low	Fetus	Developmental toxicity	NCEA
	Oral	Chronic	2 E-2	1000	1	Medium	Liver	Increased liver weight	IRIS
1,2-Dichloro ethene	Inhalation	Chronic	9.0 E-3	--	--	--	Liver	Lesions	Oral RfD
	Oral	Chronic	9.0 E-3	1000	--	--	Liver	Lesions	HEAST
Dieldrin	Inhalation	Chronic	5.0 E-5	--	--	--	Liver	Lesions	Oral RfD
	Oral	Chronic	5.0 E-5	100	1	Medium	Liver	Lesions	IRIS
Manganese	Inhalation	Chronic	1.4 E-5	1000	1	Medium	--	Impairment of neurobehavioral function	IRIS
	Oral	Chronic	1.4 E-1	1	1	Medium	--	CNS effects	IRIS

Key:

— = Information not available.
DI = Data insufficient.
RfD = Reference dose.
IRIS = United States Environmental Protection Agency, Integrated Risk Information System, entries on line as of September 1995.
HEAST = United States Environmental Protection Agency, Health Effects Assessment Summary Tables, Annual Update, FY 1994.

Table 3-20

SUMMARY OF ESTIMATED EXCESS CANCER RISKS STREAMLINED HUMAN HEALTH RISK EVALUATION GARLAND ROAD LANDFILL SITE

Receptor	Total Risk	Exposure Medium	Risk Contribution by Exposure Route	Significant Risk Contribution by Chemical
Site Trespasser	3.9×10^{-6}	Surface Soil	Incidental ingestion - 49.4% Dermal contact - 50.5% Inhalation - 0.1%	Aroclor 1248 - 34% Aroclor 1254 - 27%
Current Recreational User	5.0×10^{-6}	Sediment	Incidental ingestion - 85% Dermal contact - 15%	Arsenic - 79%
Future Recreational User	2.4×10^{-5}	Surface Soil	Incidental ingestion - 64.3% Dermal contact - 35.6% Inhalation - 0.1%	Arsenic - 24% Aroclor 1248 - 31% Aroclor 1254 - 25% Benzo(a)Pyrene - 10%

Table 3-21

**SUMMARY OF ESTIMATED HAZARD INDICES FOR NONCARCINOGENIC EFFECTS
STREAMLINED HUMAN HEALTH RISK EVALUATION
GARLAND ROAD LANDFILL SITE**

Receptor	Total Hazard Index	Hazard Quotients Greater than 1 by Chemical	Risk Contribution by Exposure Route	Significant Risk Contribution by Medium
Site Trespasser	0.25	None	Incidental ingestion - 35.7% Dermal contact - 63.8% Inhalation - 0.4%	Surface Soil - 100%
Current Recreational User (child)	0.07	None	Incidental ingestion - 92% Dermal contact - 8%	Sediment - 100%
Current Recreational User (adult)	0.01	None	Incidental ingestion - 67% Dermal contact - 33%	Sediment - 100%
Future Recreational User (child)	1.1	Aroclor 1254 - 1.02	Incidental ingestion - 67.5% Dermal contact - 31.9% Inhalation - 0.6%	Surface Soil - 100%
Future Recreational User (adult)	0.2	None	Incidental ingestion - 26.9% Dermal contact - 72.6% Inhalation - 0.5%	Surface Soil - 100%

Table 4-1

FISH REPORTED IN THE STILLWATER RIVER IN THE VICINITY OF THE GARLAND ROAD LANDFILL SITE BY OHIO ENVIRONMENTAL PROTECTION AGENCY (OEPA)

Common Name	Scientific Name
Gizzard Shad	*Dorosoma cepedianum*
Quillback Carpsucker	*Carpiodes cyprinus*
Black Redhorse	*Moxostoma duquesnei*
Golden Redhorse	*Moxostoma erythrurum*
Shorthead Redhorse	*Moxostoma macrolepidotum*
River Redhorse	*Moxostoma carinatum*
Northern Hog Sucker	*Hypentelium nigricans*
White Sucker	*Catostomus commersoni*
Spotted Sucker	*Minytrema melanops*
Common Carp	*Cyprinus carpio*
Golden Shiner	*Notemigonus crysoleucas*
River Chub	*Nocomis micropogon*
Creek Chub	*Semotilus thoreauianus*
Silver Shiner	*Notropis shumardi*
Rosyface Shiner	*Notropis rubellus*
Striped Shiner	*Luxulus chrysocephalus*
Spotfin Shiner	*Notropis spilopterus*
Sand Shiner	*Notropis stramineus*
Bluntnose Minnow	*Pimephales notatus*
Central Stoneroller	*Campostoma anomalum*
Channel Catfish	*Ictalurus punctatus*
Yellow Bullhead	*Ictalurus natalis*
Brown Bullhead	*Ictalurus nebulosus*
Black Bullhead	*Ictalurus melas*
Stonecat Madtom	*Notorus flavus*
White Crappie	*Pomoxis annularis*
Rock Bass	*Ambloplites rupestris*
Smallmouth Bass	*Micropterus dolomieui*

Table 4-1

FISH REPORTED IN THE STILLWATER RIVER IN THE VICINITY OF THE GARLAND ROAD LANDFILL SITE BY OHIO ENVIRONMENTAL PROTECTION AGENCY (OEPA)

Common Name	Scientific Name
Largemouth Bass	*Micropterus salmoides*
Green Sunfish	*Lepomis cyanellus*
Bluegill Sunfish	*Lepomis macrochirus*
Orangespotted Sunfish	*Lepomis humilis*
Longear Sunfish	*Lepomis megalotis*
Green Sunfish X Bluegill	*Lepomis cyanellus X macrochirus*
Longear Sunfish X Bluegill	*Lepomis meggalotis X macrochirus*
Blackside Darter	*Percina maculata*
Logperch	*Percina caprodes*
Johnny Darter	*Etheostoma nigrum*
Greenside Darter	*Etheostoma blennioides*
Banded Darter	*Etheostoma zonale*
Rainbow Darter	*Etheostoma caeruleum*

Source: OEPA 1995

Table 4-2

VEGETATION OBSERVED AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat
Eastern Sycamore	*Platanus occidentalis*	OF,NRF
Common Mullein	*Verbascum thapsis*	OF
Sugar Maple	*Acer saccharum*	OF,NRF
Red Maple	*Acer rubrum*	OF,NRF
Silver Maple	*Acer saccharinum*	NRF
Goldenrod species	*Solidago* spp.	OF
Flowering Dogwood	*Cornus florida*	OF
Tree-of-Heaven	*Ailanthus altissima*	OF
Eastern Cottonwood	*Populus deltoides*	OF,NRF
Queen Anne's Lace	*Daucus carota*	OF
Paper Birch	*Betula papyrifera*	OF
Eastern Redcedar	*Juniperus virginiana*	OF
Tartarian Honeysuckle	*Lonicera tatarica*	OF
Black Willow	*Salix nigra*	OF,NRF
Beggar Ticks	*Bidens frondosa*	OF
Swamp White Oak	*Quercus bicolor*	NRF
Northern Hackberry	*Celtis occidentalis*	NRF

Key:

OF = Old Field
NRF = Northern Riverine Forest

Table 4-3

BIRDS OBSERVED OR POTENTIALLY EXISTING AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat	Season	Observed
American Crow	*Corvus brachyrhynchos*	OF,NRF	Y	X
Dark-eyed Junco	*Junco hyemalis*	OF	W	X
Song Sparrow	*Melospiza melodia*	OF	Y	X
Northern Cardinal	*Cardinalis cardinalis*	OF	Y	X
Downy Woodpecker	*Picoides pubescens*	OF,NRF	Y	X
Northern Mockingbird	*Mimus polyglottos*	OF,NRF	Y	X
Pileated Woodpecker	*Dryocopus pileatus*	NRF	Y	X
Belted Kingfisher	*Cervle alcyon*	NRF,SR	Y	X
Tufted Titmouse	*Parus bicolor*	OF	Y	X
Rufous-sided Towhee	*Pipilo erythrophthalmus*	OF,NRF	Y	X
Purple Finch	*Carpodacus purpureus*	OF	W	X
White-breasted Nuthatch	*Sitta carolinensis*	OF	Y	X
Carolina Chickadee	*Parus carolinensis*	OF	Y	X
Turkey Vulture	*Cathartes aura*	OF	S	X
Mallard	*Anas platyrhynchos*	SR	Y	
Canada Goose	*Branta canadensis*	SR	Y	
Great Blue Heron	*Ardea herodias*	SR	S	
Green-backed Heron	*Butorides striatus*	NRF	S	
Mourning Dove	*Zenaida macroura*	OF	Y	
Wood Duck	*Aix sponsa*	SR	S	
Spotted Sandpiper	*Actitis macularia*	SR	S	
Killdeer	*Charadrius vociferus*	OF	Y	
Red-tailed Hawk	*Buteo jamaicensis*	OF,NRF	Y	
Brown-headed Cowbird	*Molothrus ater*	OF	Y	
Chipping Sparrow	*Spizella passerina*	OF,NRF	S	
Field Sparrow	*Spizella pusilla*	OF	Y	
Common Grackle	*Quiscalus quiscula*	OF	Y	
Eastern Meadowlark	*Sturnella magna*	OF	Y	

Table 4-3

BIRDS OBSERVED OR POTENTIALLY EXISTING AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat	Season	Observed
Gray Catbird	*Dumetella carolinensis*	OF	S	
Brown Thrasher	*Toxostoma rufum*	OF	S	
American Robin	*Turdus migratorius*	OF	S	
Blue-gray Gnatcatcher	*Polioptila caerulea*	OF.NRF	S	
Hairy Woodpecker	*Picoides villosus*	OF.NRF	Y	
Red-bellied Woodpecker	*Melanerpes carolinus*	NRF	Y	
European Starling	*Sturnus vulgaris*	OF	Y	
Great-crested Flycatcher	*Myiarchus crinitus*	OF.NRF	S	
Northern Flicker	*Colaptes auratus*	NRF	Y	
Golden-crowned Kinglet	*Regulus satrapa*	OF.NRF	W	
Eastern Bluebird	*Sialia sialis*	OF.NRF	Y	
Red-eyed Vireo	*Vireo olivaceus*	OF.NRF	S	
American Redstart	*Setophaga ruticilla*	OF.NRF	S	
Scarlet Tanager	*Piranga olivacea*	OF.NRF	S	
Indigo Bunting	*Passerina cyanea*	OF.NRF	S	
Orchard Oriole	*Icterus spurius*	OF.NRF	S	
Northern Oriole	*Icterus galbula*	OF.NRF	S	
American Kestrel	*Falco sparverius*	OF	Y	
Eastern Kingbird	*Tyrannus tyrannus*	OF	S	
Horned Lark	*Eremophila alpestris*	OF	Y	
American Goldfinch	*Carduelis tristis*	OF	Y	
Eastern Phoebe	*Sayornis phoebe*	OF.NRF	S	
Tree Swallow	*Tachycineta bicolor*	OF.NRF	S	
Common Yellowthroat	*Geothlypis trichas*	OF.NRF	S	
House Wren	*Troglodytes aedon*	OF.NRF	S	
Carolina Wren	*Thryothorus ludovicianus*	OF	Y	
Chimney Swift	*Chaetura pelagica*	OF	S	
Yellow-billed Cuckoo	*Coccyzus americanus*	OF	S	
Prothonotary Warbler	*Protonotaria citrea*	OF.NRF	S	

Table 4-3

BIRDS OBSERVED OR POTENTIALLY EXISTING AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat	Season	Observed
Blue-winged Warbler	*Vermivora pinus*	OF,NRF	S	
Cerulean Warbler	*Dendroica cerulea*	OF,NRF	S	
Yellow Warbler	*Dendroica petechia*	OF,NRF	S	
Kentucky Warbler	*Oporornis formosus*	OF,NRF	S	
Hooded Warbler	*Wilsonia citrina*	OF,NRF	S	
Grasshopper Sparrow	*Ammodramus savannarum*	OF	S	
Vesper Sparrow	*Pooecetes gramineus*	OF	S	
Savannah Sparrow	*Passerculus sandwichensis*	OF	S	
White-throated Sparrow	*Zonotrichia albicollis*	OF	W	
Red-winged Blackbird	*Agelaius phoeniceus*	OF,NRF	Y	
Cedar Waxwing	*Bombycilla cedrorum*	OF	Y	
Wood Thrush	*Hylocichla mustelina*	NRF	S	
Blue Jay	*Cyanocitta cristata*	OF,NRF	Y	
Eastern Wood-pewee	*Contopus virens*	NRF	S	
Yellow-breasted Chat	*Icteria virens*	OF	S	
White-eyed Vireo	*Vireo griseus*	OF,NRF	S	

Key:

OF = Old Field
NRF = Northern Riverine Forest
SR = Stillwater River
Y = Year-round resident
S = Summer resident only
W = Winter resident only
X = Species was observed on November 21, 1996

Table 4-4

MAMMALS POTENTIALLY EXISTING AT GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat
Shorttail Shrew	*Blarina brevicauda*	OF,NRF
Least Shrew	*Cryptotis parva*	OF,NRF
Opossum	*Didelphis marsupialis*	OF,NRF
Big Brown Bat	*Eptesicus fuscus*	NRF
Southern Flying Squirrel	*Glaucomys volans*	NRF
Silver-haired Bat	*Lasionycteris noctivagans*	NRF
Red Bat	*Lasiurus borealis*	NRF
Hoary Bat	*Lasiurus cinereus*	NRF
Woodchuck	*Marmota monax*	NRF
Striped Skunk	*Mephitis mephitis*	OF,NRF
Meadow Vole	*Microtus pennsylvanicus*	OF,NRF
Mink	*Mustela vison*	NRF,SR
Keen's Bat	*Myotis keeni*	NRF
Little Brown Bat	*Myotis lucifugus*	NRF
Evening Bat	*Nycticeius humeralis*	NRF
Muskrat	*Ondatra zibethica*	NRF
White-footed Mouse	*Peromyscus leucopus*	OF
Eastern Pipistrel	*Pipistrellus subflavus*	NRF
Raccoon	*Procyon lotor*	OF, NRF
Eastern Mole	*Scalopus aquaticus*	OF, NRF
Eastern Gray Squirrel	*Sciurus carolinensis*	NRF
Eastern Cottontail	*Sylvilagus floridanus*	OF, NRF
Eastern Chipmunk	*Tamias striatus*	OF, NRF
Red Squirrel	*Tamiasciurus hudsonicus*	NRF
Meadow Jumping Mouse	*Zapus hudsonius*	OF, NRF
Deer Mouse	*Peromyscus maniculatus*	OF, NRF
Prairie Vole	*Microtus ochrogaster*	OF, NRF
Whitetail Deer	*Odocoileus virginianus*	OF, NRF

Key:

OF = Old Field
NRF = Northern Riverine Forest
SR = Stillwater River

Table 4-5

REPTILES AND AMPHIBIANS POTENTIALLY EXISTING AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat
Snapping Turtle	*Chelydra serpentina serpentina*	SR
Common Musk Turtle	*Sternotherus odoratus*	SR
Common Map Turtle	*Graptemys geographica*	SR
Midland Painted Turtle	*Chrysemys picta marginata*	SR
Eastern Box Turtle	*Terrapene carolina carolina*	OF,NRF
Eastern Spiny Softshell	*Apalone spinifera spinifera*	SR
Five-lined Skink	*Eumeces fasciatus*	SR
Midland Water Snake	*Nerodia sipedon pleuralis*	SR
Queen Snake	*Regina septemvittata*	SR,NRF
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*	OF,NRF
Northern Brown Snake	*Storeria dekayi dekayi*	SR,NRF
Blue Racer	*Coluber constrictor foxii*	OF
Black Rat Snake	*Elaphe obsoleta obsoleta*	OF,NRF
Eastern Milk Snake	*Lampropeltis triangulum triangulum*	OF,NRF
Mudpuppy	*Necturus maculosus maculosus*	SR
Red-spotted Newt	*Notophthalmus viridescens viridescens*	SR
Smallmouth Salamander	*Ambystoma texanum*	SR
Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*	SR
Jefferson Salamander	*Ambystoma jeffersonianum*	SR
Spotted Salamander	*Ambystoma maculatum*	SR
Redback Salamander	*Plethodon cinereus*	SR
Ravine Salamander	*Plethodon richmondi*	SR
Southern Two-lined Salamander	*Eurycea cirrigera*	SR
Longtail Salamander	*Eurycea longicauda longicauda*	SR
American Toad	*Bufo americanus*	OF,NRF,SR
Fowler's Toad	*Bufo woodhousii fowleri*	SR,NRF
Gray Treefrog	*Hyla versicolor*	SR,NRF
Western Chorus Frog	*Pseudacris triseriata triseriata*	SR,NRF,OF
Northern Spring Peeper	*Pseudacris crucifer crucifer*	SR,NRF,OF

Table 4-5

REPTILES AND AMPHIBIANS POTENTIALLY EXISTING AT THE GARLAND ROAD LANDFILL SITE

Common Name	Scientific Name	Habitat
Blanchard's Cricket Frog	*Acris crepitans blanchardi*	SR,NRF
Green Frog	*Rana clamitans melanota*	SR,NRF
Bullfrog	*Rana catesbeiana*	SR,NRF
Northern Leopard Frog	*Rana pipiens*	OF,NRF,SR
Pickerel Frog	*Rana palustris*	OF,NRF,SR
Wood Frog	*Rana sylvatica*	OF,NRF,SR

Key:

OF = Old Field
NRF = Northern Riverine Forest
SR = Stillwater River

Table 4-6

CONTAMINANT SCREENING OF STILLWATER RIVER SEDIMENT
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Sediment Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Metals and Cyanide (mg/kg)								
Aluminum	7/7	100		1,250-11,000	8,220	2	460[g]	8
Arsenic	7/7	100		2.5-7.7	6.5	3	8.2[h]	0
Barium	5/7	71	20.0	34.3-135	78	3	5,800[g]	0
Beryllium	3/7	43	1	0.37-0.64 B	0.33	3	5.3[g]	0
Cadmium	2/7	29	0.5-1	0.58B-0.71B	0.38	2	0.6[f]	1
Calcium	7/7	100	1,000	38,000-81,700	37,700	7	116,000[g]	0
Chromium	7/7	100	2	3-14.6	11.2	2	81[h]	0
Cobalt	3/7	43	5-10	5.0 B-6.8 B	3.1	3	5.1[g]	2
Copper	6/7	86	2.5-5	2.8-28.0	15.1	3	34[h]	0
Cyanide	3/7	43	0.50-10	26.7-80.1	40.1	2	0.10[h]	3
Iron	7/7	100	20	3,410 MBB-16,600	12,295	3	30,000[f]	0
Lead	12/12	100	0.6	2.2-34.3	11.6	1	46.7[h]	0
Magnesium	7/7	100	1,000	10,000-35,600	12,100	5	82,000[g]	0
Manganese	7/7	100	3	149-560	350	3	460[f]	2
Mercury	1/9	11	0.08-0.1	0.08	0.045	1	0.15[h]	0
Nickel	5/7	71	4.0-8	5.6-16.4	13.4	2	21[h]	0
Potassium	4/7	57	500-1,000	508-1,560	1,057	2	53,000[g]	0

Key at end of table.

Table 4-6

CONTAMINANT SCREENING OF STILLWATER RIVER SEDIMENT
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Sediment Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Silver	3/7	43	1-2	0.7 B-1.2 B	0.65	3	1[d]	2
Sodium	3/7	43	500-1,000	235 B-277 B	199	3	680,000[g]	0
Vanadium	6/7	86	5-10	5.2-24.1	18.2	1	80[g]	0
Zinc	7/7	100	4	13.6-66.3	51.7	1	150[h]	0
Volatile Organics (ug/kg)								
Acetone	1/4	25	50	15 J	64[c]	0	64	0
Semivolatile Organics (ug/kg)								
Benzo(a)anthracene	1/12	8	330	120 J	108[c]	1	108	1
Benzo(b)fluoranthene	1/12	8	330	210 J	240[c]	0	240	0
Bis(2-ethylhexyl) phthalate	1/9	11	330	200 J	8.9E+08[c]	0	8.9E +08	0
Chrysene	1/12	8	330	110 J	340[c]	0	340	0
Fluoranthene	4/12	33	330	36 J-340 J	2,900[h]	0	2,900	0
Fluorene	1/12	8	330	150 J	540[h]	0	540	0
Phenanthrene	3/12	25	330	48 J-390 J	850[h]	0	850	0
Pyrene	4/12	33	330	35 J-380 J	660[h]	0	660	0
Pesticides/PCBs								
Aroclor 1221	1/9	11	33-66	36	28,270[c]	0	28,270	0

[a] Background values are expressed as the mean of the upstream samples from each of the three sets of data. For non-detects, half the quantitation limit was used.

Ke[illegible] of table.

Sources:

b Geisy, J.P., and R.A. Hoke, 1990, "Freshwater Sediment Quality Criteria: Toxicity Bioassessment", pp. 265-348 in sediments: Chemistry and Toxicity of In-Place Pollutants, Lewis Publishers, Inc., Chelsea, Michigan.

c Hull, B.W., and G.W. Suter II, 1994, Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1994 Revision, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ES/ER/TH-95/R1.

d Long, E.R., and L.G. Morgan, 1991, The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, National Oceanic and Atmospheric Administration Technical Memorandum MOS OHA 52.

e Persuad, D., R. Jaagumagi, and A. Hayton, August 1993, Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment

f Persuad, D., R. Jaagumagi, and A. Hayton, October 1990, The Provincial Sediment Quality Guidelines, Ontario Ministry of the Environment.

g Suter II, G.W., and J.B. Mabrey, July 1994, Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ES/ER/TH-96/R1.

h U.S. Environmental Protection Agency, 1996, ECO Update: Ecotox Thresholds, Office of Solid Waste and Emergency Response, Intermittent Bulletin, Vol. 3, No. 2, EPA/540/F-95/038.

Key:

mg/kg = Milligrams per kilogram.
ug/kg = Micrograms per kilogram.
PCB = Polychlorinated biphenyl.
Bold = Chemical of potential concern (COPC).

Key at end of table.

Table 4-7

CONTAMINANT SCREENING OF SURFACE SOILS
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Ecological Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Metals and Cyanide (mg/kg)								
Aluminum	8/8	100		3,500-14,000	33,000	0	50[j]	8
Arsenic	8/8	100		3.9-7.3	4.8	6	10[j]	0
Barium	8/8	100		130-2,400	290	4	500[j]	3
Beryllium	8/8	100		0.19-0.67	0.55	1	10[j]	0
Cadmium	8/8	100		0.44-14	0.2	8	3[j]	1
Calcium	8/8	100		24,000-130,000	3,400	8	-	-
Chromium	8/8	100		9-79	12	5	1[i]	8
Cobalt	8/8	100		2.8-7.9	19	0	20[j]	0
Copper	8/8	100		13-70	13	7	100[j]	0
Cyanide	5/8	63	0.1	0.2-12	-	5	128.9[f]	0
Iron	8/8	100		8,000-29,000	14,000	4	200[i]	8
Lead	8/8	100		46-1,100	19	8	50[j]	7
Magnesium	8/8	100		13,000-62,000	2,100	8	-	-
Manganese	8/8	100		190-490	260	6	100[i]	8
Mercury	3/8	38	0.11-0.20	0.19-0.66	0.081	3	0.1[i]	3
Nickel	8/8	100		11-190	18	5	30[j]	3
Potassium	8/8	100		500-2,100	6,300	0	-	-

Ke[illegible]d of table.

Table 4-7

CONTAMINANT SCREENING OF SURFACE SOILS
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Ecological Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Selenium	2/8	25	0.42-0.54	0.55-0.56	0.30	2	1[j]	0
Sodium	8/8	100		110-230	2,500	0	-	-
Vanadium	8/8	100		7.3-27	43	0	2[j]	8
Zinc	8/8	100		48-1,000	75	5	50[j]	7
Volatile Organics (ug/kg)								
Acetone	6/8	75	10	54.5-10,500	ND/ND	6	20,000[f]	0
1,2-Dichloroethene (total)	2/8	25	5-20	48.4-1,280	ND/ND	2	48,000[f]	0
Methylene chloride	5/8	63	5	4.4-40	ND/ND	5	11,700[f]	0
Toluene	2/8	25	5-20	2.9-3.4	ND/ND	2	28,100[f]	0
Trichloroethene	4/8	50	5-20	2.9-51.0	ND/ND	4	756[f]	0
Semivolatile Organics (ug/kg)								
Acenaphthene	1/8	13	330-3,300	280	ND/ND	1	20,000[j]	0
Acenaphthylene	1/8	13	330-3,300	270	ND/ND	1	-	-
Anthracene	2/8	25	330-3,300	290-620	ND/ND	2	1,000,000[g]	0
Benzoic Acid	1/8	13	660-6,600	4,420	ND/ND	1	-	-
Benzo(a)anthracene	2/8	25	330-3,300	320-1,460	ND/ND	2	1,150,000[d]	0
Benzo(b)fluoranthene	2/8	25	330-3,300	420-1,020	ND/ND	2	-	-
Benzo(k)fluoranthene	2/8	25	330-3,300	440-1,210	ND/ND	2	-	-

Key at end of table.

Table 4-7

CONTAMINANT SCREENING OF SURFACE SOILS
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Ecological Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Benzo(a)pyrene	2/8	25	330-3,300	280-1,160	ND/ND	2	10,000[e]	0
Benzo(g,h,i)perylene	1/8	13	330-3,300	570	ND/ND	1	-	-
Bis(2-ethylhexyl) phthalate	6/8	75	330	380-18,700	ND/ND	6	13,000[c]	1
Butyl benzylphthalate	1/8	13	330-3,300	700	ND/ND	1	159,000[h]	0
Chrysene	2/8	25	330-3,300	520-1,540	ND/ND	2	-	-
Di-n-butylphthalate	5/8	63	330-3,300	450-4,620	ND/ND	5	200,000[j]	0
Fluoranthene	2/8	25	330-3,300	880-3,610	ND/ND	2	125,000[h]	0
Fluorene	1/8	13	330-3,300	280	ND/ND	1	30,000[i]	0
Indeno(1,2,3-cd) pyrene	1/8	13	330-3,300	560	ND/ND	1	-	-
Isophorone	1/8	13	330	9,140	ND/ND	1	-	-
2-Methylnaphthalene	2/8	25	330-3,300	200-340	ND/ND	2	-	-
Phenanthrene	2/8	25	330-3,300	760-2,630	ND/ND	2	-	-
Pyrene	4/8	50	330-3,300	110-3,330	ND/ND	4	75,000[h]	0
Pesticides/PCBs								
Aroclor 1248	1/8	13	80-400	6,100	ND/ND	1	39[f]	1
Aroclor 1254	6/8	75	80	110-5,000	ND/ND	6	61[f]	6
4,4'-DDD	2/8	25	8-40	48-90	ND/8.5	2	107,000[b]	0

K ...ad of table.

Table 4-7

CONTAMINANT SCREENING OF SURFACE SOILS
ECOLOGICAL RISK EVALUATION
GARLAND ROAD LANDFILL SITE

Analyte	Frequency of Detection	Percent Detected	Range of Sample Quantitation Limits	Range of Detected Concentrations	Background Concentration[a]	Number of Samples Exceeding Background	Ecological Screening Benchmark[b]	Number of Samples Exceeding Benchmark
Dieldrin	4/8	50	8-40	13-64	ND/150	0	5,000[h]	0

[a] Background values for inorganics were obtained from literature values (see text). For organic compounds, the reported off-site concentrations are listed.

Sources:

b Agency for Toxic Substances and Disease Registry, 1994, Toxicological Profile for 4,4'-DDD, U.S. Public Health Service (USPHS), Washington, D.C.

c _____, 1993, Toxicological Profile for bis(2-ethylhexyl)phthalate, USPHS, Washington, D.C.

d _____, 1989, Toxicological Profile for Benzo(a)anthracene, USPHS, Washington, D.C.

e _____, 1989, Toxicological Profile for Benzo(a)pyrene, USPHS, Washington, D.C.

f Opresko, D.M., B.E. Sample and G.W. Suter II, 1995, Toxicological Benchmarks for Wildlife: 1995 Revision, Oak Ridge National Laboratory, Oak Ridge Tennessee, ES/ER/TH-B6/R2.

g U.S. Environmental Protection Agency, 1994, Health Effects Assessment Summary Tables (HEAST).

h U.S. Environmental Protection Agency, 1994, Integrated Risk Information System (IRIS).

i Will, M.E., and G.W. Suter II, September 1995, Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ES/ER/TH-86/R2.

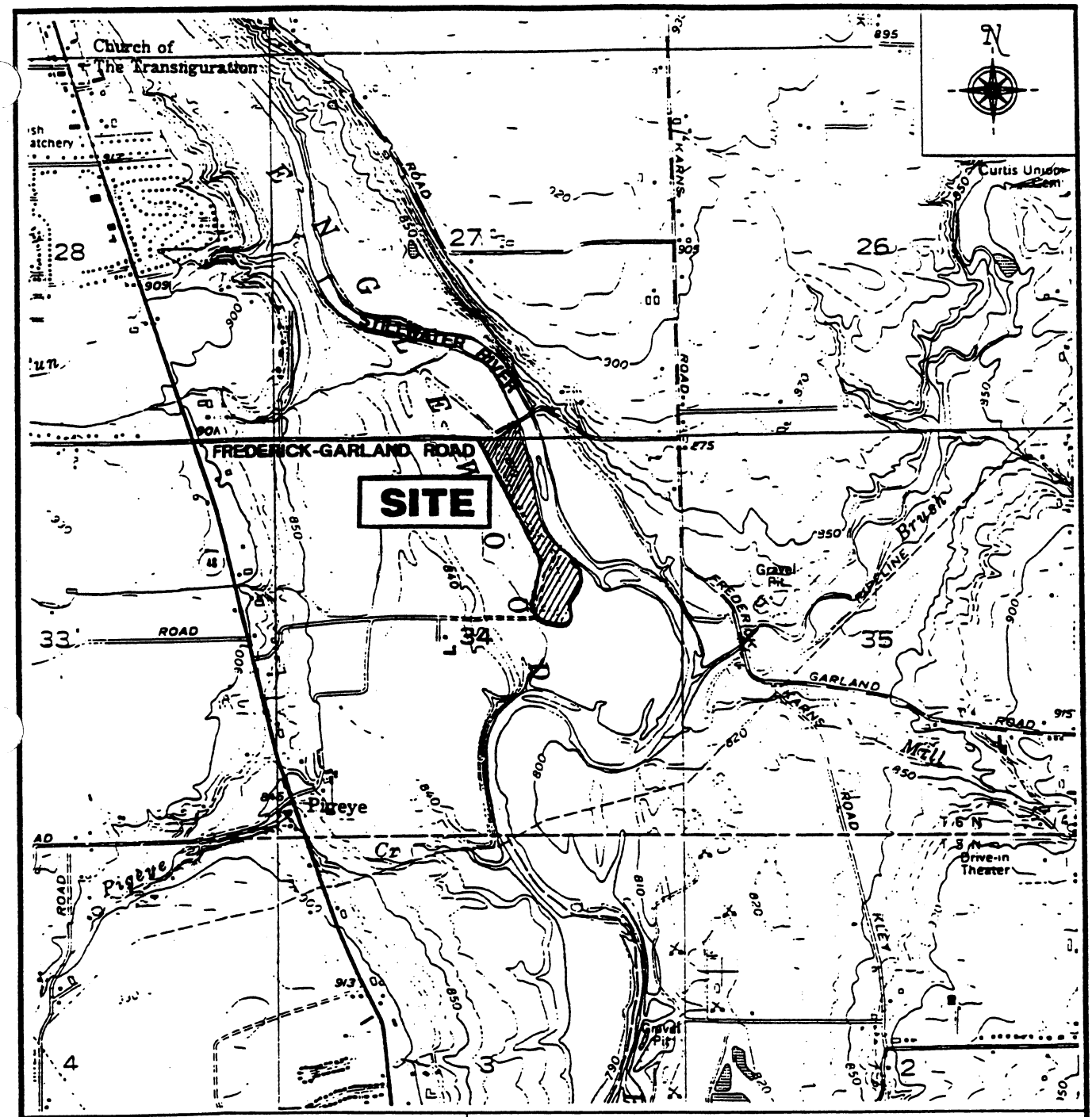
j Will, M.E., and G.W. Suter II, September 1995, Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ES/ER/TH-86/R2

Key:

mg/kg = Milligrams per kilogram.
ug/kg = Micrograms per kilogram.
PCB = Polychlorinated biphenyl.
Bold = Chemical of potential concern (COPC).
- = No benchmark available for this chemical.

Key at end of table.

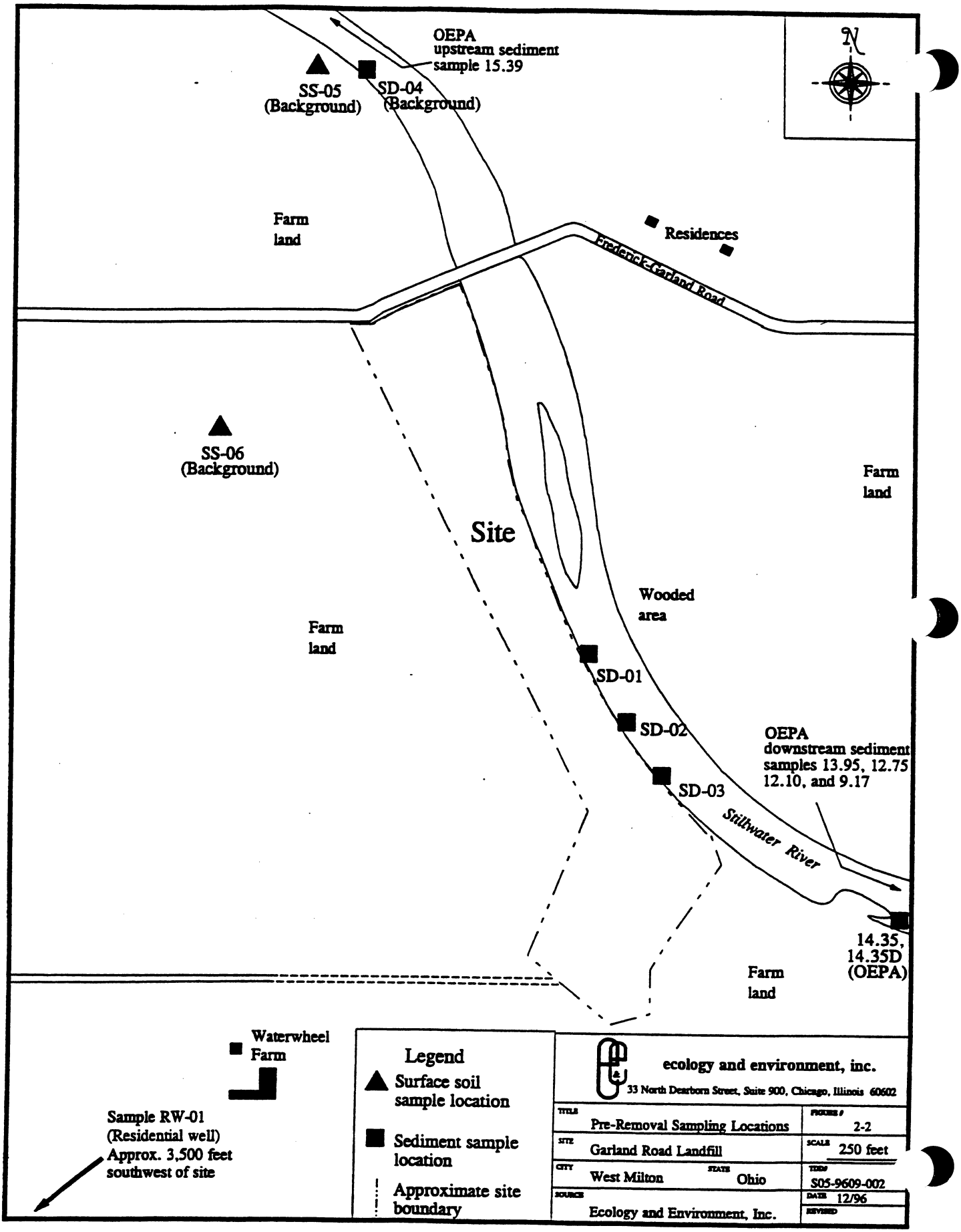
FIGURES

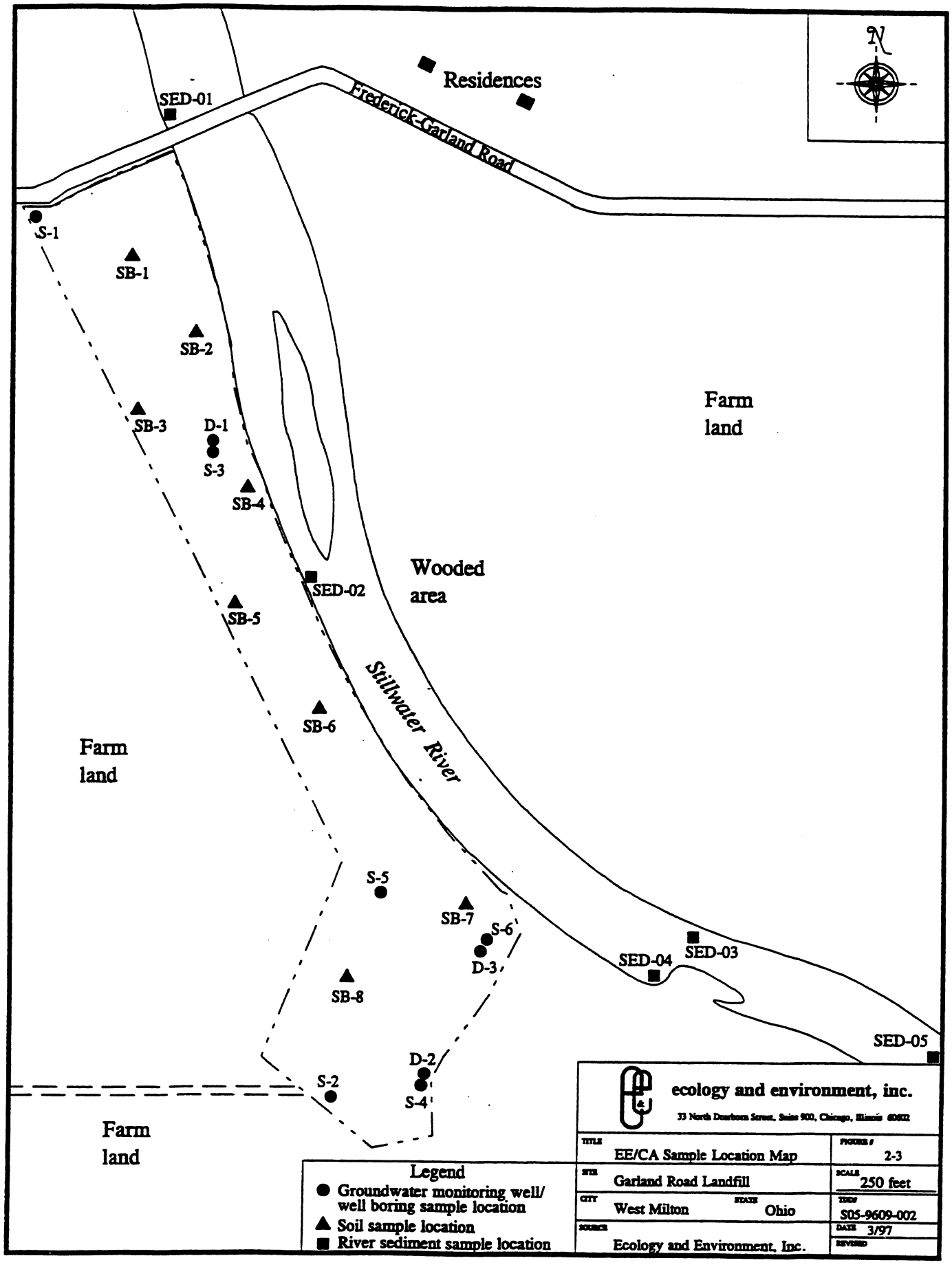


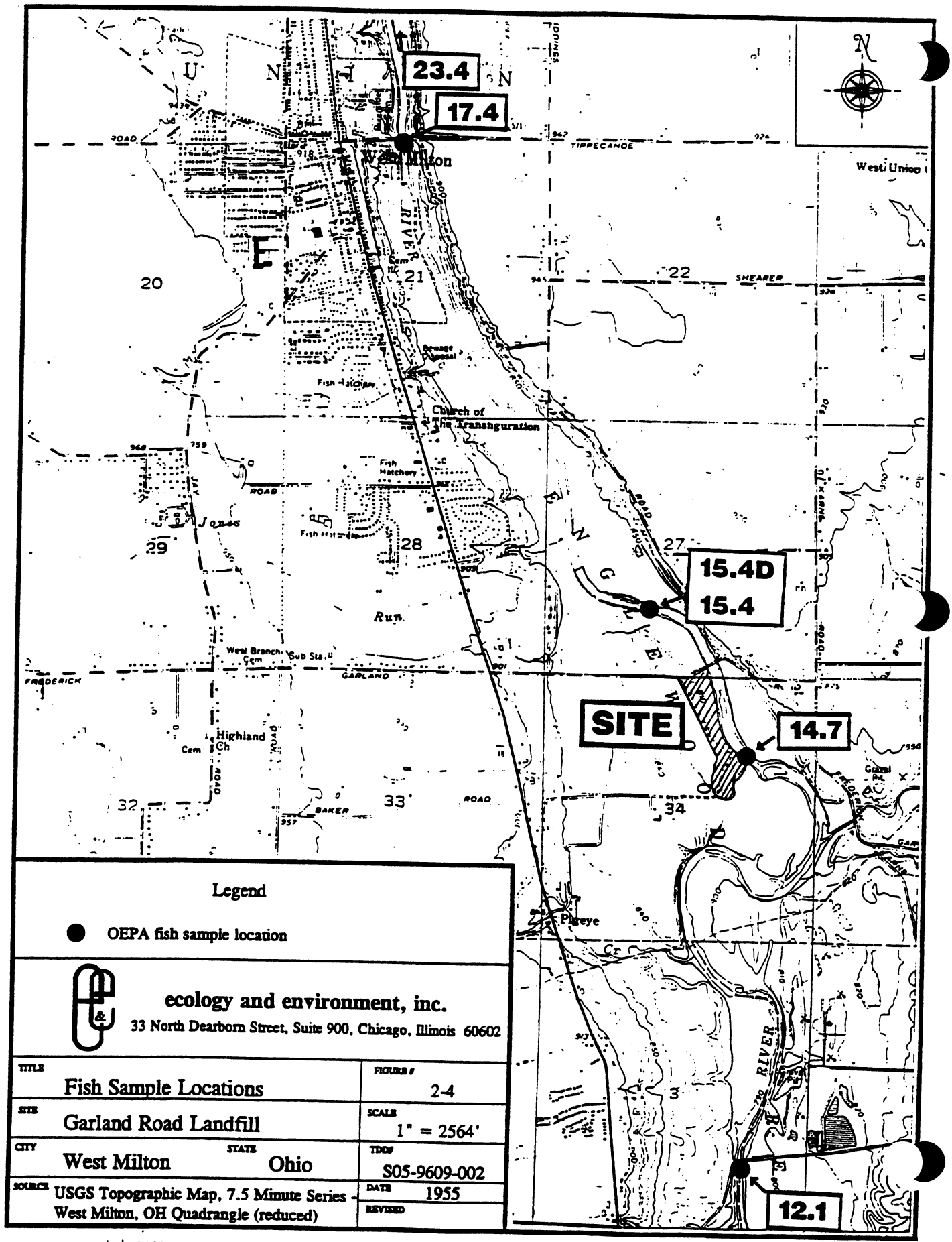
Quadrangle Location

ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602

TITLE: Site Features Map		FIGURE #: 2-1
SITE: Garland Road Landfill		SCALE: 1:24,000
CITY: West Milton	STATE: Ohio	TDD#: S05-9609-002
SOURCE: USGS Topographic Map, 7.5 Minute Series - West Milton, OH Quadrangle		DATE: 1955
		REVISED:


OEPA
upstream sediment
sample 15.39
SS-05
(Background)
SD-04
(Background)
N
Farm
land
Residences
Frederick-Garland Road
SS-06
(Background)
Farm
land
Site
Wooded
area
Farm
land
SD-01
SD-02
SD-03
OEPA
downstream sediment
samples 13.95, 12.75
12.10, and 9.17
Stillwater River
14.35,
14.35D
(OEPA)
Farm
land
Waterwheel
Farm
Sample RW-01
(Residential well)
Approx. 3,500 feet
southwest of site
Legend
Surface soil
sample location
Sediment sample
location
Approximate site
boundary
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE
Pre-Removal Sampling Locations
FIGURE #
2-2
SITE
Garland Road Landfill
SCALE
250 feet
CITY
West Milton
STATE
Ohio
TDD#
S05-9609-002
SOURCE
Ecology and Environment, Inc.
DATE
12/96
REVISED


N
Residences
SED-01
Frederick-Garland Road
S-1
SB-1
SB-2
SB-3
D-1
S-3
SB-4
SED-02
SB-5
SB-6
Wooded area
Farm land
Farm land
Farm land
Stillwater River
S-5
SB-7
S-6
D-3
SB-8
SED-04
SED-03
SED-05
D-2
S-2
S-4
Legend
Groundwater monitoring well/ well boring sample location
Soil sample location
River sediment sample location
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE EE/CA Sample Location Map
FIGURE # 2-3
SITE Garland Road Landfill
SCALE 250 feet
CITY West Milton
STATE Ohio
TDD# S05-9609-002
SOURCE Ecology and Environment, Inc.
DATE 3/97
REVISED



Legend

● OEPA fish sample location

ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602

TITLE: Fish Sample Locations	FIGURE #: 2-4
SITE: Garland Road Landfill	SCALE: 1" = 2564'
CITY: West Milton STATE: Ohio	TDD#: S05-9609-002
SOURCE: USGS Topographic Map, 7.5 Minute Series - West Milton, OH Quadrangle (reduced)	DATE: 1955 REVISED:

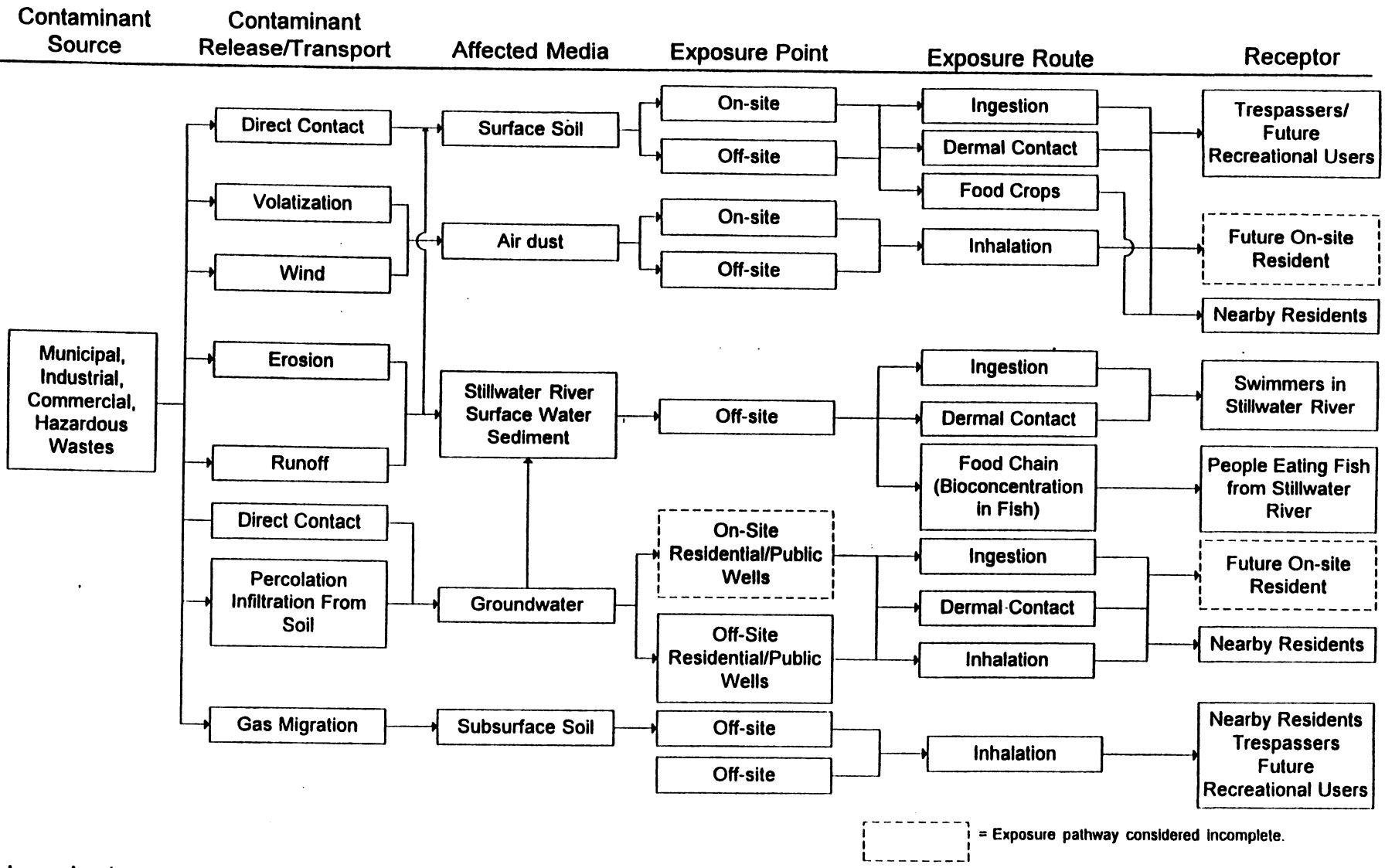
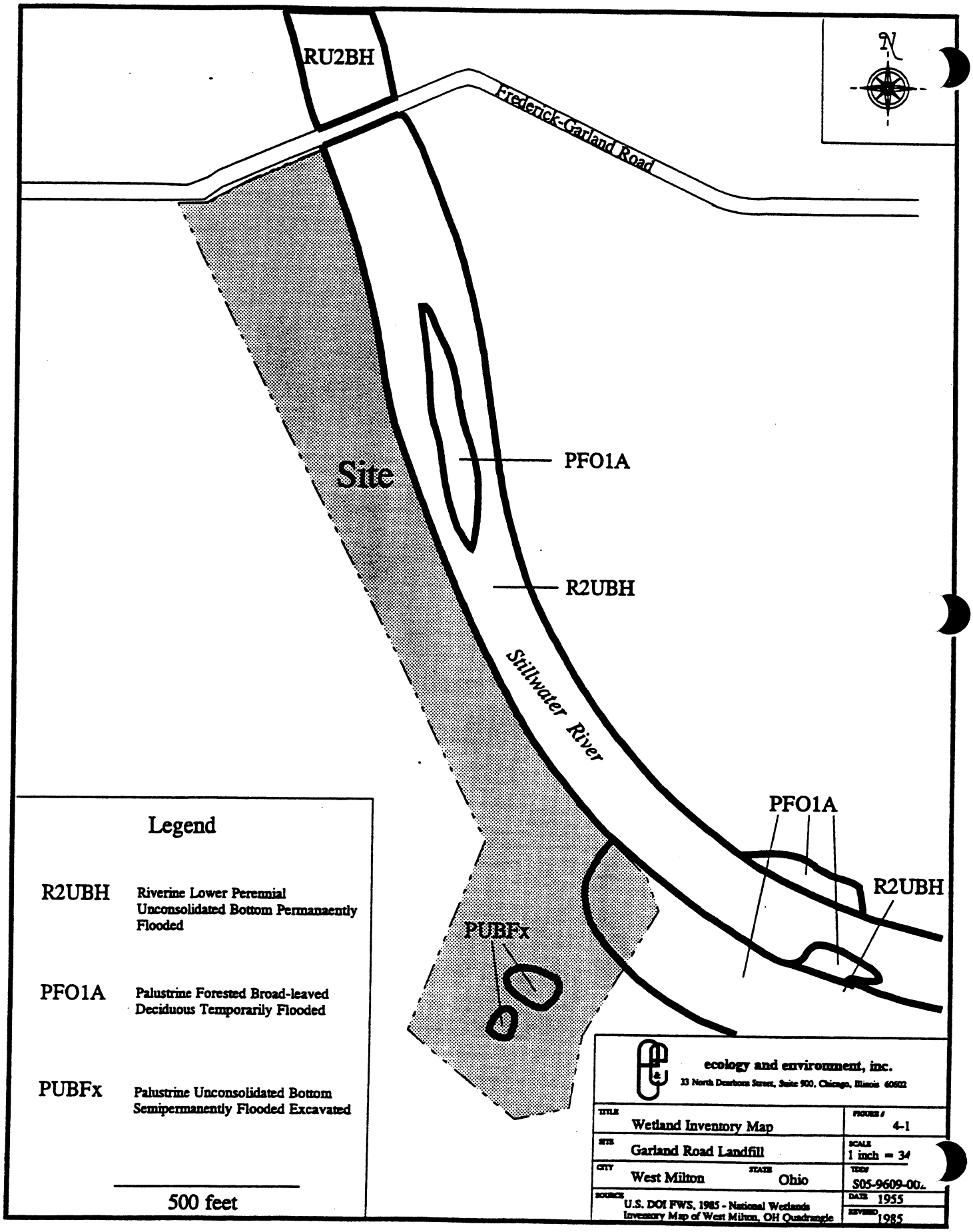
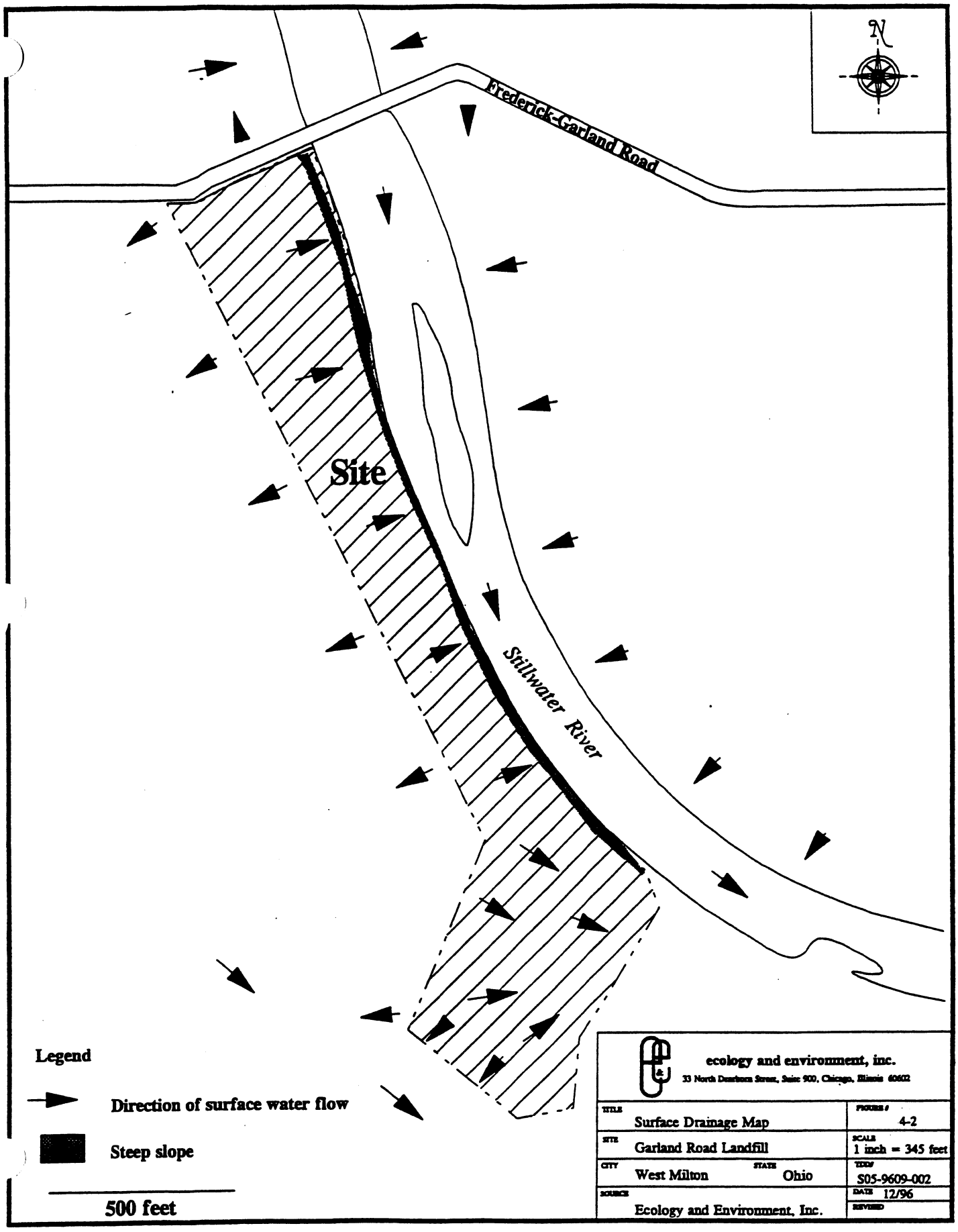
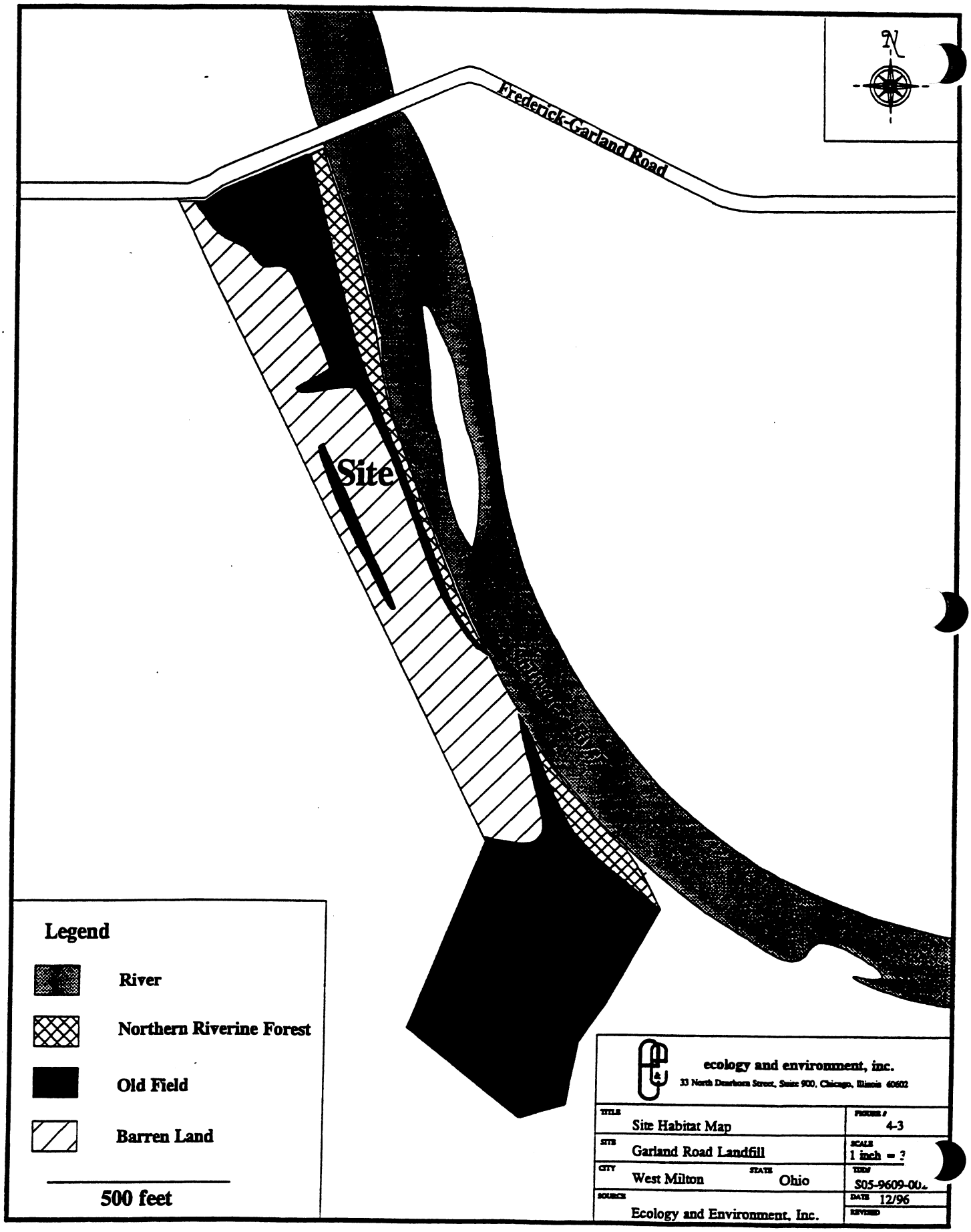
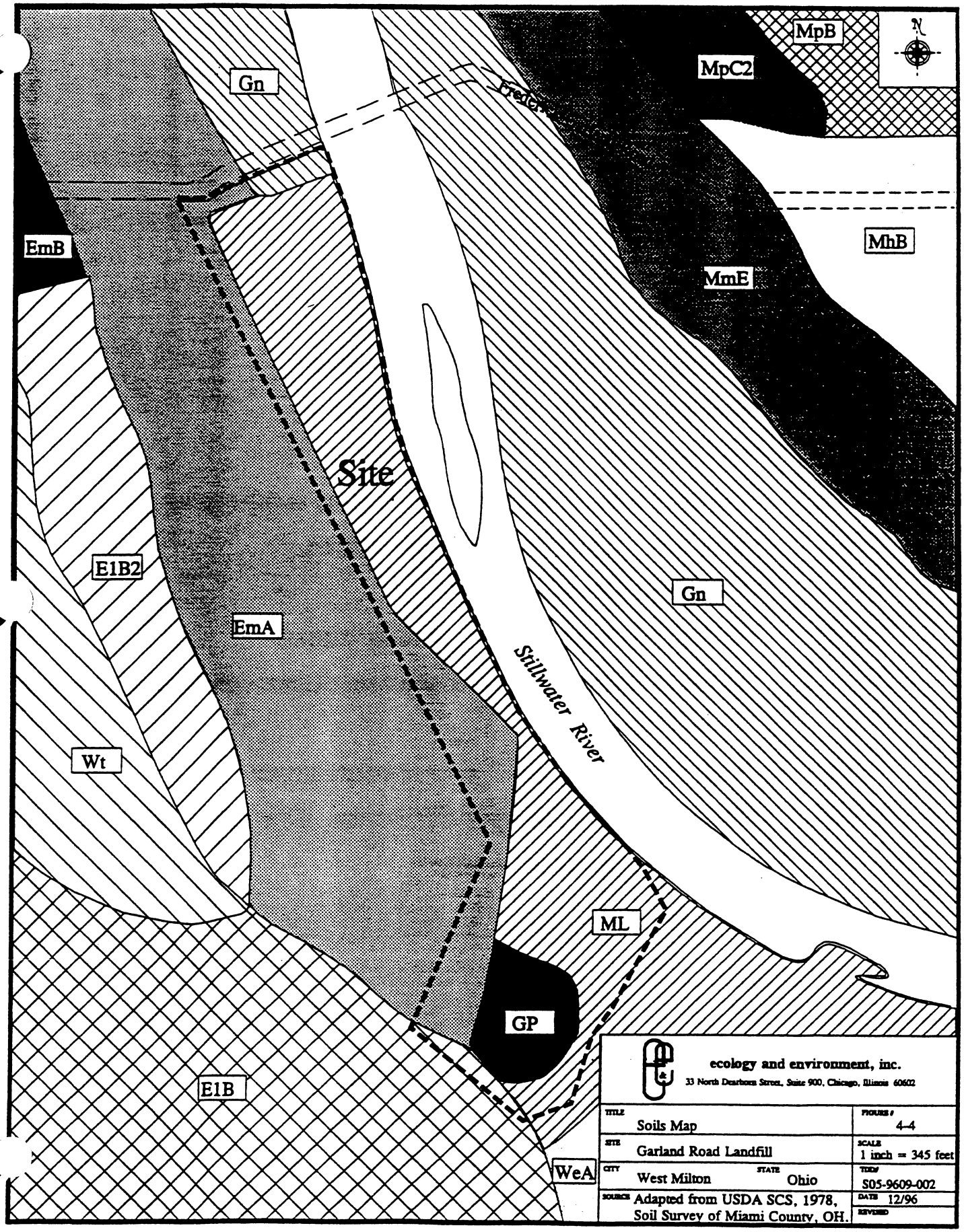


Figure 3-1
GARLAND ROAD LANDFILL STREAMLINED HUMAN HEALTH RISK EVALUATION
CONCEPTUAL SITE MODEL


RU2BH
Frederick-Garland Road
N
Site
PFO1A
R2UBH
Stillwater River
PFO1A
R2UBH
PUBFx
Legend
R2UBH Riverine Lower Perennial Unconsolidated Bottom Permanaently Flooded
PFO1A Palustrine Forested Broad-leaved Deciduous Temporarily Flooded
PUBFx Palustrine Unconsolidated Bottom Semipermanently Flooded Excavated
500 feet
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE Wetland Inventory Map
FIGURE # 4-1
SITE Garland Road Landfill
SCALE 1 inch = 3#
CITY West Milton
STATE Ohio
TDD# S05-9609-00#
SOURCE U.S. DOI FWS, 1985 - National Wetlands Inventory Map of West Milton, OH Quadrangle
DATE 1955
REVISED 1985

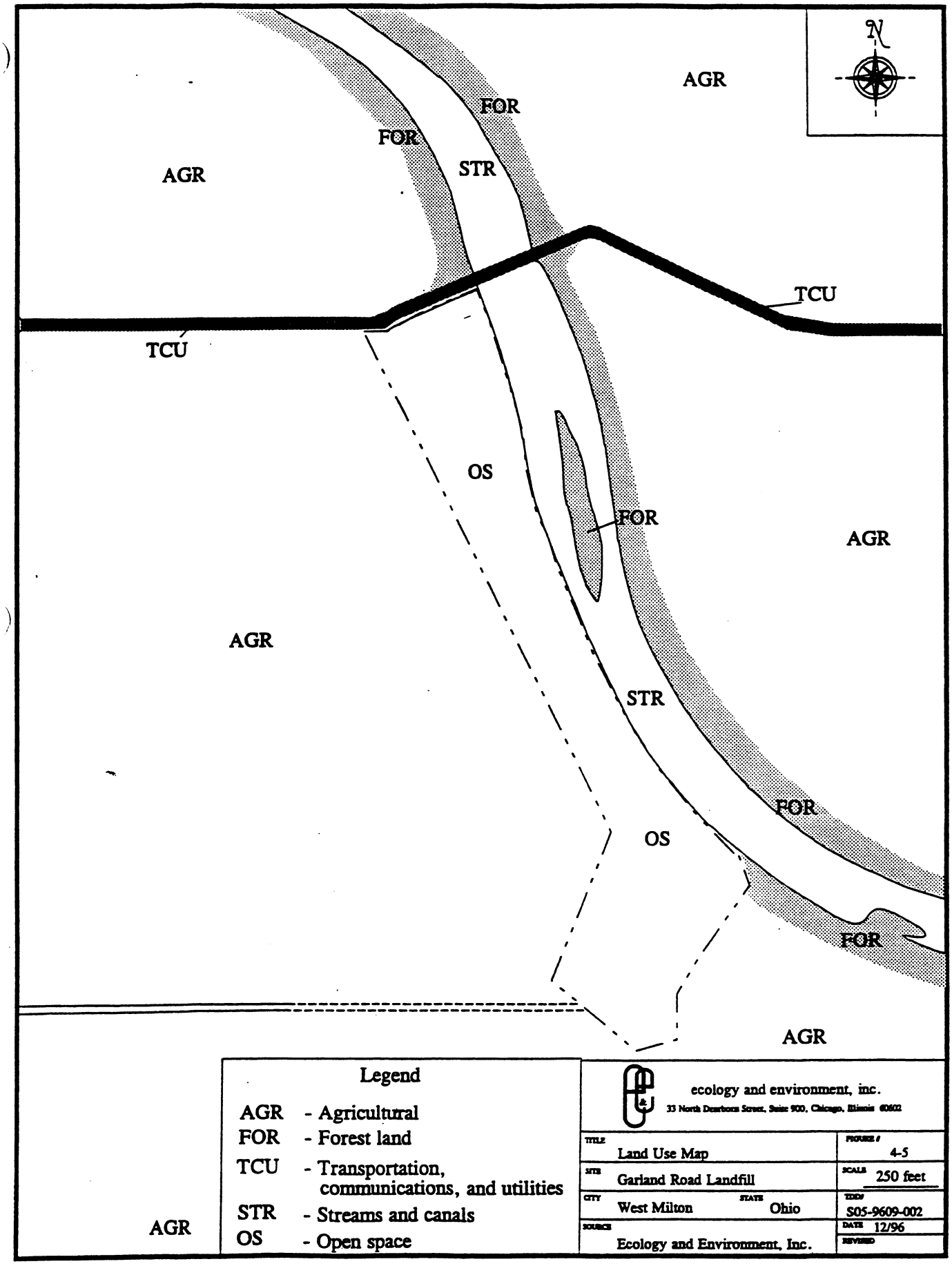

N
Frederick-Garland Road
Site
Stillwater River
Legend
Direction of surface water flow
Steep slope
500 feet
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE Surface Drainage Map
FIGURE # 4-2
SITE Garland Road Landfill
SCALE 1 inch = 345 feet
CITY West Milton
STATE Ohio
TDD# S05-9609-002
SOURCE Ecology and Environment, Inc.
DATE 12/96
REVISED


N
Frederick-Garland Road
Site
Legend
River
Northern Riverine Forest
Old Field
Barren Land
500 feet
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE Site Habitat Map
FIGURE # 4-3
SITE Garland Road Landfill
SCALE 1 inch = ?
CITY West Milton
STATE Ohio
TDD# S05-9609-00
SOURCE Ecology and Environment, Inc.
DATE 12/96
REVISED


MpB
MpC2
Gn
Creek
MhB
EmB
MmE
Site
E1B2
Gn
EmA
Stillwater River
Wt
ML
GP
E1B
WeA
N
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE Soils Map
FIGURE # 4-4
SITE Garland Road Landfill
SCALE 1 inch = 345 feet
CITY West Milton
STATE Ohio
TDD# S05-9609-002
SOURCE Adapted from USDA SCS, 1978, Soil Survey of Miami County, OH.
DATE 12/96
REVISED

Legend

Gn	- Genesee silt loam
ML	- Made land
EmA	- Eldean silt loam, 0 to 2 percent slopes
EmB	- Eldean silt loam, 2 to 6 percent slopes
E1B	- Eldean loam, 2 to 6 percent slopes
E1B2	- Eldean loam, 2 to 6 percent slopes, moderately eroded
WeA	- Wea silt loam, 0 to 2 percent slopes
Wt	- Westland silty clay loam
MpB	- Milton silt loam, 2 to 6 percent slopes
MpC2	- Milton silt loam, 6 to 12 percent slopes, moderately eroded
GP	- Gravel pit
MhB	- Miamian silt loam, 2 to 6 percent slopes
MmE	- Miamian and Hennepin silt loams, 18 to 25 percent slopes
------	- Approximate site boundary


N
AGR
FOR
FOR
STR
AGR
TCU
TCU
OS
FOR
AGR
AGR
STR
FOR
OS
FOR
AGR
AGR
Legend
AGR - Agricultural
FOR - Forest land
TCU - Transportation, communications, and utilities
STR - Streams and canals
OS - Open space
ecology and environment, inc.
33 North Dearborn Street, Suite 900, Chicago, Illinois 60602
TITLE Land Use Map
FIGURE # 4-5
SITE Garland Road Landfill
SCALE 250 feet
CITY West Milton
STATE Ohio
TDD# S05-9609-002
SOURCE Ecology and Environment, Inc.
DATE 12/96
REVISED

ATTACHMENT A
ANALYTICAL DATA SUMMARIES

Table 2

Summary of Analytical Results for Soil Samples
July 1996
Garland Road Landfill Site

Location:		D-3	D-3	D-3
Depth:		0-1.0 ft.	4.0-6.0 ft.	10.0-12.0 ft.
Sample ID:		S-MK-001	S-MK-002	S-MK-004
Sample Date:		7/23/96	7/23/96	7/23/96

Parameter	CHEM GRP	Units	S-MK-001	Q	S-MK-002	Q	S-MK-004	Q
1,1,1-TRICHLOROETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,1,2,2-TETRACHLOROETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,1,2-TRICHLOROETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,1-DICHLOROETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,1-DICHLOROETHENE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,2-DICHLOROETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
1,2-DICHLOROETHENE (TOTAL)	Volatile Organics	ug/kg	5	U	5	U	5	U
1,2-DICHLOROPROPANE	Volatile Organics	ug/kg	5	U	5	U	5	U
2-BUTANONE	Volatile Organics	ug/kg	50	U	50	U	50	U
2-HEXANONE	Volatile Organics	ug/kg	50	U	50	U	50	U
4-METHYL-2-PENTANONE	Volatile Organics	ug/kg	50	U	50	U	50	U
ACETONE	Volatile Organics	ug/kg	50	U	50	U	46	J
BENZENE	Volatile Organics	ug/kg	5	U	5	U	5	U
BROMODICHLOROMETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
BROMOFORM	Volatile Organics	ug/kg	5	U	5	U	5	U
BROMOMETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
CARBON DISULFIDE	Volatile Organics	ug/kg	5	U	5	U	5	U
CARBON TETRACHLORIDE	Volatile Organics	ug/kg	5	U	5	U	5	U
CHLOROBENZENE	Volatile Organics	ug/kg	5	U	5	U	5	U
CHLOROETHANE	Volatile Organics	ug/kg	10	U	10	U	10	U
CHLOROFORM	Volatile Organics	ug/kg	5	U	5	U	5	U
CHLOROMETHANE	Volatile Organics	ug/kg	10	U	10	U	10	U
CIS-1,3-DICHLOROPROPENE	Volatile Organics	ug/kg	5	U	5	U	5	U
DIBROMOCHLOROMETHANE	Volatile Organics	ug/kg	5	U	5	U	5	U
ETHYLBENZENE	Volatile Organics	ug/kg	5	U	5	U	5	U
METHYLENE CHLORIDE	Volatile Organics	ug/kg	5	U	5	U	5	U
STYRENE	Volatile Organics	ug/kg	5	U	5	U	5	U
TETRACHLOROETHENE	Volatile Organics	ug/kg	5	U	5	U	5	U
TOLUENE	Volatile Organics	ug/kg	5	U	5	U	5	U
TRANS-1,3-DICHLOROPROPENE	Volatile Organics	ug/kg	5	U	5	U	5	U
TRICHLOROETHENE	Volatile Organics	ug/kg	5	U	5	U	2.1	J
VINYL CHLORIDE	Volatile Organics	ug/kg	10	U	10	U	10	U
XYLENES (TOTAL)	Volatile Organics	ug/kg	5	U	5	U	5	U
1,2,4-TRICHLOROBENZENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
1,2-DICHLOROBENZENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
1,3-DICHLOROBENZENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
1,4-DICHLOROBENZENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,2'-OXYBIS(1-CHLOROPROPANE)	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,4,5-TRICHLOROPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,4,6-TRICHLOROPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,4-DICHLOROPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,4-DIMETHYLPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,4-DINITROPHENOL	Semi-volatile Organi	ug/kg	1600	U	1600	U	1600	U
2,4-DINITROTOLUENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2,6-DINITROTOLUENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2-CHLORONAPHTHALENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2-CHLOROPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2-METHYLNAPHTHALENE	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2-METHYLPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
2-NITROANILINE	Semi-volatile Organi	ug/kg	1600	U	1600	U	1600	U
2-NITROPHENOL	Semi-volatile Organi	ug/kg	330	U	330	U	330	U
3,3'-DICHLOROBENZIDINE	Semi-volatile Organi	ug/kg	1600	U	1600	U	1600	U
3-NITROANILINE	Semi-volatile Organi	ug/kg	1600	U	1600	U	1600	U
4,6-DINITRO-2-METHYLPHENOL	Semi-volatile Organi	ug/kg	1600	U	1600	U	1600	U

4-BROMOPHENYL PHENYL ETHER	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4-CHLORO-3-METHYLPHENOL	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4-CHLOROANILINE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4-CHLOROPHENYL PHENYL ETHER	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4-METHYLPHENOL	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4-NITROANILINE	Semi-volatile Organi	ug/kg	1600 U	1600 U	1600 U
4-NITROPHENOL	Semi-volatile Organi	ug/kg	1600 U	1600 U	1600 U
ACENAPHTHENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
ACENAPHTHYLENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
ANTHRACENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BENZO(A)ANTHRACENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BENZO(A)PYRENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BENZO(B)FLUORANTHENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BENZO(GHI)PERYLENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BENZO(K)FLUORANTHENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BIS(2-CHLOROETHOXY)METHANE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BIS(2-CHLOROETHYL) ETHER	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
BIS(2-ETHYLHEXYL) PHTHALATE	Semi-volatile Organi	ug/kg	230 J	230 J	230 J
BUTYL BENZYL PHTHALATE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
CARBAZOLE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
CHRYSENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DI-N-BUTYL PHTHALATE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DI-N-OCTYL PHTHALATE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DIBENZ(A,H)ANTHRACENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DIBENZOFURAN	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DIETHYL PHTHALATE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
DIMETHYL PHTHALATE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
FLUORANTHENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
FLUORENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
HEXACHLOROBENZENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
HEXACHLOROBUTADIENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
HEXACHLOROCYCLOPENTADIENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
HEXACHLOROETHANE	Semi-volatile Organi	ug/kg	1600 U	1600 U	1600 U
INDENO(1,2,3-CD)PYRENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
ISOPHORONE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
N-NITROSODI-N-PROPYLAMINE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
N-NITROSODIPHENYLAMINE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
NAPHTHALENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
NITROBENZENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
PENTACHLOROPHENOL	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
PHENANTHRENE	Semi-volatile Organi	ug/kg	1600 U	1600 U	1600 U
PHENOL	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
PYRENE	Semi-volatile Organi	ug/kg	330 U	330 U	330 U
4,4'-DDD	Pesticides	ug/kg	330 U	330 U	330 U
4,4'-DDE	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
4,4'-DDT	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
ALDRIN	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
ALPHA-BHC	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
ALPHA-CHLORDANE	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
BETA-BHC	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
DELTA-BHC	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
DIELDRIN	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
ENDOSULFAN I	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
ENDOSULFAN II	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
ENDOSULFAN SULFATE	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
ENDRIN	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
ENDRIN ALDEHYDE	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
ENDRIN KETONE	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
GAMMA-BHC (LINDANE)	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
GAMMA-CHLORDANE	Pesticides	ug/kg	3.3 U	3.3 U	3.3 U
HEPTACHLOR	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
HEPTACHLOR EPOXIDE	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
METHOXYCHLOR	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
TOXAPHENE	Pesticides	ug/kg	1.7 U	1.7 U	1.7 U
AROCLOR 1016	Pesticides	ug/kg	17 U	17 U	17 U
AROCLOR 1221	Pesticides	ug/kg	83 U	83 U	83 U
AROCLOR 1232	PCBs	ug/kg	33 U	33 U	33 U
AROCLOR 1242	PCBs	ug/kg	33 U	33 U	33 U
AROCLOR 1248	PCBs	ug/kg	33 U	33 U	33 U
AROCLOR 1254	PCBs	ug/kg	33 U	33 U	33 U
AROCLOR 1260	PCBs	ug/kg	33 U	33 U	33 U
ALUMINUM	PCBs	ug/kg	33 U	33 U	33 U
	Metals	mg/kg	6010	2890	1820

NTIMONY	Metals	mg/kg	6 U	6 U	6 U
SENIC	Metals	mg/kg	4	5	3
ARIUM	Metals	mg/kg	53.2	20 U	20 U
BERYLLIUM	Metals	mg/kg	0.5 U	0.5 U	0.5 U
CADMIUM	Metals	mg/kg	0.5 U	0.5 U	0.5 U
CALCIUM	Metals	mg/kg	58300	125000	131000
CHROMIUM	Metals	mg/kg	11.4	4.6	4.8
COBALT	Metals	mg/kg	5	5	5
COPPER	Metals	mg/kg	8.1	9.2	6.1
IRON	Metals	mg/kg	10200	7830	5310
LEAD	Metals	mg/kg	6.8	4.7	2.8
MAGNESIUM	Metals	mg/kg	17300	56700	54800
MANGANESE	Metals	mg/kg	290	362	217
MERCURY	Metals	mg/kg	0.1 U	0.1 U	0.1 U
NICKEL	Metals	mg/kg	10.6	8.1	4.6
POTASSIUM	Metals	mg/kg	843	688	500 U
SELENIUM	Metals	mg/kg	0.5 U	0.5 U	0.5 U
SILVER	Metals	mg/kg	1 U	1 U	1 U
SODIUM	Metals	mg/kg	500 U	500 U	500 U
THALLIUM	Metals	mg/kg	1 U	1 U	1 U
VANADIUM	Metals	mg/kg	15.7	12	6.4
ZINC	Metals	mg/kg	27.7	28.3	12.8
TOTAL CYANIDE	General Chemistry	mg/kg	0.5 UJ	0.5 UJ	0.5 U
TOTAL SOLIDS (RESIDUE)	General Chemistry	%	85.5	85.6	90.6

4\4U:\DBASEGRP\CHEM\7000\7043\Table 2 - Summary of Analytical R

U	Not detected.
–	Not analyzed.
J	Estimated result. Result is less than RL and greater than or equal to the MDL.
UJ	Not detected. Associated detection limit is estimated.

Table 4

Page 1 (a)
Date Printed: October 3, 1996
Time Printed

Summary of Analytical Results for Sediment Samples
August 1996
Garland Road Landfill Site

Location:		SED-01	SED-02	SED-03	SED-04	SED-05
Sample ID:		S-MT-019	S-MT-018	S-MT-017	S-MT-016	S-MT-015
Sample Date:		8/6/96	8/6/96	8/6/96	8/6/96	8/6/96
Parameter	Units					
Volatile Organics						
1,1,1-TRICHLOROETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2,2-TETRACHLOROETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2-TRICHLOROETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHENE (TOTAL)	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROPROPANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
2-BUTANONE	ug/kg	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
2-HEXANONE	ug/kg	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
4-METHYL-2-PENTANONE	ug/kg	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
ACETONE	ug/kg	ND(50)	ND(50)	ND(50)	ND(50)	15 J
BENZENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
BROMODICHLOROMETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOFORM	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOMETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON DISULFIDE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON TETRACHLORIDE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROBENZENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROETHANE	ug/kg	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CHLOROFORM	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROMETHANE	ug/kg	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CIS-1,3-DICHLOROPROPENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
DIBROMOCHLOROMETHANE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
ETHYLBENZENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
METHYLENE CHLORIDE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
STYRENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TETRACHLOROETHENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TOLUENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TRANS-1,3-DICHLOROPROPENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TRICHLOROETHENE	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
VINYL CHLORIDE	ug/kg	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
XYLENES (TOTAL)	ug/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
Semi-volatile Organics						
1,2,4-TRICHLOROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
1,2-DICHLOROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
1,3-DICHLOROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
1,4-DICHLOROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,2'-OXYBIS(1-CHLOROPROPANE)	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,4,5-TRICHLOROPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,4,6-TRICHLOROPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,4-DICHLOROPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,4-DIMETHYLPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)

I:\U:\DBASEGRP\CHEM\7000\7043\Table 4 - Summary of Analytical R

Table 4

Page 1 (b)
Date Printed: October 3, 1996
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Summary of Analytical Results for Sediment Samples
August 1996
Garland Road Landfill Site

Location:		SED-01	SED-02	SED-03	SED-04	SED-05
Sample ID:		S-MT-019	S-MT-018	S-MT-017	S-MT-016	S-MT-015
Sample Date:		8/6/96	8/6/96	8/6/96	8/6/96	8/6/96
Parameter	Units					
Semi-volatile Organics (Cont'd)						
2,4-DINITROPHENOL	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
2,4-DINITROTOLUENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2,6-DINITROTOLUENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2-CHLORONAPHTHALENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)

2-CHLOROPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2-METHYLNAPHTHALENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2-METHYLPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
2-NITROANILINE	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
2-NITROPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
3,3'-DICHLOROBENZIDINE	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
3-NITROANILINE	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
4,6-DINITRO-2-METHYLPHENOL	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
4-BROMOPHENYL PHENYL ETHER	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
4-CHLORO-3-METHYLPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
4-CHLOROANILINE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
4-CHLOROPHENYL PHENYL ETHER	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
4-METHYLPHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
4-NITROANILINE	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
4-NITROPHENOL	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
ACENAPHTHENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
ACENAPHTHYLENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
ANTHRACENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BENZO(A)ANTHRACENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BENZO(A)PYRENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BENZO(B)FLUORANTHENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BENZO(GHI)PERYLENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BENZO(K)FLUORANTHENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BIS(2-CHLOROETHOXY)METHANE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BIS(2-CHLOROETHYL) ETHER	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
BIS(2-ETHYLHEXYL) PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	200 J
BUTYL BENZYL PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
CARBAZOLE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
CHRYSENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DI-N-BUTYL PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DI-N-OCTYL PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DIBENZ(A,H)ANTHRACENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DIBENZOFURAN	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DIETHYL PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
DIMETHYL PHTHALATE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
FLUORANTHENE	ug/kg	ND(500) UJ	57 J	36 J	ND(330)	72 J
FLUORENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
HEXACHLOROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
HEXACHLOROBUTADIENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
HEXACHLOROCYCLOPENTADIENE	ug/kg	ND(2400) UJ	ND(1600)	ND(1600)	ND(1600)	ND(1600)
HEXACHLOROETHANE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)

Z:\2\U:\DBASEGRP\CHEM\7000\7043\Table 4 - Summary of Analytical R

Table 4

Date Printed: October 3, 1996
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Summary of Analytical Results for Sediment Samples
August 1996
Garland Road Landfill Site

Location:		SED-01	SED-02	SED-03	SED-04	SED-05
Sample ID:		S-MT-019	S-MT-018	S-MT-017	S-MT-016	S-MT-015
Sample Date:		8/6/96	8/6/96	8/6/96	8/6/96	8/6/96
Parameter	Units					
Semi-volatile Organics (Cont'd)						
INDENO(1,2,3-CD)PYRENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
ISOPHORONE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
N-NITROSODI-N-PROPYLAMINE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
N-NITROSODIPHENYLAMINE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
NAPHTHALENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
NITROBENZENE	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
PENTACHLOROPHENOL	ug/kg	ND(2400) R	ND(1600) R	ND(1600) R	ND(1600) R	ND(1600) R
PHENANTHRENE	ug/kg	ND(500) UJ	52 J	ND(330)	ND(330)	48 J
PHENOL	ug/kg	ND(500) UJ	ND(330)	ND(330)	ND(330)	ND(330)
PYRENE	ug/kg	ND(500) UJ	ND(330)	35 J	ND(330)	94 J
Pesticides						
4,4'-DDD	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
4,4'-DDE	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
4,4'-DDT	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
ALDRIN	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
ALPHA-BHC	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
ALPHA-CHLORDANE	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
BETA-BHC	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
DELTA-BHC	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
DIELDRIN	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
ENDOSULFAN I	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
ENDOSULFAN II	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
ENDOSULFAN SULFATE	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)

ENDRIN	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
ENDRIN ALDEHYDE	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
ENDRIN KETONE	ug/kg	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)	ND(3.3)
GAMMA-BHC (LINDANE)	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
GAMMA-CHLORDANE	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
HEPTACHLOR	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1:7)
HEPTACHLOR EPOXIDE	ug/kg	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)	ND(1.7)
METHOXYCHLOR	ug/kg	ND(17)	ND(17)	ND(17)	ND(17)	ND(17)
TOXAPHENE	ug/kg	ND(83)	ND(83)	ND(83)	ND(83)	ND(83)
PCBs						
AROCLOR 1016	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)
AROCLOR 1221	ug/kg	51 PF	ND(33)	ND(33)		36 ND(33)
AROCLOR 1232	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)
AROCLOR 1242	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)
AROCLOR 1248	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)
AROCLOR 1254	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)
AROCLOR 1260	ug/kg	ND(33)	ND(33)	ND(33)	ND(33)	ND(33)

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Table 4

Date Printed: October 3, 1996
Time Printed: 5:01 pm

Summary of Analytical Results for Sediment Samples
August 1996
Garland Road Landfill Site

Location:		SED-01	SED-02	SED-03	SED-04	SED-05
Sample ID:		S-MT-019	S-MT-018	S-MT-017	S-MT-016	S-MT-015
Sample Date:		8/6/96	8/6/96	8/6/96	8/6/96	8/6/96
Parameter	Units					
Metals						
ALUMINUM	mg/kg	3640	3540	1330	1250	3040
ANTIMONY	mg/kg	ND(6.0)	ND(6.0)	ND(6.0)	ND(6.0)	ND(6.0)
ARSENIC	mg/kg	3.1	3.3	2.5	2.5	2.6
BARIUM	mg/kg	41.7	40.3	ND(20.0)	ND(20.0)	34.3
BERYLLIUM	mg/kg	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
CADMIUM	mg/kg	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
CALCIUM	mg/kg	34800	38900	72800	81700	38000
CHROMIUM	mg/kg	5.7	5.7	3.2	3	6.3
COBALT	mg/kg	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
COPPER	mg/kg	7.6	6.7	ND(2.5)	2.8	6.1
IRON	mg/kg	6590 MBB	6800 MBB	3810 MBB	3410 MBB	5390 MBB
LEAD	mg/kg	6.6	6.2	3	4.7	9.5
MAGNESIUM	mg/kg	9800	11300	35600	21600	10000
MANGANESE	mg/kg	179	183	165	144	149
MERCURY	mg/kg	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)
NICKEL	mg/kg	6.7	6.8	ND(4.0)	ND(4.0)	5.6
POTASSIUM	mg/kg	524	508	ND(500)	ND(500)	ND(500)
SELENIUM	mg/kg	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
SILVER	mg/kg	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
SODIUM	mg/kg	ND(500)	ND(500)	ND(500)	ND(500)	ND(500)
THALLIUM	mg/kg	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
VANADIUM	mg/kg	9	9.7	5.2	ND(5.0)	8.5
ZINC	mg/kg	31.2	29.9	13.6	15.5 L	29.6
General Chemistry						
TOTAL CYANIDE	mg/kg	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)	ND(0.50)
TOTAL ORGANIC CARBON	mg/kg	14000	9300	2300	4100	14000
TOTAL SOLIDS (RESIDUE)	%	67	77.7	80 3	84.7	63.9

ND	Not detected.
–	Not analyzed.
MBB	This analyte is present at a reportable level in the associated method blank but is less than 5% of the sample amount.
PF	The parent difference between the original and confirmation analyses is greater than 50%.
J	Estimated result. Result is less than RL and greater than or equal to the MDL.
R	Rejected data. The absence of the analyte cannot be verified.
UJ	Not detect □

Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Location:		D-1	D-2	D-3	D-3	D-3	S-1	S-2	S-3
Sample ID:		W-MT-028	W-MT-021	W-MT-012	W-MT-013	W-MK-030	W-MT-024	W-MT-025	W-MT-026
Sample Date:		8/8/96	8/7/96	8/6/96	8/6/96	9/12/96	8/7/96	8/7/96	8/7/96
					Dupl.				
Parameter	Units								
Volatile Organics									
1,1,1-TRICHLOROETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2,2-TETRACHLOROETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2-TRICHLOROETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHENE (TOTAL)	ug/L		780	350	5 4.6 J		7.5 ND(5.0)	ND(5.0)	ND(5.0) 43
1,2-DICHLOROPROPANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
2-BUTANONE	ug/L	ND(250)	ND(500)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
2-HEXANONE	ug/L	ND(250)	ND(500)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
4-METHYL-2-PENTANONE	ug/L	ND(250)	ND(500)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	NI)(50)
ACETONE	ug/L	ND(250)	ND(500)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	31 J
BENZENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	3.3 J
BROMODICHLOROMETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOFORM	ug/L	ND(25)	ND(50)	NI)(5 0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOMETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON DISULFIDE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON TETRACHLORIDE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROBENZENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROETHANE	ug/L	ND(50)	ND(100)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CHLOROFORM	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROMETHANE	ug/L	ND(50)	ND(100)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CIS-1,3-DICHLOROPROPENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
DIBROMOCHLOROMETHANE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
ETHYLBENZENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
METHYLENE CHLORIDE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
STYRENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TETRACHLOROETHENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TOLUENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
TRANS-1,3-DICHLOROPROPENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	NI)(5 0)	ND(5.0)
TRICHLOROETHENE	ug/L	ND(25)	ND(50)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
VINYL CHLORIDE	ug/L		200	500	30	29	29 NI)(5.0)		11 ND(5.0)
XYLENES (TOTAL)	ug/L	ND(50)	ND(100)	ND(10)	ND(10)	ND(10)	NI)(10)	NI)(10)	120
	ug/L	ND(25)	ND(50)	NI)(5.0)	NI)(5.0)	NI)(5.0)	ND(5.0)	ND(5.0)	NI)(5.0)

Semi-volatile Organics

Parameter	Units								
1,2,4-TRICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
1,2-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
1,3-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
1,4-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,2'-OXYBIS(1-CHLOROPROPANE)	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4,5-TRICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4,6-TRICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4-DICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4-DIMETHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4-DINITROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2,4-DINITROTOLUENE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Page 1 (b)
Date Printed: October 3, 1996
Time Printed: 4:59 pm

Location:		D-1	D-2	D-3	D-3	D-3	S-1	S-2	S-3
Sample ID:		W-MT-028	W-MT-021	W-MT-012	W-MT-013	W-MK-030	W-MT-024	W-MT-025	W-MT-026
Sample Date:		8/8/96	8/7/96	8/6/96	8/6/96	9/12/96	8/7/96	8/7/96	8/7/96
					Dupl.				
Parameter	Units								
Semi-volatile Organics (Cont'd)									
2,6-DINITROTOLUENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2-CHLORONAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2-CHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2-METHYLNAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2-METHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
2-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
2-NITROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
3,3'-DICHLOROBENZIDINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
3-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
4,6-DINITRO-2-METHYLPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
4-BROMOPHENYL PHENYL ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
4-CHLORO-3-METHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
4-CHLOROANILINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
4-CHLOROPHENYL PHENYL ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
4-METHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
4-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
4-NITROPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ

ACENAPHTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
ACENAPHTHYLENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZO(A)ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZO(A)PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZO(B)FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZO(GHI)PERYLENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZO(K)FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BIS(2-CHLOROETHOXY)METHANE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BIS(2-CHLOROETHYL) ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BIS(2-ETHYLHEXYL) PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	8.2 J B
BUTYL BENZYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
CARBAZOLE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
CHRYSENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DI-N-BUTYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DI-N-OCTYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DIBENZ(A,H)ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DIBENZOFURAN	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DIETHYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
DIMETHYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
FLUORENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
HEXACHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
HEXACHLOROBUTADIENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
HEXACHLOROCYCLOPENTADIENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
HEXACHLOROETHANE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
INDENO(1,2,3-CD)PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
ISOPHORONE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
N-NITROSODI-N-PROPYLAMINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
N-NITROSODIPHENYLAMINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Location:		D-1	D-2	D-3	D-3	D-3	S-1	S-2	S-3
Sample ID:		W-MT-028	W-MT-021	W-MT-012	W-MT-013	W-MK-030	W-MT-024	W-MT-025	W-MT-026
Sample Date:		8/8/96	8/7/96	8/6/96	8/6/96 Dupl.	9/12/96	8/7/96	8/7/96	8/7/96
Parameter	Units								
Semi-volatile Organics (Cont'd)									
NAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ

NITROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
PENTACHLOROPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50) UJ
PHENANTHRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
PHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
Pesticides									
4,4'-DDD	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
4,4'-DDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
4,4'-DDT	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ALDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ALPHA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ALPHA-CHLORDANE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
BETA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
DELTA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
DIELDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDOSULFAN I	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDOSULFAN II	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDOSULFAN SULFATE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDRIN ALDEHYDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
ENDRIN KETONE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
GAMMA-BHC (LINDANE)	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
GAMMA-CHLORDANE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
HEPTACHLOR	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
HEPTACHLOR EPOXIDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ
METHOXYCHLOR	ug/L	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ
TOXAPHENE	ug/L	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ
PCBs									
AROCLOR 1016	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1221	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1232	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1242	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1248	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1254	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
AROCLOR 1260	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ
Metals									
ALUMINUM -DISS	mg/L	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
ANTIMONY -DISS	mg/L	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)
ARSENIC -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	0.042
BARIUM -DISS	mg/L	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	0.69

Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Date Printed: October 3, 1996
Time Printed: 4:59 pm

Location:		D-1	D-2	D-3	D-3	D-3	S-1	S-2	S-3
Sample ID:		W-MT-028	W-MT-021	W-MT-012	W-MT-013	W-MK-030	W-MT-024	W-MT-025	W-MT-026
Sample Date:		8/8/96	8/7/96	8/6/96	8/6/96 Dupl.	9/12/96	8/7/96	8/7/96	8/7/96
Parameter	Units								
Metals (Cont'd)									
BERYLLIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
CADMIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
CALCIUM -DISS	mg/L	108	88.5	84.6	85.4	79	87	87.1	88.6
CHROMIUM -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
COBALT -DISS	mg/L	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
COPPER -DISS	mg/L	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)
IRON -DISS	mg/L	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	ND(0.10)	4.9
LEAD -DISS	mg/L	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)
MAGNESIUM -DISS	mg/L	37.9	43.9	30.4	30.1	26.3	32.6	34.7	82.2
MANGANESE -DISS	mg/L	0.023	0.088	ND(0.015)	ND(0.015)	ND(0.015)	ND(0.015)	0.028	0.088
MERCURY -DISS	mg/L	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)
NICKEL -DISS	mg/L	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	0.065	ND(0.040)
POTASSIUM -DISS	mg/L	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	30
SELENIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
SILVER -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
SODIUM -DISS	mg/L	7.6	6.1	6.7	6.5	5.5	ND(5.0)	6.7	44.9
THALLIUM -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
VANADIUM -DISS	mg/L	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
ZINC -DISS	mg/L	ND(0.050)	ND(0.050)	0.18	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
General Chemistry									
TOTAL CYANIDE	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Date Printed: October 3, 1996
Time Printed: 5:00 pm

Location:		S-4	S-5	S-6	S-6	S-6
Sample ID:		W-MT-022	W-MT-023	W-MT-014	W-MK-031	W-MK-032
Sample Date:		8/7/96	8/7/96	8/6/96	9/12/96	9/12/96 Dupl.
Parameter	Units					
Volatile Organics						
1,1,1-TRICHLOROETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2,2-TETRACHLOROETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,1,2-TRICHLOROETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,1-DICHLOROETHENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
1,2-DICHLOROETHENE (TOTAL)	ug/L	960	130	5.2	3.0 J	3.8 J
1,2-DICHLOROPROPANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
2-BUTANONE	ug/L	ND(500)	ND(100)	ND(50)	ND(50)	ND(50)
2-HEXANONE	ug/L	ND(500)	ND(100)	ND(50)	ND(50)	ND(50)
4-METHYL-2-PENTANONE	ug/L	ND(500)	15 J	ND(50)	ND(50)	ND(50)
ACETONE	ug/L	ND(500)	ND(100)	27 J	ND(50)	ND(50)
BENZENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
BROMODICHLOROMETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOFORM	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
BROMOMETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON DISULFIDE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
CARBON TETRACHLORIDE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)

CHLOROBENZENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROETHANE	ug/L	ND(100)	ND(20)	ND(10)	ND(10)	ND(10)
CHLOROFORM	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
CHLOROMETHANE	ug/L	ND(100)	ND(20)	ND(10)	ND(10)	ND(10)
CIS-1,3-DICHLOROPROPENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
DIBROMOCHLOROMETHANE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
ETHYLBENZENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
METHYLENE CHLORIDE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
STYRENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
TETRACHLOROETHENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
TOLUENE	ug/L	ND(50)		21 ND(5.0)	ND(5.0)	ND(5.0)
TRANS-1,3-DICHLOROPROPENE	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
TRICHLOROETHENE	ug/L		450 ND(10)		23	23 27
VINYL CHLORIDE	ug/L	63 J		57 ND(10)	ND(10)	ND(10)
XYLENES (TOTAL)	ug/L	ND(50)	ND(10)	ND(5.0)	ND(5.0)	ND(5.0)
Semi-volatile Organics						
1,2,4-TRICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
1,2-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
1,3-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
1,4-DICHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2,2'-OXYBIS(1-CHLOROPROPANE)	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2,4,5-TRICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2,4,6-TRICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2,4-DICHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2,4-DIMETHYLPHENOL	ug/L	ND(10)	4.6 J	ND(10)	ND(10)	ND(10)
2,4-DINITROPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
2,4-DINITROTOLUENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Location:		S-4	S-5	S-6	S-6	S-6
Sample ID:		W-MT-022	W-MT-023	W-MT-014	W-MK-031	W-MK-032
Sample Date:		8/7/96	8/7/96	8/6/96	9/12/96	9/12/96 Dupl.
Parameter	Units					
Semi-volatile Organics (Cont'd)						
2,6-DINITROTOLUENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-CHLORONAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)

2-CHLOROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-METHYLNAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-METHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
2-NITROPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
3,3'-DICHLOROBENZIDINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
3-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
4,6-DINITRO-2-METHYLPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
4-BROMOPHENYL PHENYL ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-CHLORO-3-METHYLPHENOL	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-CHLOROANILINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-CHLOROPHENYL PHENYL ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYLPHENOL	ug/L	ND(10)		19 ND(10)	ND(10)	ND(10)
4-NITROANILINE	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
4-NITROPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
ACENAPHTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACENAPHTHYLENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZO(A)ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZO(A)PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZO(B)FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZO(GHI)PERYLENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZO(K)FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BIS(2-CHLOROETHOXY)METHANE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BIS(2-CHLOROETHYL) ETHER	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BIS(2-ETHYLHEXYL) PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BUTYL BENZYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CARBAZOLE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
CHRYSENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DI-N-BUTYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DI-N-OCTYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DIBENZ(A,H)ANTHRACENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DIBENZOFURAN	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DIETHYL PHTHALATE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
DIMETHYL PHTHALATE	ug/L	ND(10)	ND(10)	1.9 U	ND(10)	ND(10)
FLUORANTHENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
FLUORENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
HEXACHLOROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
HEXACHLOROBUTADIENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
HEXACHLOROCYCLOPENTADIENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
HEXACHLOROETHANE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
INDENO(1,2,3-CD)PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ISOPHORONE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
N-NITROSODI-N-PROPYLAMINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
N-NITROSODIPHENYLAMINE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Location:		S-4	S-5	S-6	S-6	S-6
Sample ID:		W-MT-022	W-MT-023	W-MT-014	W-MK-031	W-MK-032
Sample Date:		8/7/96	8/7/96	8/6/96	9/12/96	9/12/96 Dupl.
Parameter	**Units**					
Semi-volatile Organics (Cont'd)						
NAPHTHALENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
NITROBENZENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
PENTACHLOROPHENOL	ug/L	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)
PHENANTHRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
PHENOL	ug/L	ND(10)	3.2 J	ND(10)	ND(10)	ND(10)
PYRENE	ug/L	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
Pesticides						
4,4'-DDD	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
4,4'-DDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
4,4'-DDT	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ALDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ALPHA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ALPHA-CHLORDANE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
BETA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
DELTA-BHC	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
DIELDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDOSULFAN I	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDOSULFAN II	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDOSULFAN SULFATE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDRIN	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDRIN ALDEHYDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
ENDRIN KETONE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
GAMMA-BHC (LINDANE)	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
GAMMA-CHLORDANE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
HEPTACHLOR	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
HEPTACHLOR EPOXIDE	ug/L	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) UJ	ND(0.050) R	ND(0.050) R
METHOXYCHLOR	ug/L	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) UJ	ND(0.25) R	ND(0.25) R
TOXAPHENE	ug/L	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) UJ	ND(2.0) R	ND(2.0) R
PCBs						
AROCLOR 1016	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
AROCLOR 1221	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R

AROCLOR 1232	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
AROCLOR 1242	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
AROCLOR 1248	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
AROCLOR 1254	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
AROCLOR 1260	ug/L	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) UJ	ND(1.0) R	ND(1.0) R
Metals						
ALUMINUM -DISS	mg/L	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)	ND(0.20)
ANTIMONY -DISS	mg/L	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)	ND(0.060)
ARSENIC -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
BARIUM -DISS	mg/L	ND(0.20)	0.78	ND(0.20)	ND(0.20)	ND(0.20)

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Table 5

Summary of Analytical Results for Groundwater Samples
August/September 1996
Garland Road Landfill Site

Location:		S-4	S-5	S-6	S-6	S-6
Sample ID:		W-MT-022	W-MT-023	W-MT-014	W-MK-031	W-MK-032
Sample Date:		8/7/96	8/7/96	8/6/96	9/12/96	9/12/96
Parameter	Units					Dupl.
Metals (Cont'd)						
BERYLLIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
CADMIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
CALCIUM -DISS	mg/L	97.9	138	91.1	77.4	68.8
CHROMIUM -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
COBALT -DISS	mg/L	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
COPPER -DISS	mg/L	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)	ND(0.025)
IRON -DISS	mg/L	ND(0.10)	23.5	ND(0.10)	ND(0.10)	ND(0.10)
LEAD -DISS	mg/L	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)	ND(0.0030)
MAGNESIUM -DISS	mg/L	45.6	41.5	33.6	27	23.3
MANGANESE -DISS	mg/L	0.56	0.53	0.045	ND(0.015)	0.016
MERCURY -DISS	mg/L	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)	ND(0.00020)
NICKEL -DISS	mg/L	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)	ND(0.040)
POTASSIUM -DISS	mg/L	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)
SELENIUM -DISS	mg/L	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)	ND(0.0050)
SILVER -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
SODIUM -DISS	mg/L	6.4	5.4	7.6	5.2	ND(5.0)
THALLIUM -DISS	mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
VANADIUM -DISS	mg/L	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)
ZINC -DISS	mg/L	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)	ND(0.050)

General Chemistry							
TOTAL CYANIDE		mg/L	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)

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ND	Not detected.
–	Not analyzed.
J	Estimated result. Result is less than RL and greater than or equal to the MDL.
B	Method blank contamination. The associated method blank contains the target analyte at a reportable level.
U	Qualified as not detected at the associated value.
UJ	Not detected. Associated detection limit is estimated.
R	Rejected. The absence of the analyte cannot be verified.

Chemicals Detected in Fish Tissue Collected from the Stillwater River Study Area, 1994 by OEPA							
	Sampling Location - By River Mile						
	23.4	23.4	23.4	17.4	17.4	17.4	17.4
Parameter	Channel Catfish SFFC	Large Mouth Bass SOF	Common Carp SOFC	Common Carp WBC	Common Carp SOFC	Small-mouth Bass SOFC	Channel Catfish SFF
Metals (mg/kg)							
Mercury	1.04	0.20	0.22	<0.08	0.19	0.23	0.18

Chemicals Detected in Fish Tissue Collected from the Stillwater River Study Area, 1994 by OEPA							
	Sampling Location - By River Mile						
Parameter	15.4 Channel Catfish SFF	15.4 Small Mouth Bass SOF	15.4 Common Carp WBC	14.7 Channel Catfish SFFC	14.7 Small-mouth Bass SOFC	14.7 Common Carp WBC	12.1 Small-mouth Bass SOFC
Pesticides (µg/kg)							
Heptachlor Epoxide	3.1	<1.6	3.4	2.6	<1.7	3.9	<1.6
4,4'-DDE	22	<3.3	27	18	<3.3	32	3.8
Dieldrin	24	7.5	25	25	<3.3	27	7.1
4,4'-DDD	4.3	<3.3	7.5	18	<3.3	8.8	<3.3
4,4'-DDT	3.6	<3.3	<3.2	12	<3.3	7.5	<3.3
Endosulfan Sulfate	5.6	<3.3	11	<3.3	<3.3	<3.3	<3.3
Metals (mg/kg)							
Mercury	0.21	0.55	0.10	0.28	0.32	0.16	0.21

Chemicals Detected in Fish Tissue Collected from the Stillwater River Study Area, 1994 by OEPA							
	Sampling Location - By River Mile						
	12.1	12.1	15.4 D				
Parameter	Small Mouth Bass SOF	Common Carp WBC	Common Carp WBC				
Pesticides (µg/kg)							
Heptachlor Epoxide	<1.7	2.8	4.6				
4,4'-DDE	<3.3	25	32				
Dieldrin	4.9	12	29				
4,4'-DDD	<3.3	4.3	9.9				
Endrin Aldehyde	<3.3	<3.3	5.2				
Endosulfan Sulfate	<3.3	<3.3	11				
Methoxy-chlor	<17	<16	21				
Metals (mg/kg)							
Mercury	0.44	0.11	0.13				

ATTACHMENT B
RISK CALCULATION SPREADSHEETS

Site Name: Garland Road Landfill Site

Exposure Point Concentrations

Soil	
Chemical	Conc. (mg/kg)
Arsenic	1.1E+1
Aroclor 1248	6.1E+0
Aroclor 1254	5.0E+0
Beryllium	6.7E-1
Benzo(a)anthracene	1.5E+0
Benzo(b)fluroanthene	1.0E+0
Benzo(k)fluroanthene	1.2E+0
Benzo(a)pyrene	1.2E+0
Benzo(g,h,i)perylene	5.7E-1
Bis(2-ethylhexyl)phthalate	1.9E+1
Dieldrin	6.4E-2
Indeno(1,2,3-cd)pyrene	5.6E-1
Lead	1.1E+3
Mercury	6.6E-1
Methylene Chloride	4.0E-2
Phenanthrene	2.6E+0
Trichloroethene	5.1E-2

Sediment	
Chemical	Concentration (mg/kg)
Arsenic	7.7E+0
Aroclor 1221	3.6E-2
Benzo(a)anthracene	1.2E-1
Benzo(b)fluoranthene	2.1E-1
Beryllium	6.4E-1
Bis(2-ethylhexyl)phthalate	2.0E-1
Lead	3.4E+1
Mercury	8.0E-2
Phenanthrene	3.9E-1

Fish	
Chemical	Conc. mg/kg
Aroclor 1254	4.9E-2

Air Factors		
Chemical	(mg^3/kg)	
	VF	PEF
Arsenic	NA	1.3E+9
Aroclor 1248	1.2E+6	1.3E+9
Aroclor 1254	2.5E+6	1.3E+9
Beryllium	NA	1.3E+9
Benzo(a)anthracene	NA	1.3E+9
Benzo(a)anthracene	NA	1.3E+9
Benzo(b)fluroanthene	NA	1.3E+9
Benzo(k)fluroanthene	1.4E+9	1.3E+9
Benzo(a)pyrene	NA	1.3E+9
Benzo(g,h,i)perylene	5.7E+8	1.3E+9
Bis(2-ethylhexyl)phthalate	NA	1.3E+9
Indeno(1,2,3-cd)pyrene	NA	1.3E+9
Lead	NA	1.3E+9
Mercury	NA	1.3E+9
Methylene Chloride	4.1E+4	1.3E+9
Phenanthrene	2.5E+6	1.3E+9
Trichloroethene	3.5E+3	1.3E+9

PEF Equation:

$$PEF = Q/C \times \frac{3600\ s/h}{0.036 \times (1 - V) \times (U_m/U_t)^3 \times F(x)}$$

Where:		Defaults	Actual
PEF	Particulate emission factor (m^3/kg)	1.316E+09	1.316E+09
Q/C	Inv. of the mean conc. at the ctr. of a 0.5-acre^2 source (g/m^2-s per kg/m^3)	90.8	90.8
V	Fraction of vegetative cover (unitless)	0.5	0.5
U_m	Mean annual windspeed (m/s)	4.69	4.69
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32	11.32
F(x)	Function dependent on Um/Ut derived using Cowherd (1985) (unitless)	0.194	0.194

Source: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part B, Development of Risk-Based Preliminary Remediation Goals) Interm, Publication 9285.7-01B

Soil-to-Air Volatilization Model

$$VF = \frac{LS * V * DH * SQRT(3.14 * \alpha * T)}{2 * AR * D_{ei} * E * K_{as} * 0.001}$$

and

$$\alpha = (D_{ei} * E)/ (E + P_s * (1-E)/K_{as})$$

where:
- VF = volatilization factor
- LS = length of area (m)
- V = wind speed (m/s)
- DH = diffusion height (m)
- AR = area (cm^2)
- D_{ei} = effective diffusivity (cm^2/s) = $Di*E^{0.33}$
- E = soil porosity
- K_{as} = soil/air partition coefficient (g soil/cm^3 air) = $H/41\ K_d$
- Ps = soil density (g/cm^3)
- T = exposure time (s)
- Di = molecular diffusivity (cm^2/s)
- H = Henry's Law constant (atm-m^3/mol)
- K_d = soil-water coefficient (cm^3/g) = $K_{oc} * OC$
- K_{oc} = organic carbon coefficient (cm^3/g)
- OC = organic carbon of soil (fractional)

Chemical	D_i cm^2/s	H atm-m^3/mol	K_{oc} cm^3/g	V m/s	LS m	DH m	AR cm^2	D_{ei} cm^2/s	E	P_s g/cm^3	T s	K_d cm^3/g	K_{as} g/cm^3	OC fraction	α cm^2/s	VF m^3/kg
Arsenic				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	0.02	0.0E+00	--
Aroclor 1248	5.0E-02	2.8E-03	56200	2.25	45	2	2.0E+07	3.5E-02	0.35	2.65	7.9E+08	57324	2.0E-06	1.02	1.4E-08	1.2E+06
Aroclor 1254	5.0E-02	2.0E-03	61800	2.25	45	2	2.0E+07	3.5E-02	0.35	2.65	7.9E+08	165236	5.0E-07	2.02	3.6E-09	2.5E+06
Beryllium				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	3.02	0.0E+00	--
Benzo(a)anthracene				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	4.02	0.0E+00	--
Benzo(b)fluroanthene				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	5.02	0.0E+00	--
Benzo(k)fluroanthene				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	6.02	0.0E+00	--
Benzo(a)pyrene	4.8E-02	1.6E-06	5500000	2.25	45	2	2.0E+07	3.4E-02	0.35	2.65	7.9E+08	38610000	1.6E-12	7.02	1.1E-14	1.4E+09
Benzo(g,h,i)perylene				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	8.02	0.0E+00	--
Bis(2-ethylhexyl)phthalate	3.9E-02	1.1E-05	4180000	2.25	45	2	2.0E+07	2.7E-02	0.35	2.65	7.9E+08	37703600	1.2E-11	9.02	6.7E-14	5.7E+08
Dieldrin				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	10.02	0.0E+00	--
Indeno(1,2,3-cd)pyrene				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	11.02	0.0E+00	--
Lead				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	12.02	0.0E+00	--
Mercury				2.25	45	2	2.0E+07	0.0E+00	0.35	2.65	7.9E+08	0	0.0E+00	13.02	0.0E+00	--
Methylene Chloride	1.0E-01	2.6E-03	8.8	2.25	45	2	2.0E+07	7.1E-02	0.35	2.65	7.9E+08	123.376	8.6E-04	14.02	1.3E-05	4.1E+04
Phenanthrene	7.5E-02	1.6E-04	1400	2.25	45	2	2.0E+07	5.3E-02	0.35	2.65	7.9E+08	21028	3.1E-07	15.02	3.3E-09	2.5E+06
Trichloroethene	8.1E-02	8.9E-03	125.89	2.25	45	2	2.0E+07	5.7E-02	0.35	2.65	7.9E+08	2.51785	1.4E-01	0.02	1.6E-03	3.5E+03

Sourc[illegible] Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part [illegible]lopment of Risk-Based Preliminary Remediation Goals) Interm, Publication 9285.7-01B

Garland Road Landfill Site

Ingestion of Recreationally Caught Fish - RME Case - Child

Exposure Equation:

$$\text{Intake} = \frac{C_f \times IR \times FI \times ED \times EF}{BW \times AT}$$

where,

C_f: chemical concentration in soil
IR: ingestion rate
ED: exposure duration
EF: exposure frequency
FI: fraction ingested
BW: bodyweight
AT: averaging time

Exposure Factors:

C_f*	--	(mg/kg)
IR	0.054	(kg/meal)
ED	6	(years)
EF	350	(days/year)
FI	0.5	(unitless)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer

* - Chemical specific value

Chemical	Fish Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Aroclor 1254	4.9E-2	7.2E-6	2.00E+0	1.4E-5	8.5E-5	2.0E-5	4.2E+0
TOTAL		--	--	**1.4E-5**	--	--	**4.2E+0**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/26/97

Table B-2
Garland Road Landfill Site
Ingestion of Recreationally Caught Fish - RME Case - Adult

Exposure Equation:

$$\text{Intake} = \frac{C_f \times IR \times FI \times ED \times EF}{BW \times AT}$$

where,

C_f: chemical concentration in fish
IR: ingestion rate
ED: exposure duration
EF: exposure frequency
FI: fraction ingested
BW: bodyweight
AT: averaging time

Exposure Factors:

C_f*	--	(mg/kg)
IR	0.054	(kg/meal)
ED	24	(years)
EF	350	(days/year)
FI	0.5	(unitless)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer

* - Chemical specific value

Chemical	Fish Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Aroclor 1254	4.9E-2	6.2E-6	2.00E+0	1.2E-5	1.8E-5	2.0E-5	9.1E-1
TOTAL		--	--	1.2E-5	--	--	9.1E-1

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Garland Road Landfill Site

Soil Ingestion - RME Case - Adolescent Trespasser

Exposure Equation:

$$\text{Intake} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	CF: conversion factor
IR: ingestion rate	BW: bodyweight
ED: exposure duration	AT: averaging time
EF: exposure frequency	
FI: fraction ingested	

Exposure Factors:

CS*	--	(mg/kg)
IR	100	(mg/day)
ED	8	(years)
EF	48	(days/year)
FI	1	(unitless)
CF	1E-6	(kg/mg)
BW	42	(kg)
AT	25,550	(days) cancer
AT	2,920	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	3.9E-7	1.50E+0	5.9E-7	3.4E-6	3.0E-4	1.1E-2
Aroclor 1248	6.1E+0	2.2E-7	2.00E+0	4.4E-7	1.9E-6	NA	
Aroclor 1254	5.0E+0	1.8E-7	2.00E+0	3.6E-7	1.6E-6	2.0E-5	7.8E-2
Beryllium	6.7E-1	2.4E-8	4.30E+0	1.0E-7	2.1E-7	5.0E-3	4.2E-5
Benzo(a)anthracene	1.5E+0	5.2E-8	7.30E-1	3.8E-8	4.6E-7	NA	
Benzo(b)fluroanthene	1.0E+0	3.6E-8	7.30E-1	2.7E-8	3.2E-7	NA	
Benzo(k)fluroanthene	1.2E+0	4.3E-8	7.30E-2	3.2E-9	3.8E-7	NA	
Benzo(a)pyrene	1.2E+0	4.2E-8	7.30E+0	3.0E-7	3.6E-7	NA	
Benzo(g,h,i)perylene	5.7E-1	2.0E-8	NA		1.6E-7	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	6.7E-7	1.40E-2	9.4E-9	5.9E-6	2.0E-2	2.9E-4
Dieldrin	6.4E-2	2.3E-9	1.60E+1	3.7E-8	2.0E-8	5.0E-5	4.0E-4
Indeno(1,2,3-cd)pyrene	5.6E-1	2.0E-8	7.30E-1	1.5E-8	1.6E-7	NA	
Lead	1.1E+3	3.9E-5	NA		3.4E-4	NA	
Mercury	6.6E-1	2.4E-8	NA		2.1E-7	NA	
Methylene Chloride	4.0E-2	1.4E-9	7.50E-3	1.1E-11	1.3E-8	6.0E-2	2.1E-7
Phenanthrene	2.6E+0	9.4E-8	NA		8.2E-7	NA	
Trichloroethene	5.1E-2	1.8E-9	1.10E-2	2.0E-11	1.6E-8	6.0E-3	2.7E-6
TOTAL		--	--	**1.9E-6**	--	--	**9.0E-2**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Table B-4
Garland Road Landfill Site
Dermal Contact with Soil - RME Case - Adolescent Trespasser

Exposure Equation:

$$\text{Intake} = \frac{CS \times ABS \times CF \times SA \times AF \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in s
ABS: absorption factor
CF: conversion factor
SA: skin surface area
AF: adherence factor
ED: exposure duration
EF: exposure frequency
BW: bodyweight
AT: averaging time

Exposure Factors:

CS*	–	(mg/kg)
ABS	–	(unitless)
AF	1	(mg/cm2)
SA	3313	(cm2/event)
ED	8	(years)
EF	48	(days/year)
CF	1E-6	(kg/mg)
BW	42	(kg)
AT	25,550	(days) cancer
AT	2,920	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	ABS	Carcinogenic Effects: LADI (mg/kg-day)	Oral SF (mg/kg-day)-1	Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotient
Arsenic	1.1E+1	1.0E-2	1.3E-7	1.50E+0	2.0E-7	1.1E-6	3.0E-4	3.8E-3
Aroclor 1248	6.1E+0	6.0E-2	4.3E-7	2.00E+0	8.7E-7	3.8E-6	NA	
Aroclor 1254	5.0E+0	6.0E-2	3.6E-7	2.00E+0	7.1E-7	3.1E-6	2.0E-5	1.6E-1
Beryllium	6.7E-1	1.0E-2	7.9E-9	4.30E+0	3.4E-8	7.0E-8	5.0E-3	1.4E-5
Benzo(a)anthracene	1.5E+0	1.0E-1	1.7E-7	NA		1.5E-6	NA	
Benzo(b)fluroanthene	1.0E+0	1.0E-1	1.2E-7	NA		1.1E-6	NA	
Benzo(k)fluroanthene	1.2E+0	1.0E-1	1.4E-7	NA		1.3E-6	NA	
Benzo(a)pyrene	1.2E+0	1.0E-1	1.4E-7	NA		1.2E-6	NA	
Benzo(g,h,i)perylene	5.7E-1	1.0E-1	6.8E-8	NA		5.9E-7	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.0E-1	2.2E-6	1.40E-2	3.1E-8	1.9E-5	2.0E-2	9.7E-4
Dieldrin	6.4E-2	1.0E-1	7.6E-9	1.60E+1	1.2E-7	6.6E-8	5.0E-5	1.3E-3
Indeno(1,2,3-cd)pyrene	5.6E-1	1.0E-1	6.6E-8	NA		5.8E-7	NA	
Lead	1.1E+3	1.0E-2	1.3E-5	NA		1.1E-4	NA	
Mercury	6.6E-1	1.0E-2	7.8E-9	NA		6.8E-8	NA	
Methylene Chloride	4.0E-2	1.0E-1	4.7E-9	7.50E-3	3.6E-11	4.1E-8	6.0E-2	6.9E-7
Phenanthrene	2.6E+0	1.0E-1	3.1E-7	NA		2.7E-6	NA	
Trichloroethene	5.1E-2	1.0E-1	6.0E-9	1.10E-2	6.7E-11	5.3E-8	6.0E-3	8.8E-6
	TOTAL		--	--	2.0E-6	--	--	1.8E-1

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Garland Road Landfill Site

Inhalation from Air - Dust - RME Case - Adolescent Trespasser

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{air} \times (1/PEF)}{BW \times AT}$$

where,

Cs: chemical conc in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	PEF = Particlate Emission Factor

Exposure Factors:

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	4	(hours/day)
ED	6	(years)
EF	6	(days/year)
BW	42	(kg)
AT	25,550	(days) cancer
AT	2,920	(days) noncancer
Days at Site	48	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	PEF (m3/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Inhalation SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Inhalation RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	1.3E+9	1.0E-11	1.50E+1	1.5E-10	8.7E-11	3.0E-4	2.9E-7
Aroclor 1248	6.1E+0	1.3E+9	5.5E-12	2.00E+0	1.1E-11	4.8E-11	NA	
Aroclor 1254	5.0E+0	1.3E+9	4.5E-12	2.00E+0	9.1E-12	4.0E-11	2.0E-5	2.0E-6
Beryllium	6.7E-1	1.3E+9	6.1E-13	8.40E+0	5.1E-12	5.3E-12	5.0E-3	1.1E-9
Benzo(a)anthracene	1.5E+0	1.3E+9	1.3E-12	NA		1.2E-11	NA	
Benzo(b)fluroanthene	1.0E+0	1.3E+9	9.2E-13	6.10E+0	5.6E-12	8.1E-12	NA	
Benzo(k)fluroanthene	1.2E+0	1.3E+9	1.1E-12	6.10E+0	6.7E-12	9.6E-12	NA	
Benzo(a)pyrene	1.2E+0	1.3E+9	1.1E-12	6.10E+0	6.4E-12	9.2E-12	NA	
Benzo(g,h,i)perylene	5.7E-1	1.3E+9	5.2E-13	NA		4.5E-12	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.3E+9	1.7E-11	1.40E-2	2.4E-13	1.5E-10	5.7E-2	2.6E-9
Dieldrin	6.4E-2	1.3E+9	5.8E-14	1.60E+1	9.3E-13	5.1E-13	5.0E-5	1.0E-8
Indeno(1,2,3-cd)pyrene	5.6E-1	1.3E+9	5.1E-13	6.10E+0	3.1E-12	4.4E-12	NA	
Lead	1.1E+3	1.3E+9	1.0E-9	NA		8.7E-9	NA	
Mercury	6.6E-1	1.3E+9	6.0E-13	NA		5.2E-12	8.6E-5	6.1E-8
Methylene Chloride	4.0E-2	1.3E+9	3.6E-14	1.60E-3	5.8E-17	3.2E-13	8.6E-1	3.7E-13
Phenanthrene	2.6E+0	1.3E+9	2.4E-12	NA		2.1E-11	NA	
Trichloroethene	5.1E-2	1.3E+9	4.6E-14	6.00E-3	2.8E-16	4.0E-13	6.0E-3	6.7E-11
TOTAL			--	--	**2.0E-10**	--	--	**2.3E-6**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncancer)

NA - Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/26/97

Table B-6
Garland Road Landfill Site
Inhalation of Vapors from Soil - RME Case - Adolescent Trespasser

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{air} \times (1/VF)}{BW \times AT}$$

where,

Cs: chemical conc. in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	VF = Volatilization Factor

Exposure Factors:

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	4	(hours/day)
ED	8	(years)
EF	8	(days/year)
BW	42	(kg)
AT	25,550	(days) cancer
AT	2,920	(days) noncancer
Days at Site	48	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	VF m³/kg	Carcinogenic Effects: LADI (mg/kg-day)	Inhalation SF (mg/kg-day)-1	Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient
Arsenic	1.1E+1	NA	NA	1.50E+1		NA	3.0E-4	
Aroclor 1248	6.1E+0	1.2E+6	6.0E-9	4.00E-1	2.4E-9	5.2E-8	NA	
Aroclor 1254	5.0E+0	2.5E+6	2.4E-9	4.00E-1	9.7E-10	2.1E-8	2.0E-5	1.1E-3
Beryllium	6.7E-1	NA	NA	8.40E+0		NA	5.0E-3	
Benzo(a)anthracene	1.5E+0	NA	NA	NA		NA	NA	
Benzo(b)fluroanthene	1.0E+0	NA	NA	6.10E+0		NA	NA	
Benzo(k)fluroanthene	1.2E+0	NA	NA	6.10E+0		NA	NA	
Benzo(a)pyrene	1.2E+0	1.4E+9	1.0E-12	6.10E+0	6.2E-12	NA	NA	
Benzo(g,h,i)perylene	5.7E-1	NA	NA	NA		8.8E-12	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	5.7E+8	3.9E-11	1.40E-2	5.5E-13	NA	NA	
Dieldrin	6.4E-2	NA	NA	1.60E+1		3.4E-10	5.7E-2	6.0E-9
Indeno(1,2,3-cd)pyrene	5.6E-1	NA	NA	6.10E+0		NA	5.0E-5	
Lead	1.1E+3	NA	NA	NA		NA	NA	
Mercury	6.6E-1	NA	NA	NA		NA	NA	
Methylene Chloride	4.0E-2	4.1E+4	1.2E-9	1.60E-3	1.8E-12	NA	8.6E-5	
Phenanthrene	2.6E+0	2.5E+6	1.2E-9	NA		1.0E-8	8.6E-1	1.2E-8
Trichloroethene	5.1E-2	3.5E+3	1.7E-8	6.00E-3	1.0E-10	1.1E-8	NA	
						1.5E-7	6.0E-3	2.5E-5
TOTAL			--	--	**3.5E-9**	--	--	**1.1E-3**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Garland Road Landfill Site

Sediment Ingestion - RME Case - Child

Exposure Equation:

$$\text{Intake} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	CF: conversion factor
IR: ingestion rate	BW: bodyweight
ED: exposure duration	AT: averaging time
EF: exposure frequency	
FI: fraction ingested	

Exposure Factors:

CS*	–	(mg/kg)
IR	200	(mg/day)
ED	6	(years)
EF	72	(days/year)
FI	1	(unitless)
CF	1E-6	(kg/mg)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer

* - Chemical specific value

Chemical	Sediment Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	7.7E+0	1.7E-6	1.50E+0	2.6E-6	2.0E-5	3.0E-4	6.8E-2
Aroclor 1221	3.6E-2	8.1E-9	2.00E+0	1.6E-8	9.5E-8	NA	
Benzo(a)anthracene	1.2E-1	2.7E-8	7.30E-1	2.0E-8	3.2E-7	NA	
Benzo(b)fluoranthene	2.1E-1	4.7E-8	7.30E-1	3.5E-8	5.5E-7	NA	
Beryllium	6.4E-1	1.4E-7	4.30E+0	6.2E-7	1.7E-6	5.0E-3	3.4E-4
Bis(2-ethylhexyl)phthalate	2.0E-1	4.5E-8	1.40E-2	6.3E-10	5.3E-7	2.0E-2	2.6E-5
Lead	3.4E+1	7.7E-6	NA		9.0E-5	NA	
Mercury	8.0E-2	1.8E-8	NA		2.1E-7	NA	
Phenanthrene	3.9E-1	8.8E-8	NA		1.0E-6	NA	
TOTAL		--	--	**3.3E-6**	--	--	**0.068**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Table B-8
Garland Road Landfill Site
Sediment Ingestion - RME Case - Adult

Exposure Equation:

$$\text{Intake} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil
IR: ingestion rate
ED: exposure duration
EF: exposure frequency
FI: fraction ingested
CF: conversion factor
BW: bodyweight
AT: averaging time

Exposure Factors:

CS*	--	(mg/kg)
IR	100	(mg/day)
ED	24	(years)
EF	48	(days/year)
FI	1	(unitless)
CF	1E-6	(kg/mg)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer

* - Chemical specific value

Chemical	Sediment Concentration (mg/kg)	Carcinogenic Effects			Noncarcinogenic Effects		
		LADI (mg/kg-day)	Oral SF (mg/kg-day)-1	Cancer Risk	ADI (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotient
Arsenic	7.7E+0	5.0E-7	1.50E+0	7.4E-7	1.4E-6	3.0E-4	4.8E-3
Aroclor 1221	3.6E-2	2.3E-9	2.00E+0	4.6E-9	6.8E-9	NA	
Benzo(a)anthracene	1.2E-1	7.7E-9	7.30E-1	5.6E-9	2.3E-8	NA	
Benzo(b)fluoranthene	2.1E-1	1.4E-8	7.30E-1	9.9E-9	3.9E-8	NA	
Beryllium	6.4E-1	4.1E-8	4.30E+0	1.8E-7	1.2E-7	5.0E-3	2.4E-5
Bis(2-ethylhexyl)phthalate	2.0E-1	1.3E-8	1.40E-2	1.8E-10	3.8E-8	2.0E-2	1.9E-6
Lead	3.4E+1	2.2E-6	NA		6.4E-6	NA	
Mercury	8.0E-2	5.2E-9	NA		1.5E-8	NA	
Phenanthrene	3.9E-1	2.5E-8	NA		7.3E-8	NA	
TOTAL		--	--	**9.4E-7**	--	--	**0.005**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Garland Road Landfill Site

Dermal Contact with Sediment - RME Case - Child

Exposure Equation:

$$\text{Intake} = \frac{CS \times ABS \times CF \times SA \times AF \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	ED: exposure duration
ABS: absorption factor	EF: exposure frequency
CF: conversion factor	BW: bodyweight
SA: skin surface area	AT: averaging time
AF: adherence factor	

Exposure Factors:

CS*	--	(mg/kg)
ABS	--	(unitless)
AF	1	(mg/cm2)
SA	1750	(cm2/event)
ED	6	(years)
EF	72	(days/year)
CF	1E-6	(kg/mg)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer

* - Chemical specific value

Chemical	Sediment Concentration (mg/kg)	ABS	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	7.7E+0	1.0E-2	1.5E-7	1.50E+0	2.3E-7	1.8E-6	3.0E-4	5.9E-3
Aroclor 1221	3.6E-2	6.0E-2	4.3E-9	2.00E+0	8.5E-9	5.0E-8	NA	
Benzo(a)anthracene	1.2E-1	1.0E-1	2.4E-8	NA		2.8E-7	NA	
Benzo(b)fluoranthene	2.1E-1	1.0E-1	4.1E-8	NA		4.8E-7	NA	
Beryllium	6.4E-1	1.0E-2	1.3E-8	4.30E+0	5.4E-8	1.5E-7	5.0E-3	2.9E-5
Bis(2-ethylhexyl)phthalate	2.0E-1	1.0E-1	3.9E-8	1.40E-2	5.5E-10	4.6E-7	2.0E-2	2.3E-5
Lead	3.4E+1	1.0E-2	6.6E-7	NA		7.9E-6	NA	
Mercury	8.0E-2	1.0E-2	1.6E-9	NA		1.8E-8	NA	
Phenanthrene	3.9E-1	1.0E-1	7.7E-8	NA		9.0E-7	NA	
TOTAL			--	--	**2.9E-7**	--	--	**0.01**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Table B-10
Garland Road Landfill Site
Dermal Contact with Sediment - RME Case - Adult

Exposure Equation:

$$\text{Intake} = \frac{CS \times ABS \times CF \times SA \times AF \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in sed.	ED: exposure duration
ABS: absorption factor	EF: exposure frequency
CF: conversion factor	BW: bodyweight
SA: skin surface area	AT: averaging time
AF: adherence factor	

Exposure Factors:

CS*	--	(mg/kg)
ABS	--	(unitless)
AF	1	(mg/cm2)
SA	5000	(cm2/event)
ED	24	(years)
EF	48	(days/year)
CF	1E-6	(kg/mg)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer

* - Chemical specific value

Chemical	Sediment Concentration (mg/kg)	ABS	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	7.7E+0	1.0E-2	2.5E-7	1.50E+0	3.7E-7	7.2E-7	3.0E-4	2.4E-3
Aroclor 1221	3.6E-2	6.0E-2	7.0E-9	2.00E+0	1.4E-8	2.0E-8	NA	
Benzo(a)anthracene	1.2E-1	1.0E-1	3.9E-8	NA		1.1E-7	NA	
Benzo(b)fluoranthene	2.1E-1	1.0E-1	6.8E-8	NA		2.0E-7	NA	
Beryllium	6.4E-1	1.0E-2	2.1E-8	4.30E+0	8.9E-8	6.0E-8	5.0E-3	1.2E-5
Bis(2-ethylhexyl)phthalate	2.0E-1	1.0E-1	6.4E-8	1.40E-2	9.0E-10	1.9E-7	2.0E-2	9.4E-6
Lead	3.4E+1	1.0E-2	1.1E-6	NA		3.2E-6	NA	
Mercury	8.0E-2	1.0E-2	2.6E-9	NA		7.5E-9	NA	
Phenanthrene	3.9E-1	1.0E-1	1.3E-7	NA		3.7E-7	NA	
TOTAL			--	--	**4.8E-7**	--	--	**0.002**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Table B-11
Garland Road Landfill Site
Soil Ingestion - RME Case - Child Recreational User

Exposure Equation:

$$\text{Intake} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	CF: conversion factor
IR: ingestion rate	BW: bodyweight
ED: exposure duration	AT: averaging time
EF: exposure frequency	
FI: fraction ingested	

Exposure Factors:

CS*	--	(mg/kg)
IR	200	(mg/day)
ED	6	(years)
EF	72	(days/year)
FI	1	(unitless)
CF	1E-6	(kg/mg)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	2.5E-6	1.50E+0	3.7E-6	2.9E-5	3.0E-4	9.6E-2
Aroclor 1248	6.1E+0	1.4E-6	2.00E+0	2.8E-6	1.6E-5	NA	
Aroclor 1254	5.0E+0	1.1E-6	2.00E+0	2.3E-6	1.3E-5	2.0E-5	6.6E-1
Beryllium	6.7E-1	1.5E-7	4.30E+0	6.5E-7	1.8E-6	5.0E-3	3.5E-4
Benzo(a)anthracene	1.5E+0	3.3E-7	7.30E-1	2.4E-7	3.8E-6	NA	
Benzo(b)fluroanthene	1.0E+0	2.3E-7	7.30E-1	1.7E-7	2.7E-6	NA	
Benzo(k)fluroanthene	1.2E+0	2.7E-7	7.30E-2	2.0E-8	3.2E-6	NA	
Benzo(a)pyrene	1.2E+0	2.6E-7	7.30E+0	1.9E-6	3.1E-6	NA	
Benzo(g,h,i)perylene	5.7E-1	1.3E-7	NA		1.5E-6	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	4.2E-6	1.40E-2	5.9E-8	4.9E-5	2.0E-2	2.5E-3
Dieldrin	6.4E-2	1.4E-8	1.60E+1	2.3E-7	1.7E-7	5.0E-5	3.4E-3
Indeno(1,2,3-cd)pyrene	5.6E-1	1.3E-7	7.30E-1	9.2E-8	1.5E-6	NA	
Lead	1.1E+3	2.5E-4	NA		2.9E-3	NA	
Mercury	6.6E-1	1.5E-7	NA		1.7E-6	NA	
Methylene Chloride	4.0E-2	9.0E-9	7.50E-3	6.8E-11	1.1E-7	6.0E-2	1.8E-6
Phenanthrene	2.6E+0	5.9E-7	NA		6.9E-6	NA	
Trichloroethene	5.1E-2	1.1E-8	1.10E-2	1.3E-10	1.3E-7	6.0E-3	2.2E-5
TOTAL		--	--	1.2E-5	--	--	7.6E-1

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/26/97

Table B-12
Garland Road Landfill Site
Soil Ingestion - RME Case - Adult Recreational User

Exposure Equation:

$$\text{Intake} = \frac{CS \times IR \times CF \times FI \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	CF: conversion factor
IR: ingestion rate	BW: bodyweight
ED: exposure duration	AT: averaging time
EF: exposure frequency	
FI: fraction ingested	

Exposure Factors:

CS*	--	(mg/kg)
IR	100	(mg/day)
ED	24	(years)
EF	48	(days/year)
FI	1	(unitless)
CF	1E-6	(kg/mg)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Oral SF (mg/kg-day)-1	Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotient
Arsenic	1.1E+1	7.1E-7	1.50E+0	1.1E-6	2.1E-6	3.0E-4	6.9E-3
Aroclor 1248	6.1E+0	3.9E-7	2.00E+0	7.9E-7	1.1E-6	NA	
Aroclor 1254	5.0E+0	3.2E-7	2.00E+0	6.4E-7	9.4E-7	2.0E-5	4.7E-2
Beryllium	6.7E-1	4.3E-8	4.30E+0	1.9E-7	1.3E-7	5.0E-3	2.5E-5
Benzo(a)anthracene	1.5E+0	9.4E-8	7.30E-1	6.9E-8	2.7E-7	NA	
Benzo(b)fluroanthene	1.0E+0	6.6E-8	7.30E-1	4.8E-8	1.9E-7	NA	
Benzo(k)fluroanthene	1.2E+0	7.8E-8	7.30E-2	5.7E-9	2.3E-7	NA	
Benzo(a)pyrene	1.2E+0	7.5E-8	7.30E+0	5.5E-7	2.2E-7	NA	
Benzo(g,h,i)perylene	5.7E-1	3.7E-8	NA		1.1E-7	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.2E-6	1.40E-2	1.7E-8	3.5E-6	2.0E-2	1.8E-4
Dieldrin	6.4E-2	4.1E-9	1.60E+1	6.6E-8	1.2E-8	5.0E-5	2.4E-4
Indeno(1,2,3-cd)pyrene	5.6E-1	3.6E-8	7.30E-1	2.6E-8	1.1E-7	NA	
Lead	1.1E+3	7.1E-5	NA		2.1E-4	NA	
Mercury	6.6E-1	4.3E-8	NA		1.2E-7	NA	
Methylene Chloride	4.0E-2	2.6E-9	7.50E-3	1.9E-11	7.5E-9	6.0E-2	1.3E-7
Phenanthrene	2.6E+0	1.7E-7	NA		4.9E-7	NA	
Trichloroethene	5.1E-2	3.3E-9	1.10E-2	3.6E-11	9.6E-9	6.0E-3	1.6E-6
TOTAL		--	--	**3.5E-6**	--	--	**5.4E-2**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)
NA : Toxicity criterion not available.

Table B-14

Garland Road Landfill Site

Dermal Contact with Soil - RME Case - Adult Recreational User

Exposure Equation:

$$\text{Intake} = \frac{CS \times ABS \times CF \times SA \times AF \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	ED: exposure duration
ABS: absorption factor	EF: exposure frequency
CF: conversion factor	BW: bodyweight
SA: skin surface area	AT: averaging time
AF: adherence factor	

Exposure Factors:

CS*	--	(mg/kg)
ABS	--	(unitless)
AF	1	(mg/cm2)
SA	5000	(cm2/event)
ED	24	(years)
EF	48	(days/year)
CF	1E-6	(kg/mg)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	ABS	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	1.0E-2	3.5E-7	1.50E+0	5.3E-7	1.0E-6	3.0E-4	3.4E-3
Aroclor 1248	6.1E+0	6.0E-2	1.2E-6	2.00E+0	2.4E-6	3.4E-6	NA	
Aroclor 1254	5.0E+0	6.0E-2	9.7E-7	2.00E+0	1.9E-6	2.8E-6	2.0E-5	1.4E-1
Beryllium	6.7E-1	1.0E-2	2.2E-8	4.30E+0	9.3E-8	6.3E-8	5.0E-3	1.3E-5
Benzo(a)anthracene	1.5E+0	1.0E-1	4.7E-7	NA		1.4E-6	NA	
Benzo(b)fluroanthene	1.0E+0	1.0E-1	3.3E-7	NA		9.6E-7	NA	
Benzo(k)fluroanthene	1.2E+0	1.0E-1	3.9E-7	NA		1.1E-6	NA	
Benzo(a)pyrene	1.2E+0	1.0E-1	3.7E-7	NA		1.1E-6	NA	
Benzo(g,h,i)perylene	5.7E-1	1.0E-1	1.8E-7	NA		5.4E-7	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.0E-1	6.0E-6	1.40E-2	8.4E-8	1.8E-5	2.0E-2	8.8E-4
Dieldrin	6.4E-2	1.0E-1	2.1E-8	1.60E+1	3.3E-7	6.0E-8	5.0E-5	1.2E-3
Indeno(1,2,3-cd)pyrene	5.6E-1	1.0E-1	1.8E-7	NA		5.3E-7	NA	
Lead	1.1E+3	1.0E-2	3.5E-5	NA		1.0E-4	NA	
Mercury	6.6E-1	1.0E-2	2.1E-8	NA		6.2E-8	NA	
Methylene Chloride	4.0E-2	1.0E-1	1.3E-8	7.50E-3	9.7E-11	3.8E-8	6.0E-2	6.3E-7
Phenanthrene	2.6E+0	1.0E-1	8.5E-7	NA		2.5E-6	NA	
Trichloroethene	5.1E-2	1.0E-1	1.6E-8	1.10E-2	1.8E-10	4.8E-8	6.0E-3	8.0E-6
TOTAL			--	--	**5.3E-6**	--	--	**1.5E-1**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/28/97

Table B-13
Garland Road Landfill Site
Dermal Contact with Soil - RME Case - Child Recreational User

Exposure Equation:

$$\text{Intake} = \frac{CS \times ABS \times CF \times SA \times AF \times ED \times EF}{BW \times AT}$$

where,

CS: chemical concentration in soil	ED: exposure duration
ABS: absorption factor	EF: exposure frequency
CF: conversion factor	BW: bodyweight
SA: skin surface area	AT: averaging time
AF: adherence factor	

Exposure Factors:

CS*	--	(mg/kg)
ABS	--	(unitless)
AF	1	(mg/cm2)
SA	1750	(cm2/event)
ED	6	(years)
EF	72	(days/year)
CF	1E-6	(kg/mg)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer

* - Chemical specific value

Chemical	Soil Concentration (mg/kg)	ABS	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Oral SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	1.0E-2	2.2E-7	1.50E+0	3.3E-7	2.5E-6	3.0E-4	8.4E-3
Aroclor 1248	6.1E+0	6.0E-2	7.2E-7	2.00E+0	1.4E-6	8.4E-6	NA	
Aroclor 1254	5.0E+0	6.0E-2	5.9E-7	2.00E+0	1.2E-6	6.9E-6	2.0E-5	3.5E-1
Beryllium	6.7E-1	1.0E-2	1.3E-8	4.30E+0	5.7E-8	1.5E-7	5.0E-3	3.1E-5
Benzo(a)anthracene	1.5E+0	1.0E-1	2.9E-7	NA		3.4E-6	NA	
Benzo(b)fluroanthene	1.0E+0	1.0E-1	2.0E-7	NA		2.3E-6	NA	
Benzo(k)fluroanthene	1.2E+0	1.0E-1	2.4E-7	NA		2.8E-6	NA	
Benzo(a)pyrene	1.2E+0	1.0E-1	2.3E-7	NA		2.7E-6	NA	
Benzo(g,h,i)perylene	5.7E-1	1.0E-1	1.1E-7	NA		1.3E-6	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.0E-1	3.7E-6	1.40E-2	5.2E-8	4.3E-5	2.0E-2	2.2E-3
Dieldrin	6.4E-2	1.0E-1	1.3E-8	1.60E+1	2.0E-7	1.5E-7	5.0E-5	2.9E-3
Indeno(1,2,3-cd)pyrene	5.6E-1	1.0E-1	1.1E-7	NA		1.3E-6	NA	
Lead	1.1E+3	1.0E-2	2.2E-5	NA		2.5E-4	NA	
Mercury	6.6E-1	1.0E-2	1.3E-8	NA		1.5E-7	NA	
Methylene Chloride	4.0E-2	1.0E-1	7.9E-9	7.50E-3	5.9E-11	9.2E-8	6.0E-2	1.5E-6
Phenanthrene	2.6E+0	1.0E-1	5.2E-7	NA		6.1E-6	NA	
Trichloroethene	5.1E-2	1.0E-1	1.0E-8	1.10E-2	1.1E-10	1.2E-7	6.0E-3	2.0E-5
TOTAL			--	--	**3.3E-6**	--	--	**3.6E-1**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Table B-16

Garland Road Landfill Site

Inhalation of Vapors from Soil - RME Case - Adult Recreational User

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{air} \times (1/VF)}{BW \times AT}$$

where,

Cs: chemical conc. in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	VF = Volatilization Factor

Exposure Factors:

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	6	(hours/day)
ED	24	(years)
EF	12	(days/year)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer
Days at Site	48	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	VF m^3/kg	Carcinogenic Effects: LADI (mg/kg-day)	Inhalation SF (mg/kg-day)-1	Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient
Arsenic	1.1E+1	NA	NA	1.50E+1		NA	3.0E-4	
Aroclor 1248	6.1E+0	1.2E+6	1.6E-6	4.00E-1	6.4E-9	4.7E-6	NA	
Aroclor 1254	5.0E+0	2.5E+6	6.6E-9	4.00E-1	2.6E-9	1.9E-6	2.0E-5	9.6E-4
Beryllium	6.7E-1	NA	NA	8.40E+0		NA	5.0E-3	
Benzo(a)anthracene	1.5E+0	NA	NA	NA		NA	NA	
Benzo(b)fluroanthene	1.0E+0	NA	NA	6.10E+0		NA	NA	
Benzo(k)fluroanthene	1.2E+0	NA	NA	6.10E+0		NA	NA	
Benzo(a)pyrene	1.2E+0	1.4E+9	2.7E-12	6.10E+0	1.7E-11	7.9E-12	NA	
Benzo(g,h,i)perylene	5.7E-1	NA	NA	NA		NA	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	5.7E+8	1.1E-10	1.40E-2	1.5E-12	3.1E-10	5.7E-2	5.4E-9
Dieldrin	6.4E-2	NA	NA	1.60E+1		NA	5.0E-5	
Indeno(1,2,3-cd)pyrene	5.6E-1	NA	NA	6.10E+0		NA	NA	
Lead	1.1E+3	NA	NA	NA		NA	NA	
Mercury	6.6E-1	NA	NA	NA		NA	8.6E-5	
Methylene Chloride	4.0E-2	4.1E+4	3.1E-9	1.60E-3	5.0E-12	9.1E-9	8.6E-1	1.1E-8
Phenanthrene	2.6E+0	2.5E+6	3.3E-9	NA		9.8E-9	NA	
Trichloroethene	5.1E-2	3.5E+3	4.7E-8	6.00E-3	2.8E-10	1.4E-7	6.0E-3	2.3E-5
TOTAL			--	--	**9.4E-9**	--	--	**9.8E-4**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/26/97

Table B-15

Garland Road Landfill Site

Inhalation of Vapors from Soil - RME Case - Child Recreational User

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{av} \times (1/VF)}{BW \times AT}$$

where,

Cs: chemical conc. in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	VF = Volatilization Factor

Exposure Factors:

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	6	(hours/day)
ED	6	(years)
EF	18	(days/year)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer
Days at Site	72	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	VF m³/kg	Carcinogenic Effects: LADI (mg/kg-day)	Inhalation SF (mg/kg-day)-1	Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient
Arsenic	1.1E+1	NA	NA	1.50E+1		NA	3.0E-4	
Aroclor 1248	6.1E+0	1.2E+6	2.8E-6	4.00E-1	1.1E-6	3.3E-7	NA	
Aroclor 1254	5.0E+0	2.5E+6	1.1E-6	4.00E-1	4.6E-9	1.3E-7	2.0E-5	6.7E-3
Beryllium	6.7E-1	NA	NA	8.40E+0		NA	5.0E-3	
Benzo(a)anthracene	1.5E+0	NA	NA	NA		NA	NA	
Benzo(b)fluroanthene	1.0E+0	NA	NA	6.10E+0		NA	NA	
Benzo(k)fluroanthene	1.2E+0	NA	NA	6.10E+0		NA	NA	
Benzo(a)pyrene	1.2E+0	1.4E+9	4.8E-12	6.10E+0	2.9E-11	5.6E-11	NA	
Benzo(g,h,i)perylene	5.7E-1	NA	NA	NA		NA	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	5.7E+8	1.9E-10	1.40E-2	2.6E-12	2.2E-9	5.7E-2	3.8E-8
Dieldrin	6.4E-2	NA	NA	1.60E+1		NA	5.0E-5	
Indeno(1,2,3-cd)pyrene	5.6E-1	NA	NA	6.10E+0		NA	NA	
Lead	1.1E+3	NA	NA	NA		NA	NA	
Mercury	6.6E-1	NA	NA	NA		NA	8.6E-5	
Methylene Chloride	4.0E-2	4.1E+4	5.5E-9	1.60E-3	8.7E-12	6.4E-8	6.6E-1	7.4E-8
Phenanthrene	2.6E+0	2.5E+6	5.9E-9	NA		6.6E-8	NA	
Trichloroethene	5.1E-2	3.5E+3	8.2E-8	6.00E-3	4.9E-10	9.5E-7	6.0E-3	1.6E-4
						0.0E+0		
TOTAL			--	--	1.6E-8	--	--	6.9E-3

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Table B-18

Garland Road Landfill Site

Inhalation from Air - Dust - RME Case - Adult Recreational User

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{air} \times (1/PEF)}{BW \times AT}$$

where,

Cs: chemical conc. in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	PEF = Particlate Emission Factor

Exposure Factors:

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	6	(hours/day)
ED	24	(years)
EF	12	(days/year)
BW	70	(kg)
AT	25,550	(days) cancer
AT	8,760	(days) noncancer
Days at Site	48	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	PEF (m3/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Inhalation SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Inhalation RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	1.3E+9	2.7E-11	1.50E+1	4.0E-10	7.9E-11	3.0E-4	2.6E-7
Aroclor 1248	6.1E+0	1.3E+9	1.5E-11	2.00E+0	3.0E-11	4.4E-11	NA	
Aroclor 1254	5.0E+0	1.3E+9	1.2E-11	2.00E+0	2.4E-11	3.6E-11	2.0E-5	1.8E-6
Beryllium	6.7E-1	1.3E+9	1.6E-12	8.40E+0	1.4E-11	4.6E-12	5.0E-3	9.6E-10
Benzo(a)anthracene	1.5E+0	1.3E+9	3.6E-12	NA		1.0E-11	NA	
Benzo(b)fluroanthene	1.0E+0	1.3E+9	2.5E-12	6.10E+0	1.5E-11	7.3E-12	NA	
Benzo(k)fluroanthene	1.2E+0	1.3E+9	3.0E-12	6.10E+0	1.8E-11	6.6E-12	NA	
Benzo(a)pyrene	1.2E+0	1.3E+9	2.8E-12	6.10E+0	1.7E-11	8.3E-12	NA	
Benzo(g,h,i)perylene	5.7E-1	1.3E+9	1.4E-12	NA		4.1E-12	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.3E+9	4.6E-11	1.40E-2	6.4E-13	1.3E-10	5.7E-2	2.3E-9
Dieldrin	6.4E-2	1.3E+9	1.6E-13	1.60E+1	2.5E-12	4.6E-13	5.0E-5	9.1E-9
Indeno(1,2,3-cd)pyrene	5.6E-1	1.3E+9	1.4E-12	6.10E+0	8.4E-12	4.0E-12	NA	
Lead	1.1E+3	1.3E+9	2.7E-9	NA		7.9E-9	NA	
Mercury	6.6E-1	1.3E+9	1.6E-12	NA		4.7E-12	8.6E-5	5.5E-8
Methylene Chloride	4.0E-2	1.3E+9	9.8E-14	1.60E-3	1.6E-16	2.9E-13	8.6E-1	3.3E-13
Phenanthrene	2.6E+0	1.3E+9	6.4E-12	NA		1.9E-11	NA	
Trichloroethene	5.1E-2	1.3E+9	1.2E-13	6.00E-3	7.5E-16	3.6E-13	6.0E-3	6.1E-11
TOTAL			--	--	**5.3E-10**	--	--	**2.1E-6**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

Filename: GARLAN~1.XLS
Date: 3/26/97

Table B-17
Garland Road Landfill Site
Inhalation from Air - Dust - RME Case - Child Recreational User

Exposure Equation:

$$\text{Intake} = \frac{Cs \times ED \times EF \times IR_{air} \times (1/PEF)}{BW \times AT}$$

where,

Cs: chemical conc. in soil	ED: exposure duration
IR: inhalation rate	BW: bodyweight
ET: exposure time	AT: averaging time
EF: exposure frequency	PEF = Particlate Emission Factor

Exposure Fact

Cs*	--	(mg/m3)
IR	20	(m3/day)
ET	6	(hours/day)
ED	6	(years)
EF	18	(days/year)
BW	15	(kg)
AT	25,550	(days) cancer
AT	2,190	(days) noncancer
Days at Site	72	days/year

* - Chemical specific value

Chemical	Soil Concentration (mg/m3)	PEF (m3/kg)	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Inhalation SF (mg/kg-day)-1	Carcinogenic Effects: Cancer Risk	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Inhalation RfD (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Arsenic	1.1E+1	1.3E+9	4.7E-11	1.50E+1	7.1E-10	5.5E-10	3.0E-4	1.8E-6
Aroclor 1248	6.1E+0	1.3E+9	2.6E-11	2.00E+0	5.2E-11	3.0E-10	NA	
Aroclor 1254	5.0E+0	1.3E+9	2.1E-11	2.00E+0	4.3E-11	2.5E-10	2.0E-5	1.2E-5
Beryllium	6.7E-1	1.3E+9	2.9E-12	8.40E+0	2.4E-11	3.3E-11	5.0E-3	6.7E-9
Benzo(a)anthracene	1.5E+0	1.3E+9	6.3E-12	NA		7.3E-11	NA	
Benzo(b)fluroanthene	1.0E+0	1.3E+9	4.4E-12	6.10E+0	2.7E-11	5.1E-11	NA	
Benzo(k)fluroanthene	1.2E+0	1.3E+9	5.2E-12	6.10E+0	3.2E-11	6.0E-11	NA	
Benzo(a)pyrene	1.2E+0	1.3E+9	5.0E-12	6.10E+0	3.0E-11	5.8E-11	NA	
Benzo(g,h,i)perylene	5.7E-1	1.3E+9	2.4E-12	NA		2.8E-11	NA	
Bis(2-ethylhexyl)phthalate	1.9E+1	1.3E+9	8.0E-11	1.40E-2	1.1E-12	9.3E-10	5.7E-2	1.6E-8
Dieldrin	6.4E-2	1.3E+9	2.7E-13	1.60E+1	4.4E-12	3.2E-12	5.0E-5	6.4E-8
Indeno(1,2,3-cd)pyrene	5.6E-1	1.3E+9	2.4E-12	6.10E+0	1.5E-11	2.8E-11	NA	
Lead	1.1E+3	1.3E+9	4.7E-9	NA		5.5E-8	NA	
Mercury	6.6E-1	1.3E+9	2.8E-12	NA		3.3E-11	8.6E-5	3.8E-7
Methylene Chloride	4.0E-2	1.3E+9	1.7E-13	1.60E-3	2.7E-16	2.0E-12	8.6E-1	2.3E-12
Phenanthrene	2.6E+0	1.3E+9	1.1E-11	NA		1.3E-10	NA	
Trichloroethene	5.1E-2	1.3E+9	2.2E-13	6.00E-3	1.3E-15	2.5E-12	6.0E-3	4.2E-10
						0.0E+0		
TOTAL			--	--	**9.3E-10**	--	--	**14.8E-6**

LADI : Lifetime Average Daily Dose (Cancer)
ADI : Average Daily Dose (Noncarcer)

NA - Toxicity criterion not available.

ATTACHMENT C
ODNR SPECIES INVENTORY

OHIO Department of Natural Resources

George V. Voinovich • Governo
Donald C. Anderson • Director

November 18, 1996

Andrew J. Chartrand
Ecology & Environment, Inc.
6777 N. Engle Rd.
Middleburg Heights, OH 44130

Dear Mr. Chartrand:

After reviewing our Natural Heritage maps and files, I find the Division of Natural Areas and Preserves has no records of rare species in the Garland Road Landfill site, including a 1.5 mile radius, on the West Milton Quad. There are no existing or proposed state nature preserves at the project site. However, the landfill is located along the Stillwater River which is a designated component of the State Scenic River system. I have enclosed a brochure about the river. For additional information, please contact our Southwest Ohio Scenic River Coordinator, Bob Gable, at: (phone) 937-854-0350, (fax) 937-854-9407, or 4675 N. Diamond Mill, Trotwood, OH, 45426-4254

Our inventory program has not completely surveyed Ohio and relies on information supplied by many individuals and organizations. Therefore, a lack of records for any particular area is not a statement that rare species or unique features are absent from that area. Please note that we inventory only high-quality plant communities and do not maintain an inventory of all Ohio wetlands.

Please contact me at 614-265-6818 if I can be of further assistance.

Sincerely,

Debbie Woischke

Debbie Woischke, Ecological Analyst
Division of Natural Areas & Preserves