RCRA FACILITY INVESTIGATION
FINAL REPORT

Envirosafe Services of Ohio, Inc.

876 Otter Creek Road
Oregon, Ohio 43616

USEPA Identification Number: OHD 045 243 706
Ohio EPA Identification Number: 03-48-0092

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RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
FACILITY INVESTIGATION FINAL REPORT

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VOLUME 1

Prepared for

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1.0 INTRODUCTION

1.1 Purpose

Envirosafe Services of Ohio, Inc. (ESOI) owns and operates a treatment, storage and disposal facility (TSDF) at 876 Otter Creek Road in Oregon, Ohio (the Facility) which is permitted by USEPA and Ohio EPA under the Resource Conservation and Recovery Act (RCRA). The Facility's USEPA Identification Number is OHD 045 243 706 and its Ohio EPA Identification Number is 03-48-0092. As specified in Section VI of the August 16, 2000 Final Modified Federal RCRA Permit (Federal RCRA Permit) for the Otter Creek Road Facility, in accordance with Sections 3004(u) and 3004(v) of RCRA and regulations promulgated pursuant thereto, ESOI initiated a Corrective Action Program (CAP) to assess releases of hazardous wastes or hazardous constituents, if any, for the purpose of protecting human health and the environment. In April 2002, ESOI was notified by Ohio EPA of its intent to issue an agency-initiated permit modification to ESOI's State RCRA Permit to incorporate RCRA corrective action requirements, which would make Ohio EPA (rather than USEPA) the lead regulatory agency overseeing ESOI's CAP (Ohio EPA 2002). The State RCRA Permit modification became effective in January 2004. This Final RCRA Facility Investigation (RFI) Report was prepared to fulfill the requirements under Section E.5 of the State RCRA Permit for the Otter Creek Road Facility.

ESOI conducted the RFI to determine whether the solid waste management units (SWMUs) and areas of concern (AOCs) identified in the RCRA Permit, three additional AOCs recommended by Ohio EPA, and one additional AOC requested by USEPA have released hazardous waste or hazardous constituents that pose an unacceptable risk to human health or the environment. Based on information reviewed in the *Description of Current Conditions* (DOCC; ENVIRON/MSG 2001), nineteen SWMUs/AOCs were identified for investigation. The RFI was conducted in accordance with the *Resource Conservation and Recovery Act Facility Investigation (RFI) Work Plan* (RFI Work Plan; ENVIRON/MSG 2002), the *Revised Phase II RFI Work Plan* (Phase II Work Plan; ENVIRON 2005b), and supplemental Phase II Work Plan addenda (ENVIRON 2006b and 2007b). During the implementation of the RFI, ESOI also conducted presumptive corrective measures to address conditions at several of the landfill SWMUs, including the installation of leachate recovery systems, and modification of the existing Explosive Gas Monitoring Plan. In addition, ESOI is conducting an assessment of cap enhancements and/or cap modifications for SWMU 1. The presumptive corrective measures were implemented in accordance with work plans submitted in accordance with Condition E.9 of the State RCRA Permit and approved by Ohio EPA.

The information in this Final RFI Report describes the procedures, methods and results of the field investigations conducted during the RFI. The information includes a comparison of the RFI data with generic risk-based screening criteria to identify whether there is evidence of a potentially significant release of hazardous waste or hazardous constituents at any of the SWMUs or AOCs. Where a potentially significant release is identified, the nature and extent of hazardous constituents in the environmental media characterized during the RFI are discussed. A baseline human health risk assessment and a screening level ecological risk assessment are included in this Final RFI Report to provide a basis for determining whether the presence of these hazardous constituents poses an unacceptable risk to human health or the environment that would warrant further evaluation as part of a subsequent corrective measures study (CMS).

1.2 Report Organization

The Final RFI Report is organized as follows:

- Section 2 provides an overview of the RFI implementation, including a summary of the SWMUs, AOCs and other areas investigated during the RFI, a summary of the phases of RFI field investigations and the general approach for conducting these investigations, and a summary of the presumptive corrective measures initiated during the RFI.

- Section 3 discusses the environmental setting in the vicinity of the Facility, including information on surface water hydrology, geology, hydrogeology, background soil characteristics, background ground water characteristics, land use, and ground water use.

- Section 4 discusses the RFI results for each of the SWMUs, AOCs and other areas investigated, including areas where presumptive corrective measures were conducted during the RFI. The discussion for each investigated area includes a summary of the scope of the field investigations, a summary and evaluation of the RFI data, and an assessment of whether a potentially significant release of hazardous constituents has been identified.

- Section 5 presents a baseline human health risk assessment that evaluates the potentially significant releases of hazardous constituents at areas identified in Section 4 to determine whether corrective measures are warranted. The risk assessment includes the development of scenarios for potential human exposure under current and reasonably expected future land use at and around the Facility. Potential risk under these scenarios is evaluated by estimating cumulative cancer and noncancer risks, and comparing these risk estimates to acceptable risk levels established by USEPA and Ohio EPA.

- Section 6 presents a screening level ecological risk assessment that evaluates the potentially significant releases of hazardous constituents at areas identified with potentially complete pathways to determine whether a detailed ecological risk assessment is warranted. The risk assessment includes identification of potentially complete ecological exposure pathways at and around the Facility. Potential risk under these scenarios is evaluated by comparison to risk-based criteria and estimating cumulative risks.

- Section 7 summarizes the conclusions of the RFI, specifically, the SWMUs/AOCs which warrant evaluation in a corrective measures study.

- Section 8 provides a list of the references cited in the report.

- Tables and figures cited in the text of the report are provided at the end of the text.

- Appendix A provides the RFI field documentation, including field notes, soil boring logs and monitoring well construction logs. In addition, field instrument calibration logs and a summary of ground water indicator parameter readings are also included in Appendix A.

- Appendix B provides a complete reporting of the RFI Phase I and Phase II soil, ground water, trench water, sediment, surface water and soil gas data. Data for field quality control samples (e.g., field duplicates, blanks) are also included in Appendix B.

- Appendix C contains supporting documentation and data evaluations considered in this RFI.

- Appendix D provides Phase II data validation summaries. The complete data deliverables provided by the laboratories that performed the analysis of the samples collected during the RFI are available upon request.

- Appendix E provides the baseline risk assessment calculations and related supporting information.

- Appendix F presents the screening level ecological risk assessment calculations and related supporting information.

- Appendix G contains documentation of interim RFI submittals from ESOI to Ohio EPA that support data evaluations conducted during the RFI.

- Appendix H provides a supplement to the RFI, including an assessment of conditions along the Otter Creek corridor, a summary of observed nonaqueous phase liquids (NAPLs) encountered during the RFI, a summary of discussions with Ohio EPA relating to the investigation of potential migration under Otter Creek, and information on the newly identified AOC 12.

2.0 OVERVIEW OF THE RFI PROGRAM

2.1 Facility Description

The Facility is a RCRA-permitted TSDF located at 876 Otter Creek Road at the intersection of Otter Creek Road and York Street in the City of Oregon, Lucas County, Ohio as shown on Figure 2.1. The facility is located at Latitude 41° 41' 00" and Longitude 83° 27' 56" and occupies approximately 130 acres.

The site was initially operated as a waste management facility, starting in 1954. In the 1970's, the facility received municipal, commercial, and industrial wastes. In November 1988, the site received a hazardous waste operating permit which became effective in October 1990. Current activities at this facility include treatment, storage and disposal at an on-site landfill of industrial and hazardous wastes. ESOI serves several types of industries including chemical, manufacturing, steel, petroleum and pharmaceutical industries. Some hazardous wastes are also generated from various on-site activities. These activities include leachate generation from landfills, liquids collected from various containment areas/systems and other waste streams generated during the operation of the Stabilization/Containment Building (SCB), which includes stabilization of hazardous wastes and treatment of hazardous debris utilizing macroencapsulation and microencapsulation technologies.

The landfills at the Facility include one active hazardous waste disposal cell (Cell “M”), located in the southern portion of the property, four closed hazardous waste landfill cells (Cells “F”, “G”, “H”, and “I”) located in the northern portion of the property, and three closed solid waste landfills (Millard Landfill, North Sanitary Landfill and Central Sanitary Landfill) also located in the northern portion of the property. Other closed SWMUs on the northern portion of the property include the Old Oil Pond which had been originally used for waste oil recovery and then emptied of oil and used for disposal of solid waste, and the New Oil Pond which was used for waste oil recovery after operation of the Old Oil Pond ceased. The New Oil Pond was closed by solidifying the waste oil sludge in place with cement kiln dust. The Facility layout is shown on Figure 2.2. Figure 2.3 is an aerial photograph of the site identifying all of the SWMUs and AOCs. A more detailed description of the Facility can be found in Section 1 of the DOCC (ENVIRON/MSG 2001). Additional discussion of the Facility's surroundings, including geology, hydrogeology, surface water hydrology and land use is provided in Section 3.0 of this Final RFI Report.

2.1.1 RFI Objectives and Approach

The objectives of the RFI, and the field investigations in particular, were described in the Quality Assurance Project Plan (QAPP), provided as Appendix A of the RFI Work Plan (ENVIRON/MSG 2002) and Appendix C.1 of the Revised Phase II Work Plan (ENVIRON 2005b). As discussed in the QAPP, field investigations were conducted as necessary to support the following objectives:

- Determine whether a significant release of hazardous constituents to soil, ground water, surface water, and sediment has occurred from the SWMUs and AOCs subject to investigation;

- Characterize the source(s) of a release and determine the nature and extent of constituents in soil, ground water, surface water and sediment, as necessary to support a baseline risk assessment, where a significant release of hazardous constituents has been confirmed; and

- Collect data to support development and evaluation of corrective measures alternatives for SWMUs and AOCs where the need for corrective measures has been identified or is likely.

Accordingly, the initial phase of field investigations for the 19 SWMUs and AOCs was designed to determine whether a significant release to soil, ground water, surface water, and/or sediment had occurred. The sampling locations for these environmental media generally were biased towards areas where contamination, if present, would be most likely detected, and included locations and depths that exhibited field evidence of potential contamination. If no basis for biased sampling was apparent, sampling locations were selected to provide even coverage over an area. Other activities conducted during the initial phase of work included conducting site reconnaissance to assess current conditions in the areas to be investigated, conducting geophysical surveys to estimate waste limits; assessing areas of potential ecological significance; and gathering data pertinent to the evaluation of potential ground water-surface water interactions.

- Soil samples generally were collected from the ground surface (0 to 2 ft bgs) and from approximately 8 to 10 ft bgs. These samples were selected to represent soil to which workers might be exposed while performing routine work or occasional excavation in the area. The surface samples (0 to 2 ft bgs) are also sufficient to represent soil to which ecological receptors might be exposed. Where a potential release from a deeper source was possible, soil samples from appropriately deeper depths were collected.

- Ground water sampling included the use of existing permanent monitoring wells and the installation of temporary and permanent monitoring wells. Samples were collected from the uppermost aquifer beneath the site and from water bearing zones present above the aquifer. Samples were also collected from the monitoring trenches located on both sides of the City of Toledo raw water supply lines that transect the Facility.

- Surface water and sediment sampling was conducted in Otter Creek upstream, adjacent to and downstream of the Facility. Surface water samples were also collected from Facility outfalls to characterize stormwater runoff discharged from the Facility into Otter Creek and ditches adjacent to the Facility.

At some areas, multiple phases of investigation were necessary to characterize releases that were identified, as discussed in Section 2.2. Field investigations at each area of investigation continued until it was judged that sufficient data were available to support a reliable determination of whether a significant release has occurred. For areas where a release was identified, further phases of field investigations to characterize the nature and extent of the releases were conducted in accordance with supplemental work plans that were reviewed with Ohio EPA prior to implementation. The scope and approach for these additional phases of investigation were specific to each area and each phase of work, as described in the investigation work plans for these phases.

Data from each phase of investigation were reviewed in accordance with the RFI QAPP. As described in the QAPP, a qualitative review, using professional judgment, examined the following:

- Consistency in the types of constituents found in all sampled media at each SWMU or AOC vis-a-vis expectations based on history of operations and chemical properties of the constituents, which may indicate potential for false negative or false positive identification of constituents.

- Lateral and vertical distribution of constituent concentrations to detect any obvious spatial trends, which may indicate that concentrations significantly higher than the measured concentrations may be likely in unsampled areas or depths.

- Presence of unusually high constituent concentrations, which may indicate the presence of nonaqueous-phase liquids.

Where the qualitative review identified conditions that could lead to unreliable conclusions regarding whether a release has occurred or the nature and extent of a release, further sampling or other actions (e.g., checking for laboratory errors) were taken to address such conditions. The results of these reviews and recommendations for additional field investigation of certain areas and not others were communicated with USEPA and Ohio EPA via monthly progress reports and field investigation work plans.

In Section 4 of this Final RFI Report, the RFI data are evaluated using conservative generic risk-based screening criteria to identify evidence of a potentially significant release. An explanation of the screening criteria used for this determination is provided in Section 4. In making these determinations, a release is generally considered to have occurred if the highest concentration of a constituent in an environmental medium is higher than a screening criterion. Exceptions to this conservative approach is where a particular concentration of a constituent is deemed unreliable (e.g., because of the method of sample collection) or inconsistent with results from resampling efforts. These exceptions are discussed case-by-case in Section 4.

For an area where a potentially significant release was identified, the affected medium for the area was included in the baseline risk assessment and/or the screening level ecological risk assessment, as appropriate, described in Sections 5 and 6 of this Final RFI Report, respectively.

- In the baseline human health risk assessment, all constituents detected at an area were evaluated using exposure scenarios defined based on current conditions at the area and conditions under reasonably expected future land and ground water use. Future land use and ground water use considerations at and around the Facility are discussed in Section 3.11 and Section 3.12, respectively. Using the exposure scenarios developed for the site as part of the RFI Work Plan and refined in the Phase II Work Plan, the risk assessment determined whether reasonable maximum exposures to constituents at an area would pose an unacceptable risk that warrants corrective measures.

- In the screening level ecological risk assessment, all constituents detected at an area of potential ecological significance were evaluated using exposure scenarios based on current and reasonably expected future land use. Using the exposure scenarios developed for the Facility as part of the RFI Work Plan and refined in the Phase II Work Plan, the screening level ecological risk assessment determined whether reasonable maximum exposures to constituents at an area would pose an unacceptable risk that warrants additional risk evaluation or corrective measures.

As stated in Section 4.3 of the RFI Work Plan (ENVIRON/MSG 2002), all investigated SWMUs and AOCs will be retained for evaluation in a Corrective Measures Study (CMS) for limited corrective measures, which includes institutional controls, regardless of whether an unacceptable impact to human health or the environment is identified. SWMUs and AOCs identified as posing an unacceptable risk to human health or the environment will be evaluated for active corrective measures in order to mitigate the identified risk.

2.2 Field Investigations

2.2.1 Areas Investigated

The RFI Work Plan (ENVIRON/MSG 2002) identified the following SWMUs and AOCs for investigation. SWMUs and AOCs that were grouped together for investigation are identified with an investigative unit (IU) designation.

- SWMU 1: Landfill Cell F
- SWMU 5: Millard Road Landfill
- SWMU 6: Northern Sanitary Landfill
- SWMU 7: Central Sanitary Landfill
- SWMU 8: Old Oil Pond (South Pond) (IU A)
- SWMU 9: New Oil Pond (North Pond) (IU B)
- SWMU 10: Ash Disposal Area
- SWMU 11: Former Teepee Burner
- SWMU 12: Former Bill’s Road Oil Operation
- AOC 1: Toledo Water Lines (Southside - IU A; Northside IU B)

- AOC 2: Truck Scale
- AOC 3: Maintenance/Storage Building “C” (IU A)
- AOC 4: Building “C” Septic Tank and Leach Field (IU A)
- AOC 5: Decontamination Building (IU A)
- AOC 6: Oily Waste Above Ground Storage Tanks
- AOC 7: Butz Crock – Concrete Utility Vault (IU A)
- AOC 8: Staging Area (IU A)
- AOC 9: Cell M Surface Water Retention Basin (IU C)
- AOC 10: Rail Spur

Investigations were also conducted to evaluate the conditions in Otter Creek, which was included as part of IU C. The locations of these 19 SWMUs/AOCs and Otter Creek are shown on Figure 2.2. Additional information for each SWMU/AOC/IU is provided in Section 3 of the DOCC (ENVIRON/MSG 2001). Investigation results are discussed in Section 4 of this Report.

Based on the information reviewed in the DOCC, including the results of prior sampling events, it was determined that no further investigation was warranted for the following SWMUs:

- SWMU 2: Landfill Cell G
- SWMU 3: Landfill Cell H
- SWMU 4: Landfill Cell I
- AOC 11: Former Scale Areas

Rationale supporting the decision to not conduct further investigation of these areas was provided in the DOCC. The locations of these four SWMUs and AOCs are also shown on Figure 2.2.

2.2.2 North Sanitary Landfill RFI

In response to the remedial facility assessment (RFA) conducted in 1987 on behalf of the USEPA, ESOI performed an initial RFI in 1995 which focused on the northeast corner of the Facility, specifically the Northern Sanitary Landfill (NSL-SWMU 6). SWMU 6 is a landfill unit closed in accordance with the State of Ohio regulations and the provisions of Order No. 8 of Ohio EPA’s January 10, 1985 Final Findings & Orders. Documentation regarding the closure of SWMU 6 was submitted to Ohio EPA on June 17, 1985 (see Section 3.6 of the DOCC). The majority of field activities associated with the initial RFI, including soil borings, monitoring well installation, air sampling, and ecological assessment of the aquatic and terrestrial habitats on and near the Facility, were conducted from May 1995 to November 1995. A second sampling event of the monitoring wells installed during the initial RFI was conducted in July 1996. Based upon the initial NSL RFI findings, a supplemental investigation was requested by USEPA in September 1996. The supplemental RFI involved the installation of multiple shallow soil boring along the Facility's northern and eastern property lines in the vicinity of the NSL, as well as the installation several soil borings on the southern edge of the adjacent Gradel Landfill (i.e., north of ESOI's property line). The results of the NSL RFI were reported to the USEPA in the reports titled: *Draft Final RFI Report, Northern Sanitary Landfill* (MEC June 1997) and the *Second Draft Final RFI Report*, *Northern Sanitary Landfill* (MEC February 1998). As discussed in the RFI Work Plan (ENVIRON/MSG 2002), soil sampling data from the NSL RFI are evaluated in this Final RFI Report.

2.2.3 RFI Phase I

The first phase of the Facility-wide RFI investigation (Phase I) was initiated in March 2002 in accordance with the RFI Work Plan (ENVIRON/MSG 2002) approved by USEPA on April 10, 2002. The first phase of work included sampling of soil, ground water, surface water and sediments to investigate evidence of any potential releases of hazardous constituents from the SWMUs/AOCs listed in Section 2.2.1. Other activities conducted during the initial phase of work included site reconnaissance efforts, including geophysical surveys to estimate waste limits, an ecological survey to assess areas of potential ecological significance, and water level surveying to support the evaluation of potential ground water-surface water interactions. Phase I field investigations for the 19 SWMUs/AOCs identified for investigation in the RFI Work Plan were completed during the period of March 2002 to June 2003. The results of this phase of investigation were reported in the *RFI Phase I Report and Phase II Work Plan* (ENVIRON/MSG 2003). Based on the results of the initial phase of field investigations, ESOI recommended further characterization of the following areas:

- SWMU 1
- SWMU 5
- SWMU 6
- SWMU 7
- SWMU 10

- IU A: SWMU 8, AOC 1 (Southside), and AOC 7
- IU B: SWMU 9 and AOC 1 (Northside)
- IU C: NPDES outfalls and Otter Creek

In addition, based on the information collected during the NSL RFI and Phase I of the RFI, ESOI submitted draft Documentation of Environmental Indicator (EI) Determinations - Current Human Exposures Under Control (EI CA725) and Migration of Contaminated Groundwater Under Control (EI CA750) to USEPA, indicating that current human exposures and contaminated ground water migration were under control. In March 2005, USEPA signed the EI CA725 indicating that current human exposures are under control.

2.2.4 RFI Phase II

The second phase of Facility-wide RFI (Phase II) consisted of an expedited stage at SWMU 5 and Otter Creek followed later by investigation of the remaining areas recommended for further investigation in the Phase II Work Plan. The expedited investigation was initiated in April 2004 in accordance with the *SWMU 5 Revised Phase II Work Plan* dated April 13, 2004 (ENVIRON 2004). The expedited work included activities to evaluate possible ground water-surface water interaction; complete characterization of sediment, soil and ground water at SWMU 5; further characterize sediments in Otter Creek; and support an accelerated assessment requested by Ohio EPA for this environmentally sensitive area. The expedited work was completed during the period from April 2004 to June 2004. The results of the ground water-surface water interaction study were provided to Ohio EPA in the June 2005 report entitled *SWMU 5 Ground Water- Surface Water Interaction Investigation* (MSG 2005). The results of this stage of investigation were evaluated as part of the preparation of the Phase II Work Plan (ENVIRON 2005b).

The Phase II Work Plan was approved by Ohio EPA on April 12, 2006. The planned Phase II field activities were completed in July 2006. Activities included further investigation of potentially significant releases identified during Phase I, characterization of landfill cover conditions on Facility access roads under which the limits of waste was determined during Phase I of the investigation, gathering of supplemental hydraulic conductivity data, and confirmation of the analytical data obtained during Phase I as requested by Ohio EPA. The results of this phase of investigation are included in this Final RFI Report.

Based on field observations and sample results from Phase II of the investigation, ESOI recommended further investigation of the following areas:

- SWMU 5
- SWMU 6
- IU A: SWMU 8
- IU B: SWMU 9

The scope of work in these areas was defined in the *Revised Phase II RFI Work Plan – Addendum 1* (“Addendum 1 Work Plan”; ENVIRON 2006).

2.2.5 RFI Phase II Addendum 1

Supplemental investigation activities were completed in October 2006 in accordance with the Addendum 1 Work Plan. This work consisted of investigation of the extent and characteristics of non-aqueous phase liquid (NAPL) at SWMU 5, SWMU 8 and SWMU 9, additional landfill cover characterization in the northeast corner of SWMU6, and characterization of the leachate and landfill gas conditions at SWMU 8. Based on the field conditions encountered during this phase investigation further characterization was conducted to assess leachate and landfill gas conditions within SWMU 8. The results of this phase of investigation are included in this Final RFI Report.

Based on the results of this work and further review of the Phase II analytical data, ESOI recommended additional investigation of the following areas:

- SWMU 1
- SWMU 5
- SWMU 6
- IU A - SWMU 8 and AOC 7
- IU C – Otter Creek

The scope of work in these areas was defined in the *Phase II RFI Sampling Plan – Addendum 2* (“Addendum 2 Work Plan”; ENVIRON 2007).

2.2.6 RFI Phase II Addendum 2

The Phase II Addendum 2 field activities were initiated in August 2007 in accordance with the Addendum 2 Work Plan with concurrence from Ohio EPA. This work included soil delineation activities at SWMU 1, SWMU 6 and AOC 7, resampling ground water at multiple locations, landfill gas monitoring at SWMU 8, and additional sediment and surface water characterization in Otter Creek. Addendum 2 field investigations were completed during August and October 2007. The results of this phase of investigation are included in this Final RFI Report.

2.3 Presumptive Corrective Measures

On January 27, 2005, Ohio EPA requested that ESOI consider implementing presumptive corrective measures based on data collected during the completed phases of the RFI, including the installation of leachate collection for SWMUs 5, 6 and 7, and the improvement of the cover on SWMU 1 to minimize infiltration. As agreed with Ohio EPA on June 1, 2005, ESOI prepared a *Presumptive Corrective Measures Design Work Plan* (ENVIRON July 2005a) which outlined the plan for additional data collection to support the preparation of designs, plans and specifications for the corrective measures. This additional data collection included the performance of leachate recovery testing on SWMU 6. Based on the results of the tests at SWMU 6, a *Presumptive Corrective Measures Design Work Plan Modification* (ENVIRON 2006a) was submitted to Ohio EPA. This plan included the results from the SWMU 6 testing, and provided the scope of work for similar testing on SWMU 5 and 7.

On September 12, 2006, Ohio EPA issued a modification to the State RCRA Permit incorporating the requirements for the following presumptive corrective measures:

- Leachate collection system performance objectives for SWMUs 5, 6 and 7;
- Landfill gas mitigation for SWMUs 5, 6 and 7; and
- Cap enhancements or modifications for SWMU 1.

2.3.1 Leachate Recovery– SWMUs 5, 6 and 7

ESOI submitted the results of the predesign studies for SWMUs 5, 6 and 7 in the *Pump Test Report and 30% Presumptive Corrective Measures Design* (MSG 2006a). Based on these study results, ESOI proposed to install a recovery well system of 2, 5 and 3 recovery wells in SWMUs 5, 6, and 7, respectively. The report was approved by Ohio EPA by letter dated November 13, 2006. The *90% Presumptive Corrective Measures Design* for equipment and layout was completed in December 2006 (MSG 2006b). ESOI submitted a permit modification request to include detailed performance objectives and a performance monitoring program to Ohio EPA on January 12, 2007. Installation of the leachate recovery systems was performed during February through June 2007, and the systems became fully operational on July 1, 2007.

2.3.2 Landfill Gas Mitigation – SWMUs 1, 5, 6 and 7

On December 11, 2006, ESOI submitted the results of its assessment of landfill gas for SWMUs 1, 5, 6 and 7 in the report entitled *Landfill Gas Formation & Migration Potential for Envirosafe Services of Ohio, Inc. SWMU 1, 5, 6 & 7* (MSG 2006c). This document provided an evaluation of the current conditions at each SWMU, and the potential for landfill gas generation and migration from these SWMUs. As discussed in this report, based on the information evaluated, ESOI believes that based on the age, composition, and environment of the waste, gas formation potential is significantly less than its maximum and the majority of the gas generation possible has already happened. Gas production is declining and will continue to decline naturally. This assessment was validated by the concentrations of organics and inorganics detected in the leachate and the pH of the liquid. Finally, gas readings performed during the RFI activities and during normal operations, suggest that explosive gas concentrations are likely to remain below levels of concern. However, should explosive gas levels increase either at the facility perimeter or within the occupied structures above the specified Explosive Gas Threshold Limit, a contingency plan has been established to abate or minimize the concern. For these reasons, a gas mitigation system is not proposed for these SWMUs.

A Notice of Deficiency ("NOD") was provided by Ohio EPA Division of Solid and Infectious Waste Management ("DSIWM") on February 27, 2007 for the *Landfill Gas Formation & Migration Potential for Envirosafe Services of Ohio, Inc. SWMU 1, 5, 6 & 7* report. These comments generally deal with clarification of information presented and the proposed monitoring program. Responses to these comments were submitted by ESOI on April 30, 2007.

2.3.3 Capping Enhancements and Modifications – SWMU 1

As required by the September 2006 State Permit modification, ESOI submitted the *Preliminary Cell F Cover Modification Design Analysis Otter Creek Road Facility* (ENVIRON 2006c) presenting conceptual design alternatives for modifications to the SWMU 1 cover to minimize infiltration of liquids and promote positive drainage of precipitation. Because the alternative designs require that additional cover soil be placed on SWMU 1 to provide for greater slopes to promote drainage, ESOI is current conducting a settlement test to evaluate the potential for long term waste settlements resulting from the increased surcharge loading. This test is being conducted in accordance with the *In-Situ Settlement Test Plan for Cell F Cover Modification Design Analysis* (ENVIRON 2007a) approved by Ohio EPA on September 25, 2007. Completion of the test is scheduled for May 2008. In addition, ESOI has modified the leachate collection manhole located on SWMU 1 to minimize infiltration of stormwater around the manhole.

2.4 Other Corrective Measures

In addition to the presumptive corrective measures described above in Section 2.3, ESOI previously implemented waste removal, environmental controls and monitoring programs to mitigate migration of hazardous waste/hazardous constituents from SWMUs/AOCs. These actions are summarized below.

Waterline Monitoring & Dewatering Trenches

According to the Waterline Agreement between the City of Toledo and ESOI, ESOI was required to install protective trenches along the City's waterlines that transect the Facility. These trenches were designed and constructed at an elevation equal to the lowest depth of the waterline to detect lateral migration of liquids along the waterline. Figures showing the location and construction of these monitoring & dewatering trenches are provided in Appendix C1. ESOI currently inspects these trenches at least once each week and removes accumulated liquids. Toledo Environmental Services conducts quarterly inspections of the water line; no water line integrity concerns have been raised as a result of these inspections.

Waste Management Unit Removals

As described in Section 3 of the DOCC, ESOI has also removed waste management units as the facility was developed for permitted hazardous waste management units. These remediation activities included the following:

- During the period of 1982 to 1993, the Bills Road Oil area (SWMU 12) was removed. This work was performed in three phases: in 1982 to 1984, the liquid from the two lagoons was removed; during 1987 to 1988, two aqueous lagoons and adjacent areas were cleaned-up and the storage tanks were disassembled; and in August 1993, the excavation of the 750 cubic yards of contaminated soil within the footprint of the SCB area was conducted.

- In 1988, ash materials from the SWMU 10 area were removed in preparation for the construction of Cell G (SWMU 2). During this work, the ash material was encountered at approximately 3 feet below the original surface and extended to a depth of approximately 17 feet in some areas. Approximately 123,000 cubic yards of ash material were excavated during construction of Cell G from areas where it was encountered within the footprint of Cell G. The limits of ash removal were determined based on visual inspection during excavation. Post-excavation verification sampling was then conducted to confirm that all of the ash material was removed. The excavated material was also characterized for disposal purposes.

- The York Street Landfarm which was within the footprint of landfill Cells H and I was removed as part of the Cell H and I construction. As part of this removal action, approximately 37,000 cubic yards of soil were excavated under a closure plan approved by the USEPA in a letter dated August 3, 1989.

3.0 ENVIRONMENTAL SETTING

3.1 Location and Physiography

As noted in Section 2.1, the Facility is located in the City of Oregon, Lucas County, Ohio, as shown on Figure 2.1. The Facility lies within the Maumee Lake Plains Physiographic Region and is part of the Huron-Erie Lake Plains Physiographic Section of the Central Lowland Physiographic Province. The Maumee Lake Plains region consists of Pleistocene-age silt and clay formed in a flat-lying Ice-Age lake basin. The Facility is located on a generally flat-lying unmetamorphosed Silurian dolomite sedimentary rock (approximately 410 million years old) overlain by approximately 70 to 90 feet of unconsolidated Wisconsinan tills and lacustrine deposits.

3.2 Climate

Based on records from the National Weather Service for the City of Oregon[1], the climate in the area of the Facility is warm during the summer when temperatures tend to be in the 70s°F and very cold during the winter when temperatures tend to be in the 20s°F. The warmest month of the year is July with an average maximum temperature of 87.1°F, while the coldest month of the year is January with an average minimum temperature of 21.7°F. Temperature variations between night and day tend to be fairly small during summer with a difference that can reach 18°F, and fairly small during the winter with an average difference of 13°F.

The annual average precipitation in Oregon is 33.52 inches. Rainfall is fairly evenly distributed throughout the year. The wettest month of the year is June with an average rainfall of 3.84 inches.

3.3 Surface Water Hydrology

The predominant surface water feature in the vicinity of the Facility is Otter Creek, which is adjacent to the western edge of SWMU 5 and flows northeasterly into Maumee Bay. In addition, there are four ditches near the Facility that receive stormwater from portions of the Facility: Gradel Ditch located between the Facility's northern property line and the adjoining Gradel Landfill; Driftmeyer Ditch located northeast of the Facility; an unnamed ditch that runs along old Millard Avenue on the south side of the SWMU 5; and an unnamed ditch that runs between the Millard Avenue overpass and the north side of SWMU 5.

[1] Toledo Blade Newspaper Building Weather Station located 2.26 miles from Oregon.

Figure 2.2 shows the location of Otter Creek, Gradel Ditch, and Driftmeyer Ditch. This figure also shows the location of the nine active outfalls (001, 002, 003, 006, 009, 010, 011, and 012) and the two former outfalls (007 and 008) that discharge stormwater runoff from portions of the Facility to Otter Creek via storm sewers and ditches, and Outfall 004 which discharges toward Driftmeyer Ditch. Stormwater discharges are monitored in accordance with ESOI's current NPDES permit (Ohio EPA 2IN00013*ED).

3.3.1 Otter Creek

Otter Creek, a seven mile long perennial stream, flows northeasterly through portions of Toledo and Oregon, Ohio. It discharges to Lake Erie at Maumee Bay. The western edge of the Facility is located adjacent to Otter Creek, approximately two miles from the mouth of the creek. Flow in the creek may be influenced by seiche effects in Lake Erie and Maumee Bay, during which times surface water flow may slow or becomes stagnant; however, such effects were not observed during water level monitoring conducted as part of the RFI.

Stormwater from Outfalls 001, 002, 006, 009, 010, 011, and 012 is discharged to Otter Creek west of the Facility either directly or via storm sewer. The catchment areas for the current outfalls that discharge stormwater runoff to Otter Creek and their drainage areas are as follows:

- <u>Outfall 001:</u> SWMU 2, SWMU 7, portion of AOC 6, and Facility support building/services area, parking area, and access roads
- <u>Outfall 002:</u> SWMU 4
- <u>Outfall 006:</u> areas outside the hazardous waste limits of active and closed portions of Cell M, storage units, the SCB, and Facility parking areas and access roads
- <u>Outfall 009:</u> southern portion of the SWMU 5
- <u>Outfall 010:</u> northwest portion of SWMU 5
- <u>Outfall 011:</u> northeast portion of SWMU 5

3.3.2 Gradel Ditch

Gradel Ditch is a stormwater drainage ditch located between the facility's northern property line and the adjoining Gradel landfill. The Gradel Ditch flows westerly and discharges into Otter Creek downstream of the Facility. Typically this ditch exhibits flow conditions only during precipitation events and associated runoff period. Leachate from the Gradel Landfill has also been observed flowing into the Gradel Ditch. For example, during the visual inspection conducted as part of USEPA's RCRA Facility Assessment (RFA), USEPA's contractor noted that leachate was coming directly from the closed landfill north of the Fondessy property and was seen entering the drainage ditch separating the properties (M&E 1987). In addition, during the implementation of the NSL RFI, it was noted that a piezometer on the Gradel Landfill had a flowing artesian potentiometric water level above surrounding ground level, indicating a hydraulic pressure behind leachate seeps which have been observed discharging from the Gradel Landfill (MEC 1997).

The current outfalls that discharge stormwater runoff from the Facility to Gradel Ditch and their drainage areas are as follows:

- Outfall 003: SWMU 1, portions of SWMU 6 and SWMU 7, and access roads.
- Outfall 012: northern portion of SWMU 6 and the northeast corner of SWMU 1.

3.3.3 Driftmeyer Ditch

Driftmeyer Ditch is about 2 miles long, originating approximately 0.4 miles south of the BP Oil Refinery located along Cedar Point Road northeast of the facility. The ditch drains agricultural land, and flows northeasterly through the BP Oil Refinery before discharging into Maumee Bay.

Stormwater from Outfall 004 is discharged to the field on the east side of the facility where it then flows overland toward the Driftmeyer Ditch, located 0.5 to 1 mile east of the facility. The discharge from Outfall 004 consists of stormwater runoff from the following areas north of York Street: SWMU 3, portions of SWMU 6 and SWMU 7, and access roads.

3.4 Soil

The majority of the soil at and around the Facility belongs to the Latty-Toledo-Fulton Association, although on-Facility soils have been disturbed by construction and closure of the TSDF units. The soils map published by the United State Department of Agriculture shows some of the more specific details of the surficial geology at and around the Facility; all of these soils are silty clays or silty clay loams developed on the lacustrine deposits.

St. Clair silty clay loams, which formed in glacial till, are reported along the banks of Duck and Otter Creeks where the streams cut down through the lacustrine material and exposed the underlying glacial till.

3.5 Regional Geologic Setting

The regional geology is characterized by generally horizontal and parallel layers of sediments deposited in glacial and postglacial environments over bedrock composed of Silurian Age sedimentary rock. A review of the regional geology is provided in Section 1.3 of the DOCC; key characteristics of the regional geology are summarized below.

- The uppermost bedrock in the region consists of the Greenfield dolomite. The Upper Silurian Greenfield ranges in thickness from 30 to 97 feet. In the Toledo area, the Lockport Group underlies the Greenfield dolomite and consists of approximately 175 feet of white to light gray or brown dolomite. The next underlying formation, the Brassfield, marks the base of the Silurian rocks in northwest Ohio. The Brassfield formation is a distinctive white, light gray or medium brown fine-to-coarse-grained cherty dolomitized limestone. The Brassfield formation is about 50 feet thick in the Toledo area.

- Bedrock is covered by glacial tills deposited in pro-glacial lakes. The glacial geology consists of approximately 30 feet of older till deposited on bedrock, overlain by 30 to 50 feet of younger till. These tills are overlain by 10 to 20 feet of lacustrine deposits.

3.6 Site Geology

Geology at the Facility has been investigated through the installation of over 800 soil borings and 400 completed as piezometers and/or monitoring wells. The locations of soil borings and the monitoring wells drilled to provide geologic and hydrogeologic data during the RFI are depicted in Figure 3.1. A summary of the monitoring well construction logs including screened interval, depth, diameter, and other well data and boring logs for soil borings installed during Phase I and Phase II of the RFI are provided in Appendix A.

3.6.1 Bedrock Geology

Bedrock beneath the facility is first encountered at depths of 70 to 90 feet below ground surface and is known as the Greenfield dolomite. The Greenfield dolomite is a brown, microcrystalline medium-bedded dolomite. It characteristically contains partings of carbonaceous material that may appear shaley, and styolites and stromatolites. The styolites are wavy carbonaceous partings produced by solutioning. Stromatolites are laminated structures that are commonly attributed to fossil algae. Gypsum and anhydrate are present in small quantities, sometimes as disseminated brown grains.

3.6.2 Glacial Geology

The bedrock surface of the Greenfield formation is overlain by three distinct Late Wisconsinan deposits: a lower till, an upper till, and a proglacial lacustrine deposit. Evidence of earlier glacial activity at the facility has not been found.

- <u>Lower Till</u>

  The lower till, overlying the bedrock at the facility, is a firm, continuous, compact, very stiff, silty clay-rich till. The lower till is commonly referred to as "hardpan" because of its very hard and dense nature. It exists at the facility at thicknesses ranging from 12 to 30 feet, depending on the elevation of the underlying bedrock. The upper surface of the lower till is between 515 and 530 feet mean sea lever (MSL). The top of Lower Till contour map is provided in Appendix C2. In soil borings collected at the facility, the lower till is gray and does not exhibit the characteristic features of weathering (subareal exposure). The unit is not discolored, jointed, or bio-turbated.

  When retrieved through hollow stem augers by a split spoon or continuous sampler, the lower till often appears hard, friable, and slightly moist to dry. In some locations, the contact between the bedrock and the lower till consists of a discontinuous zone of dolomite rubble in a clay matrix, ranging from a few inches to a few feet in thickness. Grain-size analyses of the lower till indicate a particle size distribution that includes one to four percent gravel; 16 to 19 percent sand; 30 to 38 percent silt; and 39 to 53 percent clay.

  In some areas to the west and north of the facility, a lens of sand or sand and gravel lies between the lower till and the bedrock. The absence of these older sand and gravel deposits at the facility is probably related to the geographically higher elevation of the rock beneath the facility. Such deposits, if they existed in the area of the facility, were eroded away prior to the deposition of the lower till.

  During drilling of RFI borings into the lower till zone, the unit was described as stiff and hard clay with little moisture. During drilling of the new RFI bedrock monitoring wells, observations of the lower till included an unsaturated lower till zone and a dry gravel/weathered rock zone between the base of the lower till and the top of bedrock;

ground water was encountered under artesian conditions (water levels in the well rose above the top of rock) only after drilling into a water bearing zone within the bedrock.

- Upper Till

  Directly overlying the lower till is the upper till. The upper till ranges in thickness from 35 to 50 feet. This unit is similar to the lower till in sand-silt-clay percentages in the matrix (gravel ranges from 2 to 8 percent; sand ranges 17 to 26 percent; silt ranges from 28 to 38 percent; and clay ranges 30 to 48 percent). It is very soft by comparison, often appears to be less stoney (fewer pebble and gravel-size sediment) than the lower till, and is characteristically more plastic when retrieved by split spoon or continuous samplers. Mineralogically, the upper till and lower till are very similar consisting of 45 to 60 percent illite; 30 to 45 percent chlorite/kaolinite; and less than 10 percent each of vermiculite, quartz, feldspar and calcite/dolomite. The similarities in the upper and lower tills likely result from having similar parent materials.

  The upper portions of the upper till have slightly less sand. Some of the samples of this till unit appear to contain laminations typical of water-lain till deposited into a proglacial lake. This appears to be particularly true of the upper 5 to 10 feet of this deposit. This till is usually soft near the top and becomes stiffer and more consolidated with depth. The upper till also contains a few isolated inclusions.

  During drilling of RFI borings into the upper till zone, vertical fractures were noted in the interval from 16 to 17 feet below ground surface (bgs). The fractures were filled with sand and described as “iron stained”, an expression used to indicate that there was orange mottling or coloring along the length of the fracture. Below 20 feet bgs, the orange mottling is no longer present. Only minor variations in consistency and plasticity were noted in this unit.

- Contact Zone

  The contact zone between the two tills consists of a silty, clayey, medium to fine sand with small amounts of coarse sand and gravel. It ranges in thickness from zero to five feet. Grain-size analyses indicate that the unit is highly variable with one to 48 percent of the deposit in the silt, clay, and colloid fraction.

  Investigations have also shown a limited area of potentially higher permeability along the western portion of the facility at the contact zone between the upper till and lower till. This area has been defined utilizing all of the geotechnical borings for Cell G and the monitoring wells for Cell G and Cell M (see Appendix C2).

3.6.3 Proglacial Lacustrine Deposits

The lacustrine material at the facility is generally 10 feet to 20 feet thick and is comprised of laminated silt and clay layers with traces of sand and gravel. Grain size analysis of the lacustrine material indicates that the material contains between one and seven percent sand, 48 to 69 percent silt and 30 to 45 percent clay. Mineralogically, the lacustrine deposits are more variable than the tills and contain 45 to 60 percent illite; 15 to 45 percent chlorite/kaolinite; 0 to 30 percent smectite; 0 to 15 percent vermiculite; and less than 15 percent each of quartz, feldspar and calcite/dolomite.

During drilling of RFI borings into the lacustrine zone, there were limited and constrained descriptions of the presence of vertical fractures. The vertical fractures described were in distinct intervals of two feet or less and did not appear to be continuous. Size is not noted for all of the fractures, but any fractures observed during drilling were small and close to hairline in size. Infilling of the fractures and orange mottling were common descriptive traits among the few intervals where the vertical fractures were described.

3.7 Site Hydrogeology

The site hydrogeology has been investigated a number of times in the past several decades. These studies which evaluated the occurrence and movement of ground water were summarized in Section 1.3.2 of the DOCC. Data collected as part of the RFI which supplement these prior studies are summarized below.

3.7.1 Bedrock Ground Water

The bedrock aquifer in northwest Ohio consists of Devonian and Silurian limestone and dolomite. Ground water in these carbonate rocks moves through a series of complex interconnected openings. Therefore, even though the aquifer comprises different geologic formations, it is considered as a single hydraulic unit. Ground water in the bedrock formation beneath the Facility is under artesian conditions, with the overlying till unit acting as an aquitard. These conditions were evaluated during the RFI via the installation of two on-site monitoring wells completed in the bedrock aquifer. One of the objectives of these new wells was to investigate whether a saturated zone is present at the top of the bedrock surface which could provide (1) a potential pathway for contaminant migration along the top of the bedrock surface and/or (2) a hydraulic connection between the bedrock and the overlying till zone. Observations during drilling of the new bedrock monitoring wells include an unsaturated lower till zone, a dry gravel/weathered rock zone between the base of the lower till and the top of bedrock, and artesian conditions (water levels in the well rose above the top of rock) only after drilling into a water bearing zone below the upper surface of the bedrock. These data indicate little evidence of hydraulic connection between the bedrock and the lower till.

The potentiometric surface of the bedrock aquifer in the region of the Facility has historically been, and is currently, influenced by pumping from on-site and nearby industrial supply wells. Specifically, the flow direction and gradient at the Facility is influenced by the cyclical pumping of ground water at the BP Oil refinery located approximately 0.5 miles northeast of the Facility. The timing of this pumping is controlled by an automatic system that responds to the refinery's demands for cooling water, which occurs primarily during the period of April to October. For example, as shown on the bedrock potentiometric surface map for April and August 1995 (see Appendix C3), during non-pumping periods, the observed gradient is relatively flat (i.e., on-site water levels all within a few tenths of a foot of each other), but when BP Oil is withdrawing ground water (spring through fall), the ground water levels at the Facility decline and the gradient is steeper toward the northeast. The flow direction and gradient at the Facility can also be influenced by pumping of bedrock ground water from the Facility’s industrial supply well, as suggested by the October 2005 Preliminary Report of Ground Water Quality for the Facility. Potentiometric surface maps from monitoring events conducted during the RFI timeframe (April 2002 and October 2006) are provided in Appendix C3. Water level data collected during the RFI sampling events are presented on Table 3.1a and 3.1b.

In 2006, ENVIRON completed a series of slug tests to gather data for calculating the hydraulic conductivity (K-value) of the bedrock aquifer zone in which monitoring wells are screened. Based on testing conducted during the RFI, the geometric mean of the hydraulic conductivities of the bedrock aquifer tests was 5.7×10^{-3} cm/sec and 1.4×10^{-2} cm/sec for the falling head and rising head slug tests, respectively. Additional information on this testing is provided in Section 4.18.

3.7.2 Ground Water Conditions in the Glacial Deposits

The thick tills that overlay the dolomite bedrock in the vicinity of the Facility contain trapped pore water. As discussed in Section 1.3.2 of the DOCC, a study conducted to determine the age of the ground water in the glacial deposits indicated that this water is of ancient origin, with adjusted ^{14}C isotope dates ranging from about 9,000 to 13,000 years before the study. In addition, the results indicated that ground water in these deposits has little or no component of modern, post-1952 recharge present.

Further, studies conducted at the Facility have determined that these units are incapable of providing usable supplies to wells because of low horizontal and vertical permeabilities of the tills. In addition, the sand inclusions within the tills are not interconnected and do not serve as conduits for flow. These characteristics are also demonstrated during the routine ground water monitoring events where wells are frequently pumped dry during purging prior to sampling and then take several days to recharge. Therefore, the glacial deposits cannot be regarded as aquifers but as semi-confined water bearing zones. Prior evaluations of ground water elevations in the shallow and deep till wells have shown that there is no discernable regional gradient in these water bearing zones. Finally, the results of on-site hydrogeologic testing indicate that there is no measurable hydraulic connection between the glacial deposits and the bedrock aquifer. The till zone water levels at the Facility reported for monitoring events conducted during the RFI timeframe (April 2002 and October 2006) are provided in Appendix C3. Water level data collected during the RFI sampling events are provided on Table 3.1a and Table 3.1b.

In 2006, ENVIRON completed a series of slug tests to gather data for calculating the hydraulic conductivity (K-value) of the till water bearing zones in which wells at the Facility are screened. For purposes of comparison in this discussion, the tests have been grouped into two categories: shallow till wells screened across the lacustrine/upper till contact, and deep till wells screened across the upper till/deep till contact (additional information on this testing is provided in Section 4.18):

- The geometric mean of the hydraulic conductivities of the lacustrine/upper till contact zone tests was calculated at 1.6×10^{-5} cm/sec and 9.8×10^{-6} cm/sec for the falling head and the rising head slug tests, respectively. The geometric mean of the hydraulic conductivities for this water bearing zone as calculated by Weston in 1985 based on field testing was 1.8×10^{-5} cm/sec using a different subset of wells (ENVIRON/MEC 2001).

- The geometric mean of the hydraulic conductivities of the upper till/deep till contact zone tests was 5.3×10^{-6} cm/sec and 2.7×10^{-6} cm/sec for the falling head and rising head slug tests, respectively. The geometric mean of the hydraulic conductivities for this water bearing zone as calculated by Weston in 1985 based on field testing was 1.8×10^{-7} cm/sec using a different subset of wells (ENVIRON/MEC 2001).

These data confirm the low hydraulic conductivity of the contact zones between the lacustrine/upper till and the upper till/lower till that are monitored as part of ESOI's ground water monitoring program. It should be noted that these hydraulic conductivity values reflect the horizontal hydraulic conductivity of the contact zones and not the vertical hydraulic conductivity. As described in the DOCC, the vertical hydraulic conductivities are on the order of 1×10^{-9} cm/sec for the lower till unit and 1×10^{-8} cm/sec for the upper till unit. The differences between the horizontal hydraulic conductivity values and previously measured vertical hydraulic conductivity values are typical of geologic formations with layered heterogeneities, where vertical conductivities can be lower than horizontal hydraulic conductivities by a factor of 10 to 100 (Freeze and Cherry 1979).

3.8 Ground Water-Surface Water Interaction

In accordance with the April 22, 2004 Revised *Expedited SWMU 5 Phase II Work Plan* and subsequent comments provided by Ohio EPA, The Mannik & Smith Group, Inc. (MSG) completed a ground water – surface water interaction evaluation along the west side of SWMU 5. This investigation was completed to better evaluate the potential for hydraulic connection between ground water and surface water in the vicinity of SWMU 5, in particular, the potential for discharge of shallow ground water from the lacustrine/upper till zone to Otter Creek along the western facility boundary. This investigation included:

- The installation of new temporary wells along the west side of SWMU 5;
- Installation of a temporary leachate well within the west portion of SWMU 5;
- Installation of a staff gauge for measuring water levels in Otter Creek; and
- The construction of permanent monitoring wells in the locations of former temporary monitoring wells T-17S, T-20S, and T-23S.

Once these monitoring points were installed, monthly surface water/ground water/leachate elevation monitoring events were initiated and continued monthly for one year. The results of this investigation were submitted in the report entitled *SWMU 5 Ground Water- Surface Water Interaction Investigation* (MSG 2005). These data are provided in Appendix G.

As part of the monthly ground water – surface water interaction inspections, data collected from the Otter Creek staff gauge were compared to the water levels recorded from Maumee

River Water Level Gauging Station No. 9063085. Comparison of the Maumee River Water levels with those from Otter Creek showed an almost direct correlation with the water levels in Otter Creek being consistently one or more feet higher in elevation than those in the Maumee River. Based upon this comparison, there is no indication during this year-long evaluation of the occurrence of seiches.

3.9 Background Soil Characterization

Background soil samples were collected during the RFI to characterize the naturally-occurring levels of metals in soil at the Facility so that background risks and site-related risks for certain potential exposures can be distinguished in the RFI baseline risk assessment. Consistent with the RFI Work Plan (ENVIRON/MSG 2002), background soil samples were collected from twelve locations where no manufacturing or management of production materials or wastes is known to have occurred. These locations are shown on Figure 2.3 from the *RFI Phase I Report and Phase II Work Plan* (ENVIRON/MSG 2003; a copy is provided in Appendix G). At each location, one sample was collected from the surface (typically 0 to 0.5 ft bgs[2]), and one from a deeper interval (between 5 and 11 ft bgs) in the vadose zone. The boring logs for these locations and the analytical data for the background samples are provided in Appendix A and Appendix B, respectively. The metal concentrations that have been used in the calculation of soil background levels are the surface soil data as summarized on Table 3.2a. This table includes background data from all surface samples, which is the interval expected to be most commonly encountered by routine workers at the Facility.

In accordance with the RFI Work Plan, site-specific background levels were calculated as a statistical upper prediction interval at a 0.01 level of significance for each constituent (USEPA 1989b) using nonparametric bootstrap methods (USEPA 1997b; Efron and Tisshirani 1998). Nonparametric bootstrap statistical limits are more reliable than parametric statistical limits because, unlike parametric limits, they do not rely on assumptions about distribution shapes that are often difficult to justify. The background analysis was also conducted without data that could be considered statistical outliers; these results are presented on Table 3.2b.

In addition, since the background soil concentrations are considered in assessing Facility-related contributions to metals concentrations, upper confidence limits (UCLs) on the mean

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[2] The surface sample collected at location B7 is identified as being collected over the interval between 0 and 4 ft bgs.

concentrations were calculated for the background metals levels, which is consistent with the approach for calculating exposure concentrations for soil. The UCLs presented on these tables are nonparametric BCa bootstrap confidence limits on the mean (Efron and Tibshirani 1998) calculated from 4,000 bootstrap replications and at a 0.05 level of significance. Concentrations of metals in soil at or below these UCLs are considered to be within background levels; for concentrations higher than these UCLs, the differences between the detected concentrations and background UCLs are considered site-related and are used to assess the site-related cumulative cancer and noncancer risks for exposure to soil in human health risk assessment.

Tables 3.2a and 3.2b also summarize the UCL calculations for site-specific background metals. As shown on Table 3.2a, UCLs were not calculated for antimony, cobalt, mercury, silver and thallium because these metals were infrequently detected or not detected in the site-specific background samples. Therefore, background values are not subtracted from concentrations of these metals when comparing to screening criteria or calculating risks.

Table 3.3 presents estimates of cancer risk and hazard quotient that are associated with the background levels presented in Table 3.2a, using the exposure and toxicity assumptions for ESOI Facility worker, maintenance worker, resident, and recreational visitor exposures to soil defined in Section 5 and Appendix E.

3.10 Background Ground Water Characterization

Ground water samples from the Facility's RCRA program wells which are identified as being "unaffected" pursuant to the State RCRA Permit specifications were used to generate a range of background concentrations of metals in ground water in the upper and lower till zones. In accordance with the RFI Work Plan, site-specific background levels were calculated as a statistical upper prediction interval (UPI) at a 0.01 level of significance for each constituent (USEPA 1989b) using nonparametric bootstrap methods (USEPA 1997b; Efron and Tisshirani 1998), where the calculations could be reasonably performed. For certain constituents there was a large percentage of non-detect results (greater than 50%) and prediction intervals could not be calculated. Table 3.4a summarizes the ground water data from unaffected RCRA monitoring wells and the 99% UPIs, where calculations were possible. This table also presents the range of concentrations from these "unaffected" wells by till zone. The values considered background metals concentrations are the maximum detected concentrations, as it was not possible to calculate UPIs for over half of the metals in ground water. The background analysis was also conducted without data that could be considered statistical outliers, at Ohio EPA's request. The results of these calculations are summarized on Table 3.4b.

A comparison of the RFI data with the background levels presented on Table 3.4a is provided in Appendix C8. As discussed with Ohio EPA, these background ranges in till zone ground water can be used to identify locations where ground water concentrations are considered elevated relative to these background levels.

3.11 Land Use

As discussed in Section 2.1, the Facility occupies approximately 130 acres in the City of Oregon, Lucas County, Ohio and currently consists of one active waste disposal cell, located in the southern portion of the property, several closed landfill cells and other SWMUs/AOCs located in the northern portion of the property. It is reasonably expected that use of the Facility for waste management activities will continue into the future.

This subsection discusses the current land use patterns around the Facility, trends in the economy, population, and housing in Oregon, the City's plans for revitalization, and the implications of these factors for future land use at the Facility. The information discussed below is based primarily from the *City of Oregon Master Plan* (Zande & Associates 2007).

3.11.1 Land Use Patterns

Zoning in the City of Oregon is divided into 15 districts, which include classes of residential, business, industrial, and other uses. Figure 2.2 shows the zoning districts for the Facility and areas in the vicinity of the Facility. The Facility is located within an industrial/commercial district. Properties adjacent to and east, north and west of the Facility are also zoned for industrial/commercial use. This industrial area encompasses various chemical, petroleum, waste management, recycling, and manufacturing facilities. Residential properties are located south of the adjacent railroad yard. There are no adjacent properties owned by private individuals.

Of particular importance are two inactive landfills located in the vicinity of ESOI's property which are not owned by ESOI. One of these is the Gradel Landfill located to the north and immediately adjacent to the facility (also known as Commercial Oil landfill), and the other is the Westover Landfill located west of the facility across Otter Creek Road and immediately adjacent to Otter Creek. The Gradel Landfill is an abandoned landfill identified by Environmental Data Resources, Inc., of Southport, Connecticut as an Ohio, State Hazardous

Waste Site, based upon a review of the Ohio EPA Master Site List. The Gradel Landfill is owned by Commercial Oil Services, Inc.

North of the Gradel Landfill is the Commercial Oil Services, Inc. site which until 1999 included abandoned oil lagoons. The site is listed on the USEPA's Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) and in 1999 the sludge and liquids within the lagoons was solidified and placed into a landfill constructed on the Commercial Oil site. North of the Commercial Oil Services property is a BP refinery. Located to the south of the Facility is the Norfolk and Southern Railroad Homestead Yard. Located to the west of the Facility is the City of Toledo water treatment sludge lagoons, a Buckeye Pipeline Company pump station, and the inactive Westover Landfill. Located to the east of the Facility is Toledo Edison property (currently operated as farmland) and a Buckeye Pipeline Company storage tank farm.

Within the immediate vicinity of the Facility are major transportation corridors, which include major railroads, highways, and ports. Although such high traffic transportation corridors are unattractive to residential development, they provide essential support to industrial use of the area at and around the Facility.

3.11.2 Economy, Population and Housing Trends

The City of Oregon's economy has historically been centered on the industrial sector because of its water, rail, and surface transportation access. This access to transportation led to the location of two major refineries in Oregon around the turn of the century. Currently, the City's largest employers are two full service community hospitals (Oregon 2007). However, only 49.4% of the population of Oregon is in the labor force (Oregon 2007).

The population in Oregon has increased slowly through time, corresponding with increases in industrial manufacturing. The following shows Oregon's population trend from 1960 to 1999 (Zande & Associates 2007).

Year	Population	Change	% Change
1960	13,319		
1970	16,563	3,244	24%
1980	18,529	1,966	12%
1990	18,334	-195	-1%
2000	19,355	1,021	6%

The City's population projections since the last decennial census to 2007 estimate an approximate 1.3% decrease (Oregon 2007).

While the number of new houses built has decreased from approximately 180 units in 1995 to approximately 60 units in 2005, most of the new residential growth has moved east and along the Maumee Bay shoreline (Oregon 2007).

3.11.3 Industrial Redevelopment Plans

The City of Oregon's Master Plan recommends preserving the City's existing base of businesses and industries and clustering suppliers or related businesses around existing businesses. While there are no specific plans for industrial redevelopment identified in Oregon's Master Plan, a number of incentives are identified as being available to businesses who establish themselves in the City. One of these incentives is the Foreign-Trade Zone (FTZ) which is located in the C-I zoned area northeast of the Facility. The purpose of the FTZ economic area is to stimulate the foreign imports and exports through special tariff status and tax relief. The Facility is not included in the FTZ. The FTZ is located approximately one mile east of the Facility and is centrally located within an area zoned for industrial use.

3.12 Ground Water Use

Ground water in the bedrock formation beneath the Facility is under artesian conditions, with the overlying till unit acting as an aquitard. Although some sand and gravel inclusions are occasionally encountered within the thick glacial clays overlying the bedrock, these deposits are discontinuous, limited in areal extent, and lack direct recharge. Therefore, all known ground water supplies in the vicinity of the facility are found in the bedrock formation, which is defined as the uppermost aquifer. Potable water at and around the Facility is provided by municipal sources. The public water supply is obtained from Lake Erie and does not depend on ground water from the bedrock aquifer. Further, properties in areas to the north and west of the facility have received an Urban Setting Designation (USD) from the Ohio EPA's Division of Emergency and Remedial Response Voluntary Action Program. The USD provides official recognition that ground water is not used as a source of potable water. Bedrock ground water is used at the Facility for fire protection system makeup water and process water for on-site operations. It is also used at the BP Refinery, located north of the Facility, for cooling water.

Based on this information, bedrock is identified as a potential source of water under current and reasonably likely future conditions at the Facility (nonpotable use) and off-Facility areas that are upgradient and outside of the USD area (potential potable use).

4.0 INVESTIGATION RESULTS AND DISCUSSION

The overall goal of the RFI is to determine whether potential risks to human health and the environment associated with hazardous waste or hazardous constituents released from the investigated SWMUs and/or AOCs warrant interim or corrective measures. As proposed in the RFI Work Plan, data necessary to make this determination were collected during a multi-phased investigation (NSL, Phase I and Phase II). After each phase of field investigation, the adequacy of the data to meet the RFI goal was evaluated to determine whether additional data collection was warranted. Risk-based data evaluation techniques were used during the field investigation to streamline this decision-making. Specifically, human health risk-based criteria and ecological benchmarks were used to guide and streamline field investigations and to identify existing conditions that warranted interim measures.

The scope and results of the field investigations conducted during the NSL RFI and Phase I and Phase II of the Facility-wide RFI for each SWMU/AOC are discussed in this section. In addition, an assessment of the results is provided with respect to whether a potentially significant release of hazardous constituents has been identified and if so, the nature and extent of the release.

4.1 Summary of RFI Investigation Activities

As discussed in Section 2.2, RFI activities were initiated at SWMU 6 (North Sanitary Landfill) beginning in 1996. The scope and results of this investigation were presented in the *Draft Final RFI Report, Northern Sanitary Landfill* (MEC 1997) and the *Second Draft Final RFI Report, Northern Sanitary Landfill* (MEC 1998), and are summarized in Section 4.6..

Phase I of the Facility-wide RFI was conducted from March 2002 through June 2003 in accordance with the RFI Work Plan approved by USEPA on April 10, 2002. Documentation of the Phase I activities is provided in the RFI Phase I Report and the findings are summarized below. As agreed between ESOI and Ohio EPA, most Phase II sampling activities proposed for SWMU 5 were implemented on an expedited basis during the period of April 2004 to April 2005 to provide Ohio EPA with sufficient information to make a determination on the need for interim measures. The remainder of the Phase II activities was completed in 2006 and 2007 in accordance with the Phase II Work Plan approved by Ohio EPA on April 12, 2006.

4.1.1 Reconnaissance Phase

A field reconnaissance was conducted during Phase I as part of the initial RFI activities to (1) collect additional information on the horizontal and vertical limits of waste prior to intrusive investigation activities, (2) gather information on the hydraulic relationship between the monitored ground water zones and the adjacent surface water bodies, and (3) assess current conditions in each area subject to investigation under this RFI and other closed RCRA Subtitle C regulated landfills (Cells G, H and I).

No indications of significant leachate outbreaks or seepages were noted during the initial reconnaissance of the SWMUs and AOCs. Further, with the exception of areas on top of SWMU 1 and SWMU 9, the landfill covers were found to provide positive drainage without evidence of significant ponding of stormwater. SWMU 1 and SWMU 9 were identified as having areas on the top of the units where stormwater accumulates[3]. In addition, only small areas of staining were noted at SWMU 1, SWMU 9, AOC 10 and AOC 7 . Oil outbreaks and tar-like seeps were later identified at SWMU 8 and SWMU 9. Investigation of these seeps were completed during the RFI activities described further in Sections 4.14 and 4.15.

Information from the reconnaissance activities and the Phase I boring logs were utilized to update the approximate limits of each SWMU and AOC. The Phase I Investigation borings determined that while a less permeable subsurface separation exists between SWMUs 1, 6, 7, and 9, waste material was encountered across these separations. The revised limits of the SWMUs are presented on Figure 3.1. A copy of the landfill cover thickness isopach map for this combined unit is provided in Appendix C4.

4.1.2 Phase I Investigation Overview

Phase I of the RFI included the following data collection activities:

[3] The final cap for SWMU 1 was constructed to accommodate a utility easement that traverses the footprint of the landfill. Specifically, First Energy holds a 100-foot wide easement across the central portion of this landfill. In order to comply with clearance requirements of the National Electric Safety Code, the final grading plan was designed to provide a clearance of 21 feet (minimum) between the lowest transmission wire and highest ground surface directly beneath it. This necessitated lowering the final cap elevation within this easement relative to the surrounding crown portion of the cap.

- Characterizing soils at the identified horizontal and vertical waste limits to assess the potential for hazardous waste or hazardous constituent migration.

- Assessing the thickness of in-place waste and the depth of any accumulated leachate within the unit.

- Characterizing ground water at the perimeter of the waste unit or group of units to assess the potential for hazardous waste or hazardous constituent migration.

- Characterizing surficial and/or subsurface soils within the footprint of AOCs, as appropriate to evaluate potential on-site and off-site exposures for the given unit.

- Characterizing existing stormwater discharge points and receiving streams upstream and downstream of these discharge points, to distinguish contributions from individual units and off-site sources to the extent practical.

- Assessing physical characteristics of clay cover soils on the side slopes and top of landfill units subject to investigation during the RFI.

All samples collected for the purpose of determining if a significant release has occurred at any of the SWMUs and/or AOCs were analyzed for all VOCs, SVOCs, PCBs, herbicides, pesticides and inorganics listed in Appendix IX to 40 CFR 264. In addition, based on the results of ESOI's ongoing RCRA ground water monitoring program, all samples were analyzed for tetrahydrofuran. Additional information on the selection of the analytical parameters to be analyzed for during the RFI program (referred to the "Phase I Parameter List") is provided in the RFI QAPP.

During the implementation of the Phase I activities, some changes to the scope of work were necessary to accommodate encountered field conditions. The significance of these modifications relative to the RFI goals and objectives were reviewed in the RFI Phase I Report (ENVIRON/MSG 2003), and data gaps were addressed as part of the Phase II investigation.

4.1.3 Phase II Investigation Overview

Based on the evaluation of the RFI Phase I data in comparison with conservative risk-based screening criteria, further investigation was proposed to gather additional data to determine the nature and extent of constituents in soil, sediment, surface water and/or ground water at certain SWMUs and AOCs, as necessary to support the RFI risk assessments. Phase II of the RFI consisted of an expedited investigation at SWMU 5 and Otter Creek (Expedited Phase II) and the investigation of the remaining areas recommended for follow-up investigation.

The following field changes and clarifications were made to the RFI Work Plan as discussed and agreed upon with Ohio EPA on July 11, 2006:

- **Slug Testing:** ESOI conducted slug tests at the following existing and proposed monitoring well locations:

  MR-3S/D and R-23 (new bedrock well)
  MR-6S
  T-20S(3)
  MR-2S/D and R-4
  MR-5S/D
  New temporary well cluster located north of Millard Landfill
  New temporary well located north of Millard overpass
  MR-1S(A)
  T-25(sand)
  F-2S/D
  SW-1S
  SW-2S/D
  SW-4S/D
  SW-3S/D and R-24

  It was agreed that slug testing would not be performed at the following locations:

  - The existing 1-inch diameter temporary wells original specified in Ohio EPA's Phase II RFI approval letter;
  - The new temporary well installed between SWMU 1 and SMWU 7; and
  - The temporary leachate monitoring wells installed adjacent to Building C.

- **Bedrock Well Installation:** During drilling for the two new bedrock wells, split-spoon sampling was conducted beginning at a depth of 60-feet below ground surface (corresponding to a depth approximately 4 to 5-feet above the screened interval of the adjacent deep till zone monitoring well) to the top of bedrock. The well log for the adjacent well is referenced in the boring log for the new bedrock wells.

- **Temporary Wells West of Otter Creek:** The site inspection to locate suitable locations for till zone monitoring wells on the west side of Otter Creek determined the density of underground petroleum pipelines and other access restrictions makes installation of a well at a location that would provide useful data extremely challenging and potentially dangerous to the well drilling crew. Therefore, the existing data were further reviewed to assess the potential risks to off-site receptors west of Otter Creek. This review of the RFI Phase I data in comparison with risk-based screening criteria pertinent to the potential pathways of exposure to overburden ground water west of Otter Creek determined that existing on-site concentrations do not indicate a potential risk to receptors west of the creek. In particular, the potential risk to workers involved with the installation of these wells was considered to be far greater than the potential hypothetical risks associated with ground water receptors.

In addition, during implementation of Phase II investigation activities more frequent monitoring was conducted to assess the presence of measurable NAPL at SWMU 5. In addition, the NAPL recovery rate was evaluated by removing NAPL from the wells until no measurable product remained and then monitoring for changes in NAPL thickness.

The following field changes were made to the Phase II Work Plan Addendum as discussed and agreed upon with Ohio EPA on October 27 and 31, 2006:

- Four additional borings were completed at the toe of SWMU 6 to further characterize the cap in the location where damage to the cap was incurred by vehicle traffic during the leachate extraction work plan implementation;
- Five additional soil borings were completed on the cap of SWMU 9 to better define the limits of the free liquid;
- Slug testing at the temporary leachate wells installed at SWMU 8 was modified as follows: slug testing was performed at one 2-inch temporary well which did not exhibit separate phase liquids since the separate phase liquid could interfere with the operation of the pressure transducers and interpretation of results. Bail-down tests were conducted at all the remaining temporary wells to gauge the rate-of-recovery of liquids into a well.

- One additional boring to delineate NAPL in soil was completed at the request of Ohio EPA upslope of the temporary shallow well location that was installed to delineate NAPL at the T-20S(5) location.

During a meeting with Ohio EPA on March 28, 2007 at the Facility, the inability to obtain property access for installation of two off-site wells on the east side of SWMU 6 was discussed. Similar to the analysis of off-site wells on the west side of Otter Creek, the existing data was further reviewed to assess the potential risks to off-site receptors east of SWMU 6. This review of the RFI Phase I data in comparison with risk-based screening criteria pertinent to the potential pathways for exposure (vapor intrusion and direct contact by construction workers east of SWMU 6) determined that existing on-site concentrations do not indicate a potential risk to receptors east of SWMU 6. It was agreed that ground water samples from SW-4S and SW-4D would be collected and analyzed for VOCs and SVOCs to confirm results and assess temporal variability.

4.2 Validation/Usability

All laboratory data were subject to data validation in accordance with the RFI QAPP by a third party to verify that the data reported by the analytical laboratories meet the quality limits established for this project and to assess the usability of the data for use in the RFI. Based on this data validation, all Phase I and Phase II data were determined to be valid and usable in the RFI unless otherwise rejected by the data validator ("R" qualified).

4.2.1 Summary of Data Validation Process

Validation of analytical data was performed as specified in the RFI QAPP (ENVIRON/MSG 2001), as revised for Phase II of the RFI (ENVIRON June 2006). Each analytical data package was identified as a Sample Delivery Group (SDG), and given a number for unique identification. Data validation memoranda were prepared for each SDG and submitted to Ohio EPA. The validation process generally involved the evaluation of GC/MS instrument performance check sample results, results of initial and continuing calibration, and review of all technical holding times, all blanks, surrogate spikes, matrix spikes/matrix spike duplicates, laboratory control samples, internal standards, target compound identification and quantitation, and system performance checks. In addition, all forms summarizing this information were checked and the overall completeness of the data package was confirmed. Copies of the RFI Phase I validation memoranda were provided in Appendix F of the RFI Phase I Report (ENVIRON/MSG 2003). Copies of the RFI Phase II validation memoranda are provided in Appendix D of this Report.

4.2.2 Phase I Data Validation

Each analytical data package received from Biological and Environmental Controls Laboratories, Inc. (BEC), the Phase I and expedited Phase II analytical laboratory, was validated following the RFI QAPP specifications. In October 2003, Ohio EPA and USEPA issued comments on the RFI Phase I Report, including a request for additional evaluation of the RFI Phase I, as well consideration of split sampling data collected by Ohio EPA, to determine whether additional sampling should be conducted beyond that proposed for Phase II of the RFI. As agreed between ESOI and Ohio EPA, the scope of supplemental data evaluation included:

1. Reviewing Ohio EPA soil and ground water data.
2. Conducting supplemental validation of Phase I SDGs.
3. Reviewing "J" qualified data.
4. Conducting 25% confirmation of RFI data.

4.2.2.1 Review of Ohio EPA Data

The review of the Ohio EPA soil and ground water data was conducted as part of the supplemental data evaluation performed as part of the Phase II investigation planning. These results were presented in the Phase II Work Plan (ENVIRON 2005).

4.2.2.2 Supplemental Data Validation

As agreed with Ohio EPA, ESOI reviewed the RFI Phase I SDGs for specific systematic problems that could lead to additional data being rejected ("R" qualified) due to non-compliance with specified QC criteria. Supplemental data validation was initially completed for four selected SDG reports generated for Phase I. Ohio EPA selected these SDGs as being representative of the data validation reports submitted for Phase I of the RFI. The purpose of this supplemental data validation effort was to provide additional QC review not originally reported in the validation memoranda that were included in the July 2003 RFI Phase I Report, and most importantly, identify any systematic laboratory QC concerns that may influence decisions regarding data usability (i.e., data that should have been "R" qualified due to significant deviation from specified QC criteria).

The supplemental Phase I analytical data review for the four selected SDG reports was submitted to Ohio EPA in June 2005 (ESOI 2005a). As discussed in this submittal, additional data were "R" qualified as a result of the supplemental validation. Most frequently, these additional sample results were flagged "R" due to non-compliance with the laboratory control sample (LCS) QC criteria (organics only, no additional inorganic or general chemical data were rejected). The LCS results are contained in the original SDG reports provided by BEC Laboratories, but were not reviewed in the initial data validation process. Further it was noted that the LCS criteria are specific and unique to the low concentration water method (specified under CLP methods) and are not typically applied to SW846 methods, except perhaps in the case of the SVOC analyses where SIM methods are applied (as SIM is normally used to achieve very low detection limits). Nonetheless, based on the findings of the potential systematic problems indicated by the LCS results in SDG-1, 6, 8 and 24, ESOI reviewed the LCS data in each of the remaining Phase I RFI SDGs to determine if additional data should be "R" qualified due to similar non-compliance with specified QC criteria. The results of this supplemental validation were submitted on November 4, 2005 (ESOI 2005b); this submittal was amended in the submittal on January 12, 2006 (ESOI 2006).

Sample results identified as being rejected during the original validation, or where this supplemental evaluation identified additional data to be "R" qualified, the need for additional data collection at these sampling locations was reviewed and the necessary data were collected during Phase II of the investigation. The additional sample collection was reviewed with Ohio EPA in July 2006 prior to implementing the Phase II field activities.

4.2.2.3 Qualified Data Review

As discussed in the Phase II Work Plan, certain Phase I data were "J" qualified to indicate uncertainty in the reported concentration of a chemical, but not in its assigned identity. Therefore, as specified in Risk Assessment Guidance for Superfund (RAGS) Part A (USEPA 1989), these data can be used the same as positive data with no qualifiers. However, given the potential uncertainties with the reported concentrations for these J-qualified data, Ohio EPA requested an additional of review of those samples that could lead to incorrect decisions regarding the adequacy of delineation to levels at or below screening levels. To address this concern, ESOI implemented the following procedure for conducting a supplemental review of these J-qualified data in accordance with the approved Phase II Work Plan:

1. Assembled "J" qualified soil, sediment and ground water data and identify those locations that represent samples from the Facility perimeter.

2. Compared the reported concentrations to the minimum human health and ecological risk screening criteria.

3. For those constituent concentrations that are less than the criteria, but within a factor of 2 of the criteria, the laboratory data package and validation report were reviewed to determine if the data may be "low biased" and the probable cause of this bias.

4. For low biased data identified in Step 3, the sample location was reviewed in the context of other data at and around that location to assess whether the potential low-bias concentration would likely alter remedial decisions (e.g., consider if other sampling has been performed in the vicinity of or at other depths at this location, if the concentration is a significant contributor to cumulative risk estimates, etc.). If the potential low-bias concentration would likely alter remedial decisions, then a determination was made whether resampling would likely eliminate the low-bias. If so, then this location was identified for resampling. Otherwise, resampling would not be beneficial to remedial decisions, and no resampling was performed.

This review of all J-qualified Phase I data and expedited Phase II data were conducted prior to implementing the remainder of the Phase II investigation activities. The findings of this review and impacts on the scope of the RFI sampling were submitted to Ohio EPA on April 26, 2007 (ESOI 2007a; a copy of this submittal is provided in Appendix G). Where this evaluation determined the need for additional data collection, the data were collected as part of Phase II Addendum #2 field activities.

4.2.2.4 25% Confirmation Sampling

In accordance with the Ohio EPA's April 12, 2006 RCRA Facility Investigation Phase II Work Plan Approval, certain Phase II data were evaluated as part of the confirmatory sampling requested in Ohio EPA's March 28, 2006 Phase I Data Validation Resolution letter to ESOI. As specified in Ohio EPA's Phase I Data Validation Resolution letter, ESOI collected the following confirmatory samples at SWMU 5 for VOCs, SVOCs, and PCBs:

- Sediment confirmation samples were collected adjacent to Sites 1 and 4, and SED-05.
- Soil confirmation samples were collected adjacent to locations T-16 (6-8 feet), T-20 (11-13 feet), T-21 (15.5 - 17.5 feet), T-22 (0-0.5 feet), T-23 (8-10 feet), T-24S (6-8 feet), T-25 (0-0.5 feet), T-26 (4-6 feet), and T-27 (4-6 feet).

In addition, as proposed in the Phase II Work Plan, certain monitoring wells were resampled to confirm the results from Phase I of the investigation.

The results of the confirmatory samples were evaluated considering the USEPA Region 5 *Guidance Regarding Historical Data Usage In RCRA Facility Investigations in Region 5* (USEPA 1998) and the intended use of the Phase I and Phase II data for supporting decisions in this RFI. Specifically, the original data were compared with confirmatory data to determine which of the following categories describe the relationship between the original and confirmation data:

- Original data and confirmatory data correlate well;
- Original data identify significant releases, but the confirmatory data do not indicate a significant release; or
- Original data identify no significant releases, but the confirmatory data do indicate a significant release.

The purpose of this review was to determine whether the Phase I data are sufficient for meeting the RFI objectives. Based on this evaluation, it was concluded that the Phase I and Phase II data sets are comparable and the Phase I data are adequate for meeting the RFI objectives (ESOI 2007b, c; a copy of these submittals are provided in Appendix G).

4.2.3 Phase II Data Validation

All Phase II RFI data were validated in accordance with the revised RFI QAPP (ENVIRON, version 4 dated June 22, 2006d) approved by Ohio EPA on December 13, 2006.

4.2.3.1 Estimated Quantitation Limits

The estimated quantitation limits for each target analyte were provided with each SDG. A copy of the list may be found in Tables 1-1a through 1-1g of the RFI QAPP.

4.2.3.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Field accuracy was assessed through the regular calibration of field instruments and through the collection of field and trip blanks. Laboratory accuracy was assessed through the analysis of matrix spike and method spike samples. The review of matrix spike and method spike samples is provided in the individual validation reports provided in Appendix D.

4.2.3.3 Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision was assessed through the collection and measurement of field duplicates. Precision of field measurements was assessed by making duplicate measurements of field-measured parameters. Laboratory precision was assessed through the analysis of matrix spike/matrix spike duplicates (MS/MSD), which is provided in the individual validation reports provided in Appendix D.

4.2.3.4 Completeness

Completeness is a measure of the amount of valid measurements obtained from all the measurements planned for each matrix and analysis in a given investigation area. The goal for both Phase II field and laboratory completeness is 90 percent or greater. A summary of the samples and analyses that were planned for the Phase II investigation and a summary of the data that were actually collected is provided in Appendix D7. As indicated in Appendix D7, the number of samples actually collected during the Phase II investigation meets or exceeds the planned scope of sampling. In addition, with the exception of four SWMUs, the number of valid analyses in comparison with the reported analyses exceeds 90%. For three SWMUs, the number of valid analyses is between 80% to 90% and one SWMU has 77% valid analyses in comparison with the reportable analyses. The significance of rejected data is reviewed below.

<u>Review of Rejected Data –Phase II and Phase II Addendum #1 Data</u>

As part of the development of the scope of work for the Addendum #2 Work Plan, ENVIRON reviewed available data from the Phase II investigation (including the Phase II Addendum #1 data) that were rejected during data validation conducted in accordance with the revised QAPP. The purpose of this review was to identify potential data gaps or systematic problems with laboratory analysis or validation.

There were 666 records (chemical/sample combinations) across all matrices that were identified as rejected during validation of the Phase II data. The potential impact of the rejected data on the RFI completeness is discussed below.

1. 348 non-detect SVOC results from the re-extraction of three ground water samples were rejected. The analytical results for the original extraction of these three samples were accepted as valid. Therefore, the rejection of these data does not result in a data gap.

2. 29 non-detect Pesticide and PCB results from the original extraction of one ground water sample were rejected. The results for the re-extraction analysis for this sample were accepted as valid. Therefore, the rejection of these data does not result in a data gap.

3. 116 SVOC results from the original extraction of one soil sample were rejected. All of these results were non-detect except for bis(2-ethylhexyl)phthalate. The results for a re-extraction analysis for this sample were accepted as valid. Therefore, the rejection of these data does not result in a data gap.

4. 18 non-detect SVOCs results from the original extraction of one ground water sample were rejected. Insufficient volume existed for a laboratory re-extraction but a field duplicate was collected at this location. The field duplicate sample was accepted as valid. Therefore, the rejection of these data does not result in a data gap.

5. 18 non-detect SVOCs results from the original extraction of one ground water sample were rejected. Insufficient volume existed for a laboratory re-extraction of this sample. These constituents were infrequently or never detected in other ground water samples at the site, and where detected, did not exceed the screening criteria in ground water or soil. Therefore, these constituents have not been identified as contaminants of potential concern in the RFI. This sample was collected at temporary well T-28S, which is internal to the site. Based on these considerations, the rejection of the data for this sample is not considered a data gap which warranted resampling.

6. 132 non-detect VOCs results were rejected from 68 ground water, 8 leachate, 6 NAPL, 12 sediment, 26 soil and 12 trench water samples. These VOCs include 1,4-dioxane (only in soil, sediment and NAPL), acetonitrile, acrolein, acrylonitrile, isobutyl alcohol, and propionitrile because of poor relative response factors. With the exception of 1,4-dioxane in ground water, these VOCs have not been identified as contaminants of concern based on the results of numerous other samples collected during the RFI. In addition, several of these constituents are solvents that may be associated with liquid chromatography analytical methods. However, these constituents are not included in the same category as the common lab contaminants (e.g., acetone and methylene chloride). Based on these considerations, the rejected data may be considered data gaps, however, it was considered unlikely that the laboratory would be able to produce consistently acceptable results for these

constituents in future analyses because theses compounds generally do not purge well from the instrument.

7. The remaining 5 rejected results consist of two tin results in soil samples from location S8-203 and three tetrahydrofuran results in ground water samples from locations R-23 and R-24. The detected tin results were rejected because of low surrogate recoveries in the MS and MSD samples. Tin is not a known contaminant at this Site and, therefore, does not constitute a data gap. The non-detect tetrahydrofuran results were rejected due to low relative response in the continuing calibration. Tetrahydrofuran is a potential contaminant of concern in ground water, but it was subsequently analyzed as part of the RCRA permit monitoring program at these two wells; tetrahydrofuran was non-detect at R-23 and 0.69 ug/L at R-24 (compared with an equivalent drinking water level of 7,300 ug/L). Since valid tetrahydrofuran data are available from the RCRA ground water monitoring program, a data gap does not exist at these locations.

<u>Review of Rejected Data –Addendum #2 Data</u>

Following the validation of the Phase II Addendum #2 data, potential data gaps resulting from rejection of some of these data were reviewed. Given that Phase II Addendum #2 was the final field event, the data qualified as rejected were evaluated relative to prior validation results from the RFI. This review identified two categories of R-qualified data. The first consisted of those constituents that were qualified as rejected in RFI Phase II Addendum #2 and were also qualified as rejected in prior to RFI sampling events. The second consisted of those data that were qualified as being rejected during Addendum #2 and were not qualified as rejected during prior to RFI sampling events. The results of this evaluation and the potential impact of the rejected data on the RFI completeness is discussed below.

- Several results were identified as being rejected in the RFI Phase II Addendum #2 data that were also qualified as rejected during validation of data from prior field events. The constituents included in this category are limited to four VOCs that are commonly rejected due to poor analytical performance in both solid and liquid matrices. The rejection of these data is consistent with prior validation results at the Facility and as such is not considered a significant data gap.

- Results for several constituents were rejected in the Phase II Addendum #2 data, but were not rejected in prior data. These are discussed below by matrix.

- <u>Surface Water</u>

  One SVOC was rejected in surface water at location Site 4. This constituent has not been identified as a constituent of interest during the RFI and was rejected only this one time out of eleven surface water samples. However, given that the affected constituent has not been identified as a constituent of interest during the RFI or as a potential constituent of concern in either the human health or ecological risk assessments (Sections 5 and 6, respectively) no data gap exists.

- <u>Soil</u>

  Ten non-detect results for VOCs were rejected in soil from the surface sample collected at AOC 7. No detected results from this sample were qualified as rejected. The sample was collected to verify low bias reported for detected VOCs in a prior sample. The Addendum#2 results were rejected as a result of laboratory issues with the standards and calibration. The constituents identified with possible low bias in prior sampling were detected during the Addendum #2 sampling and as such rejection of non-detect data do not indicate a data gap.

- <u>Sediment</u>

  A number of SVOCs that were not rejected in prior events were rejected in sediment samples during Addendum #2. The frequency of rejection for the affected constituents ranged from 5% to 30% in the Addendum #2 sediment samples. A review of these data determined that the rejected results were from samples collected locations Site 3, Site 4, and Site 9 which were all collected in August 2007. These data were collected to confirm prior results. Samples for alkylated PAHs were also collected at these same locations in October 2007; none of the alkylated PAH results were qualified as rejected. An evaluation of each of the affected locations follows:

  - Site 3 had a number of SVOC constituent results rejected. No duplicate sample was collected at this location. Prior sampling results at this location and the alkylated PAH results from October 2007 were not qualified as rejected and are sufficient to assess the potential significance of detected concentrations at this location. Therefore, no data gap exists at this location.

- Site 4 had a number of SVOC constituent results rejected. A duplicate sample was collected at this location and these SVOCs were not qualified as rejected. The results for the duplicate sample from August 2007, the prior sampling results, and the alkylated PAH results from this location are sufficient to assess the potential significance of detected concentrations at this location. Therefore, no data gap exists at this location.

- Site 9 had fewer SVOC constituent results rejected, than at Sites 3 and 4. No duplicate sample was collected at this location. Site 9 is an upstream sample location within Otter Creek and the rejected constituents were not identified as likely constituents of concern in downstream creek samples. Therefore, the prior data and the alkylated PAH results from this location are sufficient to assess the potential significance of detected concentrations at this location. Therefore, no data gap exists at this location.

4.2.4 Data Usability

As discussed in Section 4.1.2, based on the results of the Phase I data evaluation, supplemental validation and confirmatory data evaluation, the Phase I data were determined by the validators and ENVIRON to be adequate for meeting the RFI objectives. Similarly, validation of the Phase II data determined that with the exception of data qualified as rejected (as discussed by the data validators in the validation reports included in Appendix D), the data are acceptable for use in accordance with the approved QAPP.

Following validation, ENVIRON implemented the following procedures to prepare the data to support data review and ultimately, a quantitative risk assessment. These procedures, which are based on USEPA's Risk Assessment Guidance (RAGS) Part A (USEPA 1989a), are as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ-qualified data) during data validation are evaluated as non-detects. The "UJ" qualified data indicate that the constituent was not detected but there is some uncertainty with the detection limit. Consistent with RAGS, these data are treated as nondetects since there was no identification of this constituent in the sample. If there is reason to believe that the constituent may be present in a sample below the reported sample quantitation limit (SQL), then a value of one-half the SQL is used in developing risk estimates.

- Constituent concentrations qualified as not usable (i.e., R-qualified data) during data validation are not included in the risk assessment.

- Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment. The “J” qualifier is used to indicate uncertainty in the reported concentration of a chemical, but not in its assigned identity. Therefore, as specified in RAGS Part A, these data can be used just as positive data with no qualifiers. To aid in the assessment of the potential uncertainties associated with these qualified data, the data qualifiers have been supplemented with codes to identify those estimated concentrations having either a low- or high bias; if data qualified with a J contribute significantly to the risk estimates, then the potential uncertainty in the risk estimates is reviewed.

- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.

- The concentrations of 1,3-dichloropropene (total), methylphenol (total) and xylenes (total) in a sample are the sums of the concentrations of the detected isomers and half the quantitation limits of isomers not detected in the sample but detected in the same matrix at the Facility. If no isomer is detected in a sample, the constituent is considered to be not detected in the sample.

- The concentration of PCBs (total) in a sample is the sum of the concentrations of the detected Aroclors and half the quantitation limits of Aroclors not detected in the sample but detected in the same matrix at the Facility. If no Aroclor is detected in a sample, PCBs are considered to be not detected in the sample.

- As a conservative assumption, all concentrations of organic constituents are assumed to be facility-related, since the RFI field investigation has not attempted to establish a site-specific background level for any organic constituent. As a conservative assumption, all concentrations of organic constituents are used for initial risk estimates, even if having a low frequency of detection. The frequency of detection is subject to further review if the constituent is identified as contributing significantly to the initial risk estimates. For example,

- Acrylonitrile was detected in once out of over 450 RFI samples.
- Hexachlorophene was only detected in ground water only once (at location T-55S during Phase I of the RFI), and a total of four times among over 350 RFI samples.
- N-nitrosodi-n-butylamine was detected at a low frequency (11 out of over 400 samples) and only in samples analyzed by BEC Laboratories.[4]

Given the extremely low detection frequencies, the reported presence of these constituents is considered suspect.

The assessment of potential data uncertainties in the risk estimates, including uncertainties associated with J-qualified data that contribute significantly to the risk estimates, are discussed in the risk assessments presented in Section 5 and 6.

4.3 Data Evaluation Overview

The identification of a potentially significant release at a SWMU/AOC is based on comparison of the characterization data collected during the RFI with generic risk-based screening criteria. The criteria utilized for this evaluation were defined in the RFI Work Plan and Phase II Work Plan. Supplemental information describing the derivation of certain of these criteria was provided to Ohio EPA during the Phase II implementation (a copy of these interim submittals is provided in Appendix G). The approach for evaluating the soil, ground water, sediment and surface water data in comparison with these criteria is discussed below.

[4] The presence of n-nitrosodi-n-butylamines may be the result of the analytical laboratory or the type of nitrile gloves they used during the Phase I and Expedited Phase II RFI. This constituent was not detected after the RFI laboratory and glove type were changed.

Soil

Based on current and reasonably expected future land use at the Facility, the primary soil screening criteria are based on information gathered during the site-specific exposure assessment (see Section 3.11).

- Routine worker soil screening criteria calculated using site-specific exposure assumptions developed for ESOI Facility workers who potentially contact soil while working outdoors. The criteria are calculated at a target cancer risk of 10^{-6} and a target Hazard Quotient (HQ) of 1.

- Soil screening criteria calculated to assess vapor intrusion to industrial building indoor air. The criteria to evaluate the potential for vapor intrusion are calculated at a target cancer risk of 10^{-6} and a target HQ of 1.

- Soil screening criteria protective of constituent leaching to potable ground water (USEPA 1996b). These criteria are applied to concentrations from the deepest vadose zone sample interval in each boring. The criteria to evaluate the potential for migration to ground water are conservatively calculated using drinking water criteria (maximum contaminant levels [MCLs] or equivalent drinking water levels [EDWLs] calculated at a target cancer risk of 10^{-5} and a target HQ of 1).

- USEPA Region 5 ecological screening criteria (USEPA 2003) and other relevant ecological screening values (see Section 6). These criteria are applied to surface soil samples collected within areas within or immediately adjacent to potentially valued ecological resources.

A potentially significant release to soil is identified at an area when the highest concentrations of the constituents detected in soil at the area are higher than these screening criteria. It should be noted that an area with constituent concentrations in soil that are higher than these screening criteria (i.e., a "potentially significant concentration") does not mean that it necessarily poses an unacceptable risk; it only means that the potential for the area to pose an unacceptable risk should be evaluated. The site-specific evaluation of potential risks posed by constituents in an area where a potentially significant release is identified is addressed in the baseline human health risk assessment described in Section 5 and the screening level ecological risk assessment described in Section 6 for areas of valued ecological resources.

Ground Water

Similar to the approach for screening soil characterization data, ground water monitoring data collected during the RFI are compared with generic risk-based screening criteria to identify whether a potentially significant release from an area to ground water has occurred. The ground water monitoring data are compared with drinking water screening criteria based on MCLs and EDWLs for constituents without MCLs. The EDWLs are generic risk-based drinking water limits calculated using conservative standard default exposure factors for estimating high-end exposures via daily drinking water consumption, and a target cancer risk and HQ of 10^{-6} and 1, respectively. A potentially significant release to ground water is identified when the highest concentrations of constituents detected in a monitoring well are higher than these screening criteria (i.e., a "potentially significant concentration").

It should be noted that the ground water screening criteria described above are designed to be protective of potential exposures via drinking water use and represent highly conservative screening criteria for evaluating ground water that is not a current or reasonably expected future drinking water supply. Therefore, the presence of ground water with constituent concentrations higher than these generic screening criteria does not mean that the ground water necessarily poses an unacceptable risk; rather, it indicates that the potential for the ground water to pose an unacceptable risk should be evaluated considering potential site-specific exposures pathways.

Water table and lacustrine/upper till zone ground water results are also evaluated using risk-based concentrations protective of (1) dermal contact with shallow ground water and inhalation of vapors from ground water by workers during excavations, and (2) risk-based concentrations protective of vapor intrusion to residential and industrial building indoor air. These criteria are calculated at a target cancer risk of 10^{-6} and a target HQ of 1.

Data for shallow ground water near a surface water body (including water table wells and lacustrine/upper till wells located next to Otter Creek and the Gradel Ditch) are also compared with USEPA Region 5 ecological screening criteria (USEPA 2003), federal ambient water quality criteria and Ohio water quality criteria for surface water.

The site-specific evaluation of potential risks posed by constituents in ground water where a potentially significant release is identified is addressed in the baseline human health risk assessment described in Section 5 and the screening level ecological risk assessment described in Section 6 for areas of potentially valued ecological resources.

Sediment

Generic risk-based screening criteria for evaluating the significance of potential exposure of humans to sediments are not well established. Therefore, as a conservative approach to the identification of a potentially significant release to sediment, the sediment characterization data collected during the RFI are compared with the generic routine worker risk-based screening criteria described above for evaluating the soil characterization data. Sediment concentrations are also initially screened using the USEPA Region 5 ecological screening criteria (USEPA 2003) and other relevant screening values (see also Section 6).

The site-specific evaluation of potential risks posed by constituents in sediment where a potentially significant release is identified is addressed in the baseline human health risk assessment described in Section 5 and the screening level ecological risk assessment described in Section 6.

Surface Water

The identification of a potentially significant release to surface water is based on a comparison of the surface water characterization data collected during the RFI with the generic risk-based screening criteria described above for evaluating construction worker exposures to shallow ground water. Surface water results are also initially screened using and USEPA Region 5 ecological screening criteria (USEPA 2003) for surface water, federal ambient water quality criteria and Ohio water quality criteria for surface water.

The site-specific evaluation of potential risks posed by constituents in surface water where a potentially significant release is identified is addressed in the baseline human health risk assessment described in Section 5 and the screening level ecological risk assessment described in Section 6.

Discussion of the RFI field investigations in the following subsections is organized by SWMU or AOC. Tables comparing the RFI characterization data collected in an area with the screening criteria discussed above are included as Tables 4.3 through 4.9. Each subsection also references figures (Figures 4.4 through 4.17) that show the spatial distribution of the RFI data for constituents having at least one concentration higher than the most conservative screening criteria in any media at any SWMU or AOC[5]. Figures 4.13 through 4.15 present the vertical profile of these constituent detections along the Facility property boundary.

4.4 SWMU 1 – Landfill Cell F

Cell F is a closed permitted RCRA hazardous waste landfill unit that encompasses an area of approximately three acres and is located within the northwest portion of the ESOI site. The Cell is bounded to the west by Otter Creek Road, the north by the Gradel Ditch and the Gradel Landfill, owned by Commercial Oil Services, Inc, the east by SWMU 6, and the south by SWMU 2. The cell was operated from 1980 to 1983 for the disposal of both non-hazardous industrial waste and RCRA hazardous waste. Wastes disposed of within this cell were bulk and containerized solids which primarily consisted of treated sludges, landfarm soil, ignitable solids, refinery solids, paint solids and contaminated soils, along with non-hazardous industrial waste solids. Cell F has an estimated waste thickness of 50 to 55 feet, with a total disposed volume of waste of approximately 146,000 tons. Additional information on the construction and closure of Cell F is provided in Section 3.1 of the DOCC.

Cell F is currently maintained and monitored in accordance with the substantive requirements of the post-closure plan, which was included with the Facility's State RCRA Part B Permit and Application. In addition, leachate is removed regularly from this landfill. The ongoing post-closure activities are designed to maintain the integrity of the final cover, liners and other components of the containment system, and the function of the unit's monitoring systems.

4.4.1 Scope and Results

The scope of the RFI field investigations at SWMU 1 involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at SWMU 1. In addition, physical properties (e.g., landfill cap, landfill gas, etc.) of the SWMU were evaluated during the RFI. The RFI sampling locations for soil and ground water are shown on Figure 3.1. Soil boring logs and field notes from the RFI activities are provided in Appendix A.

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[5] In developing the constituent list to be presented on the data figures based on till zone ground water data, only the wells at the perimeter of the Facility were compared with drinking water criteria (see Appendix C10).

The following is a summary of the sampling activities conducted for each medium during the RFI at SWMU 1:

- Ground water at the perimeter of the landfill was characterized by installing one boring approximately every 100 linear feet on the north side of the landfill, at least 5 feet outside of the limits of the unit to a depth at which the upper till/lower till contact was encountered. Ground water samples were collected from the water table interface, the lacustrine/upper till contact zone, and the upper till/lower till contact zone using temporary wells, dedicated disposable bailers and/or peristaltic pump, as appropriate. Existing shallow and deep till monitoring wells located adjacent to the landfill were also sampled[6]. Ground water samples were analyzed for the Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. Where well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the QAPP (Section 4 of Appendix A of the RFI Work Plan) and sampling plan addendum (MSG 2002); the sampling plan addendum (included in Appendix G) included a list of thirty temporary monitoring wells with no or low yield. For wells with sufficient yield, samples for metals analysis were collected as both unfiltered and field filtered samples (i.e., for total and dissolved metals, respectively). Sufficient sample volume was not available during Phase I to collect samples for the complete Phase I Parameter List from locations T-36W, T-36S and T-37S. Due to the low-volume, these temporary wells were re-sampled during Phase II of the RFI. In addition, certain wells were re-sampled during Phase II to confirm the Phase I results. Data for ground water indicator parameters collected during Phase II are provided in Appendix A12.

- Unsaturated soil recovered during the installation of the ground water sampling points described above were field screened using an organic vapor analyzer (OVA) and examined for visual evidence of contamination. Soil samples were also collected from these perimeter ground water sampling locations where there was visual evidence of contamination or high organic vapor readings (i.e., greater than 50 ppm). Flame ionization detector (FID) readings were noted from 12-14 feet bgs at T-37S (681 ppm), and a sample was collected for laboratory analysis. All soil samples were analyzed for the Phase I Parameter List.

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[6] As indicated in Section 3.2.2 of the approved RFI Work Plan, sampling of existing monitoring wells coincided with ESOI's April 2002 RCRA ground water monitoring program sampling activities.

- The physical properties of the clay cover soil were characterized by installing one shallow boring on each side slope and one shallow boring per acre on top of the landfill. Soil borings were evenly distributed as best as possible within the limits of the landfill and drilled to a depth at which waste was first encountered. Samples of the clay cap were collected using a Shelby tube from 0 to 2 feet bgs and from 2 to 4 feet. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils.

- Surficial soils at areas of stressed vegetation were characterized by collecting a single surficial soil sample (0 to 0.5 feet bgs) from this location (SWMU1-1). Previously reported leachate staining in this area was not observed during the RFI Phase I. The soil samples were analyzed for the Phase I Parameter List and for Appendix IX dioxins and furans. Based on results from the initial sampling, iterative sampling was completed to further characterize the dioxin/furan impacts with for ecological screening purposes.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Dioxins/ Furans	Herb	Metals	PCBs	Pest	SVOCs	VOCs
Ground Water	DEEP TILL		5	6	5	5	5	5
Ground Water	SHALLOW TILL		5	5	5	5	5	9
Ground Water	WATER TABLE		1	2	2	2	2	4
Soil	NA	9	4	4	4	4	5	5

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.3 and 4.4. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B. A cross-section through this unit is provided on Figure 4.18a.

4.4.2 Discussion of Results

The concentrations of constituents detected in soil and ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 1. The results of the comparisons for soil and ground water are summarized on Tables 4.3 and 4.4, respectively.

Landfill Cover Assessment

The RFI data on physical properties are summarized in Table 4.1. The cover on SWMU 1 was found to range from 9 to 10 feet thick. Geotechnical data results and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 1 are acceptable. As described above, one area of the cap tends to accumulate stormwater as are result of grading to accommodate the overhead electric transmission lines. An assessment of the adequacy of the existing cover will be included in the CMS to be performed upon completion of the RFI.

Landfill Gas Assessment

Results of the explosive gas monitoring are summarized in Table 4.2. Explosive gas measurements from SWMU 1 did not exceed the screening level of 25% of the lower explosive limit; however OVA readings greater than 50 ppm were measured in the physical property borings for SWMU 1. In accordance with the facility's routine explosive gas monitoring program, no additional investigation is required since none of the sustained readings from the monitoring probes and punch bars exceeded the screening criteria. Further, given the thickness of the existing cap it is reasonably expected that the cap will mitigate any significant vapor migration. Therefore, no further investigation of organic vapor levels is warranted.

Soil Assessment

Results of the soil sampling are summarized in Table 4.3. No compounds were detected in SWMU 1 soil at concentrations above the generic screening criteria for the protection of human health. However, certain metals (cadmium, total cyanide, lead, selenium, and zinc), 4,4'-DDT and 2,3,7,8-TCDD equivalent along Gradel Ditch were identified above the ecological screening criteria. The soil data collected at this area are also summarized on Figure 4.5, which highlights concentrations exceeding the screening criteria.

Ground Water Assessment

As shown on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.12b, which highlight concentrations exceeding the screening criteria.

- Water Table

  Ground water in water table wells exceeded drinking water criteria for 1,2-dichloropropane, 1,4-dioxane, aldrin, alpha-BHC, total and dissolved arsenic and benzene at wells along the northern boundary of SWMU 1. Additionally, as this water table ground water is considered potentially relevant to ecological exposures via hypothetical discharges to Gradel Ditch, these data were also screened with ecological criteria. In addition to several of the above-listed constituents, several pesticides, and total and dissolved arsenic were also detected during at concentrations that exceeded human health-based water quality.

- Shallow Till

  In the shallow till wells, ground water concentrations exceeded the drinking water criteria for 1,4-dioxane, 1,2-dichloroethane, arsenic, chromium, lead and vanadium. However, chromium, lead and vanadium were not detected in dissolved (filtered) samples. In addition, several of the above-listed constituents, as well as vinyl chloride, total thallium and total and dissolved arsenic concentrations exceeded human health-based water quality.

- Deep Till

  Ground water in the deep till wells exceeded the drinking water criteria for total arsenic, lead and vanadium, and dissolved antimony.

- Bedrock

  Data from nearest bedrock wells do not indicate a release to the bedrock aquifer (i.e., all concentrations in the bedrock wells are below drinking water criteria).

No ground water concentrations from any saturated zone were higher than non-drinking water criteria (i.e., ground water contact or ground water vapor intrusion).

As shallow ground water is considered potentially relevant to ecological exposures via hypothetical discharges to Gradel Ditch, these data were also screened using ecological-based water quality criteria. The following constituents had concentrations detected in water table ground water during Phase II that exceeded ecological screening criteria (Region 5 ESLs for surface water, federal AWQC for freshwater or Ohio EPA criteria for protection of aquatic life in the Lake Erie drainage basin): ethyl benzene, aldrin, 4,4-DDE, endrin, heptachlor epoxide, total and dissolved cadmium, copper, nickel, and selenium, and total barium, lead, vanadium, and zinc. Additionally, concentrations of the following metals exceeded ecological screening criteria in shallow till zone wells: total and dissolved cadmium, copper, and selenium, and total barium, chromium, cobalt, lead, nickel, vanadium, and zinc.

4.4.3 Conclusions

RFI soil and ground water data from SWMU 1 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 1. In particular, as discussed in Section 3.3.2, releases of leachate into Gradel Ditch from the adjacent Gradel Landfill have been observed on a number of occasions, including during the visual inspection conducted as part of USEPA's RFA and during the implementation of the NSL RFI (MEC 1997).

In addition, shallow ground water has the potential to migrate into Gradel Ditch at concentrations above ecological criteria, and soil concentrations adjacent to Gradel Ditch exceed ecological criteria. Data from deep till wells also indicate concentrations above drinking water criteria, although there is no evidence of a release to the bedrock aquifer.

The concentrations of metals detected in soil at SWMU 1 are lower than the human health screening criteria and are consistent with naturally occurring background levels. No shallow ground water concentrations were identified at SWMU 1 that exceed non-drinking water criteria; therefore, the data indicate that ground water is not migrating off-site at concentrations that would be considered potentially significant for the known or likely human exposures to shallow ground water.

The RFI soil and ground water sampling has adequately characterized the extent of soil and ground water contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 1 is evaluated in Section 5 (baseline risk assessment) and Section 6 (screening level ecological risk assessment).

4.5 SWMU 5 – Millard Road Landfill

SWMU 5, the Millard Avenue Landfill, is a pre-RCRA unit that encompasses an area of approximately eight acres located northwest of the intersection of Otter Creek Road and Millard Avenue. It is bounded to the south by old Millard Avenue, to the west by Otter Creek, to the east by Otter Creek Road, and to the north by the ESOI fence and property line. The new Millard Avenue overpass is located north of this unit. It was operated from approximately 1976 to 1981 and was used primarily for disposal of construction and demolition material and solid waste. As stated in the DOCC, facility representatives indicated that the disposed material was principally debris from the demolition of an oil refinery. The in-place waste has an approximate waste thickness of 24 to 50 ft and the volume is reported to be approximately 224,600 cubic yards. Additional information on the construction and closure of the Millard Avenue Landfill is provided in Section 3.5 of the DOCC.

ESOI's monitoring and maintenance program for SWMU 5 is designed to maintain the integrity of the final cover and the function of the unit's monitoring systems. The landfill is equipped with a gas monitoring system and a leachate collection system (installed as part of ESOI's presumptive corrective action activities).

4.5.1 Scope and Results

The scope of the RFI field investigations at SWMU 5 involved collection of soil, sediment and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at SMWU 5. Leachate in SWMU 5 was also sampled and the physical properties (i.e., landfill cap, landfill gas, etc.) of the SWMU were also evaluated. The RFI sampling locations are depicted on Figure 3.1. Soil boring logs and field notes related to the RFI are provided in Appendix A. Figures 4.13 through 4.15 present the vertical profile of these constituent detections along the Facility property boundary. A cross-section of this unit is provided in Figure 4.18.

The following is a summary of the sampling activities conducted for each medium during the RFI at SWMU 5:

- The horizontal limits of waste were confirmed by installing one soil boring approximately every 100 linear feet on the west side of the landfill, and installing one soil boring approximately every 200 linear feet on the north, east and southwest sides of the landfill. Based upon this general spacing and field conditions, one fewer soil boring was installed along the south side of this landfill than proposed in the Approved RFI Work Plan. Each boring was located within 5 feet of the estimated limits of waste as defined based on the information obtained during the reconnaissance phase. If waste was encountered at any depth in the boring, the thickness of the waste was logged, the boring was abandoned, and a new boring was located 5 feet (or less) further away from the landfill. Each soil boring was drilled to a depth at which the upper till/lower till contact was encountered. Soil samples were collected at 0 to 0.5 feet bgs, 0 to 2 feet immediately above the first saturated zone, and at intermediate depths exhibiting the highest organic vapor reading, and/or exhibiting visual evidence of contamination. Samples were collected from intermediate depths at T-20S and T-21S based on visual evidence of black stained soils. All soil samples were analyzed for the Phase I Parameter List. One sample from location T-20S (selected based per OEPA request) was also analyzed for Appendix IX dioxins and furans. Additional soil samples were collected during Phase II for further evaluation of the stained soils identified along the western side of the landfill and to address OEPA request that 25% of Phase I samples be analyzed for confirmation purposes.

- The vertical limit of waste was estimated by installing one boring through the existing landfill cover. Based upon topography and the reconnaissance data, the boring was placed where the maximum depth of waste was expected to be encountered. The soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. A surface soil sample was also collected at 0 to 0.5 feet bgs. The thickness of accumulated leachate was measured and a sample of the liquid was collected. Soil and leachate samples were analyzed for the Phase I Parameter List.

- Ground water at the perimeter of the landfill was characterized during the implementation of the perimeter soil sampling activities described above (soil borings installed every 100 linear feet on the west side of the landfill, and every 200 linear feet on the north, east and southwest sides of the landfill) for confirmation of the horizontal limits of waste. Ground water encountered at the lacustrine/upper till and upper till/lower till contact zones in these borings was sampled using temporary wells, dedicated disposable bailers and/or a peristaltic pump, as appropriate. In addition, ground water samples were collected from the water table interface at all borings along the northern and western perimeter of the landfill where ground water was encountered and yield was sufficient to facilitate ground water sample collection. Due to the proximity of overhead electrical transmission wires parallel to Otter Creek Road, the drill rig was not able to set up on three soil boring locations along the east side of the landfill, therefore, ground water samples were collected only from the lacustrine/upper till contact zone at these locations. Additional permanent (bedrock monitoring well) and temporary monitoring wells were installed during Phase II activities and utilized to further evaluate ground water conditions at SMWU 5. Data for ground water indicator parameters collected during Phase II are provided in Appendix A.

- In addition to ground water sampling from the soil boring locations, intermediate ground water sampling points were installed every 40 linear feet along the western perimeter of the landfill between the soil borings described above. Ground water samples from these intermediate borings were collected from the water table interface where ground water was encountered and yield was sufficient to facilitate ground water sample collection. Unsaturated zone soils recovered from these intermediate borings were field screened for evidence of contamination. Soil samples were collected for Phase I Parameter List analysis at T-19S and T-45S due to visual evidence of contamination.

- Ground water samples were analyzed for the Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the QAPP (Section 4 of Appendix A of the RFI Work Plan). As discussed in the November 5, 2002 memorandum from MSG regarding Low Yielding Wells (provided in Appendix G), wells T-20W, T-20D, T-19W, T-22S, T-22W, T-23W, T-47W, T-46W, T-17S, and T-26S did not yield enough to obtain a complete sample set, and therefore had no sample or a reduced parameter list for ground water samples submitted for analysis. For wells with sufficient yield, samples for metals analysis were collected as both unfiltered and field filtered samples (i.e., for total and dissolved metals, respectively). Additional ground water samples were collected during Phase II for completeness from low yielding wells and to further evaluate ground water results for SMWU 5 identified during Phase I of the investigation.

- The physical properties of the clay cover soil were characterized by installing one shallow boring on each side slope and one shallow boring per acre on top of the landfill. Soil borings were evenly distributed within the limits of the landfill and drilled to a depth at which the waste was first encountered. Soil samples were collected using a Shelby tube from 0 to 2 feet bgs and 2 to 4 feet. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils.

- Sediments adjacent to the landfill were characterized by collecting a sediment sample from the runoff ditch at the end of the catch basin discharge pipe on the north and south sides of the landfill (Outfalls 009 and 011); at a point upstream of the discharge points; and at a location in the runoff ditch within 5 feet of the confluence of the ditch with Otter Creek. Sediment samples were collected from depths of 0 to 0.5 feet bgs and analyzed for the Phase I Parameter List. Additional sediment samples were collected during Phase II activities to further delineate and characterize sediments located in ditches adjacent to SWMU 5.

- The presence of explosive gas was evaluated by field screening during the completion of the borings installed during the confirmation of the vertical limits of waste and characterizing the physical properties of the soil cover (as described above). The existing explosive gas monitoring probes and punch bars were also screened for explosive gas in accordance with the facility's routine monitoring program and their *Explosive Gas Monitoring Plan*, dated September 1999 and Revised May 2002.

- The potential presence of Light Non-Aqueous Phase Liquid (LNAPL) was evaluated by field screening, including hydrophobic dye testing, during the completion of soil borings and temporary monitoring wells positioned along the western portion of SMUW 5.

The number of locations from which samples were collected during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins / Furans	Herb-icides	Metals	PCBs	Pest-icides	SVOCs	VOCs
Ground Water	BEDROCK	3		3	3	3	3	3	4
Ground Water	DEEP SAND[7]	2		2	2	2	2	2	2
Ground Water	DEEP TILL	15		15	16	15	15	15	16
Ground Water	SHALLOW TILL	21		18	19	19	19	16	21
Ground Water	WATER TABLE	9		3	5	5	3	6	12
NAPL	NA	1		1	1	1	1	1	1
Sediment	NA	14		8	10	11	8	16	15
Soil	NA	29	1	37	50	48	37	54	49

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

Summaries of the analytical data for each medium are shown in Tables 4.3 through 4.6 and Tables 4.7a, b and c. Leachate data for SWMU 5 is provided on Table 4.8. Where field duplicates were collected, the concentrations of an analyte for each duplicate pair have been averaged to provide a representative concentration for the analyte. The analytical data for all samples (including field QC samples) are provided in Appendix B.

4.5.2 Discussion of Results

The concentrations of constituents detected in soil, ground water and sediment were compared with the generic risk-based screening criteria discussed in Section 4.3to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 5. The results are summarized on Tables 4.1 through 4.5 and Tables 4.7a, b and c.

Landfill Cover Assessment

Results of the physical property sampling are summarized on Table 4.1. The cover on SWMU 5 was found to range from 6.5 to 17 feet thick. In addition, based on the Phase I reconnaissance and observations during subsequent phases of the RFI, the cap provides adequate drainage (no evidence of significant areas of ponding of stormwater). Geotechnical data results and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 5 are acceptable.

7 Although results for deep sand wells are presented separately in this section, the deep sand wells are considered to be associated with the deep till zone.

Landfill Gas Assessment

Results of the explosive gas monitoring are summarized in Table 4.2. Initial explosive gas measurements from monitoring probe 13 near SWMU 5 exceeded the relevant screening level of 25% of the lower explosive limit. OVA readings greater than 50 ppm were measured in the physical property borings for SWMU 5. In accordance with the facility's routine explosive gas monitoring program protocol, no additional investigation is required since none of the sustained explosive gas readings from the SWMU 5 exceeded the screening criteria. Further, given the thickness of the existing cap is reasonably expected to mitigate any significant vapor migration, no further investigation of organic vapor levels is warranted.

LNAPL Assessment

LNAPL and ground water elevation measurements from wells located at SWMU 5 are presented in Table 4.7b. Measurements during liquid gauging events checked for the presence of both light and dense separate phase liquids. Dense non-aqueous phase liquid (DNAPL) was not encountered at the Facility during the RFI activities. In addition, when LNAPL was identified during the RFI monitoring activities the material was removed using a disposable Teflon bailer and containerized for disposal. The characteristics of the LNAPL were analyzed (chemistry data are summarized in Table 4.7a), and the rate of recovery following sampling was monitored. As indicated on Table 4.7b, the rate of recovery was minimal during the RFI activities (i.e., approximately 70% of the LNAPL in T-20S(5) recovered after one month of monitoring). Physical properties of the LNAPL are provided in Table 4.7c. The limits of the LNAPL impacted soils along the west side of SWMU 5 identified during RFI activities are presented on Figure 4.1. As summarized and depicted on Figure 4.1, LNAPL and observations of soil staining identified during the RFI along the western portion of SWMU 5 are generally located within a peat layer encountered during drilling in this area and in the pore spaces in the soil layers present above and below the peat layer.

Soil Assessment

As shown on Table 4.3, soil concentrations exceeded certain human health screening criteria. The soil data collected at this area are also summarized on Figure 4.4, which highlights concentrations exceeding the screening criteria.

- Concentrations of certain polycyclic aromatic hydrocarbons (PAHs) and arsenic exceeded the site worker contact criteria were identified at certain locations at SWMU 5.
- One benzene concentration at T-27S exceeded the screening criteria for vapor intrusion from soil into a generic commercial/industrial building.
- Seven arsenic results and one lead result from the deepest sample in their respective boring, exceeded the soil migration to ground water criteria which are based on protection of drinking water uses. The highest concentrations of arsenic were detected within a peat layer encountered in the borings along the western side of this unit.

In addition, given the proximity of this unit to Otter Creek, soil sample results were also compared with ecological screening criteria. Concentrations of 4,4'-DDT, PCBs (total), arsenic, cadmium, lead, mercury, and zinc had concentrations higher than the ecological screening criteria from locations identified as being potentially significant for ecological exposures. These results are shown on Figure 4.4.

In addition, soil results at several locations exceed the saturation concentration. As described on Table 4.11a the physical descriptions of soils from these locations do not indicate that soils contained free product; however, staining was observed in certain locations.

<u>Ground Water Assessment</u>
As shown on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.12b, which highlight concentrations exceeding the screening criteria. A shallow ground water potentiometric surface map for the northwest portion of SWMU 5 is provided as Figure 4.19.

- <u>Water Table Wells</u>:
  Concentrations of benzene, 1,4-dioxane, total arsenic, total cadmium, total lead, dissolved arsenic and dissolved selenium in water table wells exceeded drinking water criteria. Additionally, as this water table ground water is considered potentially relevant to exposures via hypothetical discharges to Otter Creek, these data were also screened using human health-based water quality criteria. In addition to several of the above-listed constituents, bis(2-ethylhexyl)phthalate

and vinyl chloride were detected at concentrations that exceeded water quality criteria for the protection of human health.

- Shallow Till Wells:
    - Ground water concentrations of one VOC (1,4-dioxane) exceeded the drinking water criteria.

    - Bis(2-ethylhexyl)phthalate phthalate and n-nitrosodi-n-butylamine were detected above drinking water criteria. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect.

    - Total ground water results for antimony, arsenic, beryllium, cadmium, chromium, lead, selenium, thallium, and vanadium were detected above drinking water criteria. Dissolved results for arsenic and thallium also exceeded the drinking water criteria in certain samples.

    - Additionally, as this shallow till ground water is considered potentially relevant to exposures via hypothetical discharges to Otter Creek, these data were also screened using ambient water quality criteria. Concentrations of 1,4-dioxane, bis(2-ethylhexyl)phthalate, n-nitrosodi-n-butylamine, phenol, total and dissolved arsenic and thallium, and total cadmium, chromium, copper, led, nickel and selenium exceeded the water quality criteria for the protection of human health at locations adjacent to Otter Creek. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect.

- Deep Till Wells:
  Ground water concentrations of one VOC (1,4-dioxane) exceeded the drinking water criteria at deep till wells during Phase I. These results were not confirmed during Phase II resampling of these same locations. Total ground water results for antimony, arsenic, chromium, lead and vanadium were above drinking water criteria. Dissolved results for antimony, arsenic and lead also exceeded the drinking water criteria in certain samples.

- Bedrock Wells:
  Bedrock monitoring well sampling did not detect any Phase I Parameter List constituent at concentrations able applicable screening criteria.

As shallow ground water (water table and shallow till) is considered potentially relevant to ecological exposures via hypothetical discharges to Otter Creek, these data were also screened using ecological-based water quality criteria. The following constituents had concentrations detected in water table ground water samples that exceeded ecological screening criteria (Region 5 ESLs for surface water, federal AWQC for freshwater or Ohio EPA criteria for protection of aquatic life in the Lake Erie drainage basin): bis(2-ethylhexyl)phthalate during Phase I and total barium, cadmium, copper, cyanide, lead, nickel, selenium, vanadium, and zinc, and dissolved selenium. Additionally, concentrations of the following metals exceeded ecological screening criteria in shallow till zone wells: bis(2-ethylhexyl)phthalate, phenanthrene, total and dissolved barium, nickel, selenium, and thallium and total arsenic, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, mercury, vanadium, and zinc in shallow till ground water.

In addition, the bis(2-ethylhexyl)phthalate concentration from MR-6S (formerly T-20S) exceeds the solubility limit. As described in Table 4.11b, the physical description of this location does not indicate that ground water contained free product at the time of drilling; however, LNAPL was later observed at this location.

Sediment Assessment

Concentrations of the following constituents in sediment samples collected from the ditches on the north and south side of SWMU 5 exceeded one or more of the screening criteria for evaluating potential ecological exposures to sediment. The sediment data collected in this area are also summarized on Table 4.5 and Figure 4.16, which highlights concentrations exceeding the screening criteria. Only arsenic (SED 06) and benzo(a)pyrene (SED 05) concentrations exceeded human health screening criteria.

- North Ditch
  - One VOC (acetonitrile) exceeded ecological screening criteria at several locations.
  - 4,4'-DDD exceeded the ecological screening criteria at one location.

  - The following metals exceeded the ecological criteria: arsenic, lead, mercury, and nickel.

- South Ditch
  - Two VOCs (acetone and acetonitrile) exceeded ecological screening criteria at several locations during Phase I.
  - The following SVOCs exceeded ecological screening criteria one or more locations during Phase I and/or Phase II: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrelene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene.
  - PCBs, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT exceeded the ecological screening criteria at two locations.
  - One or more of following metals also exceeded the ecological criteria in the three south ditch samples: arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, and zinc.

Sediment data collected along Otter Creek (west of SWMU 5) are discussed in Section 4.16.

4.5.3 Conclusions

RFI soil, ground water and sediment data collected adjacent to SWMU 5 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 5. In addition, if ground water were to migrate into the adjacent Otter Creek, it could do so at potentially significant concentrations. In addition, data from deep till wells indicate concentrations above drinking water criteria, although there is no evidence of release to the bedrock aquifer. Ditch sediments also indicated the presence of hazardous constituents at concentrations of potential concern, although there was no evidence of discharge from the unit; given the type of constituents found in the ditches (i.e., primarily PAHs and/or metals) the presence of these constituents could be the result of a release at this unit or runoff from the adjacent roadways.

The RFI sampling has adequately characterized the extent of soil, sediment and ground water contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 5 is evaluated in Section 5 (baseline risk assessment) and Section 6 (screening level ecological risk assessment).

4.6 SWMU 6 – Northern Sanitary Landfill

SWMU 6, the Northern Sanitary Landfill (NSL), is a pre-RCRA unit that encompasses an area of approximately six and one-half acres and is located in the northern portion of the Facility. It is bounded on the west by SWMU 1, the south by SWMU 7, the east by a farm field owned by First Energy Corporation, and the north by Gradel Ditch and the Gradel Landfill, owned by Commercial Oil Services, Inc. The NSL was operated from 1976 through 1981 for disposal of solid waste. Additional information on the construction and closure of the Northern Sanitary Landfill is provided in Section 3.6 of the DOCC. A cross-section of this unit is provided in Figures 4.18a and 4.18b.

ESOI's monitoring and maintenance program for SWMU 6 is designed to maintain the integrity of the final cover and the function of the unit's monitoring systems. The landfill is equipped with a gas monitoring system and a leachate collection system (installed as part of ESOI's presumptive corrective action activities).

4.6.1 Scope and Results

The scope of the RFI field investigations at SWMU 6 involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at SMWU 6. Leachate in SWMU 6 was also sampled and the physical properties (i.e., landfill cap, landfill gas, etc.) of the SWMU were also evaluated. The RFI sampling locations are depicted on Figure 3.1. Soil boring logs and field notes related to the site wide RFI are provided in Appendix A; logs from the NSL RFI are provided in the *Draft Final RFI Report, Northern Sanitary Landfill* (MEC 1997) and the *Second Draft Final RFI Report, Northern Sanitary Landfill* (MEC 1998).

The following is a summary of the sampling activities conducted for each medium during the RFI at SWMU 6.

- In May, October and November 1995, ESOI drilled soil borings and collected subsurface soil samples at selected locations along the Facility's northern property boundary to determine the extent of solid waste in the vicinity of the NSL. The soils borings were drilled along five north-south traverses (i.e., rows of borings perpendicular to the northern property line) designated as QD-1 through QD-5, with QD-1 being the easternmost traverse and QD-5 the westernmost traverse. Soil borings were installed in a northerly direction until the soil borings did not indicate the presence of any solid waste materials or any oil stained soils. After delineating the extent of solid waste at each of the five traverses (QD-1 through QD-5), soil borings were installed 5 feet beyond the northernmost limit of the solid waste materials in each traverse for collection of subsurface soil samples. At each of these boring locations, one soil sample was collected from the boring and analyzed for parameters including: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, cyanide, total phenolics, pesticides, herbicides and PCBs.

- Upon delineating the northernmost extent of solid waste along any of the soil boring traverses, two monitoring wells were installed 5 feet north of the solid waste findings along each traverse; one monitoring well was screened at the contact between the lacustrine and the upper till, and the second was screened at the contact between the upper till and the lower till. The well designations corresponding to the five boring traverses are QD-1S (well) through QD-5S (well) for the shallow monitoring wells (contact between lacustrine and upper till), and QD-1D (well) through QD-5D (well) or the deep monitoring wells (contact between upper till and lower till). At one location, the boring traverse at QD-3, a third monitoring well (QD-3R) was installed which was screened within the underlying bedrock aquifer. The monitoring wells were sampled and analyzed in December 1995 and July 1996. Ground water samples were collected from these monitoring wells and were analyzed for VOCs, SVOCs, metals, cyanide, phenols, pesticides, herbicides and PCBs.

- Based on the findings of the initial RFI activities conducted in 1995, USEPA required ESOI to conduct a supplemental investigation of soil and ground water along the northern and eastern boundaries of the NSL. This work was conducted in October 1996 through March 1997. In general, these field activities included the installation of soil borings and the collection of soil samples using the GeoProbe direct-push sampling method and the installation of piezometers.

For the purpose of the Supplemental RFI, soil borings along ESOI's eastern property line were designated with the prefix "QE" and a number designating the distance south from the northeast property corner. The collected soils samples were field screened and field analyzed to aid in sample selection. Initially, soil samples were evaluated based on the presence or absence of solid waste materials. If waste materials were encountered, then an additional soil boring was drilled five feet beyond the original boring. However, if no waste material was encountered, then the soil samples from the boring were screened with a photoionization detector (PID) or flame ionization detector (FID) and the depth interval with the highest PID or FID reading was selected for analysis in the field for Total Petroleum Hydrocarbons (TPH), PAHs and PCBs using immunoassay field test kits. If no elevated readings were detected with the PID or FID, then a sample depth interval for immunoassay field testing was selected based on visual identification of suspect areas or areas of saturated soils. If constituents were detected using the immunoassay test kits, then an additional soil boring was required to be drilled five feet beyond the original boring and the entire process was repeated. If no constituents were detected using the immunoassay field test kits then the samples were analyzed for gasoline range organic compounds (GRO) using a field gas chromatograph (GC). If the GRO analysis was positive, then an additional soil boring was required to be drilled five feet beyond the boring and the entire process was repeated. If, however, the GRO field screening was negative, a sample was selected and analyzed for VOCs, SVOCs, PAHs, PCBs, 1,4-dioxane, Diesel Range Organics (DRO), and pentachlorophenol (PCP) analyses.

In addition to the samples required by USEPA's field screening criteria, ESOI collected and analyzed additional soils samples. These samples were selected in areas where ESOI considered additional investigation to be warranted to evaluate the presence/absence of constituents on a 3-dimensional basis. The additional samples were collected from areas where the field immunoassay test kit or field GC indicated organic constituents to be present but the drilling of the five foot "stepped out" boring was delayed due to access difficulties or delays in access authorization for the adjacent properties.

In addition to the installation of the GeoProbe soil borings, 34 piezometers were installed into the lacustrine water bearing zone; the locations of the piezometers were spaced to provide coverage along the NSL's northern and eastern property lines, and on the south slope of the Gradel Landfill. Ground water samples collected from the piezometers were analyzed for PCBs, PCP, PAHs, DRO, VOCs, SVOCs, and 1,4 dioxane.

- The physical properties of the clay cover soil were characterized by installing one shallow boring on each side slope and one shallow boring per acre on top of the landfill. Soil borings were evenly distributed within the limits of the landfill and drilled to a depth at which the waste was first encountered. Soil samples were collected using a Shelby tube from 0 to 2 feet bgs and 2 to 4 feet. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils. Data collected during Phase I indicated that portions of the SWMU 6 cover are at least 2-feet thick. In addition, as part of corrective measures design field activities, vehicle traffic in the northeastern portion of this unit may have compacted the cover soil to less than the 2-feet (the minimum thickness identified in the approved RFI Work Plan). Additional soil borings were completed during Phase II activities to evaluate the clay cap thickness in the area compacted by vehicles and where potential leachate seepage was observed.

- During Phase I of the RFI, the vertical limits of waste were confirmed by installing one boring through the existing landfill cover. Based upon topography and the reconnaissance data, the boring was placed where the maximum depth of waste was anticipated to be encountered. The soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. A surface soil sample was collected from 0 to 0.5 feet bgs. The thickness of accumulated leachate was measured and a sample of the liquid was collected. The soil and leachate samples were analyzed for the Phase I Parameter List.

- Ground water at the perimeter of the landfill was further characterized during Phase I and Phase II of the site-wide RFI by collecting samples from the lacustrine/upper till and upper till/lower till contact zones using temporary wells, dedicated disposable bailers and/or a peristaltic pump, as appropriate. One lacustrine/upper till sampling location was placed midway between monitoring wells SW-1S and F-2S, and two lacustrine/upper till and upper till/lower till locations were spaced between SW-2S and SW-3S. Ground water samples from the shallow till ground water were also collected from the temporary sampling locations which border the Gradel Ditch.

Ground water samples were also collected from existing wells H-2S, H-2D, SW-1S, SW-2S, SW-2D, SW-3S, and SW-3D. Ground water samples were analyzed for the Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the RFI QAPP. For wells with sufficient yield, samples for metals analysis were collected as both unfiltered and field filtered samples (i.e., for total and dissolved metals, respectively). Wells T-2S, T-3S, and T-8D did not yield enough to obtain a complete sample, and therefore had a reduced parameter list for ground water samples submitted for analysis. During the Phase II activities one lacustrine/upper till contact zone temporary well (T-1S) was abandoned and replaced with a permanent monitoring well (SW-4S) and one upper till/lower till contact zone temporary well (T-1D) was upgraded to a permanent monitoring well and redesignated (SW-4D). In addition one bedrock monitoring well (R-24) was installed adjacent to the SW3-S/D well cluster. Additional temporary monitoring wells were proposed east of SMWU 6 on the First Energy property; however, permission was not granted for off-site sampling. Subsequent ground water samples were collected during Phase II to confirm previous RFI sampling results. Data on ground water indicator parameters collected during Phase II are provided in Appendix A.

- The presence of explosive gas was evaluated by field screening during the implementation of the borings installed during characterization of the physical properties of the soil cover and the confirmation of the vertical limits of waste (as described above). The existing explosive gas monitoring probes and punch bars were also screened for explosive gas in accordance with the facility's routine monitoring program and their *Explosive Gas Monitoring Plan*, dated September 1999 and Revised May 2002.

  The soil borings drilled during the Initial RFI and Supplemental NSL RFI encountered limited amounts of solid waste, as defined in the RFI Work Plan, in a localized area along the northern property line. The extent of this material was delineated during this investigation using a conservative assumption regarding the aerial extent of waste materials when defining the extent of solid waste. Generally, the finding of solid waste beyond the northern property line was limited to the area less than 10 feet from the property line (see Figure 3.1). The thickness of the solid waste material encountered varied but where encountered was less than 2 feet. The finding of solid waste did not extend north to the Gradel Ditch. Based on the locations of this material, and the reported operational landfilling procedures, it is likely that these materials are a result of the Northern Sanitary Landfill operations.

Solid waste was encountered at thicknesses of at least 4 to 10 feet in every soil boring installed on the south slope of the Gradel Landfill with the exception of GR9. The locations of these "Gradel" soil borings were less than ten feet north of the Gradel Ditch. However, the southern extent of this material was not determined during this investigation. Based on the thickness of the solid waste materials encountered in the "Gradel" borings and their proximity to the Gradel Ditch, it is suspected that the solid waste materials from the Gradel Landfill extends, at a minimum, to the Gradel Ditch.

No finding of solid waste was noted in any of the soil borings drilled along the eastern property line. Road base materials, however, were noted in the soil borings installed inside the eastern property line. The thickness of these road base materials varied but was generally 4 to 6 feet.

The number of locations from which samples were collected for each medium during Phase I and Phase II of the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins / Furans	Herb-icides	Metals	PCBs	Pest-icides	SVOCs	VOCs
Ground Water	BEDROCK	1		1	1	1	1	1	1
Ground Water	DEEP TILL	9		9	10	9	9	10	10
Ground Water	SHALLOW TILL	10		10	12	9	9	12	12
Soil	N	2	1	4	4	4	4	4	7

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is provided on Tables 4.1 through 4.4. Leachate data for SWMU 6 is provided on Table 4.8. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all Phase I and Phase II RFI samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.6.2 Discussion of Results

The concentrations of constituents detected in soil from the NSL RFI and soil and ground water during the site-wide RFI were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 6. The results are summarized on Tables 4.3 and 4.4. Soil boring logs and field notes related to the RFI are provided in Appendix A.

<u>Landfill Cover Assessment</u>

Results of the physical property sampling are summarized in Table 4.1. The cover on SWMU 6 was found to range from 2 to 7 feet thick. Geotechnical data results and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 6 are acceptable, with the exception of the northeast corner of SWMU 6 where the cap thickness was less than 2 feet and stormwater/leachate was observed and landfill gas was noted bubbling through a crack in the cover soil. The northeast corner of the cap was repaired on March 23, 2007 to mitigate the seepage and repair damage caused by vehicles during the corrective measures field activities. Periodic monitoring occurs to ensure the cap continues to remain intact. In addition, leachate recovery operations with gas venting began in July 2007 which will reduce the potential for future occurrences. Other than the northeast corner of the landfill, based on the Phase I reconnaissance and observations during subsequent phases of the RFI, the cap provides adequate drainage (no evidence of significant areas of ponding of stormwater).

In addition, as shown in the cross section on Figure 4.18b, while a less permeable subsurface separation exists between SWMU 6, 7 and 9, waste material was encountered within those separations. Therefore, additional physical property samples were collected from locations along the access roads to ensure that the soil cover in areas between the originally designated unit boundaries is sufficient across this entire area. These data are discussed in Section 4.7.2.

<u>Landfill Gas Assessment</u>

Results of the explosive gas monitoring are summarized on Table 4.2. Initial explosive gas measurements from Punch Bar (PB) 3 associated with SWMU 6 exceeded the relevant screening level of 25% of the lower explosive limit. In addition, as shown on

Table 4.2, the sustained reading at PB 3 in March 2002 exceeded the screening level; however subsequent monthly sustained readings from PB 3 have not exceeded the screening level. OVA readings greater than 50 ppm were measured in the physical property borings (through the cap) in SWMU 6. In accordance with the facility's routine explosive gas monitoring program, no additional investigation is required since none of the sustained readings measured over several events from the monitoring probes and punch bars exceeded the screening criteria. Further, given the thickness of the existing cap is reasonably expected to mitigate any significant vapor migration, no further investigation of organic vapor levels is warranted.

<u>Soil Assessment</u>

As shown on Table 4.3, benzo(a)pyrene was detected above the routine worker soil contact criterion in subsurface samples at two locations and dibenz(a,h)anthracene was detected above routine worker contact criterion at one location. The soil data collected in this area are also summarized on Figure 4.5.

<u>Ground Water Assessment</u>

As shown on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected in this area are also summarized on Figures 4.10a through 4.12b, which highlights concentrations exceeding the screening criteria. Figures 4.14 and 4.15 present the vertical profile of these constituent detections along the Facility property boundary.

- <u>Shallow Till</u>:
  - The extent of constituents that exceeded the NSL RFI objectives in the ground water on the Gradel property has not been delineated during this investigation. In general, the concentrations and number of constituents that exceed NSL RFI data objectives are greater on the Gradel Landfill than adjacent to the Northern Sanitary Landfill. Every ground water sample in the Gradel Landfill contained exceedances of the respective objectives for benzene and 1,4-dioxane and many contained exceedances for 1,1-dichlorobenzene, phthalates, PAHs or BTEX compounds (MEC 1997, 1998). Also, it was noted that piezometer GR-1 on the Gradel Landfill had a flowing artesian potentiometric water level of 587.28 when installed. This elevation is above surrounding ground level and demonstrates the driving force behind

leachate seeps which have been documented discharging from the Gradel Landfill.

- o Ground water concentrations of two VOCs (acrylonitrile and 1,4-dioxane) exceeded the drinking water criteria at certain shallow till wells at SWMU 6. The acrylonitrile result was from a Phase I sample at T-1S; this detection was not confirmed during Phase II.

- o Two SVOCs (n-nitrosodi-n-butylamine and pyridine) were detected in ground water at T-1S during Phase I above screening criteria. However, these concentrations were not confirmed in ground water during Phase II sampling of the same location. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect.

- o Concentrations of total antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, thallium, and vanadium were higher than the drinking water criteria in certain shallow till wells. Chromium also exceed the maintenance worker contact criterion, however, this concentration was not confirmed during Phase II sampling. Dissolved arsenic concentrations from Phase I samples also exceeded the drinking water criteria for arsenic, however, these concentrations were not confirmed during Phase II sampling.

- o Concentrations of 1,4-dioxane, total and dissolved arsenic and nickel, and total antimony, barium, beryllium, cadmium, chromium, copper, lead, mercury and thallium exceeded human health based water quality criteria at locations near the Gradel Ditch.

- <u>Deep Till</u>:
  Ground water concentrations of 1,4-dioxane and bis(2-ethylhexyl)phthalate exceeded the drinking water criteria at certain deep till wells at SWMU 6. However, the bis(2-ethylhexyl)phthalate concentration was not confirmed during Phase II sampling. Total ground water results from deep till wells sampled during Phase I for antimony, arsenic, beryllium, chromium, cyanide (total), lead, thallium, and vanadium were higher than drinking water criteria. Dissolved ground water results from deep till wells sampled during Phase I for antimony

and arsenic were higher than drinking water criteria. However, the metals concentrations in deep till ground water were not confirmed during the Phase II sampling.

- Bedrock Wells:
  Bedrock monitoring well sampling did not detect any Phase I Parameter List constituent at concentrations able applicable screening criteria.

Additionally, total and dissolved chromium, nickel and selenium, and total arsenic, barium, beryllium, cadmium, cobalt, copper, lead, mercury, thallium, vanadium and zinc exceeded surface water criteria for ecological receptors in the shallow till ground water at SWMU 6 wells located along Gradel Ditch.

4.6.3 Conclusions

RFI ground water data collected adjacent to SWMU 6 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 6. In particular, as discussed in Section 3.3.2, releases of leachate into Gradel Ditch from the adjacent Gradel Landfill have been observed on a number of occasions, including during the visual inspection conducted as part of USEPA's RFA and during the implementation of the NSL RFI (MEC 1997).

There is also a potential for ground water along the north side of the SWMU 6 to migrate into the adjacent Gradel Ditch at potentially significant concentrations, if shallow ground water levels reach the base of the ditch. In addition, data from deep till wells indicate concentrations above drinking water criteria, although there is no evidence of a release to the bedrock aquifer. No shallow ground water concentrations were confirmed during the site-wide RFI at SWMU 6 that exceed non-drinking water criteria; therefore, the data do not indicate that ground water is migrating off-site at concentrations that would be considered potentially significant for the known or likely human exposures to ground water.

The RFI soil and ground water sampling has adequately characterized the extent of soil and ground water contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 6 is evaluated in Section 5 (baseline risk assessment) and Section 6 (screening level ecological risk assessment).

4.7 SWMU 7 – Central Sanitary Landfill

SWMU 7, the Central Sanitary Landfill (CSL), is a pre-RCRA unit that encompasses an area of approximately seven acres and is located in the north central portion of the Facility. This SWMU is bounded to the north by SWMU 6, the east by SWMU 3, the south by SWMU 9 and the west by SWMU 2. SWMU 7 was the first major cell which received solid waste at the Facility and historical data indicate that this landfill was operated from 1969 to 1983. Additional information on the construction and closure of the Central Sanitary Landfill is provided in Section 3.7 of the DOCC. A cross-section of this unit is provided in Figure 4.18b.

ESOI's monitoring and maintenance program for SWMU 7 is designed to maintain the integrity of the final cover and the function of the unit's monitoring systems. The landfill is equipped with a gas monitoring system and a leachate collection system (installed as part of ESOI's presumptive corrective action activities).

4.7.1 Scope and Results

The scope of the RFI field investigations at SWMU 7 involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at SMWU 7. Leachate in SWMU 7 was also sampled and the physical properties (i.e., landfill cap, landfill gas, etc.) of the SWMU were evaluated. The RFI sampling locations are shown on Figure 3.1. Soil boring logs and field notes related to the RFI are provided in Appendix A.

The following is a summary of the sampling activities conducted for each medium during the RFI at SWMU 7:

- The horizontal limits of waste were confirmed by installing one soil boring approximately every 200 linear feet along the perimeter of the landfill. Selection of boring locations was coordinated with investigation of SWMU 9 (see Investigation Area B, Section 4.15). Each boring was located within 5 feet of the estimated limits of waste based on the information obtained during the reconnaissance stage of Phase I. If waste was encountered at any depth in the boring, the thickness of the waste was logged, the boring was abandoned, and a new boring was located 5 feet (or less) away from the landfill. Each soil boring was drilled to a depth at which the upper till/lower till contact was encountered. Soil samples were collected from 0 to 0.5 feet bgs, 0 to 2 feet immediately above the first saturated zone, and at intermediate depths exhibiting the highest organic vapor reading and/or exhibiting visual evidence of contamination. Samples were collected from intermediate depths at T-8S, S7-7 and S7-9 based on visual evidence of discolored soils. All soil samples were analyzed for the Phase I Parameter List. One soil sample (selected based on field screening or visual evidence of contamination) was also analyzed for dioxins and furans. Two locations were targeted for sampling during the Phase II sampling activities for completeness and delineation purposes.

- The vertical limit of waste was estimated by installing one boring through the existing landfill cover. Based upon topography and the reconnaissance data, the boring was placed where the maximum depth of waste was anticipated to be encountered. The soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. A surface soil sample was collected from 0 to 0.5 feet bgs. The thickness of accumulated leachate was measured and a sample of the liquid was collected. Soil and leachate samples were analyzed for the Phase I Parameter List.

- Ground water at the perimeter of the landfill was characterized by collecting samples from the lacustrine/upper till and upper till/lower till contact zones using a temporary wells installed during the implementation of the perimeter soil sampling activities for the confirmation of the horizontal extent of waste (as described above). Ground water samples were also collected from the existing shallow till monitoring well H-1S, from deep monitoring well G-10A, and from two new wells (designated as H-7S and H-8S) installed approximately 100-feet west and east of well H-1S, respectively, and screened across the lacustrine/upper till contact zone. Ground water samples were analyzed for the Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the RFI QAPP. For wells with sufficient yield, samples for metals analysis were collected as both total and dissolved samples. Wells T-5S, T-11S, and T-8D did not yield enough to obtain a complete sample set, and therefore had a reduced parameter list for ground water samples submitted for analysis. One additional temporary well was installed in the northwest portion of the SWMU for delineation purposes. Additional ground water samples were collected from certain monitoring wells during Phase II for completeness, confirmation, and delineation purposes. Data for ground water indicator parameters collected during Phase II are provided in Appendix A.

Unsaturated zone soils recovered during the installation of ground water sampling points associated with well H-1S were field screened and examined for evidence of contamination. No soil samples were collected from these borings (i.e., no visual indictors of contamination were noted and no OVA readings exceeded 50 ppm).

- The physical properties of the clay cover soil were characterized by installing one shallow boring on each side slope and one shallow boring per acre on top of the landfill. Soil borings were evenly distributed within the limits of the landfill and drilled to a depth at which the waste was first encountered. Soil samples were collected using a Shelby tube from 0 to 2 feet bgs and 2 to 4 feet. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils. One Shelby tube sample from this SWMU [i.e., STS7-3 (2-4 feet)] was remolded according to ASTM D-5084 - Section 8.3, prior to hydraulic conductivity testing. Based on the results of Phase I, additional landfill cover samples were collected during Phase II from borings within the access roads bordering the unit. Borings were evaluated to determine landfill cover thickness and permeability.

- The presence of explosive gas was evaluated by field screening during the implementation of the borings installed during confirmation of the vertical limits of waste and characterization of the cover soil (as described above).

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/ Furans	Herb	Metals	PCBs	Pest	SVOCs	VOCs
Ground Water	DEEP SAND[8]	1		1	1	1	1	1	1
Ground Water	DEEP TILL	8		7	8	8	8	9	8
Ground Water	SHALLOW TILL	10		8	11	9	8	12	14
Soil	NA	13	6	27	29	27	27	31	36

[8] Although the results for deep sand wells are presented separately in this section, the deep sand wells are considered to be associated with the deep till zone.

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is presented on Tables 4.1 through 4.4. Leachate data for SWMU 7 is provided on Table 4.8. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.7.2 Discussion of Results

The concentrations of constituents detected in soil and ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 7. The results are summarized in Tables 4.3 and 4.4.

Landfill Cover Assessment

Results of the physical property sampling are summarized in Table 4.1. Cover soils were found to range from 3.6 to 7.8 feet thick on SWMU 7. Geotechnical data and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 7 and the roadway cover soils are acceptable, with the exception of the roadway cover sample collected from S7-202. The hydraulic conductivity at S7-202 from 4 to 6 feet bgs (7.10×10^{-5} cm/sec) is greater than the requirement 10^{-5} cm/s specified in the RFI Work Plan, although the cap at this location is 10.5 feet thick. In addition, it was noted that this sample contained gravel that had been placed for the roadway, and the mixing of road gravel with the clay cover soil may have contributed to this higher conductivity. It was also reported that the sample collected from location STS 7-3, 2-4 was remolded for conductivity testing, resulting in potentially uncertainty with these results. However, the cap thickness at this location is approximately 7 feet, and the hydraulic conductivity for the sample collected from 0-2 feet at this location was acceptable. Further, based on the Phase I reconnaissance and observations during subsequent phases of the RFI, the cap provides adequate drainage (no evidence of significant areas of ponding of stormwater)

Landfill Gas Assessment

Results of the explosive gas monitoring are summarized in Table 4.2. Explosive gas measurements from the physical property borings for SWMU 7 were all below 25 % LEL, however, the OVA screening level of 50 ppm was exceeded. Given the thickness of the existing cap is reasonably expected to mitigate any significant vapor migration; no further investigation of organic vapor levels is warranted.

Soil Assessment

As summarized on Table 4.3, no constituent concentrations in soil exceeded the routine site worker contact criteria. The vinyl chloride concentration in the 12-14 ft bgs soil sample at S9-14 exceeded criteria for volatilization into a generic commercial/industrial building. It should be noted that there are no buildings at or near SWMU 7. Additionally, concentrations of arsenic, chromium, selenium, and cyanide (total) exceeded the soil migration to ground water criteria at certain locations, in the deepest sample at each of their respective locations. The soil data collected at this area are also summarized on Figure 4.7, which highlights concentrations exceeding the screening criteria.

In addition, the indeno(1,2,3-cd)pyrene concentration from T-10S exceeds the saturation limits. As described in Table 4.11a, the physical descriptions of this location do not indicate that free product or staining is present.

Ground Water Assessment

As summarized on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.12b, which highlight concentrations exceeding the screening criteria.

- Shallow Till:
  Ground water concentrations for two VOCs (benzene and 1,4-dioxane) exceeded the drinking water criteria at certain shallow till wells around SWMU 7. Two SVOCs (n-nitrosodi-n-butylamine and nitrobenzene) were detected at concentrations exceeding the drinking water criteria in ground water during Phase I. Additionally, n-nitrosodi-n-butylamine at T-11S exceeded the ground water volatilization to indoor air criteria for generic commercial/industrial buildings. However, the concentrations of the SVOCs were not confirmed

during Phase II sampling of the same locations. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect. Concentrations of total antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, thallium, and vanadium were higher than drinking water criteria. Dissolved concentrations also exceeded the drinking water criteria for arsenic, thallium and selenium at certain wells.

- Deep Till:
  Ground water concentrations of total antimony, arsenic, barium, beryllium, chromium, lead, nickel, selenium, thallium and vanadium in deep till wells sampled during Phase I at SWMU 7 were higher than drinking water criteria. Dissolved antimony and arsenic concentrations also exceeded the drinking water criteria in deep till wells during Phase I. However, the total and dissolved metals concentrations from the deep till wells at SWMU 7 were not confirmed during Phase II.

4.7.3 Conclusions

RFI soil and ground water data from SWMU 7 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 7. No shallow ground water concentrations were confirmed at SWMU 7 that exceed non-drinking water criteria; therefore, the data do not indicate that ground water is migrating off-site at concentrations that would be considered potentially significant for the known or likely human exposures to ground water. In addition, data from deep till wells indicate concentrations above drinking water criteria, although there is no evidence of release to the bedrock aquifer.

The RFI soil and ground water sampling has adequately characterized the extent of soil and ground water contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 7 is evaluated in Section 5 (baseline risk assessment).

4.8 SWMU 10 – Ash Disposal Area

SWMU 10, Ash Disposal Area, is an unregulated unit that encompasses an area of approximately three acres and is located on the western side of the Facility. This SWMU is bounded to the south by AOC 2 and the west by Otter Creek Road. During the late 1960's and through the 1970's, SWMU 11 - Teepee Burner (see Section 4.9) was operated for burning selected solid waste (dry combustible material) and some liquid waste. SWMU 10, which overlaps with Cell G (SWMU 2) comprised a borrow pit that was used during the 1950's, 1960's and early 1970's as a source of soil for surrounding port development and highway construction, was used to dispose of the ash generated from SWMU 11.

Ash materials were removed from this SWMU in 1988 in preparation for the construction of Cell G (SWMU 2). During this work, the ash material was encountered at approximately 3 feet below the original surface and extended to a depth of approximately 17 feet in some areas. Approximately 123,000 cubic yards of ash material were excavated during construction of Cell G. All the ash that encountered the footprint of Cell G was removed; other areas of ash disposal were not removed. Additional information on the construction and closure of SWMU 10 is provided in Section 3.10 of the DOCC.

4.8.1 Scope and Results

The scope of the RFI field investigations at SWMU 10 involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at SMWU 10. Leachate in SWMU 10 was also sampled and the physical properties (i.e., landfill cap, landfill gas, etc.) of the SWMU were also evaluated. The RFI sampling locations are depicted on Figure 3.1. Soil boring logs and field notes related to the RFI are, provided in Appendix A.

The following is a summary of the sampling activities conducted for each medium during the RFI at SWMU 10:

- The horizontal limits of waste were confirmed by installing one boring every 200 feet along the outer perimeter of the estimated limits of waste placement (outside the footprint of Cell G and outside the sheet pile wall). Each boring was located within 5 feet of the estimated limits of waste as defined based on the information obtained during the reconnaissance phase. If waste was encountered at any depth in the boring, the thickness of the waste was logged, the boring was abandoned, and a new boring was located 5 feet, or less, away from the ash disposal area. In no case were the boring locations extended inside the monitoring trenches along the Toledo water lines (AOC 1). Each soil boring was drilled to a depth at which the lacustrine/upper till contact was encountered. Soil samples were collected from 0 to 0.5 feet bgs, 0 to 2 feet immediately above the first saturated zone, and at intermediate depths exhibiting the highest organic vapor reading, and/or exhibiting visual evidence of contamination. Samples were collected from intermediate depths at S10-40, T-44S, T-57S, T-58S, and T-60S based on visual evidence of stained soils. Soil samples were analyzed for the Phase I Parameter List and Appendix IX dioxins and furans. Three additional soil borings were conducted during Phase II activities to delineate arsenic concentrations identified at T-60S.

- The vertical limits of waste were confirmed by installing borings within the estimated limits of SWMU 10. Borings were installed between the limits of Cell G and the retention pond, between the retention pond and the truck scale (AOC 2), and on the west side of the sheet pile wall west of the retention pond (near monitoring well G-2S). Each soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. Soil samples were collected from 0 to 0.5 feet bgs and 2 to 4 feet beneath the visible limits of waste. Water/leachate was encountered within the ash area during installation of the boring S10-03, and a sample of the water was collected. Soil and water samples were analyzed for the Phase I Parameter List. Soil samples were also analyzed for Appendix IX dioxins and furans.

- Ground water at the perimeter of the unit was characterized during the implementation of the perimeter soil sampling (as described above). Ground water encountered at the lacustrine/upper till contact zone was sampled using a temporary well and dedicated disposable bailers and/or a peristaltic pump, as appropriate. Ground water samples were collected from the existing shallow till monitoring wells located adjacent to the unit. Ground water samples were analyzed for the Phase I Parameter List. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the RFI QAPP. For wells with sufficient yield, samples for metals analysis were collected as both total and dissolved metals. The following wells did not yield enough to obtain a complete sample set at T-57S and T-58S, and therefore had a reduced parameter list for ground water samples submitted for analysis. Additional ground water samples were collected during Phase II activities from low yielding wells for completeness and to confirm previous findings. Data for ground water indicator parameters collected during Phase II are provided in Appendix A.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/ Furans	Herb	Metals	PCBs	Pest	SVOCs	VOCs
Ground Water	DEEP TILL	4		3	4	4	4	4	3
Ground Water	SHALLOW TILL	9		7	9	9	7	15	14
Soil	NA	15	23	23	29	23	23	28	25

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.1 through 4.4. Leachate data for SWMU 10 is provided on Table 4.8. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B

4.8.2 Discussion of Results

The concentrations of constituents detected in soil and ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 10. These results are summarized in Tables 4.3 and 4.4.

Soil Assessment

The arsenic concentration in the 4-6 ft bgs soil sample at T-60S exceeded site worker contact criteria. Additionally, concentrations of arsenic and cyanide (total) in the deepest sample exceeded the soil migration to ground water criteria at S10-39 and T-11S, respectively. Delineation sampling was conducted in this area during Phase II. The soil data collected at this area are also summarized on Figure 4.6, which highlights concentrations exceeding the screening criteria.

Ground Water Assessment

As summarized on Table 4.4d, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.11b, which highlights concentrations exceeding the screening criteria.

- Shallow Till:
  Ground water concentrations of 1,4-dioxane exceeded the drinking water criteria in shallow till well T-43S in SWMU 10. Three SVOCs (bis(2-ethylhexyl)phthalate, nitrobenzene, and n-nitrosodi-n-butylamine) were detected at concentrations exceeding the drinking water criteria in ground water during Phase I. Additionally, the concentrations of n-nitrosodi-n-butylamine exceeded the ground water volatilization to indoor air criteria for generic commercial/industrial buildings. However, the concentrations of the SVOCs were not confirmed in ground water during Phase II sampling of the same locations. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect. Concentrations of total arsenic, cadmium, lead, thallium, and vanadium were detected at concentrations greater than drinking water criteria. Dissolved concentrations of arsenic also exceeded the drinking water criteria at shallow till well T-60S.

- Deep Till:
  Ground water concentrations for total arsenic, beryllium, chromium, lead and vanadium in deep till wells sampled during Phase I at SWMU 10 were higher than drinking water criteria. No dissolved metals concentrations exceeded the screening criteria.

4.8.3 Conclusions

RFI soil and ground water data from SWMU 10 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 10. In addition, data from deep till wells indicate concentrations above drinking water criteria, although there is no evidence of a release to the bedrock aquifer. The RFI soil and ground water sampling has adequately characterized the extent of soil and ground water contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 10 is evaluated in Section 5 (baseline risk assessment).

4.9 SWMU 11 – Former Tepee Burner

SWMU 11, the former Teepee Burner, was a pre-RCRA unit located north of Building C, within the limits of the current Cell G (SWMU 2). Based on the available aerial photographs (USEPA, 1997a), this unit was installed in the mid to late 1960’s, operated into the 1970’s and was removed prior to 1980. Additional information on the construction and closure of SWMU 11 is provided in Section 3.11 of the DOCC.

4.9.1 Scope and Results

Potential impacts from the operation of this former unit were assessed in conjunction with the RFI at SWMU 10. Specifically, one of the perimeter soil borings proposed for the SWMU 10 investigation (see Section 3.4.5.4 of the Approved RFI Work Plan) was located as close a possible to the former location of this unit (see Figure 3-2), but outside the footprint of Cell G.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/Furans	Herbicides	Metals	PCBs	Pesticides	SVOCs	VOCs
Soil	NA	1	2	2	2	2	2	2	2

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for this unit is included with the data for SWMU 10 (see Table 4.3). In this table, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.9.2 Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 11. The results of the comparisons are summarized in Table 4.3.

<u>Soil Assessment</u>

The arsenic concentration in the 1.5-3.5 ft bgs soil sample at S10-39 (the deepest sample at this location) exceeded the soil migration to ground water criteria. This location was also discussed in Section 4.8(SWMU 10). The soil data collected at this area are also summarized on Figure 4.6, which highlights concentrations exceeding the screening criteria.

4.9.3 Conclusions

The RFI soil data from SWMU 11 indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 11. The RFI soil sampling has adequately characterized the extent of potential soil contamination at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 11 is evaluated in Section 5 (baseline risk assessment).

4.10 SWMU 12 – Former Bill's Road Oil Operation

SWMU 12, former Bill's Road Oil Site, is a pre-RCRA unit located south of York Street in a portion of the facility currently occupied by the Stabilization/Containment Building (SCB). This unit was an oil recycling facility that consisted of two small aqueous lagoons and five storage tanks (two tanks adjacent to the aqueous lagoons and three tanks at the south end of the property adjacent to the railroad tracks). The "east" lagoon had an average depth of 3.5 feet and a total volume of 120,000 gallons, the "west" lagoon was the larger lagoon with an average depth of approximately 6.5 feet and a total volume of 345,000 gallons. During the period of 1987 to 1988, a clean-up of the two aqueous lagoons, the storage tanks, and the adjacent areas was conducted by ESOI. Additionally, during this clean-up action, the two tanks which are located adjacent to the aqueous lagoons were disassembled, and the area which contained the other three tanks at the south end of the property was converted into vehicle storage/maintenance sheds. A large portion of this SWMU is now covered by the operating SCB. Additional information on the closure of SWMU 12 is provided in Section 3.12 of the DOCC.

4.10.1 Scope and Results

Ground water in the vicinity of the SWMU 12 was characterized by collecting samples from the shallow till wells surrounding this area. Ground water samples were analyzed for the Phase I Parameter List. Samples for metals analysis were collected for both total and dissolved analysis.

The number of locations from which samples were collected for each media during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Herbicides	Metals	PCBs	Pesticides	SVOCs	VOCs
Ground Water	SHALLOW TILL	6	6	6	6	6	6	6

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for ground water is shown in Table 4.4. On this table, the sample count for each analyte includes only valid data and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field QC samples and unreliable data) are provided in Appendix B.

4.10.2 Discussion of Results

The concentrations of constituents detected in ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at SWMU 12. The results are summarized in Table 4.4.

<u>Ground Water Assessment</u>

No constituent concentrations detected in shallow till ground water at SWMU 12 exceeded the drinking water criteria. The ground water data collected at this area are also summarized on Figures 4.10a and 4.10b.

4.10.3 Conclusions

The RFI ground water data do not indicate that potentially significant concentrations of hazardous constituents exist at or near SWMU 12. The RFI ground water sampling has adequately characterized ground water at this SMWU for risk evaluation purposes. The significance of potential exposures at SWMU 12 is evaluated in Section 5 (baseline risk assessment).

4.11 AOC 2 – Truck Scale

AOC 2 is the active truck scale located near the intersection of Otter Creek Road and York Street and south of SWMU 2. These above grade scales are used to weigh the quantities of waste trucked into the Facility prior to disposal. While in this area, shipments of waste arriving at the Facility have occasionally been noted to drip liquids from the transport container. When transport containers are identified as leaking, plastic swimming pools are used to collect liquids until the truck is temporarily repaired prior to off-loading. Any material remaining at the scale as a result of this type of incident is cleaned, either manually or by power washer. All spills are remediated in compliance with appropriate requirements of the Facility's Contingency Plan or Standard Operating Procedures for Minor Spills.

Additional information regarding the operations at AOC 2 is provided in Section 3.14 of the DOCC.

4.11.1 Scope and Results

Potential releases from this AOC were characterized by collecting surface soil samples (0 to 0.5 feet bgs) from 2 locations within the unpaved portion of the truck scale area. Soil boring locations were biased toward areas of stained soils and/or areas where spills were determined to have possibly occurred. All soil samples were analyzed for the Phase I Parameter List. One soil sample was also analyzed for Appendix IX dioxins and furans.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group from on-site sample locations are as follows:

Medium	Well Zone	Locations	Dioxins/Furans	Herbicides	Metals	PCBs	Pesticides	SVOCs	VOCs
Soil	NA	2	1	2	2	2	2	2	2

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for this AOC is shown in Table 4.3. On this table, the sample count for each analyte includes only valid data and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field QC samples and unreliable data) are provided in Appendix B.

4.11.2 Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at AOC 2. The results are summarized in Table 4.3.

<u>Soil Assessment</u>

No constituent concentrations in soil at AOC 2 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.6.

4.11.3 Conclusions

The RFI soil data do not indicate that potentially significant concentrations of hazardous constituents exist at or near AOC 2. The RFI soil sampling has adequately characterized the soil at this AOC for risk evaluation purposes. The significance of potential exposures at AOC 2 is evaluated in Section 5 (baseline risk assessment).

4.12 AOC 6 – Oily Waste Aboveground Storage Tanks

AOC 6 consists of Oily Waste Above Ground Storage Tanks located at the southeast corner of SWMU 7. These tanks were erected and placed into operation in approximately 1969 or 1970. Runoff is prevented by a soil berm that surrounds the area; stormwater from within the bermed area is removed and managed with the Facility's leachate. Additional information regarding the operations at AOC 6 is provided in Section 3.18 of the DOCC.

4.12.1 Scope and Results

Potential releases from this AOC were characterized by collecting surface soil samples (0 to 0.5 feet bgs) from 2 selected locations within the bermed area. Based upon the reconnaissance data, the locations were selected randomly within the bermed area. Soil samples were analyzed for the Phase I Parameter List. One soil sample was also analyzed for Appendix IX dioxins and furans.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/Furans	Herbicides	Metals	PCBs	Pesticides	SVOCs	VOCs
Soil	NA	2	1	2	2	2	2	2	2

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for AOC 6 is shown in Table 4.3. On this table, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.12.2 Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at AOC 6. The results of the comparisons are summarized in Table 4.3.

Soil Assessment

No constituent concentrations in soil at AOC 6 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.5.

4.12.3 Conclusions

The RFI soil data from AOC 6 do not indicate that potentially significant concentrations of hazardous constituents exist at or near AOC 6. The RFI soil sampling has adequately characterized soil at this AOC for risk evaluation purposes. The significance of potential exposures at AOC 6 is evaluated in Section 5 (baseline risk assessment).

4.13 AOC 10 – Rail Spur

AOC 10 is the portion of the rail spur which is located between Gate #9 and Rail Storage Area N, northwest of the CSB. The rail siding entrance to the facility is a chain link fence gate which is kept closed, except when receiving rail shipments. The rail area between the west end of Rail Storage Area N and the Norfolk Southern property is constructed with a minimum of 6 inches of compacted subballast above the subgrade. Additional information regarding the operations at AOC 10 is provided in Section 3.22 of the DOCC.

4.13.1 Scope and Results

Potential releases from this AOC were characterized by collecting surface soil samples (0 to 0.5 feet bgs) every 25 linear feet on each side of the on-site rail spur. Based on the sample spacing specification and actual length of the rail line within AOC 10, one less sample was collected during Phase I of the investigation. All soil samples were analyzed for the hazardous constituents associated with K061 waste (antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, lead, mercury, nickel, selenium, silver, thallium, and zinc).

The number of locations from which samples were collected for each medium for the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Metals
Soil	NA	12	12

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data is shown on Table 4.3. On this table, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.13.2 Discussion of Results

The concentrations of constituents detected in soil were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at AOC 10. The results are summarized in Table 4.3.

Soil Assessment

No constituent concentrations in soil at AOC 10 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.9.

4.13.3 Conclusions

The RFI soil data at AOC 10 do not indicate that potentially significant concentrations of hazardous constituents exist at or near AOC 10. The RFI soil sampling has adequately characterized the soil at this AOC for risk evaluation purposes. The significance of potential exposures at AOC 10 is evaluated in Section 5 (baseline risk assessment).

4.14 Investigation Unit A

Investigative Unit (IU) A consists of one SWMU and six AOCs situated along the southern central portion of the Facility immediately north of York Street. These SWMU/AOCs were combined into a single area of investigation for the RFI because of their close proximity to one another. The SWMU/AOCs associated with IU A are described below and shown on Figure 3.1.

SWMU 8 - Old Oil Pond #1 (South Pond)

SWMU 8 is a closed pre-RCRA unit located immediately north of York Street, west of SWMU 4. This oil recovery pond operated from the early 1960's through 1969. It was abandoned in the late 1960's by pumping the remaining oil into a newly constructed oil pond located immediately north of the old pond (SWMU 9). The area was backfilled with assorted sanitary and municipal waste and covered with a clay cap. Based on available information, it is understood that at least part of the maintenance building (Building C) was constructed on top of SWMU 8. Additional information regarding the operations and closure of the Old Oil Pond is provided in Section 3.8 of the DOCC.

AOC 1 - Toledo Water Lines

AOC 1, the Toledo Water Lines, consists of two low-pressure raw water transmission lines that bisect the Facility in an east/west direction north of York Street. These lines carry raw Lake Erie water to the city of Toledo Collins Park Water Treatment Plant. One of the transmission lines is a 78 inch, bituminous coated, steel pipe, constructed in 1939-1940 at a depth ranging from 11 to 21 ft bgs. Backfilling was accomplished with "selected clay", compacted to 24 inches above the top of the pipe. In 1973-1974 this line was improved by adding a ½-inch thick cement grout lining to the intercore of the pipe. The second line, a 60-inch steel encased prestressed concrete pipe was installed north of the original line in 1967 at a depth ranging from 9 to 18 ft bgs. The easement in which these two lines are located ranges from 80 to 105 feet in width, leaving the outside edges of the lines 7 to 22 feet from the limits of the easement. Monitoring trenches are located along both sides of the water lines midway between the adjacent waste areas and the water lines. Each trench was installed at least one foot below the depth of the adjacent water line and is approximately 2.5 feet wide. Trenches are sloped at one percent grade with collection sumps at 200 foot intervals. Only the "Southside" of AOC 1 is included as part of IU A; the northside is included in IU B. Additional information regarding the construction of the water lines and monitoring trenches is provided in Section 3.13 of the DOCC.

AOC 3 - Maintenance/Storage Building "C"

AOC 3 is located north of York Street and is used for the storage and maintenance of equipment and as office space. As discussed above, it is understood that at least part of this building was constructed on SWMU 8. Potential environmental concerns associated with this AOC may be related to the possible spillage of materials carried in Facility vehicles. There have been no reported releases from this AOC, however oil infiltration, presumably from SWMU 8, has been noted in floor drains.

AOC 4 - Building "C" Septic Tank and Leach Field

AOC 4 is a septic tank and leach field that is reported to have received wastewater and other liquids disposed in Building C (AOC 3). The leach field was located west of Building C and was partially removed during the construction of the water line monitoring trenches in May 1987. The septic tank, which was also located west of Building C, was removed in April 1989 concurrent with the installation of a 4,000-gallon capacity, double-wall fiberglass underground holding tank, which remains operational today.

AOC 5 - Decontamination Building

AOC 5 is a former decontamination building located at the northeast corner of SWMU 8. Decontamination water generated in this area was collected in an underground storage tank. The decontamination underground storage tank and another wastewater underground storage tank both remain in this area. The decontamination building and associated components were removed in the winter of 2008.

AOC 7 - Butz Crock Concrete Utility Vault

AOC 7 is a concrete utility vault for access to a water line serving Building C located south of Building C within the footprint of SWMU 8. AOC 7 is an oval cement sewer pipe installed vertically, with the following inside dimensions: 60 inch length; 38 inch width; and 108 inches deep. Oily liquids occasionally observed to accumulate in AOC 7 are believed to originate from SWMU 8.

AOC 8 - Staging Area East of Building C

AOC 8 is the Staging Area and consists of a horseshoe shaped roadway located east of Building C and located on SWMU 8. Incoming trucks use the area as a turn around and parking area.

4.14.1 Scope and Results

The scope of the RFI field investigations at IU A involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the waste management and related operations at IU A. Leachate in SWMU 8 was also sampled and the physical properties (i.e., landfill cap, landfill gas, etc.) of the SWMU were also evaluated. The RFI sampling locations are depicted on Figure 3.1. Soil boring logs and field notes related to the RFI are provided in Appendix A. A cross-sections through this unit are provided in Figures 4.2 and 4.18b.

The following is a summary of the sampling activities conducted for each medium during the RFI at IU A:

- The horizontal limits of waste in SWMU 8 were confirmed by installing one soil boring approximately every 200 linear feet along the perimeter of the unit. Each boring was located within 5 feet of the estimated limits of waste as defined based on the information obtained during the reconnaissance phase. Where waste was encountered at any depth in a boring, the thickness of the waste was logged, the boring was abandoned, and a new boring was located 5 feet, or less, from the oil pond. In no cases were boring locations extended inside the monitoring trenches along the Toledo water lines (AOC 1). Each soil boring was drilled to a depth at which the lacustrine/upper till contact was encountered. Soil samples were collected from 0 to 0.5 feet bgs, 0 to 2 feet immediately above the first saturated zone, and at intermediate depths exhibiting the highest organic vapor reading and/or exhibiting visual evidence of contamination. Samples were collected from intermediate depths at T-32S, T-34S, and T-53S based on visual evidence of discolored soil. All soil samples were analyzed for the Phase I Parameter List. One soil sample (selected based on field screening or visual evidence of contamination) was also analyzed for dioxins and furans. During the installation of T-42, an on-site water line was broken, and a manhole, similar in construction to Butz Crock (AOC 7), was identified near the location of T-42. Water was evacuated from this manhole to determine if the vault contained a shut off valve in the event one was required. Upon inspection it was determined that the vault contained an elbow heading in the approximate direction of Decontamination Building (AOC 5). The other end of the elbow was in the approximate direction of Butz Crock (AOC 7). Staining was noted in the soil adjacent to T-42. During Phase II activities a test pit was also completed to locate the water line leading west of Butz Crock, and to determine if this line could be acting as a preferential pathway for liquid migration from Butz Crock.

- The vertical limits of waste in SWMU 8 were confirmed by installing three borings at locations evenly distributed over the existing cover. Based upon the reconnaissance data, one boring was placed where the maximum depth of waste was anticipated to be encountered. Each soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. Surface soil samples were collected at 0 to 0.5 feet bgs. The thickness of accumulated leachate was measured in each soil boring and a sample of the liquid waste collected. Soil and leachate samples were analyzed for the Phase I Parameter List. Additional soil samples were collected as part of the Phase II activities to further characterize cap and waste conditions associated with IU A.

- Ground water at the perimeter of SWMU 8 was characterized by collecting samples from the lacustrine/upper till contact zone during the implementation of the perimeter soil sampling activities discussed above. In addition, ground water samples were collected from existing shallow monitoring wells located adjacent to this area. Ground water samples were analyzed for Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the RFI QAPP. For wells with sufficient yield, samples for metals analysis were collected as both total and dissolved samples. Wells T-33S, T-34S, T-52S, T-59S, T-56S, T-55S, and T-31S did not yield enough water to obtain a complete sample, and therefore had a reduced parameter list for ground water samples submitted for analysis.

  During ground water sampling, separate phase material was encountered in well T-33S. Measurements during liquid gauging events checked for the presence of both light and dense separate phase material. The physical characteristics of this liquid are provided on Table 4.7c. This liquid has been characterized as LNAPL; DNAPL was not encountered during the RFI activities. During Phase II activities two additional borings were completed adjacent to T-33S to delineate the extent of LNAPL. In addition, ground water samples were collected during Phase II at wells that did not produce enough water during Phase I and to further characterize ground water conditions in IU A. Data for ground water indicator parameters collected during Phase II are provided in Appendix A.

- The physical properties of the SWMU 8 cover soil were characterized by installing 4 shallow soil borings at locations evenly distributed within the limits of the Old Oil Pond (1 boring per acre). Each soil boring was drilled to a depth at which the waste was first encountered. Soil samples were collected from 0 to 2 feet bgs and 2 to 4 feet. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils. Due to the presence of leachate seepage (described in the field as "oily, sludge-like" and "tar-like" material) on the eastern toe of the SMWU 8 cap, one test pit was completed during Phase II to examine a potential leachate migration pathway through the cap.

- The presence of explosive gas was evaluated by field screening during the completion of borings and temporary leachate monitoring wells in SMWU 8. During Phase II, additional geoprobe borings were installed at locations spaced across SWMU 8 to assess gas pressure and LFG characteristics. Leachate levels were also collected within SWMU 8. In addition, three borings were completed in the vicinity of Building C to collect soil vapor samples.

- Potential releases from the AOCs were characterized by collection of soil and liquid samples, as follows:

  - <u>AOC 1 (southside):</u> liquid samples (trench water) were collected from the southern monitoring sumps for the trench located adjacent to SWMU 8 (identified as Trench Sumps IV-1 and IV-2), the southern monitoring sumps for Trench II (identified as Sumps II-1, II-2, II-3) and the monitoring sump for Trench VI (identified as Sump VI-1). Samples from the Trench II sumps were combined into a single sample prior to analysis. Additional liquid samples from trench sumps were collected during Phase II RFI activities for confirmation purposes.

  - <u>AOC 3:</u> no samples were collected. The building floor drains were dye tested and all drains were found to discharge to an on-site holding tank.

  - <u>AOC 4:</u> one soil boring was installed through the approximate center of the former leach field location and a soil sample was collected at 0 to 2 feet beneath the approximate invert of the leach field piping or bedding material.

  - <u>AOC 5:</u> one soil boring was installed at the end of the decontamination water UST location and a soil sample was collected at 0 to 2 feet beneath the invert of the UST.

  - <u>AOC 7:</u> one sample of accumulated liquid was collected from the crock. No soil samples were collected from within the crock as it was found to be constructed with a concrete bottom. One surface soil sample (0 to 0.5 feet bgs) was collected from immediately adjacent to the crock. During Phase II confirmation samples were collected from soil adjacent to the crock. In addition, a test pit was completed to determine if a water-line connecting through the crock was acting as a migration pathway. One soil sample was collected from the test pit. During Phase II, LNAPL was identified in the crock. One sample of the LNAPL was collected and analyzed for Phase I parameters.

- AOC 8: surface soil samples (0 to 0.5 feet bgs) were collected from 3 randomly selected locations within the staging area.

Soil and liquid samples were analyzed for the Phase I Parameter List.

The number of locations from which samples were collected for each medium during the RFI at IU A and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/ Furans	Herb	Metals	PCBs	Pest	SVOCs	VOCs
Ground Water	DEEP TILL	1		1	1	1	1	1	1
Ground Water	SHALLOW TILL	20		15	18	19	18	21	25
Leachate	NA	6		4	4	6	4	7	7
NAPL	NA	6		6	3	6	6	6	6
Soil	NA	24	1	46	48	46	46	51	52
Soil Vapor	NA	3						3	3
Trench Water	NA	5		3	5	3	3	6	6

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.1 through 4.4 and Tables 4.7a through 4.9. Leachate data for SWMU 8 are provided on Table 4.8. In these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.14.2 Discussion of Results

The concentrations of constituents detected in soil and ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at Investigation Unit A. The results of the comparisons are summarized in Tables 4.3, 4.4, and 4.7a through 4.9.

Landfill Cover Assessment

Results of the physical property sampling are summarized in Table 4.1. The cover at SWMU 8 was found to range from 7 to 15 feet thick. Geotechnical data results and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 8 are acceptable. Test pit activities did not identify a clear pathway for the leachate seepage; however, the seepage is likely related to seams between soil lifts in the cap or other weaknesses in the cover soil, and LFG pressure observed during drilling into this SWMU.

Landfill Gas Assessment

Results of the explosive gas monitoring are summarized in Table 4.2. As shown in Figure 4.2, a total of 15 geoprobe borings were initially installed at locations spaced across SWMU 8 in October 2006. The borings were advanced until the underlying native till was encountered. At each of these locations, temporary drive probes (i.e., Geoprobe's Post-Run Tubing System) were used to assess gas pressure and LFG characteristics (i.e., total volatile organics using a miniRae 2000 PID, explosive gas conditions using Bacharach's GA-94 landfill gas meter and hydrogen sulfide and carbon monoxide using QRae combustible gas meter). Samples were collected immediately below the clay cap (i.e., shallow borings) and at the base of SWMU 8 (i.e., deep borings). As shown on Table 4.2, elevated methane, hydrogen sulfide and/or explosive gas levels were detected at several of these locations, including the shallow and deep borings located immediately adjacent to Building C (Borings LFG-202 and -205).

Generally higher methane and hydrogen sulfide concentrations were measured immediately below the clay cap. Detected hydrogen sulfide concentrations ranged between 0 and 406 ppm. Although the peak concentration is below the hydrogen sulfide LEL of 4 percent (4,000 ppm), it is above OHSA's permissible exposure level (PEL) of 10 ppm and the Immediately Dangerous to Life and Health (IDLH) concentration of 100 ppm. Similarly, detected methane concentrations ranged between 0 and 100 percent[9], while recorded LEL levels ranged between 0 and 100 percent. The apparent discrepancies[10] between recorded LEL levels and measured methane concentrations are likely the result of the presence of other combustible gases, such as hydrogen sulfide or a result of instrument errors that could be associated with gas flow at relatively high pressures. Notwithstanding these apparent discrepancies, the detected methane concentrations are well above methane's LEL of 5 percent methane by volume.

In addition to direct measurement of LFG within SWMU 8, soil gas samples were collected from the cover soil adjacent to Building C to assess the potential for gas migration through the cover.

Soil Assessment – SWMU 8

Benzo(a)pyrene and lead concentrations in certain soil samples at IU A (SWMU 8) exceeded the site worker screening criteria. Additionally, arsenic and lead from the deepest samples at T-31S and S8-201, respectively, exceeded the soil migration to ground water criteria. The soil data collected at this area are also summarized on Figure 4.8, which highlights concentrations exceeding the screening criteria.

In addition, SVOCs were detected at concentrations that exceed the saturation limits at locations S8-201 and T-56S. As described in Table 4.11a, the physical descriptions of these locations did not identify free product or staining.

Soil Assessment – AOC 4

The benzene result from the 6-8 ft bgs soil sample collected at AOC 04(01) exceeded the soil vapor intrusion criteria for generic commercial/industrial buildings in Phase I. There are no buildings at AOC 4. The soil data collected at this area are also summarized on Figure 4.8, which highlights concentrations exceeding the screening criteria.

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[9] Concentrations of methane in landfill gas generally do not exceed 60 percent by volume. Measured concentrations in excess of 60 percent may reflect instrument errors possibly associated with gas flow at relatively high pressures.

[10] Measured methane concentrations and LEL readings do not correlate.. For instance at LFG-202, a methane concentration of 51.1 percent and an LEL of 49.2 percent were measured. Since methane has an LEL of 5 percent, a measured methane concentration of 51.1 percent would represent an LEL of over 1,000 percent and not the measured 49.2 percent. Alternatively, a measured LEL of 49.2 percent would correspond to a methane concentration of approximately 2.5 percent methane.

Soil Assessment – AOC 5

No constituent concentrations in soil at AOC 5 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.8.

Soil Assessment – AOC 7

No constituent concentrations in soil at AOC 7 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.8.

Soil Assessment – AOC 8

No constituent concentrations in soil at AOC 8 exceeded soil screening criteria. The soil data collected at this area are also summarized on Figure 4.8.

Ground Water Assessment

As summarized on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.11b, which highlights concentrations exceeding the screening criteria.

- Shallow Till:
  - Constituent concentrations from shallow till ground water wells exceeded the drinking water criteria for certain VOCs (1,4-dioxane, ethyl benzene, toluene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride) during the Phase I and/or Phase II sampling.

  - Concentrations of certain SVOCs (benzo(a)anthracene, bis(2-ethylhexyl)phthalate, dibenz(a,h)anthracene, hexachlorophene, and n-nitrosodi-n-butylamine) detected in shallow till ground water exceeded drinking water criteria during the Phase I sampling. The concentration of n-nitrosodi-n-butylamine also exceeded the ground water vapor intrusion criteria for generic commercial/industrial buildings. However, it is noted that during the Phase II sampling, only one SVOC (bis(2-ethylhexyl)phthalate) was confirmed at concentrations that exceeded the screening criteria. In addition, as noted in Section 4.2, n-nitrosodi-n-butylamine and hexachlorophene were detected at very low frequencies during the Phase I RFI, and their presence in the samples is considered suspect.

- Shallow till ground water concentrations of PCBs and pesticides (aldrin, beta-BHC, dieldrin, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT) exceeded the drinking water criteria during sampling conducted in Phase I and/or Phase II.

- Shallow till ground water concentrations of total antimony, arsenic, barium, beryllium, cadmium, chromium, lead, thallium and vanadium concentrations were identified exceeding the drinking water criteria during Phase I and/or Phase II. Dissolved arsenic from shallow till wells also exceeded the drinking water criterion at three locations (T-31S, T-35S and T-55S) during Phase II.

- In addition, concentrations of pesticides, PCBs, and SVOCs in the sample collected from T-33s exceed the solubility limit. As described in Table 4.11b, free product has been identified at this location. Concentrations of SVOCs were also identified in the Trench IV sample that exceed the solubility limit. As described in Table 4.11b, free product and/or sheen was not identified in the trench sample.

- Sampling of the southern monitoring sumps detected the following constituent concentrations above drinking water criteria: bis(2-ethylhexyl)phthalate in Trench II and Trench IV (not confirmed in Phase II); and SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoroanthene, indeno(1,2,3-cd)pyrene), VOCs (1,4-dioxane, benzene and vinyl chloride) and cadmium in Trench IV.

- Deep Till:
  In the deep till wells at SWMU 8, total lead was the only constituent detected at a concentration that exceeded the drinking water criterion in Phase I. This concentration was not confirmed during Phase II.

LNAPL – SWMU 8

The results of sampling of the LNAPL recovered from SWMU 8 are summarized on Table 4.7a. LNAPL and liquid elevation measurements from wells located within SWMU 8 are presented in Table 4.7b. The location and thickness of LNAPL in SWMU 8 is depicted on Figure 4.2. As part of the Phase II RFI activities, the LNAPL was bailed down in the leachate wells and monitored over a period of approximately 4 hours to assess the rate of recovery of the LNAPL (see Table 4.7b). As indicated on Table 4.7b, the LNAPL layer recoveries ranged from 0 to over 100%.

<u>NAPL and Water in Butz Crock</u>
Concentrations of 1,4-dioxane, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene exceeded drinking water criteria in the Phase II sample of water in AOC 7. Total arsenic also exceeded the drinking water criteria at this same location during Phase I. However, the arsenic result was not confirmed as exceeding drinking water criteria during Phase II. The water data collected at this area are also summarized on Figures 4.10a and 4.10b, which highlights concentrations exceeding the screening criteria. The NAPL characterization data are provided on Table 4.7a.

<u>Soil Gas (LFG)</u>
Soil gas data from boring locations installed adjacent to Building C in SWMU 8 are presented in Table 4.9. These data were compared with occupational inhalation criteria to assess the potential significance of LFG migration through the cover soil under current conditions. As shown on Table 4.9, no concentrations in landfill gas are greater than the criteria used for comparison.

4.14.3 Conclusions

The RFI soil and ground water data from IU A indicate that potentially significant concentrations of hazardous constituents exist at or near some of the areas (SWMU or AOCs) included in this IU. NAPL (described in the field as “oily, sludge-like” and “tar-like” material) has been measured in wells installed into SWMU 8, and has also been observed to seep through the cover soils on top of SWMU 8, as well as into Butz Crock and the Building C floor drains. The RFI soil and ground water sampling has adequately characterized the extent of potential soil and ground water contamination at this IU for risk evaluation purposes. The significance of potential exposures at IU A is evaluated in Section 5 (baseline risk assessment).

4.15 Investigation Unit B

Investigative Unit B (IU B) consists of one SWMU and one AOC located at the central portion of the Facility north of York Street. These SWMU/AOCs were combined into a single area of investigation for the RFI because of their close proximity to one another. The SWMU/AOCs associated with IU B are described below:

<u>SWMU 9 - New Oil Pond (North Pond)</u>

SWMU 9 is an approximately 1.6 acre pre-RCRA unit located in the center of the Facility, north of York Street, between SWMU 7 and SWMU 8. This unit was used for waste oil recovery after SWMU 8 was abandoned in the late 1960's; SWMU 9 was operated through 1980. Additional information regarding the operations and closure of the New Oil Pond is provided in Section 3.9 of the DOCC.

<u>AOC 1 - Toledo Water Lines</u>

As described in Section 4.14, AOC 1 consists of two low-pressure raw water transmission lines that bisect the Facility in an east/west direction north of York Street. The "Northside" of AOC 1 is included with IU B. The "Southside" of AOC 1 is included as part of IU A.

4.15.1 Scope and Results

The scope of the RFI field investigations at IUB involved collection of soil and ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of the former operations at this IU. In addition, physical properties of the SWMU and AOCs were evaluated. The RFI sampling locations are depicted Figure 3.1. Soil boring logs and field notes related to the RFI are provided in Appendix A. Cross-sections of this unit are provided in Figure 4.3 and Figure 4.18b.

- The horizontal limits of waste in SWMU 9 were determined by installing one soil boring approximately every 200 linear feet along the perimeter of the oil pond, with a minimum of one boring per side of the unit, and approximately every 200 linear feet along the north side of AOC 1 adjacent to SWMU 9. Selection of boring locations was coordinated with the investigation of SWMU 7 (Central Sanitary Landfill). Each boring was located within 5 feet of the estimated limits of waste based upon the information obtained during the reconnaissance phase. Where waste was encountered at any depth in the boring, the thickness of the waste was logged, the boring was abandoned, and a new boring was located 5 feet or less away from the oil pond. In no case were the boring locations extended inside the monitoring trenches along the City of Toledo water lines (AOC 1). Each soil boring where waste was not encountered was drilled to a depth at which the lacustrine/upper till contact was encountered. Soil samples were collected from 0 to 0.5 feet bgs, 0 to 2 feet immediately above the first saturated zone, and at intermediate depths exhibiting the highest organic vapor reading, as well as, the highest level of visual contamination. Samples were also collected from intermediate depths at T-28S, S9-13, S9-14, S9-29, S9-30, and S9-51 based on visual evidence of discolored and stained soils. All soil samples were analyzed for the Phase I Parameter List. One soil sample (selected based on field screening or visual evidence of contamination) was also analyzed for dioxins and furans. Additional shallow soil sampling was conducted during Phase II activities to further characterize the SVOCs identified along the eastern portion of SWMU 9.

- The vertical limits of waste in SWMU 9 were confirmed by installing one boring through the existing cover. Based upon topography and review of the reconnaissance data, the boring was placed where the maximum depth of waste was expected to be encountered. The soil boring was drilled to a depth at which native clay (exhibiting no visible waste) was encountered. A surface soil sample was collected from 0 to 0.5 feet bgs. Upon completion, the soil boring was left open for several hours but no liquids accumulated within the borehole. Soil samples from the SWMU were analyzed for the Phase I Parameter List. Subsequent to the Phase I work, oily water was reported on top of the unit near existing vent pipes. Additional borings were completed through the clay cap at SWMU 9 during the Phase II activities to determine the extent of free liquids. One composite sample of free liquid was collected from certain locations within SWMU 9 and analyzed for the Phase I Parameter List.

- Ground water at the perimeter of SWMU 9 was characterized by collecting samples at the lacustrine/upper till contact zone during the implementation of the perimeter soil sampling activities discussed above. Ground water samples were analyzed for Phase I Parameter List, where sufficient yield was obtained from the ground water-bearing zone. In the event well yield was insufficient to generate sufficient sample volume to completely analyze the Phase I Parameter List, samples were collected in accordance with the sample collection prioritization sequence included in the RFI QAPP. For wells with sufficient yield, samples for metals analysis were collected for both total and dissolved metals. Wells T-28S, T-43S and T-44S did not yield enough to obtain a complete sample, and therefore had a reduced parameter list for ground water samples submitted for analysis. Additional ground water samples were collected during the Phase II activities of low yielding wells for completeness and confirmation. Data for ground water indicator parameters collected during Phase II are provided in Appendix A.

- The physical properties of the SWMU 9 clay cover soil were characterized by installing two shallow soil borings at locations evenly distributed within the limits of the New Oil Pond (1 boring per acre). Each soil boring was drilled to a depth at which the waste was first encountered. Soil samples were collected from 0 to 2 feet bgs and 2 to 4 feet. The soil sample completed at S9-51 was targeted toward an area lacking vegetation on the east slope of SWMU 9. Soil samples were characterized for grain size distribution and evaluated using a variable head permeability test to estimate the vertical hydraulic conductivity of the cover soils.

- Potential releases to AOC 1 were characterized by collecting liquid samples (trench water) from northern monitoring sumps for the trench located adjacent to SWMU 9 (identified as Trench Sumps III-1 and III-2). Samples were also collected from Trench Sumps I-1, I-2, I-3, V-1 and V-2; samples from the sumps for each of these individual trenches were composited for analysis. Liquid samples were analyzed for the Phase I Parameter List.

The number of locations from which samples were collected for each medium during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Dioxins/ Furans	Herb	Metals	PCBs	Pest	SVOCs	VOCs
Ground Water	DEEP TILL	2		2	2	2	2	2	2
Ground Water	SHALLOW TILL	3		2	4	3	2	5	5
NAPL	NA	1			1	1	1	1	1
Soil	NA	14	3	25	25	25	25	30	31
Trench Water	NA	4		3	5	4	3	3	3

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.1 through 4.4 and Tables 4.7a and 4.7b. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.15.2 Discussion of Results

The concentrations of constituents detected in soil and ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at IU B. The results of the comparisons are summarized in Tables 4.3, 4.4, 4.7a, and 4.7b.

<u>Landfill Cover Assessment</u>

Results of the physical property sampling are summarized in Table 4.1. The cover soils were found to range from 6 to 9 feet thick at SWMU 9. Geotechnical data results and cap thickness measurements indicate that the physical properties of the clay soil cover on SWMU 9 are acceptable.

As described above, stormwater and oily liquid seepage accumulates in a small area on the top of SWMU 9. Outside of this area, the Phase I reconnaissance and observations during subsequent phases of the RFI, indicate that the cap provides adequate drainage (no evidence of significant areas of ponding of stormwater other than the area on the immediate top of the unit).

<u>Landfill Gas Assessment</u>

Results of the explosive gas monitoring are summarized Table 4.2. Explosive gas readings from the physical property borings were below screening criteria. OVA measurements from the physical property borings in SWMU 9 were greater than the screening level of 50 ppm. In accordance with the facility's routine explosive gas monitoring program, no additional investigation is required since none of the explosive gas readings exceeded the screening criteria. Further, given the thickness of the existing cap is reasonably expected to mitigate any significant vapor migration, no further investigation of organic vapor levels is warranted.

<u>Free-Liquid Delineation</u>

The delineation the free liquids in SWMU 9 are summarized on Figure 4.3. Results of the free-liquid testing are summarized on Table 4.7b. Physical properties of the liquid is provided on Table 4.7c. RFI activities delineated the extent of free-liquids as being limited to the top area of SWMU 9. Therefore, no further investigation of the free liquids in SWMU 9 is warranted.

<u>Soil Assessment</u>
The benzo(a)pyrene result from the surface soil sample collected at S9-51 exceeded the site worker soil contact criteria in Phase I. The vinyl chloride concentration discussed in Section 4.7 (SWMU 7) as exceeding soil volatilization to indoor air criteria for a generic commercial/industrial building was also used to evaluate conditions at SWMU 9. The soil data collected at this area are also summarized on Figure 4.7, which highlights concentrations exceeding the screening criteria.

In addition, the benzo(a)pyrene and chrysene concentration at S9-51 exceeds the saturation limit. As described in Table 4.11a, the physical descriptions of this location did not identify free product or staining.

<u>Ground Water Assessment</u>
As summarized on Table 4.4, ground water concentrations exceeded certain human health screening criteria. The ground water data collected at this area are also summarized on Figures 4.10a through 4.11b, which highlight concentrations exceeding the screening criteria.

- <u>Shallow Till</u>:
    - One VOC (1,4-dioxane) exceeded drinking water criteria in the shallow till ground water at T-43S during Phase II. One SVOC (n-nitrosodi-n-butylamine) exceeded drinking water criteria, and ground water volatilization to indoor air criteria at T-43S, T-28S and T-15S during Phase I. However, these SVOC concentrations were not confirmed as exceeding criteria during Phase II. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect. Additionally, total arsenic exceeded drinking water criteria in shallow till ground water at T-43S during Phase II.

    - Sampling of the northern monitoring sumps detected the following constituent concentrations above drinking water criteria: SVOCs (bis(2-ethylhexyl)phthalate, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene), VOCs (1,4-dioxane, benzene) and PCBs in Trench III; and cadmium and benzene in Trench V.

- Deep Till:
  In the deep till wells at SWMU 9, total antimony, arsenic, barium, chromium, lead, nickel, selenium, thallium and vanadium concentrations were identified as exceeding the drinking water criteria during Phase I at T-15D. Additionally, dissolved antimony exceeded the drinking water criteria during Phase I at T-15D. However, none of the metals concentrations identified as exceeding drinking water criteria during Phase I were confirmed during Phase II.

- In addition, concentrations of SVOCs and PCBs exceed the solubility limit in the sample collected from Trench III. As described in Table 4.11b, the physical descriptions of this location do not indicate that ground water contained free product and/or sheen.

4.15.3 Conclusions

The RFI soil and ground water data from IU B indicate that potentially significant concentrations of hazardous constituents exist at or near some of the areas included in this IU. An oil water mixture has also been observed to seep through the cover soils in the vicinity of the vent pipes located on top of the SWMU 9. The RFI soil and ground water sampling has adequately characterized the extent of potential soil and ground water contamination at this IU for risk evaluation purposes. The significance of potential exposures at IU B is evaluated in Section 5 (baseline risk assessment).

4.16 Investigation Unit C

Investigative Unit C (IU C) consists of one AOC, nine NPDES outfalls and Otter Creek. These areas were combined into a single area of investigation for the RFI because of their common function (i.e., collection, retention, discharge, and receipt of stormwater runoff). The areas associated with IU C are described below:

AOC 9 - Cell M Surface Water Retention Basin

AOC 9 is the Cell M surface water retention basis which serves as the surface water management system. The system which consists of drainage ditches, a stormwater basin, and the necessary equipment to discharge the collected water, was designed to control surface water in the Cell M area generated by a 100 year, 24 hour storm and to prevent this water from entering the active cell. This AOC has a permitted discharge under the Facility's NPDES Permit.

<u>NPDES Outfalls</u>

Nine stormwater outfalls are currently in-use at the ESOI Facility. The location and purpose for each of these outfalls is discussed in Section 3.3. Routine monitoring of outfalls included in the Facility's current NPDES permit has not identified evidence of releases to surface water other than isolated exceedances for total suspended solids which have been attributed to the procedures by which accumulated stormwater is manually pumped.

<u>Otter Creek</u>

The description of Otter Creek is discussed in Section 3.3.1.

4.16.1 Scope and Results

The RFI activities of IU C included the following (sample locations are shown on Figure 4.17).

- The quality of stormwater discharges from the NPDES outfalls were characterized by collecting the following samples:
  - Outfall 1: Collected samples of stormwater discharged from the Cell G detention pond during a rainfall event.
  - Outfall 3: Collected samples of stormwater runoff discharging through Cell F runoff gate valve during a rainfall event.
  - Outfall 4: Collected samples of stormwater discharged from the Cell H detention pond during a rainfall event.
  - Outfall 6 (AOC 9): Collected samples of stormwater discharged from Cell M detention pond during a rainfall event.
  - Outfalls 009, 010 and 011: Collected samples of stormwater runoff discharging from the catch basins associated with the three Millard Road Landfill (SWMU 5) outfalls during a rainfall event.

- Outfall 012: Collected samples of stormwater discharging from the access road culvert pipe at the northeastern corner of the NSL (SWMU 6) during a rainfall event.

Water samples were analyzed for the Phase I Parameter List. Water samples for metals analysis were collected as total and dissolved samples. In addition, analyses were completed for general chemistry, i.e., total dissolved solids (TDS), total suspended solids (TSS), biological oxygen demand (BOD), chemical oxygen demand (COD), and nutrients (ammonia, phosphate, nitrate and nitrogen).

- The condition of Otter Creek was characterized by collecting the following surface water and sediment samples (see Figure 3.1):

  - Reference surface water and sediment samples were collected from Otter Creek at 4 upstream locations between the adjacent rail yard and Consaul Street.

  - Surface water and sediment samples were collected at the York Street crossing (where the York Street storm sewer discharges into Otter Creek11), and upstream of the old Millard Avenue crossing (downstream of the Westover Landfill).

  - Surface water and sediment samples were collected from two locations in Otter Creek adjacent to the Facility: adjacent to Millard Road Landfill and at the confluence of the northern Millard Landfill drainage ditch with Otter Creek.

  - Surface water and sediment sample were collected from Otter Creek at one downstream location (at a location immediately upstream of the rail yard).

Sediment samples were collected at 0 to 0.5 feet bgs. Sediment and water samples were analyzed for the Phase I Parameter List. Water samples for metals analysis were collected and analyzed as both unfiltered and filtered samples. In addition, water samples were analyzed for general chemistry parameters, i.e., TDS, TSS, BOD, COD, and nutrients (ammonia, phosphate, nitrate and nitrogen). During Phase II, sediment samples were also analyzed for total organic carbon (TOC), acid volatile sulfides (AVS), and alkylated PAHs.

[11] It is noted that the York Street storm sewer conveys both stormwater discharges from the ESOI Facility (from Outfalls 002 and 006) and stormwater runoff from York Street and neighboring properties.

In addition, the flow in Otter Creek was measured during the Phase II activities at certain locations from Consul Road to the Facility. At each location a cross-section of the stream was estimated (i.e., width and depth at three discrete locations) and the stream velocity was measured using a velocity flow meter. Figure 4.20 depicts the transect locations and the measured stream velocity results.

The number of locations from which samples were collected during the RFI, and the number of samples analyzed for each analyte group are as follows:

Medium	Well Zone	Locations	Herbicides	Metals	PCBs	Pesticides	SVOCs	VOCs
Sediment	NA	9	9	9	11	9	11	11
Surface Water	NA	17	26	43	26	26	25	26

The above sample counts include only valid data (e.g., they do not include data that were qualified as unreliable [R-qualified]) and do not include quality control (QC) samples (e.g., field duplicates).

A summary of the analytical data for each medium is shown in Tables 4.5 and 4.6. On these tables, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.16.2 Discussion of Results

The concentrations of constituents detected in surface water, and sediment were compared with the generic risk-based screening criteria discussed above in Section 4.3, to determine whether a potentially significant release of hazardous constituents has occurred at Investigation Unit C. The results of the comparisons are summarized in Tables 4.5 and 4.6. Sediment and surface water sample results are also presented on Figures 4.16 and 4.17, respectively.

4.16.2.1 NPDES Outfalls to Otter Creek

The total thallium result from Phase I sampling of Outfall 1 stormwater exceeded the federal AWQC for protection of human health (organism consumption) and the Ohio WQC for protection of human health in the Lake Erie drainage basin for drinking and non-drinking exposures. Total thallium did not exceed the maintenance worker contact criterion.

During the Phase I sampling, total and dissolved antimony exceeded the Ohio WQC for protection of human health in the Lake Erie drainage basin for drinking exposures in stormwater at Outfall 6. Additionally, the bis(2-ethylhexyl)phthalate concentration from this Outfall exceeded the federal AWQC for protection of human health (organism consumption), the Ohio WQC for protection of human health in the Lake Erie drainage basin for drinking and non-drinking exposures, and the maintenance worker contact criterion for the site.

The total arsenic result from Phase I sampling of Outfall 10 stormwater exceeded the federal AWQC for protection of human health (organism consumption) and the Ohio WQC for protection of human health in the Lake Erie drainage basin for drinking exposures. Total arsenic did not exceed any other criteria, including the maintenance worker contact criterion for the sites.

4.16.2.2 NPDES Outfalls to Driftmeyer Ditch

The total arsenic result from Phase II sampling of Outfall 4 stormwater exceeded the federal AWQC for protection of human health (organism consumption). Total arsenic did not exceed any other criteria, including the maintenance worker contact criterion for the sites.

4.16.2.3 Otter Creek - Upstream

Sediment Assessment

Concentrations of the following constituents in sediment samples collected from the upstream portion of Otter Creek (Site 6 through 9) exceeded one or more of the screening criteria for evaluating potential ecological exposures to sediment. The sediment data collected in this area are also summarized on Figure 4.16, which highlights concentrations exceeding the screening criteria.

- Three VOCs (acetone, 2-butanone and carbon disulfide) exceeded at several locations during Phase I. With the exception of acetone at Site 4, these concentrations were not confirmed during Phase II sampling.

- SVOCs exceeding one or more criteria at locations in the upstream portion of Otter Creek during Phase II included: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrelene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, phenanthrene, and pyrene.

- Total PCBs, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT exceeded the ecological screening criteria.

Surface Water Assessment

Total and dissolved arsenic results from Phase II sampling of Site 6, 7, 8, and 9 exceeded one or more of the screening criteria for evaluating potential ecological exposures to surface water. The total mercury result from Phase II sampling of Site 7 exceeded the Ohio WQC for protection of human health in the Lake Erie drainage basin for drinking and non-drinking exposures.

The surface water data collected at this area are also summarized on Figure 4.17, which highlights concentrations exceeding the screening criteria.

4.16.2.4 Otter Creek - Downstream

Sediment Assessment

Concentrations of the following constituents in sediment samples collected from the downstream portion of Otter Creek (Site 1 through 5) exceeded one or more of the screening criteria for evaluating potential ecological exposures to sediment. The sediment data collected at this area are also summarized on Figure 4.14, which highlights concentrations exceeding the screening criteria.

- Three VOCs (acetone, acetonitrile, and 2-butanone) exceeded at one or more locations.

- SVOCs exceeding one or more criteria at downstream locations included: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrelene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, 4-chloro-3-methylphenol, 4-chloroaniline, chrysene, dibenz(a,h)anthracene, dibenzofuran, 2,4-dichlorophenol, 2,4-dimethylphenol, fluoranthene, fluorene, hexachlorobutadiene, indeno(1,2,3-cd)pyrene, isophorone, 2-methylnaphthalene, naphthalene, nitrobenzene, n-nitrosodi-n-butylamine, phenanthrene, phenol, pyrene, and O,O,O-triethyl phosphorothioate. As noted in Section 4.2, n-nitrosodi-n-butylamine was detected at very low frequencies during the Phase I RFI, and its presence in the samples is considered suspect.

- Total PCBs, 4,4’-DDD, 4,4’-DDE, and 4,4’-DDT exceeded the ecological screening criteria.

Surface Water Assessment

Concentrations of total and dissolved arsenic from both Phases of investigation exceeded one or more of the screening criteria for evaluating potential ecological exposures to surface water at Sites 1, 2 ,3, 4 and 5. Additionally, the total antimony result from Site 2 during Phase I exceeded one or more of the screening criteria for evaluating potential ecological exposures to surface water. The surface water data collected at this area are also summarized on Figure 4.17, which highlights concentrations exceeding the screening criteria.

4.16.3 Conclusions

The RFI sediment and water data from IU C indicate that potentially significant concentrations of hazardous constituents exist at or near this IU. The RFI sediment and water sampling has adequately characterized the extent of potential sediment and surface water contamination at this IU for risk evaluation purposes. The significance of potential exposures at IU B is evaluated in Section 5 (baseline risk assessment) and Section 6 (screening level ecological risk assessment).

4.17 RCRA Monitoring Well Sampling

In accordance with the March 22, 2002 letter from ESOI to USEPA, additional ground water sampling was conducted from RCRA monitoring program overburden wells associated with Cells G, H, and I. Previously available data for these wells had elevated reporting limits compared to the quantitation limits specified for the RFI. The constituents with elevated limits included certain SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene) and metals (antimony and thallium). In order to achieve lower quantitation limits, SVOC analysis was conducted using the selective ion monitoring (SIM) procedure.

4.17.1 Scope and Results

The RFI activities included sampling of the following RCRA program wells to address USEPA comments regarding the reporting limits for certain constituents reported in the DOCC.

Cell G	Cell H	Cell I
G-1DA	H-3S	I-3SA
G-2DA	H-4S	I-5SA
G-3D	H-5S	I-6S
G-7	H-6S	I-7S
G-9	H-1D	I-8S
G-11	H-3D	I03D
	H-4D	I-4D
	H-5D	I-5D
	H-6D	I-6D
		I-4S

These samples were analyzed for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene by EPA Method 8270C - Selected Ion Monitoring; antimony by EPA Method 7041 - GFAA; and thallium by EPA Method 7841 - GFAA.

All of the SVOC analyses for these wells were below the respective detection limits. Note that samples from four wells (G-7, G-11, I-8S and I-4S) were inadvertently not analyzed for the selected SVOCs during Phase I; these wells were resampled during Phase II for the constituents omitted in Phase I. Wells H-3D, H-3S, I-5SA, I-3D, and I-7S were resampled for thallium and antimony (filtered and unfiltered) to assess variability in concentrations of these constituents during Phase II of the RFI.

The results from this sampling have been summarized in ESOI's routine RCRA monitoring report for April 2002. The analytical data from these wells are included in Table 4.4. On this table, the sample count for each analyte includes only valid data, and concentrations among duplicate pairs have been averaged. The analytical data for all samples (including field duplicate samples and unreliable data) are provided in Appendix B.

4.17.2 Discussion of Results

The concentrations of constituents detected in ground water were compared with the generic risk-based screening criteria discussed above in Section 4.3 along with other data collected from the same area (SWMU or AOC). The results of the comparisons are summarized in Table 4.4. The data comparison did not identify any concentrations from these wells exceeding screening criteria.

4.17.3 Conclusions

The RFI ground water data from the RCRA program wells do not indicate that a potentially significant release of hazardous constituents has occurred at or near these wells.

4.18 In-Situ Hydraulic Conductivity Testing Results

In accordance with the request from Ohio EPA, ESOI completed a series of hydraulic conductivity tests from August 7 to August 11, 2006 to gather supplemental data on the hydraulic conductivity of the strata in which wells are screened at the Facility. In-situ tests were conducted on wells specified by Ohio EPA in each of the following zones: shallow till wells screened across the lacustrine/upper till contact, deep till wells screened across the upper till/deep till contact, and bedrock wells screened in bedrock.

4.18.1 Scope and Results

ESOI conducted hydraulic conductivity tests on the following wells: shallow till wells F-2S, MR-1SA, MR-2S, MR-3S, MR-5S, MR-6S, SW-2S, SW-3S, SW-4S, T-203S, T-204S and T-20S(3); deep till wells F-2D, MR-2D, MR-3D, MR-5D, SW-2D, SW-3D, SW-4D, T-203D and T-205; and bedrock wells R-4, R-23 and R-24.

A MiniTroll datalogger, programmed to gather data on a logarithmic scale was used to record ground water elevation data through the course of the tests. The ground water elevation was recorded before the MiniTroll was lowered into each well. Because the hydraulic conductivities of the zones tested were generally low, the wells were left to stabilize for significant periods of time (several minutes to hours) after lowering the MiniTrolls into the wells. After the stabilization period, a second ground water elevation was recorded and used as the zero reference point for the start of each test. The MiniTroll was then programmed to begin recording data and an appropriately sized slug was lowered into each well for the “slug in” or falling head test. Depending on the response, the length of the tests ranged between 5 minutes for the rock wells, to over ten hours for certain till wells. After enough time passed for each test, the MiniTroll was manually commanded to stop recording data and was reprogrammed to begin recording new data for the “slug out” or rising head test. Once the datalogger was programmed for the new test to begin, the slug was removed. As with the “slug in” analysis, the tests ran as long as necessary to see a perceptible response by the water bearing zone to the removal of the slug.

The data stored on the MiniTrolls was transferred into AQTESOLV®, a software program that combines the raw data from the slug tests with information about well installation and construction as well as data about the water bearing zones, to calculate hydraulic conductivity (k value). Once the necessary data were entered into the software, the Bower-Rice Method for confined zones was selected to calculate the hydraulic conductivity. The Bower-Rice Method is considered the appropriate slug test analytical method for determining hydraulic conductivity in confined water bearing zones. Each of the water bearing units tested was determined to be confined or semi-confined based on the following:

- During drilling activities, the only saturated conditions in the overburden were observed at the contacts and the wells were consequently screened across or within these contacts.
- The hydraulic head in each of the wells, including the bedrock wells, is above the screened interval.
- The soils above the screened interval are composed of silty clays and are not saturated.

Slug test analysis also requires knowledge of the thickness of the saturated zone being tested. Zones of saturated sand, where present within the screened interval of a well, were considered the conductive zone and the thickness of the sand unit was used as the water bearing zone thickness. For those wells where a sand unit was not encountered, the screen length was assumed to be the water bearing zone thickness. Only those soils hydraulically connected to the well screen would be impacted by the insertion and removal of the slug and thus, the screen length was considered the best default value for water bearing zone thickness when more specific information was not available. For the bedrock wells, the aquifer thickness was considered the depth from the bedrock/overburden interface to the base of the well. A summary of the calculated hydraulic conductivities compared to historical data generated at the site during field testing by Weston and WW Engineering and Science are presented as Table 4.10. In addition, the slug test solutions and individual results are provided in Appendix C5.

- The geometric mean of the hydraulic conductivities of the shallow lacustrine/upper till tests were calculated at 1.6×10^{-5} cm/sec and 9.8×10^{-6} cm/sec for the falling head and the rising head slug tests, respectively. The geometric mean of the hydraulic conductivities for this water bearing zone as calculated by Weston in 1985 was 1.8×10^{-5} cm/sec. In computing the K values Weston treated the unit as unconfined and tested a different subset of wells than tested during the August 2006 investigation.

- The geometric mean of the calculated hydraulic conductivities of the intermediate, upper till/deep till tests was 5.3 x 10^{-6} cm/sec and 2.7 x 10^{-6} cm/sec for the falling head and rising head slug tests, respectively. The geometric mean of the hydraulic conductivities for this unit as calculated by Weston in 1985 was 1.8 x 10^{-7} cm/sec. As above, Weston treated the upper till/deep till as unconfined and used a different subset of wells.

- Finally, the geometric mean of the hydraulic conductivities of the bedrock aquifer tests was 5.7 x 10^{-3} cm/sec and 1.4 x 10^{-2} cm/sec for the falling head and rising head slug tests, respectively. These results are consistent with the K value estimated by WW Engineering and Science for the Greenfield formation (2.0 x 10^{-3} cm/sec) in a pumping test at the Facility conducted in May 1992 (by reference in Part B Permit Application, Appendix E.10, Appendix E.10.19. p 19-30 in the Investigation Compendium).

4.18.2 Discussion of Results

The results of the hydraulic conductivity tests completed during the RFI activities confirm the results of many other studies of hydraulic conductivity at the site. These tests all conclude that horizontal hydraulic conductivities of the till contact zones are low and consistent with that expected of till and for silty clayey sands (10^{-10} to 10^{-4} cm/sec; Freeze and Cherry, 1979). Bedrock hydraulic conductivity beneath the Site is 3 to 4 orders of magnitude greater than the till zones.

5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

5.1 Introduction

As discussed in Section 4, the comparison of site characterization data collected during the RFI field investigation with conservative risk-based screening criteria identified evidence of potentially significant releases of hazardous constituents to the environment at or near the ESOI Otter Creek Road Facility. The human health risk assessment presented in this section evaluates the potential significance of reasonable maximum exposures to affected environmental media under current and reasonably expected future land and ground water use at and around the Facility. As specified in Section 4.3.1 of the approved RFI Work Plan, this risk assessment has been conducted consistent with USEPA risk assessment policy and guidance. In addition, where appropriate, the exposure assessment methodologies and exposure assumptions specified in ESOI's alternate concentration limit (ACL) model (ESOI 2006b) have been incorporated for certain pathways and receptors. The results of the risk assessment will be used to identify where a potential release of hazardous constituents from the Facility may cause reasonable maximum exposures to be significant enough to warrant further assessment in a corrective measures study. Decisions regarding the need for corrective measures and the type of corrective measures that are appropriate to mitigate significant exposures will be dependent on the source of the hazardous constituents and evaluation of corrective measure alternatives.

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) presented in Table 5.1. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Facility in terms of the potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The CSM was developed based on the site information and investigation data discussed in Sections 3 and 4, respectively. The scenarios for potential human exposure are discussed further in Section 5.3.

The discussion of the human health risk assessment is organized as follows:

- The preparation of data used in the risk assessment is discussed in Section 5.2 – Data Collection and Preparation.

- The scenarios for potential human exposure are discussed in Section 5.3 – Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.

- Toxicity information for the constituents included in the risk assessment is summarized in Section 5.4 – Toxicity Assessment.

- The risk estimates associated with the potential exposures discussed in Section 5.3 are quantified and their significance is discussed in Section 5.5 – Risk Characterization. Uncertainties associated with the risk estimates are also discussed in this section.

- The findings and conclusions of the human health risk assessment are summarized in Section 5.6 – Summary and Conclusions.

5.2 Data Collection and Preparation

5.2.1 Data collection

All soil, ground water, sediment, surface water, trench water, leachate, outfall water and NAPL data collected during the RFI were considered for use in the health risk assessment. The objectives of data collection during the RFI and strategies for determining when additional data collection is warranted were described in the RFI Work Plan (ENVIRON/MSG 2002), Phase II Work Plan (ENVIRON 2005) and Phase II Work Plan addenda (ENVIRON 2006, 2007). The scope of the RFI field investigation and a summary of the data collection activities are described in Section 4 of this report. The complete set of Phase I and Phase II RFI data (including R-qualified data and separate results for each sample of a duplicate pair) are provided in Appendix B.

5.2.2 Data Preparation

As discussed in Section 4.2, validation of all soil, ground water, sediment, surface water, trench water, leachate, outfall water and NAPL data collected during the RFI was performed in accordance with the QAPP in the RFI Work Plan (ENVIRON/MSG 2002) and subsequent revision for the Phase II RFI Work Plan (ENVIRON 2005). In addition, the following procedures were used to prepare the data to support quantitative risk assessment. These procedures, which are based on USEPA guidance on human health risk assessment (USEPA 1989), are as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ-qualified data) during data validation are evaluated as non-detects.

- Constituent concentrations qualified as not usable (i.e., R-qualified data) during data validation are not included in the risk assessment.

- Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment.

- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.

- The concentrations of endosulfan, methylphenol, 1,3-dichloroproene, xylenes, and polychlorinated biphenyl (PCB) are the sums of the concentrations of the isomers or Aroclors that were detected and half the quantitation limits of the isomers or Aroclors that were not detected in the same sample but were detected in the same matrix at the Facility. If no isomer or Aroclor was detected in a sample, the constituent is considered to be not detected in the sample.

- Concentrations of metals in soil that are at or below the site-specific background levels summarized in Table 3.2a are considered to be background and not site-related. Metal concentrations in soil samples that are in excess of the site-specific background levels are considered to be site-related, and are used in the calculation of site-related risks.

- As a conservative assumption, all concentrations of organic constituents detected in on-site matrices are assumed to be site-related.

- Dioxin and furan congener concentrations are combined using toxic equivalency factors (TEFs; USEPA 1989) to calculated a 2,3,7,8-TCDD TEQ concentration (see Appendix C7).

No constituent that was detected in soil, ground water, sediment, surface water, trench water, outfall water, or NAPL is excluded from the risk assessment, except as noted above.

5.3 Exposure Assessment

This section discusses the potential exposures that are relevant under current and reasonably expected future land use at and around the Facility. The exposure setting, potentially exposed populations, and exposure pathways are discussed below in this section.

For potential exposures via ingestion and dermal contact, as discussed in this section, exposure is quantified in terms of a dose, as follows:

$$Dose = Concentration \cdot Intake$$

The dose for evaluating cancer risk is averaged over a lifetime and is called the lifetime average daily dose (LADD). For evaluating long-term (or chronic) and shorter-term (subchronic) noncancer effects, the dose is averaged over the duration of potential exposure and is called the average daily dose (ADD). The concentration term in the dose equation refers to the chemical concentration in an environmental medium to which a population is exposed over a specified duration. The intake term refers to the intake rate of the contaminated environmental medium, which is a function of the magnitude, frequency, and duration of exposure. The methods for estimating the concentration term are discussed in Section 5.3.4 and 5.3.5. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 5.3.3.

Potential exposures via inhalation are quantified as an average daily concentration in air. The exposure concentration for evaluating cancer risk is averaged over a lifetime. For evaluating chronic and subchronic noncancer effects, the exposure concentration is averaged over the period of exposure.

5.3.1 Exposure Setting

The environmental setting at and around the Facility, including climate, geology, hydrogeology, land cover, surface water bodies, water supply and ground water use, is discussed in Section 3, and is not repeated in this section.

5.3.2 Potentially Exposed Populations

As discussed in Sections 2.1 and 3.11, the Facility occupies approximately 130 acres in the City of Oregon, Lucas County, Ohio and currently consists of one active waste disposal cell, located in the southern portion of the property, several closed landfill cells and other

SWMUs/AOCs located in the northern portion of the property. It is reasonably expected that use of the Facility for waste management activities will continue into the future.

Under current conditions at the Facility, the only populations with reasonably expected exposures of potential significance are ESOI Facility workers, and occasional utility maintenance workers. Public access is limited by fencing, security patrols, and warning signs and, as such, trespasser exposure is unlikely.

The off-site areas within approximately one half-mile of the Facility consist of commercial/industrial and residential land use, and current zoning is expected to remain unchanged, as discussed in Section 3.11. As such, the largest potentially exposed populations around the Facility are residents and workers. Additionally, it is possible that people could be exposed to sediment and surface water in Otter Creek during recreational activities.

In summary, the potentially exposed populations at and around the Facility under current and reasonably expected future land use include the following:

On-Site:	ESOI Facility workers
	Maintenance (or occasional construction) workers
	Trespassers
Off-Site:	Routine workers
	Maintenance (or occasional construction) workers
	Recreational visitors
	Residents

5.3.3 Exposure Pathways

The exposure pathways evaluated in the risk assessment are summarized in the conceptual site model shown in Table 5.1. Exposure pathways for on-site receptors are discussed in Section 5.3.3.1, and exposure pathways for off-site receptors are discussed in Section 5.3.3.2.

5.3.3.1 Potential On-Site Exposure

On-site receptors include routine workers, maintenance workers, and trespassers. The types of potential exposures for each receptor are discussed below.

Routine Workers

Current and future routine workers at the ESOI Facility are expected to be engaged in activities that generally take place indoors, but could also involve inspection and maintenance of the closed landfill cells present at the Facility. Currently, these workers follow proper health and safety procedures to minimize exposure as required by ESOI's RCRA Permit. During limited time outdoors, workers could contact soil in unpaved areas. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact and inhalation of soil vapor and airborne particulates. These workers could also have incidental exposure to hazardous constituents in NAPL or leachate if these liquids are encountered at ground surface.

While indoors, these workers could be exposed to constituents in surface and subsurface soil, shallow ground water (characterized in the RFI as either water table or shallow till zone ground water), and NAPL if the constituents were to volatilize and migrate through cracks in building foundations into indoor air.

Exposure of ESOI Facility workers via potable ground water use is not evaluated because ground water is not used as a potable water supply at the Facility. Potable water at and around the Facility is provided by municipal sources, and as discussed in Section 3.12, future potable use is unlikely at the Facility.

Maintenance (or Occasional Construction) Workers

Certain workers at the Facility conduct occasional subsurface construction or maintenance, which could result in contact with surface and subsurface soil. Currently, these workers follow proper health and safety procedures to minimize exposure as required by ESOI's RCRA Permit. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

In excavations that encounter shallow ground water (characterized in the RFI as either water table or shallow till zone ground water), which is typically found at about 10 ft below ground surface at and around the Facility, maintenance workers could be exposed to ground water. Potential routes of exposure would include incidental ingestion, dermal contact and inhalation of vapor.

Maintenance workers also could be exposed to NAPL and NAPL-containing soil in the smear zone in areas where NAPL was encountered during the RFI (i.e., SWMUs 5, 8, 9 and AOC 7). The most potentially significant routes of exposure to NAPL are expected to include dermal contact and inhalation of vapor. Potential routes of exposure to NAPL-containing smear zone soil would include incidental ingestion, inhalation of vapor and dermal contact.

Maintenance workers could be potentially exposed to surface water at the outfalls during occasional maintenance activities that require accessing the Facility's permitted stormwater outfalls. Potential routes of exposure would include dermal contact, incidental ingestion and inhalation of vapor.

Maintenance workers could be potentially exposed to sediment in the ditches north and south of SWMU 5 during occasional maintenance activities. Potential routes of exposure would include incidental ingestion, dermal contact and inhalation of vapor.

Trespassers

Potential exposure of trespassers is possible currently and in the future, although fencing and security deter trespassing. While on-site, trespassers could come into contact with surface soil in unpaved areas. Potential routes of exposure would include incidental ingestion, dermal contact and inhalation of soil vapor and airborne particulates.

Trespasser exposures to soil in this risk assessment are indirectly evaluated using exposure estimates for routine workers. Use of an indirect evaluation streamlines the risk assessment and is conservative because trespasser exposures to soil are expected to be lower than those for the ESOI Facility worker's exposures to surface soil.[12]

Trespassers could be potentially exposed to surface water at the outfalls and sediment in the ditches located both north and south of SWMU 5. Potential routes of exposure for surface water would include ingestion, dermal contact and inhalation of vapor. Potential routes of exposure for sediment would include incidental ingestion and dermal contact. Trespasser exposures to surface water and sediment in this risk assessment are

[12] ESOI Routine Workers are estimated to have outdoor exposures to soil for approximately 30 8-hour days per year for 25 years. In contrast, because of Facility security, adolescent trespassers would be assumed to be on site for less than 1 8-hour day a month over a period of 10 years.

indirectly evaluated using exposure estimates for recreational visitors in Otter Creek, who are expected to have higher exposure than trespassers in on-site ditches. [13]

5.3.3.2 Potential Off-Site Exposure

Off-site receptors include routine workers, maintenance workers, recreational visitors, and residents. The types of potential exposures for each receptor are discussed below.

Routine Workers

Off-site workers could be exposed to constituents in shallow ground water underneath off-site buildings if the constituents volatilize and migrate through cracks in building foundations. These potential exposures are conservatively evaluated in this risk assessment by estimating cumulative cancer risk and HI using maximum concentrations in ground water at the on-site areas that are could migrate off-site.

Exposure to bedrock ground water via potable use is possible since ground water is used within the City of Oregon, Ohio. However, bedrock ground water is not currently contaminated; the potential for future migration of hazardous constituents detected in the lower till zone to bedrock ground water at levels of concern is evaluated in Section 5.5.4.

Presently, no NAPL plume is known to exist off-site beneath any off-site buildings; therefore exposure of offsite routine workers is not considered likely under current conditions. Off-site workers could be exposed to constituents in NAPL present underneath offsite buildings in the future if the constituents volatilize and migrate through cracks in building foundations. Potential exposures are evaluated in this risk assessment by estimating cumulative cancer risk and HI using maximum concentrations in NAPL at the areas that are located at the downgradient edge of the Facility where the NAPL could migrate off-site onto properties where commercial/industrial buildings may be present (e.g., west of SWMU 5).

Maintenance (Occasional Construction) Workers

Off-site maintenance workers performing construction that extends into the ground water could be exposed to constituents in shallow ground water (water table or shallow

[13] Recreational visitors in Otter Creek are assumed to have outdoor exposures to sediment and surface water for 50 days per year for 3 years. In contrast, because of Facility security, adolescent trespassers in the ditches would be assumed to be on site for less than 1 day a month over a period of 10 years.

till zone ground water), in areas where the ground water is within typical excavation depths, which are assumed to be 10 to 15 ft bgs. Potential routes of exposure would include incidental ingestion, dermal contact and inhalation of vapor. These potential exposures are evaluated in this risk assessment in the same way as those for on-site maintenance workers.

Recreational Visitors

Although the properties adjacent and downstream of the ESOI Facility are largely comprised of landfills and industrial/commercial properties, including closed landfills and an active rail yard, it is assumed that hypothetical recreational visitors could be potentially exposed to surface water and sediment in Otter Creek while wading in the creek adjacent to the Facility. Potential routes of exposure for surface water would include dermal contact, incidental water ingestion, and inhalation of vapor. Potential routes of exposure for sediment would include incidental ingestion and dermal contact.

Residents

Off-site residents located south of the Facility (south of the adjacent rail yard) could be exposed to constituents in shallow ground water (water table or shallow till zone ground water) present underneath off-site buildings if the constituents volatilize and migrate through cracks in foundations of potential future buildings. These potential exposures are conservatively evaluated in this risk assessment by estimating cumulative cancer risk and HI using maximum concentrations detected in on-site ground water to represent off-site concentrations.

Exposure to bedrock ground water via potable use is possible since ground water is used within the City of Oregon, Ohio. However, as discussed in Section 4, an Urban Setting Designation has been established for the area downgradient of the Facility limiting the potential for off-site exposure to ground water flowing beneath the Facility. In addition, bedrock ground water is not currently contaminated; the potential for future migration of hazardous constituents detected in the lower till zone to bedrock ground water at levels of concern is evaluated in Section 5.5.4.

Presently, no NAPL plume is known to extend off-site beneath any off-site buildings; therefore current exposure of off-site residents is not possible under current conditions. NAPL from SWMU 5, SWMU 8, or AOC 7 is not likely to migrate in the future below any residential buildings located south of the Facility and south of the rail yard in the future.

Off-site receptors also could be exposed to constituents in soil that are transported off-site by wind erosion or vapors that migrate off-site. These potential exposures are conservatively evaluated by estimating cumulative cancer risk and HI for residential receptors via inhalation of vapor and particulates using the maximum detected concentrations in on-site soil. In addition, on the east side of SWMU 6 (the NSL), off-site receptors could be exposed to constituents in surface soil to the extent contamination extends off-site in soils. For the purpose of this risk assessment, it is assumed that a hypothetical resident is present on the east side of SWMU 6, and this hypothetical resident may be exposed to soil via direct contact, inhalation and dermal contact. These potential exposures are evaluated in this risk assessment by estimating cumulative cancer risk and HI using maximum constituent concentrations reported in on-Facility soils along the east side of SWMU 6.

5.3.4 Selection of Exposure Concentrations

Soil

Exposures are conservatively estimated in this risk assessment by first using the maximum detected concentrations at any depth in each area to calculate upper bound estimates of cumulative cancer and noncancer risks for each area. If these upper bound estimates of risks are compared with USEPA's cumulative cancer and noncancer risk triggers for corrective measures (i.e., cumulative Site-related cancer risk of 10^{-4} and noncancer hazard index (HI) of 1). In addition, based on discussions with Ohio EPA, the cumulative cancer risk and HI estimates for each receptor population are also compared with Ohio EPA's preferred cumulative cancer risk level of 10^{-5} and HI limit of 1, respectively; if upper bound risks are below these levels, then further calculations are not necessary. Otherwise, further assessment is conducted to determine the potential for corrective measures.

For areas where upper bound risk estimates trigger further evaluation, the risk estimates may be refined using more representative exposure concentrations for those constituents contributing most significantly to the risk estimate. As recommended by USEPA, these exposure concentrations can be represented by the 95% upper confidence limit (UCL) on the mean concentration (USEPA 1992c). In cases where a refined exposure concentration is estimated as a 95% UCL on the mean concentration, the 95% UCL is calculated using a nonparametric bootstrap method known as the BCa (bias-corrected and accelerated) method (Efron and Tibshirani 1998) with 4,000 bootstrap replications to ensure adequate accuracy.

Like all nonparametric methods, this nonparametric bootstrap method does not require identification of a probability distribution for the data and are reliable for a wide range of distributions including normal and lognormal data (USEPA 1997b). Current USEPA guidance now recommends the use of nonparametric methods (including nonparametric bootstrap methods) in favor of methods recommended in older guidance, especially for situations where the probability distribution of a data set is not normal or is difficult to identify.

The resultant risk estimates are considered high end values since they are still based on the use of maximum detected concentrations for other constituents present in soil at a SWMU or AOC. The use of maximum concentrations for many constituents introduces more conservatism than necessary for risk estimates because it assumes constant simultaneous worst-case exposure to many constituents, when the reasonable maximum exposure (RME) generally would not have so many constituents at worst-case concentrations at all times. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

Shallow Ground Water

To assess potential exposures to shallow ground water under current and future conditions, the maximum detected concentration from the RFI sampling for each constituent from each on-site and off-site well screened in the water table and shallow till ground water zones were used in the risk assessment. There is currently no complete exposure pathway to ground water in deeper well zones, because these are beyond the depth to which workers are expected to excavate at the site (about 10 feet), and vapor migration from deeper well zones is overlain by ground water in the shallow till/lacustrine zone, which prohibits vapor migration from deeper zones to the surface. Further, the deeper till zone is not identified as a source of potable water. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

Bedrock Ground Water

As discussed in Section 4, bedrock ground water is not contaminated by site-related constituents. The potential for bedrock ground water to be impacted at levels of concern in the future as a result of hazardous constituent migration from the deep till zone is evaluated in Section 5.5.4. To assess potential exposures to bedrock ground water impacted by contaminants in deep till ground water under future conditions, the maximum detected concentration from the RFI sampling for each constituent from each on-site well screened in the deep till ground water zone were used in the risk assessment.

Outfall and Trench Water

To assess potential exposures to outfall and trench water under current and potential future conditions, the maximum concentrations for detected constituents in outfall water and trench water were used. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

Sediment and Surface Water

To assess potential exposures to surface water and sediment under current conditions, the maximum concentrations for detected constituents in surface water and sediment were used. In addition, the significance of discharges of shallow ground water to surface water where exposures may occur is also assessed in this risk assessment (see Section 5.5.3). To assess potential exposures to surface water impacted by contaminants in shallow till and water table zone ground water under future conditions, the maximum detected concentration from the RFI sampling for each constituent from each on-site and off-site well screened in the water table and shallow till were used in the risk assessment. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

NAPL and Smear Zone Soil

To assess potential exposures to NAPL and smear zone soil, the maximum concentrations among the samples collected in each SWMU or AOC were used for all detected constituents. These NAPL characterization data are summarized in Table 4.7a. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

Leachate

To assess potential exposures to surface seeps observed at SMWU 6 where on-site surficial exposures may occur, the maximum concentrations in leachate at this SWMU were conservatively used for all detected constituents. These leachate characterization data are summarized in Table 4.8. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.5.

5.3.5 Fate and Transport Models

The following fate and transport models are used in the baseline risk assessment to estimate exposure concentrations for the exposure scenarios discussed in Section 5.3.1. These models are used by USEPA and state regulatory agencies for screening-level analysis. The following are brief descriptions of the models. Further details of these models are provided in Appendix E.

Vapor Intrusion into Buildings

Indoor air concentrations resulting from migration of vapors from soil or ground water into a building are estimated using the model described by Johnson and Ettinger (1991), which USEPA recommends for screening-level evaluations (USEPA 2004a). The vapor intrusion scenario for on-site and off-site workers is conservatively based on Michigan Department of Environmental Quality (MDEQ) guidance for deriving generic vapor intrusion criteria for commercial/industrial buildings.[14] The vapor intrusion calculations for soil included a mass balance check to ensure that the assumed mass of a chemical infiltrating into the building over the assumed exposure period does not exceed an upper-bound estimate of the chemical's mass in the vadose zone soil underlying the building. The values used in this risk assessment for soil-related parameters are conservatively based on "silty clay" as the soil type, based on the predominant soil type in the vadose zone at the Facility. For an off-site residential scenario, the significance of assumed vapor intrusion from shallow ground water was assessed in the same way as for on-site areas, except the calculations were based on residential building parameters. A discussion of the model and the input parameters used in the assessment is provided in Appendix E.

[14] The generic assumptions used by MDEQ are believed to be conservative for current and future buildings at the Facility and current buildings off site. Neither Ohio EPA nor USEPA has developed assumptions for evaluating vapor intrusion from soil or ground water into hypothetical commercial/industrial buildings.

Vapor Emission from Exposed Water

The model for estimating vapor emissions from exposed water surfaces in excavations is based on mass-transfer coefficients recommended in USEPA guidance (USEPA 1995a). Discussions of the model and the input parameters used in the assessment for exposed subsurface water in excavations are provided in Appendix E.

Vapor Emission from Exposed Soil

Vapor emissions from exposed soil are estimated using the Jury model (Jury et al. 1983), based on depletion over time of soil initially contaminated from the surface to an infinite depth. A discussion of the model, adapted by USEPA for screening-level calculations (USEPA 1996a), is provided in Appendix E.

Vapor Emission from NAPL

Vapor emissions from exposed NAPL is estimated using Raoult's Law and mass transfer coefficients from the "oil film surface emission model" (USEPA 1987). A discussion of the model and the input parameters used in the calculation is provided in Appendix E.

Particulate Emissions

Emission of respirable soil particulates (PM_{10}) for routine worker and resident exposures to outdoor soil are calculated using the wind-erosion model recommended by USEPA (1996a) with USEPA-default soil parameters and Site-specific wind speed (NOAA 2004).

Emission and dispersion modeling were not used to estimate airborne dust concentrations for maintenance/construction activities, because such activities are required to ensure that dust levels do not exceed air standards for dust. Specifically, it is expected that dust concentrations will comply with the National Ambient Air Quality Standards (NAAQS). The annual average NAAQS for PM_{10} (50 ug/m^3) is used in the assessment of maintenance worker exposures. It was conservatively assumed that the PM_{10} concentration would be at these limits every day for the entire assumed periods of exposure. The annual average NAAQS is more appropriate than the 24-hour average NAAQS, as meeting the 24-hour limit for 60 days per year would likely result in the annual average concentrations over 50 ug/m^3.

Air Dispersion

Air concentrations from soil and ground water emissions are conservatively estimated using USEPA's empirical correlation for estimating annual-average, on-source, ground-level concentrations (USEPA 2002). The correlation was applied conservatively assuming a square source areas for each receptor as follows: maintenance (occasional construction) workers are based on a 15 by 15 foot excavation (a square source using the approximate length of the longer side [5 meters] of the excavation that is cited in ESOI's ACL model); routine workers and residents are based on 40 acres (the approximate area of SWMUs 1, 5, 6, 7, 8, and 9 located north of York Street). Air concentrations for assessing hypothetical exposures to surficial NAPL and leachate are based on a 15 x 15 foot area representing the extent of exposed NAPL and leachate. Correlation coefficients for the Cleveland, Ohio meteorological area were used in the calculation of air dispersion.

For the maintenance worker scenarios, the maximum 1-hour air concentrations are converted to maximum 24-hour average air concentrations using a conservative factor of 0.4 (USEPA 1995b). For the routine worker and resident scenarios, the maximum 1-hour air concentrations are converted to maximum annual average air concentrations using a conservative factor of 0.08 (USEPA 1995b). The air concentrations estimated in this approach are conservative (i.e., expected to predict higher concentrations than the actual air concentrations to which receptors would be exposed).

Steady-State Mass Loading

The significance of potential exposures to constituents that could potentially migrate from shallow ground water to Otter Creek was evaluated using a mass balance approach to estimate the steady-state mass loading to surface water. This evaluation was conservatively based on the estimated rate at which shallow ground water discharges to the Creek, taking into consideration Facility-specific hydraulic conductivity of this water bearing zone, the observed hydraulic gradients, and the saturated thickness of this zone. These predicted Creek concentrations are considered conservative upper-bound estimates since the evaluation (1) assumed infinite mass of contamination to the shallow ground water, (2) did not include fate and transport mechanisms (e.g., degradation and/or dispersion) that would reduce ground water concentrations prior to reaching the Creek, and (3) assumed the maximum concentration detected in ground water would enter the Creek along the full length of the discharge zone. A discussion of the modeling approach and the input parameters used in the calculations is provided in Appendix C6.

Vertical Migration

To assess the potential significance of constituents that could potentially migrate from the till zones to the bedrock aquifer where future exposures could occur via potable use of bedrock ground water, future concentrations in the bedrock aquifer are estimated utilizing the fate and transport modeling approach developed for ESOI's ACL model (ESOI 2006b). The ACL model is based on the application of an appropriate solution to the one-dimensional advection-dispersion equation to determine the generic DAF for each constituent. The maximum concentration of each constituent exceeding drinking water criteria in till zone ground water is then divided by the DAF to yield the maximum concentration of the constituent that will reach the bedrock aquifer. Dilution and attenuation is assumed to occur once the constituent reaches the bedrock aquifer prior to reaching a receptor (i.e., potable well); the DAF in the bedrock zone is estimated based on the volumetric flow in the upper 10-feet of the bedrock zone. The potential health risk associated with that concentration is then estimated based on exposure to the ground water at a downgradient point. A discussion of the modeling approach and the input parameters used in the calculations is provided in Appendix C6.

5.3.6 Estimation of Intakes

In this risk assessment, standard default exposure factors recommended by USEPA for estimating reasonable maximum exposures for the exposure scenarios summarized in the CSM and discussed in Section 5.3.3 are used where available and appropriate. Where standard default exposure factors are not available or not appropriate for an exposure scenario, the evaluation is conducted using similarly conservative exposure factors that are based on site-specific considerations and professional judgment. The standard default and similarly conservative exposure factors are summarized in Table 5.2 and discussed further below.

5.3.6.1 ESOI Facility Workers

In this risk assessment, potential exposure of routine workers to soil is evaluated using a combination of standard default (recommended by USEPA 1991a) and site-specific exposure factors that were agreed upon by Ohio EPA and ESOI prior to completion of the RFI field activities (Ohio EPA 2006a). In developing these site-specific exposure factors, ESOI performed a survey of activities necessary to maintain the Facility during the RCRA post-closure period and from this information estimated the likely frequency of exposure for four worker populations at the Facility during 30-years of post-closure monitoring and maintenance. The estimates of exposure frequency for the most significantly exposed population are used to represent all ESOI Facility workers for a duration of 25-years. All other exposure factors are standard default values recommended by USEPA. According to USEPA, the standard default exposure factors are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are intended to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of a potentially exposed population.

Soil Ingestion Rate

A soil ingestion rate of 50 mg/day is used for routine workers. USEPA has recommended the use of this value for evaluating high-end routine worker exposures to soil (USEPA 1991a).

Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin area of 3,300 cm^2 and the soil-to-skin adherence factor of 0.2 mg/cm^2 are the USEPA-recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings (USEPA 2004b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA 2004b).

Exposure Frequency

The exposure frequency (EF) of 30 days/year is based on a review of worker activities (i.e., type and frequency of outdoor activities) at the ESOI Facility, as shown in Attachment 1 of the documentation of On-Facility Routine Worker Screening Criteria Development (ESOI 2006b; see Appendix G). This exposure frequency is based on the job duties identified for ESOI's "Worker Category B", which represents the highest annual outdoor exposure time estimated for the four worker categories associated with ESOI's operations. To be conservative, the time associated with this worker was rounded up to 30 days/year, increasing the exposure frequency by more than 30% over the highest estimated individual worker exposure time.

Exposure Duration

The exposure frequency (ED) of 25 years is the value recommended by USEPA for evaluating high-end routine worker exposures (USEPA 1991a).

Body Weight

The body weight of 70 kg is the standard USEPA-recommended body weight for assessing exposure to adults (USEPA 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989).

In this risk assessment, the risk estimates for ESOI Facility workers are used to evaluate potential exposures of adolescent trespassers to soil because the exposure to these receptors are expected to be lower than those evaluated for the ESOI Facility worker, as discussed in Section 5.3.3.1.

5.3.6.2 Maintenance Workers

The exposure factors used for evaluating potential exposure of maintenance (occasional construction) workers to soil, smear zone soil, ground water, and NAPL during excavations associated with occasional maintenance or construction activities are as follows:

Soil and Smear Zone Soil Ingestion Rate

A soil ingestion rate of 200 mg/day is used for workers performing maintenance work that involves excavation into soil. This rate is lower than the 480 mg/day that is often cited as USEPA's recommended soil ingestion rate for excavation or construction scenarios (USEPA 1991a). However, the 480 mg/day rate is based on an assumption regarding soil adherence to hands that has been shown in USEPA-funded field studies to overestimate (by 3 to 4-fold) soil adherence to hands during various excavation and construction activities. Replacing the earlier soil adherence assumption with soil adherence data from the USEPA-funded studies (USEPA 1997b) would give a soil ingestion rate of approximately 120 mg/kg to 160 mg/kg. Therefore, using a rate of 200 mg/kg is conservative.

Soil and Smear Zone Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin area of 4,640 cm^2 based on the input assumptions specified in ESOI's ACL model, and the soil-to-skin adherence factor of

0.2 mg/cm^2 which is the USEPA-recommended adherence factor for evaluating high-end contact with soil by workers in industrial settings (USEPA 2004b). The exposed skin area in the ACL model is higher than the USEPA-recommended exposed skin surface area for evaluating high-end contact with soil by workers in industrial settings (USEPA 2004b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA 2004b).

Ground Water Ingestion Rate

A rate of 0.005 L/hour is used for incidental ingestion of ground water during construction work in excavations that extend into ground water. This rate is 10% of the rate that USEPA (1989) recommends for ingestion while swimming, and represents a very conservative estimate of incidental ground water ingestion that could occur while workers are in an excavation pit.

Ground Water and NAPL Dermal Contact Rates

The exposed skin surface area of 4,640 cm^2 is based on the input assumptions specified in ESOI's ACL model. This value is higher than the USEPA-recommended exposed skin surface area for evaluating high-end contact with soil by workers in industrial settings (USEPA 2004b). Workers are conservatively assumed to be covered with ground water or NAPL over this exposed skin surface area for 2 hours per event. The absorbed dose for organic chemicals is estimated using a nonsteady-state approach (USEPA 2004b), which is more conservative than the steady-state approach (USEPA 1989), particularly for hydrophobic chemicals. The permeability coefficient (K_p) for dermal absorption from ground water and NAPL are estimated following USEPA guidance (1992a, 2004b).

Exposure Frequency and Duration

The number of days of maintenance-related construction that involves actual excavation into the water table is assumed to be 60 days, which is assumed to occur at a frequency of 60 days/year for a period of 1 year. This combination of exposure frequency and exposure duration is based on ESOI's ACL model and is expected to be conservative for the amount of time that workers are actually in contact with ground water and NAPL (as opposed to the total time for maintenance or construction, which typically includes time not associated with excavation).

Body Weight

The body weight of 70 kg is the standard USEPA-recommended body weight for assessing exposure to adults (USEPA 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989).

5.3.6.3 Recreational Visitors

This section discusses the high-end exposure factors associated with the incidental exposure of recreational visitors to sediment and surface water in Otter Creek. These recreational visitors are assumed to consist primarily of off-site residents.

Sediment Ingestion Rate

An ingestion rate of 50 mg/day is used for assessing exposure of recreational visitors. This is the value specified in the ACL Model, which is also the value USEPA has recommended the use of this value for evaluating high-end routine worker exposures to soil (USEPA 1991a).

Incidental Water Ingestion

A rate of 0.01 L/hour is used for incidental ingestion of surface water, as specified in the ACL Model.

Dermal Contact Rate

For dermal exposures with chemicals in water, the dermal contact rate is the product of the exposed skin surface area, a chemical-specific K_p, and the exposure time. The exposed skin surface area of 9,918 cm^2 is a conservative full-body skin area for high-end contact with water by adolescents, as specified in ESOI's ACL Model, which is higher than the median full-body skin areas for evaluating high-end contact with water by children (USEPA 1997b). The absorbed dose for organic chemicals is estimated using the nonsteady-state approach (USEPA 2004b). The K_p for dermal absorption of organic chemicals from ground water is estimated following USEPA guidance (USEPA 1992a, 2004b).

The dermal contact rate for sediment is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin area is 9,918 cm^2 as discussed above for water, and the soil-to-skin adherence factor of 0.2 mg/cm^2 is the USEPA-recommended adherence factor for evaluating high-end contact with soil (USEPA 2004b). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by USEPA-recommended absorption factors for absorption from soil (USEPA 2004b).

Exposure Frequency, Time and Duration

The assumed exposure frequency, time and duration of exposure for recreational visitors to sediments and surface water is 50 days/year for 2 hours per day for 3 years, as specified in the ESOI's ACL Model.

Body Weight

The body weight of 48.7 kg is used for an adolescent recreational visitor, per ESOI's ACL Model.

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (USEPA 1989a).

5.3.6.4 Trespassers

Although access to the Facility is restricted by fencing, individuals may contact soil, sediment, and surface water during occasional trespassing. However, adolescent trespasser exposures to soil are expected to be less than the ESOI Facility worker exposures evaluated using the exposure factors in Section 5.3.6.1; therefore, quantitative evaluation of trespassers' exposure to soil is unnecessary. Additionally, trespasser exposures to sediment and surface water are expected to be less than or equivalent to the recreational visitor exposures evaluated using the exposure factors in Section 5.3.6.3; therefore, quantitative evaluation of trespassers' exposure to sediment and surface water is unnecessary.[15]

5.4 Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals, and determines the dose-response relationship between exposure and the occurrence of adverse effects. The toxicity values used in deriving site-specific soil, ground water, outfall water, surface water, and sediment screening criteria, and the associated estimates of cumulative cancer and noncancer risks for all matrices evaluated in this risk assessment, were compiled from USEPA's hierarchy of sources, as follows:

1. Integrated Risk Information System (IRIS);
2. Provisional Peer Reviewed Toxicity Values (PPRTV); and
3. Other Toxicity Values (e.g., historical HEAST and NCEA provisional values).

When a toxicity value was not available from the first two tiers of the hierarchy, other USEPA and non-USEPA sources of toxicity values were consulted. The toxicity values used in the risk assessment and their sources are summarized in Appendix E and are discussed below.

5.4.1 Cancer Toxicity Values

USEPA considers chemicals belonging to the following USEPA cancer weight-of-evidence groups as human carcinogens:

Group A	Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans
Group B1	Probable Human Carcinogen: Limited evidence of carcinogenicity in humans
Group B2	Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans
Group C	Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans

[15] For trespassers, the calculated intakes are approximately 1.25 to 5 lower than those for a ESOI Routine Worker or a Recreational Visitor.

As shown in Appendix E, USEPA has designated some of the constituents as Group B2 or Group C, which means that USEPA acknowledges that there is either inadequate evidence or a lack of evidence that these constituents actually cause cancer in humans. Therefore, evaluating these constituents as human carcinogens in the risk assessment is conservative.

USEPA-derived cancer slope factors (SFs) and inhalation unit risk factors (URFs) for these constituents and their sources are shown in Appendix E. The oral SFs and URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose. As recognized by USEPA, there is significant scientific evidence that some of the SFs and URFs may be overly conservative and may ignore the potential existence of threshold doses. Nonetheless, they are used here as conservative assessment tools.

5.4.2 Noncancer Toxicity Values

USEPA-derived chronic reference doses (RfDs) and chronic inhalation reference concentrations (RfCs) and their sources are shown in Appendix E. Subchronic RfDs and RfCs are also used in the risk assessment for evaluating the subchronic exposures associated with the maintenance worker scenario. These values and their sources are included in Appendix E.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects during a lifetime. These RfDs and RfCs typically incorporate several safety factors to account for uncertainties in their derivation, which in combination often result in overall uncertainty factors of 1,000 or more. Furthermore, for many constituents, there is significant scientific debate about the validity of these RfDs and RfCs, and the association of these doses and concentrations to potential adverse health consequences. Nonetheless, the RfDs and RfCs are used here as conservative assessment tools.

5.4.3 Extrapolation of Toxicity Values

The USEPA sources of toxicity values listed above do not provide dermal toxicity values for any of the constituents. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values, where appropriate, are made in this route-to-route extrapolation following USEPA guidance (USEPA 2003b).

The USEPA sources of toxicity values listed above do not provide inhalation toxicity values (URFs and RfCs) for all of the constituents. For a constituent that has no inhalation toxicity values, the oral SF and/or RfD, if available, is converted to an URF and/or RfC using default USEPA assumptions (USEPA 1997a).

Uncertainties introduced by using extrapolated toxicity values are discussed in Section 5.5.5.

5.5 Risk Characterization

The health significance of the potential exposures identified in Section 5.3 is discussed in the following subsections. Section 5.5.1 describes the methods for quantifying cancer risks and noncancer hazard indices. Section 5.5.2 discusses the risk estimates and the significance of the potential exposures. Uncertainties in the risk evaluation are discussed in Section 5.5.5.

5.5.1 Cancer Risk and Noncancer Hazard Index

The cancer risk associated with potential exposure to a carcinogenic chemical via ingestion and dermal contact is calculated by multiplying an estimate of the lifetime average daily dose (LADD) for a particular exposure scenario by the cancer slope factor (SF) for the chemical, as follows:

$$Risk = LADD \cdot SF$$

For the inhalation route, the cancer risk is calculated using the chemical concentration in air (C_{air}) and the URF, as follows:

$$Risk = C_{air} \cdot URF \cdot \frac{EF \cdot ED}{AT}$$

where EF is exposure frequency, ED is exposure duration, and AT is averaging time.

The noncancer hazard quotient (HQ) associated with potential exposure via ingestion and dermal contact to a chemical being evaluated for potential noncarcinogenic health effects is calculated by dividing an estimate of the average daily dose (ADD) for a particular exposure scenario by the reference dose (RfD) for the chemical, as follows:

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

For the inhalation route, the HQ is calculated using C_{air} and the RfC, as follows:

$$HQ = \frac{C_{air}}{RfC} \cdot \frac{EF \cdot ED}{AT}$$

The potential cancer risk and noncancer effects that may result from exposure to the combination of constituents at an area are estimated following USEPA guidance (USEPA 1989), as follows:

$$Cumulative\ Risk = \sum_i Risk_i$$

$$Hazard\ Index = \sum_i HQ_i$$

where:

$Risk_i$	=	estimated cancer risk for the *i*th constituent
HQ_i	=	hazard quotient for the *i*th constituent

This approach may result in estimates of cumulative cancer and noncancer risks that are more conservative than necessary. For example, different chemicals may cause different and unrelated non-cancer health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effects. Nonetheless, this approach is used here as a conservative assessment tool.

The cumulative cancer risk and HI estimates for each receptor population are compared with USEPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively, for determining whether a site warrants corrective measures (61 *Federal Register* 19432, May 1, 1996; USEPA 1991b). Based on discussions with Ohio EPA, the cumulative cancer risk and HI estimates for each receptor population are also compared with Ohio EPA's preferred cumulative cancer risk level of 10^{-5} and HI limit of 1, respectively. The risk estimates and results of the comparison to the USEPA-established limits and Ohio EPA's preferred limits are discussed in the following sections.

5.5.2 Risk Characterization for Potentially Exposed Populations

5.5.2.1 ESOI Facility Workers

The significance of risks associated with potential exposure of ESOI Facility workers to on-site soil, ground water, NAPL and leachate is discussed below.

Soil

Site-related cumulative cancer risk and HI estimates were calculated for each investigated area, using the exposure factors noted above, along with appropriate toxicity values and physical/chemical property values for the chemicals. The initial bounding estimates of cumulative cancer and noncancer risks for exposure to soil for each of the SWMUs and AOCs are summarized on Table 5.3; all estimates are shown with one significant digit per USEPA convention. These calculations considered all detected constituents, except lead, which was evaluated separately, as discussed below. These estimates are considered bounding estimates because the RME risks for any of the areas would be lower if representative exposure concentrations were used for each area. Further information regarding the detailed basis for these calculations is provided in Appendix E.

The bounding estimates of site-related cumulative cancer and noncancer risks for each of the areas were compared to USEPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively. Ohio EPA's preferred cancer risk level of 10^{-5} was also considered in the evaluation. For an area where the upper-bound estimate of either cancer risk or HI was higher than the USEPA or Ohio EPA limits, refined calculations were conducted, as appropriate.

The results in Table 5.3 show that there are no areas with potentially significant cumulative cancer risk estimates for ESOI Facility workers, when compared with USEPA's cancer risk limit of 10^{-4}. However, when considering Ohio EPA's preferred cancer risk level of 10^{-5}, there are two areas (SWMU 5 and SWMU 9) where the cumulative upper bound cancer risk estimate could be considered potentially significant. No areas have a HI estimate higher than 1 for the ESOI Facility worker.

The significance of potential exposure to soil at SWMU 5 and SWMU 9 was further evaluated, as follows:

- The detected concentrations of benzo(a)pyrene and arsenic in subsurface soil samples accounted for cumulative cancer risk estimate ($8x10^{-5}$) at SWMU 5. The maximum benzo(a)pyrene concentration (and concentrations of other PAHs) was detected at T-26S at a depth of 4-6 ft bgs. This location was subsequently delineated and found to be limited to subsurface contamination. The detected arsenic concentration that contributed significantly to the cumulative cancer risk estimates was also found in subsurface samples at depths below 4 ft bgs. As discussed in Section 4.5, the deeper arsenic concentrations are found in a peat layer which is unlikely associated with former activities at the Facility. Based on the depth of these detected concentrations, ESOI Facility workers are not expected to come into contact with the soil at these locations currently or in the future, and potential exposures are more appropriately evaluated under a maintenance worker scenario (discussed below). The refined estimated risks for routine worker exposures to surface soil at SWMU 5 is $3x10^{-6}$, as shown on Table 5.12a. This hypothetical risk is below the levels specified by Ohio EPA and USEPA for trigging corrective measures.

- The maximum detected concentration of benzo(a)pyrene accounted for most of the cumulative cancer risk of $2x10^{-5}$ estimated at SWMU 9. This concentration was detected in the surface soil sample at location S9-51. Additional samples were collected to delineate the benzo(a)pyrene to within approximately 30 feet of the original location. The refined cumulative cancer risk for ESOI Facility workers' exposure to soil after replacing the maximum detected benzo(a)pyrene concentration with the 95% UCL concentrations is $3x10^{-6}$ (see Table 5.12b), which is below Ohio EPA's preferred cumulative cancer risk level.

Based on this risk analysis, potential exposures to constituents in on-site surface soils do not pose a significant risk to on-site ESOI Facility workers. Further information regarding the detailed basis for these refined calculations is provided in Appendix E.

The soil lead data were evaluated separately, since USEPA guidance recommends evaluating lead exposures based on blood lead rather than cancer risk or HI. For risk characterization regarding potential worker exposures to lead in surface soil, the soil lead data collected during the RFI were compared to the USEPA-recommended range of screening criteria for industrial workers, which is 750 mg/kg to 1,750 mg/kg (USEPA 2003a). These soil criteria are intended to protect workers that include child-bearing age women, and are based upon an assumed exposure frequency of 219 days per year. RFI soil sampling results for lead are summarized on Table 5.4. The results show that only two areas (SWMU 5 and SWMU 8) have maximum lead concentrations from any depth higher than 750 mg/kg, which is the low-end of USEPA's range of screening criterion. The significance of potential exposure at these two areas was further evaluated, as follows:

- The location at SWMU 5 where the detected concentration of lead in soil (concentration of 1,000 mg/kg) was within the range of the screening criterion was from a 12-14 ft bgs sample. Based on the depth of this concentration, ESOI Facility workers are not expected to come into contact with the soil at this area and potential exposures to lead at this location are more appropriately evaluated under a maintenance worker scenario. In addition, as shown on Table 5.4, the arithmetic average concentration of lead in soil at SWMU 5 is less than 100 mg/kg, which is much less than USEPA's average protective level of approximately 1,000 mg/kg. Further, it is noted that the lead screening criterion assumes that workers contact soil for 219 days/year, which is significantly more than assumed for routine worker exposure. Therefore, significant exposure of ESOI workers is not expected given the depth of the sample, the average exposure concentration is less than 1,000 mg/kg, the shorter exposure of routine workers, and that the location has been delineated to a small area (within 40 ft).

- At SWMU 8, the maximum lead concentration of 1,700 mg/kg is in the surface soil (0 to 0.5 ft bgs) sample from location T-53S. The lead concentration in the surface soil (0 to 0.5 ft bgs) samples from approximately 30 feet away at borings S8-201 and S8-202 are 383 mg/kg and 118 mg/kg, respectively (see Figure 4.8). These data show that the elevated lead concentration at T-53S is limited in extent. The mean surface lead concentration in this area is 733 mg/kg and the mean lead concentration in all SWMU 8 soils is 78 mg/kg (see Table 5.4), which is below USEPA's range of criterion. Therefore, potential routine worker exposure to lead in soil at SWMU 8 is not expected to be significant.

Potential exposure of ESOI Facility workers to exposed constituents in soil that are assumed to volatilize and migrate through foundation cracks into the indoor air of a building was first evaluated using upper bound estimates of RME cumulative cancer and noncancer risks to streamline the risk assessment, as explained in Section 5.3.4. The initial estimates were calculated using maximum Site-related concentrations for all constituents detected in soil at an area. These estimates are considered bounding estimates because the RME risks for an area would be lower if concentrations representative of the area were used instead of maximum concentrations, and if Site-specific exposure factors were used to account for the magnitude, frequency, and duration of exposures appropriate for the area. Details of the vapor intrusion modeling calculations are provided in Appendix E.

The estimates of cumulative cancer and noncancer risks for each area are summarized on Table 5.3. These calculations considered all detected volatile constituents. The results in Table 5.3 show that there are no areas with potentially significant cumulative cancer risk or HI estimates for routine indoor workers due to vapor intrusion. The cumulative cancer risk and HI estimates are at or below both USEPA's risk limits and Ohio EPA's preferred risk limits.

In addition, since indoor air quality at the Facility is subject to requirements under Occupational Safety and Health Administration (OSHA) programs, the predicted indoor air concentrations are evaluated using OSHA permissible exposure limits (PELs) or other occupational inhalation standards for chemicals that do not have PELs. As shown on Table 5.3, the predicted the equivalent indoor air concentrations for the vapor mixture from soil volatilization to indoor air are also below occupational standards; exposure is within acceptable limits when an equivalent exposure for the mixture, E_{m}, given by the following:

$$E_m = \sum_i \frac{C_{air,i}}{L_i}$$

does not exceed 1, where $C_{air,\,i}$ and L_i are the indoor air concentration and exposure limit for chemical i, respectively.

<u>Ground Water</u>

As discussed in Section 5.2, the ground water characterization data collected from water table and shallow till zone monitoring wells were evaluated using upper bound estimates of RME cumulative cancer and noncancer risks associated with direct contact exposures and exposures via vapor intrusion to streamline the risk assessment. The initial estimates were calculated using maximum concentrations for all constituents detected in shallow ground water at an investigated area. Details of the vapor intrusion modeling calculations are provided in Appendix E. The upper bound estimates of Site-related cumulative cancer and noncancer risks are summarized on Table 5.5. As indicated on Table 5.5, the upper bound cumulative cancer risk and HI estimates are at or below both USEPA's risk limits and Ohio EPA's preferred risk limits for the vapor intrusion pathway.

In addition, since indoor air quality at the Facility is subject to requirements under OSHA, the predicted indoor air concentrations are evaluated using OSHA permissible exposure limits (PELs) or other occupational inhalation standards for chemicals that do not have PELs. As shown on Table 5.5, the predicted the equivalent indoor air concentrations for the vapor mixture from ground water volatilization to indoor air are also below occupational standards (exposure is within acceptable limits when E_m does not exceed 1).

Exposures of routine workers via potable ground water use is not currently expected because ground water is not currently used as a drinking water supply on the Facility and future potable use of ground water on the Facility is not reasonably expected.

<u>NAPL</u>

The estimates of cumulative cancer risk and HI for potential exposure of routine workers to constituents in NAPL via direct contact with exposed NAPL are summarized on Table 5.6a. Table 5.6a shows that risk estimates from potential exposure to NAPL exceed both USEPA's risk limits and Ohio EPA's preferred risk level at all areas where NAPL was identified. The HI estimate at AOC 7 exceeds USEPA's limit for potential direct contact exposure to NAPL at this area. However, NAPL at this area is found only within "Butz Crock" and routine workers are not expected to contact this NAPL at the frequency and duration assumed for routine workers. The cancer risk estimate at SWMU 5 exceeds only Ohio EPA's preferred cumulative cancer risk level and USEPA's HI limit for potential direct contact exposure to NAPL at this area. However, NAPL at this area is found in subsurface soils at depths greater than 4-feet bgs and therefore, surficial exposures are not reasonable expected. Because the NAPL at AOC 7 and SWMU 5 is inaccessible to routine workers, the risk estimates are considered hypothetical since actual exposure is not expected to occur. The cancer risk estimate at SWMU 8 exceeds only Ohio EPA's preferred cumulative cancer risk level and the HI estimates exceeds USEPA's HI limit for potential direct contact exposure to NAPL at T-33S (SWMU 8-1) and TLW-202 (SWMU 8-2). The cancer risk and HI estimates at SWMU 9 exceeds exceed both USEPA's risk limits and Ohio EPA's preferred risk level and the HI estimates exceeds USEPA's HI limit for potential direct contact exposure to NAPL. However, observations made during the RFI indicate that the areas where NAPL is occasionally found at the surface at SWMU 8 and SWMU 9 are each less than the 15-ft by 15-ft size assumed for this risk assessment. Because these areas of exposed NAPL at SWMU 8 and SWMU 9 are very small, these risk estimates are likely overstated; i.e., ESOI Facility worker are expected to come into contact with NAPL only by chance (e.g., no more than 5 days), as opposed to the 30 days of exposure each year assumed in these risk estimates.

The upper bound estimates of cumulative cancer risk and HI for potential exposure of routine workers to constituents in NAPL detected at SWMU 8 and hypothetical exposures at SWMU 5 via vapors intrusion into indoor air are summarized on Table 5.6c. As indicated on Table 5.6c upper bound risk estimates for potential exposure to NAPL via vapor intrusion are at or below both USEPA's risk limits and Ohio EPA's preferred risk levels. Potential vapor intrusion exposures at AOC 7 and SWMU 9 are not evaluated as there is no potential for current or future vapor intrusion at these areas.

In addition, since indoor air quality at the Facility is subject to requirements under OSHA programs, the predicted indoor air concentrations are evaluated using OSHA PELs or other occupational inhalation standards for chemicals that do not have PELs. As shown on Table 5.6c, the predicted the equivalent indoor air concentrations for the vapor mixture from NAPL volatilization to indoor air are also below occupational standards (exposure is within acceptable limits when E_m does not exceed 1).

Leachate

The estimates of cumulative cancer risk and HI for potential exposure of routine workers to constituents in leachate at SWMU 6 via direct contact with exposed leachate are summarized on Table 5.7. As indicated on Table 5.7 the upper bound risk estimates from potential exposure to leachate exceed USEPA's risk limits for cancer risk and HI. However, the area where seepage has been observed is small relative to the area covered by the routine workers. The area of SWMU 6 is only 10% of the total site area and the area of SWMU 6 where seepage was observed at the surface is less than 25% of SWMU 6. Therefore, the area where leachate is found at the surface is less than 2.5% of the total site area assumed for a routine worker outdoor exposure. Scaling the risk estimates for the actual area of potential leachate seepage results in cumulative cancer risk and HI estimates of $6x10^{-6}$ and 0.2 respectively, which are below Ohio EPA's preferred risk levels. Additionally, these risk estimates likely overstate actual ESOI Facility worker exposures as (1) the seepage is likely comprised of stormwater rather than leachate, and (2) these workers are expected to come into contact with leachate only by chance (no more than 5 days), as opposed to the 30 days of exposure each year assumed in these risk estimates.

5.5.2.2 Maintenance Workers

The significance of risks associated with potential exposure of maintenance workers to on-site soil, on-site and off-site ground water, NAPL, outfall water, surface water, and sediment is discussed below.

Soil

Site-related cumulative cancer risk and HI estimates were calculated for each area, using the exposure factors noted above, along with appropriate toxicity values and physical/chemical property values for the chemicals. The initial estimates of upper bound cumulative cancer and noncancer risks for each of the areas are summarized on Table 5.3. These calculations considered all detected constituents. Further information regarding the detailed basis for these calculations is provided in Appendix E.

The upper-bound estimates of site-related cumulative cancer and noncancer risks were compared to USEPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively. The results on Table 5.3 show that there are no areas with a cumulative cancer risk estimate or HI estimate that exceeds 10^{-4} or 1, respectively. However, the cumulative cancer risk estimate at SWMU 5 is slightly higher than Ohio EPA's preferred cancer risk level of 10^{-5}. The concentration of benzo(a)pyrene at T-26S contributes most significantly to this cumulative cancer risk estimate. The refined cumulative cancer risk for maintenance worker exposure to soil after replacing the maximum detected benzo(a)pyrene concentration with the 95% UCL concentration is $7x10^{-6}$ (Table 5.12c), which is below Ohio EPA's preferred cumulative cancer risk level.

Soil lead data were evaluated separately, since lead exposures are evaluated based on blood lead rather than cancer risk or HI. The soil lead data collected during the RFI were categorized relative to the USEPA range of screening criteria for industrial workers, which is 750 mg/kg to 1,750 mg/kg. These soil criteria are intended to protect workers that include child-bearing age women, and are based on an assumed exposure frequency of 219 days per year. Because maintenance workers are assumed to have less frequent exposure to on-site soil, they can encounter higher lead concentrations in on-site soil without a health concern during occasional sub-surface activities. Adjusting the low-end of the USEPA range of screening criteria by the relative exposure frequency for these two populations (219 days versus 60 days per year), and conservatively using a soil ingestion rate of 200 mg/day instead of 50 mg/day, yields an acceptable range of 700 mg/kg to 1,600 mg/kg for lead screening for protection of (occasional) maintenance workers. This range is essentially equivalent to the one published by USEPA (1996b). As discussed above, unacceptable exposures to lead are not expected based on the average lead concentration in soils in these areas, therefore, potential exposure to lead for maintenance workers is considered to be insignificant.

Ground Water

Site-related cumulative cancer risk and HI estimates were calculated for water table and shallow till ground water at each investigated area. The initial upper-bound estimates of cumulative cancer and noncancer risks for each of the areas are summarized on Table 5.5. These calculations considered all detected constituents, as discussed in the following section. Further information regarding the detailed basis for these calculations is provided in Appendix E.

The results on Table 5.5 show that there are three areas (SWMUs 5, 6 and 8) with potentially significant cumulative cancer risk estimates for maintenance worker exposure to shallow ground water, when using USEPA's cancer risk and HI limit of 10^{-4} of 1, respectively. Additionally, cumulative cancer risk estimates for shallow ground water are greater than Ohio EPA's preferred cancer risk level of 10^{-5} at AOC 7.

The significance of potential exposure of maintenance workers to shallow till ground water at these areas was further evaluated, as follows:

- The upper-bound estimates of cumulative cancer risk and hazard index for on-site ground water contact at SWMU 5 are 1 x 10^{-5} and 2, respectively. Two of the constituents contributing most significantly to the HI at SWMU 5 are chromium and vanadium, based on concentrations from unfiltered samples collected during Phase I. Total (unfiltered) concentrations of chromium and vanadium were detected in ground water samples, but were not detected in any of 18 filtered samples. The calculation of dermal dose from exposure to chemicals in ground water should be based on aqueous-phase concentration data (i.e., without any solid-phase contributions) because the permeability coefficients (K_p) used in the calculations are valid only for dissolved-phase chemicals (see USEPA guidance 1992a, and RAGS Part E). Therefore, filtered data are more appropriate for evaluating maintenance worker exposure to ground water since unfiltered ground water samples may contain small amounts of entrained particulates which overstate the dissolved-phase concentrations that are available for dermal absorption. Using the results for filtered samples, the total hazard index excluding the unfiltered concentrations of chromium and vanadium is 0.6, as shown on Table 5.13a, which is below the noncancer HI limit and would not indicate a potential for unacceptable exposure.

- The upper-bound estimates of cumulative cancer risk and hazard index for maintenance workers who could contact ground water at SWMU 6 are $3x10^{-6}$ and 3, respectively. The constituents contributing most significantly to the HI are chromium and vanadium. The highest concentrations of chromium and vanadium were both detected in total (unfiltered) ground water samples. Dissolved (filtered) samples were collected at the same time as the total samples in SWMU 6. Vanadium was not detected in any of the corresponding dissolved samples, and chromium was detected once at a concentration two orders of magnitude lower than the maximum in the total sample. The total hazard index including only the dissolved concentrations of chromium and vanadium is 0.7, as shown on Table 5.13b, which is below the noncancer HI limit and would not indicate a potential for unacceptable exposure.

- The upper-bound estimates of cumulative cancer risk and hazard index for maintenance worker direct exposure to ground water at SWMU 8 are 2×10^{-3} and 1,000, respectively. These results are based primarily on the detection of PCBs at T-33S. However, because NAPL has been identified in this well and the maximum detected concentration of PCBs (0.452 mg/L in Phase I) is comprised of Aroclor 1254 (0.252 mg/L) and Aroclor 1260 (0.2 mg/L), which are more than 20 and 70 times their respective solubility limits, this ground water sample likely contained entrained NAPL during collection, or that the reported concentration may not be accurate. Several other constituents, including bis(2-ethylhexyl)phthalate and DDT, were also detected above their solubility limits in the sample at location T-33S collected during Phase I. Based on the assessment of the data used to calculate the upper-bound risk estimate, the following refinements were evaluated:

- Phase I data for T-33S were removed from the refined risk calculation for this area as these concentrations are indicative of NAPL, which was identified at this SWMU and evaluated separately below.

- The maximum detected concentration of hexachlorophene contributed significantly to the risk estimate. Hexachlorophene was only detected in ground water only once (at location T-55S during Phase I RFI) among 100 RFI samples. Similarly, n-nitrosodi-n-butylamines was detected in T-55S during the Phase I RFI, but not confirmed in the same well during the Phase II sampling. In addition, as discussed in Section 4.2, this constituent was detected at a low frequency (11 out of approximately 450 samples) and only in samples analyzed by BEC Laboratory. Given the extremely low detection frequencies, the reported presence of these constituents is considered suspect. Therefore, these constituents were removed from the refined risk evaluation.

- Chromium and vanadium were identified as contributing significantly to the HI. The highest concentrations of chromium and vanadium were both detected in total (unfiltered) ground water samples. Dissolved (filtered) samples were collected at the same time as the unfiltered samples. Chromium was detected twice in the dissolved samples and vanadium was detected once, both at concentrations at least two orders of magnitude lower than the maximum in the unfiltered sample.

The revised cumulative cancer risk and HI estimates at SWMU 8 after refining the exposure concentrations are $5x10^{-6}$ and 2, respectively, as shown on Table 5.13c. The refined upper bound HI remains above USEPA's target HI limit and Ohio EPA's preferred levels. The constituent contributing most significantly to the refined HI estimate is PCBs, specifically, the PCB concentration of $7.29x10^{-4}$ mg/L at temporary well T-208.

- The upper-bound estimates of cumulative cancer risk and hazard index for ground water contact by maintenance workers at AOC 7 are $3x10^{-5}$ and 0.003, respectively. While the constituents contributing most significantly to the cumulative cancer risk are benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene, it should be noted these concentrations are above solubility and that this sample was collected from within the crock and does not directly measure concentrations in shallow ground water. Further, NAPL was observed in this crock during the RFI. After removing the constituent concentrations above solubility, the cumulative cancer estimate is $2x10^{-6}$, as shown on Table 5.13d. It is appropriate to remove the concentrations exceeding solubility from an evaluation of exposure to ground water as they are indicative of NAPL, which was identified at this SWMU and evaluated separately in below.

NAPL and Smear Zone Soil

Estimates of risks for potential exposure of maintenance workers to NAPL and smear zone soil are calculated in Appendix E. These upper bound estimates are summarized on Table 5.6b, which shows that the estimates of site-related cumulative cancer risk and HI do not exceed the limits of 10^{-4} and 1, respectively or Ohio EPA's preferred cancer risk level of 10^{-5}, except for NAPL in SWMU 8 at location SWMU 8-2 (based on data from TLW-202). The HI estimate at this location in SWMU 8 exceeds USEPA's HI limit for potential inhalation exposure to smear zone soil containing NAPL.

Outfall Water

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of Maintenance Workers via contact with water at the outfalls, using the same contact rates as used in the assessment of utility maintenance workers to ground water. Quantitative assessment of potential exposures to outfall water is shown on Table 5.7. As shown on Table 5.7, that the upper bound risk estimates from potential exposure to outfall water are at or below both USEPA's risk limits and Ohio EPA's preferred risk levels.

Trench Water

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of Maintenance Workers via contact with water in the collection trenches at AOC 1, using the same contact rates as used in the assessment of utility maintenance worker exposures to ground water. For the initial risk estimates, the maximum detected concentrations in any of the southern trench section manholes (IU A) and the maximum detected concentrations in any of northern trench section manholes (IU B) were used.[16] Quantitative assessment of potential exposures to trench water is shown in Table 5.7. Table 5.7 shows that upper bound risk estimates from potential exposure to trench water in the south trench system are at or below both USEPA's risk limits and Ohio EPA's preferred risk limits. However, risk estimates for maintenance worker contact with water in the north trench system exceed USEPA's cumulative cancer risk and HI limits. Based on these upper bound estimates, and considering that the exposures of a worker to trench water within the manholes may be less than assumed for the maintenance worker (e.g., periodic removal of trench water rather than a one-time excavation-type exposures), the exposure factors for a worker exposure to trench water were also assessed using an exposure frequency of 5 days a year, an exposure duration of 10 years, an exposure time of 2 hours, and a skin surface area of 3,330 cm^2. The refined cumulative cancer risk and HI estimates are $2x10^{-4}$ and 20, respectively, for the north trench water, as shown in Table 5.13e. These risk estimates primarily result from PCBs detected in Trench Section III (location III-2 at a concentration of 0.22 mg/L) located adjacent to SWMU 7, 9 and 10. This concentration is indicative of either NAPL or PCBs on particulates.

Surface Water

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of Maintenance Workers via contact with surface water in Otter Creek, using the same contact rates as used in the assessment of utility maintenance workers to ground water. Quantitative assessment of potential exposures to surface water is shown in Table 5.8. As indicated on Table 5.7, the upper bound risk estimates from potential exposure to surface water in Otter Creek are at or below both USEPA's risk limits and Ohio EPA's preferred risk limits.

Sediment

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of maintenance workers to sediment in Otter Creek and in the ditches north and south of SWMU 5. Quantitative assessment of potential exposures to sediment by maintenance workers is shown on Table 5.9.

[16] As described in Section 3.13 of the DOCC, the waterline monitoring trench system is actually comprised of several independent sections numbered I through VI. The southern trench system (IU A) includes sections II, IV, and IV, and the northern trench system (IU B) includes sections I, III and V.

As indicated on Table 5.9, the upper bound risk estimates from potential exposure to sediment in Otter Creek and the SWMU 5 ditches below both USEPA's risk limits and Ohio EPA's preferred risk limits.

5.5.2.3 Recreational Visitors

The significance of risks associated with potential exposure of recreational visitors to surface water and sediment in Otter Creek (IU C) is discussed below.

Surface Water

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of recreational visitors via contact with surface water in Otter Creek, using the contact rates as discussed in Section 5.3.6.3. Quantitative assessment of potential exposures to surface water is shown on Table 5.8. As indicated on Table 5.8, the upper bound risk estimates from potential recreational visitor exposure to surface water in Otter Creek are below both USEPA's risk limits and Ohio EPA's preferred risk limits.

Sediment

As discussed in Section 5.3.3.1, the risk assessment evaluated potential exposure of recreational visitors via contact with sediment in Otter Creek, using the contact rates as discussed in Section 5.3.6.3. Quantitative assessment of potential exposures to sediment is shown on Table 5.9. As indicated on Table 5.9, the upper bound risk estimates from potential recreational visitor exposure to sediment in Otter Creek are below USEPA's risk limits and Ohio EPA's preferred cancer risk level.

5.5.2.4 Off-Site Residents

The significance of risks associated with potential exposure of hypothetical future residents via direct contact with soil in the agricultural field east of SWMU 6 and potential off-site inhalation exposure to vapor and particulates from on-site soil is discussed below.

Soil East of SWMU 6

As discussed in the RFI Phase I Report, the upper bound cumulative cancer risk estimates for residential direct contact exposure to soil on the east side of SWMU 6 are slightly higher than Ohio EPA's preferred cancer risk limit of 10^{-5}. This risk estimate was primarily attributable to a benzo(a)pyrene concentration at one location (QE-360BB). However, this benzo(a)pyrene concentration (10 mg/kg) is actually on-site and was delineated by additional soil boring locations closer to the property line which have much lower benzo(a)pyrene concentrations. To provide a risk estimate that is more representative of hypothetical benzo(a)pyrene concentrations in the off-site soil in the agricultural field, on-site sample QE-360BB was removed from the risk calculations and the risk estimate was recalculated by retaining the benzo(a)pyrene concentration at location QE-360B which is the on-site boring location closest to the Facility boundary and the adjacent agricultural field. This more representative but still conservative estimate of risk for exposures to off-site soil in the field is 9×10^{-6}, as shown in Table 5.10. This cumulative cancer risk estimate was calculated based on the 95% UCL for benzo(a)pyrene after removing the benzo(a)pyrene concentration at QE-360BB. This cumulative cancer risk estimate is below both USEPA's risk limits and Ohio EPA's preferred risk limits.

<u>Off-site Exposure to Wind-blown Dust and Vapors</u>

Off-site receptors also could be exposed to constituents in soil that are transported off-site by wind erosion or vapors that migrate-offsite. In this risk assessment, potential airborne exposures of off-site receptors are evaluated for a hypothetical residential receptor located on the downwind side of the Facility. Table 5.3 shows that risk estimates from potential off-site residential exposure to vapors and particulates from on-site soil are below USEPA's risk limits and Ohio EPA's preferred cancer risk level.

<u>Exposure via Vapor Intrusion from Ground Water</u>

As discussed in Section 5.3.3.2, there is a potential for future off-site exposures to hazardous constituents detected in shallow ground water via vapor intrusion into buildings. As a conservative assessment of this potential exposure, a hypothetical residence was assumed to be exposed to vapors from the maximum detected shallow ground water concentration. As shown on Table 5.5, these hypothetical upper bound risk estimates are below USEPA's risk limits and Ohio EPA's preferred cancer risk level.

5.5.2.5 Off-Site Workers

<u>Exposure via Vapor Intrusion from Ground Water</u>

As discussed in Section 5.3.3.2, there is a potential for future off-site exposures to hazardous constituents detected in shallow ground water via vapor intrusion into buildings. As a conservative assessment of this potential exposure, a routine worker is assumed to be exposed to vapors from the maximum detected on-Facility shallow ground water concentration (i.e., using the on-site routine worker as a surrogate). As shown on Table 5.5, these hypothetical upper bound risk estimates are below USEPA's risk limits and Ohio EPA's preferred cancer risk level.

It is also possible that NAPL may migrate off-site where potential exposures via vapor intrusion to indoor air could occur. This scenario is possible along the west side of SWMU 5 which has a commercial business present west of Otter Creek. As shown on Table 5.6c, using the on-site routine worker as a surrogate, the risks associated with vapor intrusion from LNAPL present at SWMU 5 is below USEPA's risk limits and Ohio EPA's preferred cancer risk level.

5.5.2.6 Trespassers

Potential exposure of trespassers to soil is evaluated indirectly using exposure estimates for ESOI Facility workers and Recreational Visitors, as explained in Section 5.3.3.1. This streamlines the risk assessment and is conservative because trespasser exposures would be lower than exposures for these other receptor populations. Therefore, the risk and HI estimates for trespassers are expected to be no higher than the estimates discussed in Section 5.5.2.1 and 5.5.2.3.

5.5.3 Hypothetical Discharges to Surface Water

As discussed in Section 4.16, data from samples of surface water and stormwater from outfalls were compared with criteria established for the designated uses of Otter Creek[17]. The significance of these concentrations was further evaluated in a site-specific assessment of potential human exposure along Otter Creek adjacent to the Facility (see Section 5.5.2). In addition, this baseline human health risk assessment includes an assessment of hypothetical surface water concentrations in Otter Creek assuming shallow ground water from the Facility discharges to Otter Creek during lower stream flows than observed during the RFI. For the purpose of assessing the potential significance of such hypothetical concentrations relative to health-based water quality criteria, in-stream concentrations were calculated based on

[17] The Ohio EPA has established surface water quality criteria for potential contaminants in the state's rivers to protect the rivers' designated uses. For the segment of Otter Creek that is adjacent to the Facility, the applicable criteria are based on agricultural or industrial water supply use, and primary contact recreational use (but not public water supply use; OAC 3745-1-07, -21, -34).

harmonic mean flow (see Appendix C6). These calculated concentrations are considered conservative upper-bound estimates since the evaluation (1) assumed an infinite mass of contaminated shallow ground water, (2) did not include fate and transport mechanisms (e.g., degradation and/or dispersion) that would reduce ground water concentrations prior to reaching the Creek, and (3) assumed the maximum concentrations detected in ground water would enter the Creek along the full length of the Facility along Otter Creek. A discussion of the modeling approach and the input parameters used in the calculations is provided in Appendix C6.

The hypothetical in-stream concentrations are compared with the previously identified conservative human health screening criteria for Otter Creek in Appendix C6. As shown in Appendix C6, the hypothetical concentrations for several metals, 1,4-dioxane, bis(2-ethylhexyl phthalate) and n-nitrosodi-n-butylamine exceed one or more of the screening criteria.

- Among these metals, only hypothetical concentrations for arsenic and thallium were based on filtered samples which better represent the concentrations that may migrate with ground water. When more realistic assumptions are considered for arsenic and thallium (i.e., mean detected ground water concentration and mean ground water discharge rate), only arsenic concentrations are predicted to marginally exceed federal ambient water quality criterion for consumption of organisms (hypothetical concentration of 1.9×10^{-4} mg/L versus a AWQC of 1.4×10^{-4} mg/L). Further, this hypothetical in-stream concentration for arsenic is lower than the levels that are protective of receptors identified in the site-specific risk assessment for this portion of Otter Creek (see Appendix C6). Thus, thallium and arsenic do not warrant further evaluation.

- Bis(2-ethylhexyl)phthalate was reported in shallow ground water samples at SWMU 5. When more realistic assumptions are considered for this constituent (i.e., mean detected ground water concentration and mean ground water discharge rate), the hypothetical in-stream concentration is below the surface water criteria. Further, this constituent was detected at a low frequency in shallow ground water near the Creek (4 out of 30 samples). Thus, bis(2-ethylhexyl)phthalate does not warrant further evaluation.

- N-nitrosodi-n-butylamine was reported in shallow ground water samples at SWMU 5. As discussed in Section 4.2, this constituent was detected at a low frequency (11 out of approximately 450 samples) and only in samples analyzed by BEC Laboratory. Given the extremely low detection frequencies, the reported presence of these constituents is considered suspect. Therefore, this constituent does not warrant further evaluation.

5.5.4 Hypothetical Discharges to Bedrock Ground Water

Direct sampling of the bedrock aquifer in the vicinity of the areas investigated during the RFI did not detect evidence of migration of hazardous constituents in the aquifer. The potential future risk from potable use of the bedrock ground water was assessed based on the hypothetical migration of constituents detected in shallow and deep till ground water into the bedrock aquifer (see Appendix C6). The results of this assessment for constituents detected in till zone ground water at concentrations exceeding drinking water criteria determined that existing lower till ground water concentrations are not expected to result in bedrock ground water concentration exceeding drinking water criteria.

5.5.5 Uncertainty Analysis

5.5.5.1 Exposure Concentrations

As discussed in Section 5.3.4, most exposure concentrations for soil, ground water, outfall water, trench water, sediment, surface water, NAPL and NAPL-smear zone soil in this risk assessment are based on the highest concentrations detected in each media at each area. This approach inflates the cumulative cancer risk and HI estimates that do not exceed 10^{-5} and 1, respectively, relative to RME risk estimates which would be based on realistic exposure concentrations rather than maximum concentrations. The use of maximum concentrations for all constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to all constituents constantly, when the RME generally would not have all constituents at worst-case concentrations at all times. The inflation of these risk and HI estimates makes them closer to the Ohio EPA's preferred cumulative cancer risk limit of 10^{-5} and the HI limit of 1 than they would be if 95% UCLs were used.

Most exposure concentrations that are based on mathematical modeling of constituent transfer from soil or ground water to air are conservative for the same reasons discussed above, since the model estimates are based on the use of maximum concentrations in soil or ground water. In addition, the model estimates are conservative because they generally do not account for the reduction of constituent concentrations in the soil or ground water as constituents transfer from these media. As a result, risk estimates that are based on the sum of risk estimates for multiple media are more conservative than necessary for RME estimates. These include almost all of the risk estimates discussed in Sections 5.5.1 to 5.5.4.

The exposure concentrations used in the calculation of RME estimates also do not account for concentration reduction as a result of degradation (and consequently, the potential accumulation of degradation products). In developing the Phase II Work Plan for sampling off-site monitoring wells, an assessment of potential degradation products for organics detected in ground water at SWMU 5 and SWMU 1 (areas where till zone ground water may discharge off-site) was conducted. The results of this assessment determined that all the organics detected in ground water at these two units all into one of the following categories: (1) the constituent has the potential to degrade, and the degradation products are constituents that were analyzed and included in the risk assessment (if detected); (2) the constituent has the potential to degrade, and the degradation products are not target constituents on the Phase I Parameter list; or (3) the constituent is not expected to degrade to any significant extent. As a result, all degradation products that may be of concern for corrective action have been analyzed in the ground water, and if detected, are included in the RME estimates.

As indicated in Section 5.5.2, several RME estimates exceeded acceptable risk thresholds as a result of using concentrations of metals reported in unfiltered samples from temporary wells. However, the calculation of dermal dose from exposure to chemicals in ground water should be based on aqueous-phase concentration data (i.e., without any solid-phase contributions) because the permeability coefficients (K_p) used in the calculations are valid only for dissolved-phase chemicals (see USEPA guidance 1992a, and RAGS Part E). In some instances, using the concentration data from filtered samples would result in RME risk estimates that do not indicate a potential for unacceptable exposure, as discussed in Section 5.5.2. RAGS Part E (Section 3.1.2.2) suggests that the actual bioavailable concentration, and therefore, the actual risk may be somewhere between the estimates based on unfiltered samples and the estimates based on filtered samples.

5.5.5.2 Exposure Factors

As discussed in Section 5.3.6, most of the exposure factors used in the risk assessment are high-end (i.e., 90th to 95th percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90th percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual, particularly when such exposure factors are combined with exposure concentrations that are based on maximum concentrations.

Also, the use of common exposure factors for evaluation of potential exposure of workers to soil is more conservative than necessary for RME estimates, which allow the use of site-specific considerations (USEPA 1989). For example, the "fraction contacted" terms used in this evaluation assume that ESOI Facility workers are exposed to soil for an entire work day at each area, but workers generally spend only a part of the work day at a particular part of the Facility.

5.5.5.3 Extrapolated Toxicity Values

As discussed in Section 5.4, the dermal toxicity values used in the risk assessment are oral toxicity values that were extrapolated to the dermal route without chemical-specific judgment regarding whether such extrapolation might be appropriate for a particular chemical. This is a conservative approach to ensure that potential risk via the dermal route is not overlooked. However, some constituents might exhibit different degrees of toxicity for the dermal route relative to the oral route. For such constituents, the extrapolation approach used in the risk evaluation could introduce uncertainty.

The conversion of an oral toxicity value to an inhalation toxicity value generally should be justified by consideration of a number of factors, including point of entry effects, pharmacokinetic data on the chemical's behavior in the different routes of exposure, and differences in the target organs affected. However, as a conservative measure for constituents without any inhalation toxicity values, oral SFs and RfDs were converted to inhalation URFs and RfCs in this risk assessment. Use of these extrapolated inhalation toxicity values reduces the potential for underestimating inhalation risks, but could introduce uncertainty.

5.5.5.4 **Qualified Data**

As discussed in Section 5.2.2, concentrations qualified as estimated (i.e., J-qualified data) are included in this quantitative risk assessment. As part of the RFI data validation process, these estimated concentrations were identified, if possible, as either biased high or biased low. Such biased data may contribute to a bias in the risk estimates, if these concentrations contribute significantly to the risks. As indicated on Table 5.11, several constituent concentrations that were used in this quantitative risk analysis and identified as potentially contributing significantly to risk estimates (i.e., single chemical risks greater than 10^{-6} or HI of 0.1) were J-qualified values. The validation reports for these data were reviewed to determine if they were biased low. Based on this review, none of these data were identified as having a bias.

5.5.5.5 Risk Characterization

The summation of cancer risks and HQs for multiple constituents, as described in Section 5.5.1, is based on USEPA guidance (1989) to assume dose additivity, which means that constituents in a mixture are assumed to have no synergistic or antagonistic interactions and each constituent has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative cancer risk and HI estimates in this risk assessment are dominated by contributions from no more than a few constituents, so that the cumulative risk estimates are nearly the same as those for the few key constituents.

5.6 Summary and Conclusions

RFI sampling described in Section 4 identified potentially significant releases of hazardous constituents or hazardous waste in soil, ground water, surface water, and sediment at some of the SWMUs and AOCs investigated during the RFI. In addition, soil gas sampling near an on-site building constructed on one of the SWMUs identified the potential for vapor intrusion into the building. The significance of these releases under current and reasonably expected future land use at the Facility was evaluated in a baseline human health risk assessment to identify where a release may cause reasonable maximum exposures to be significant enough to warrant corrective measures. The risk assessment used constituent concentrations in soil, ground water, leachate, LNAPL, sediment and surface water to derived highly conservative estimates of reasonable maximum exposures. The data used in the risk assessment are discussed in Section 4 and the methods used in the risk assessment are consistent with USEPA risk assessment guidance. The significance of potential exposures was determined by comparing estimates of site-related cumulative cancer risk and noncancer HIs with an acceptable cumulative cancer risk limit of 10^{-4} and a HI limit of 1, respectively, which USEPA has established as triggers for corrective measures under RCRA corrective action (USEPA, 1991b). In addition, the estimates of site-related cumulative cancer risk and HI were also compared to Ohio EPA's preferred cancer risk limit of 10^{-5} and a HI limit of 1.

The results and conclusions for the receptors evaluated in the baseline human health risk assessment are summarized below:

ESOI Facility Workers

Risks to on-site routine workers were evaluated for potential exposures to outdoor soil via direct contact (incidental ingestion, dermal contact, and inhalation), direct contact with leachate and NAPL seeps, and to constituents in soil, ground water, and NAPL via vapor intrusion. The results are as follows:

- Potential exposure of ESOI facility workers to on-site soil is not significant.

- Potential exposure of ESOI facility workers to constituents in on-site soil, ground water, and NAPL via vapor intrusion is not significant.

- Potential exposure of ESOI facility workers to NAPL at AOC 7 and SWMU 5, if it were to occur, and NAPL seeps at SWMU 8 and SWMU 9 is potentially significant. However, the risk estimates are likely overstated since it is unlikely that workers would contact NAPL at AOC 7 and SWMU 5, and it is unlikely that workers would spend the entire outdoor exposure period over 25 years at the SWMU 8 or SWMU 9 seeps. Further, workers at the Facility are currently covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- Potential exposure of ESOI facility workers to leachate seeps at SWMU 6 are potentially significant. However, these risks are likely overstated since it is unlikely that workers would spend the entire outdoor exposure period over 25 years at these seeps. In addition, the exposure concentrations used in this assessment assumed that the seepage consisted solely of leachate, rather than a mixture of leachate and stormwater which would lower the actual exposure concentration. Further, workers at the Facility are currently covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

Maintenance Workers

Risks to maintenance workers were evaluated for potential exposures to soil, shallow ground water, trench water, and NAPL via direct contact during excavation activities. The results are as follows:

- Potential exposure of maintenance workers to on-site soil is not significant.

- Potential exposure of maintenance workers to on-site ground water indicate a potential for significant exposures based on unfiltered ground water samples at SWMUs 5 and 6. However, when dissolved metals data are used as more relevant concentrations for dermal exposures, these exposures are not significant. Therefore, risks to maintenance workers from exposure to ground water at these SWMUs are considered marginal. There is also a potential for significant exposures to maintenance workers that encounter shallow ground water in the vicinity of temporary well T-208 located at the northeast corner of SWMU 8. However, maintenance workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site excavation activities.

- Potential exposure of maintenance workers to on-site NAPL is potentially significant at SWMU 8. However, workers at the Facility are currently covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- Potential exposure of maintenance workers to on-site stormwater at the Facility outfalls, sediments in ditches adjacent to SWMU 5, and surface water and sediments in Otter Creek is not significant.

- Potential exposure of maintenance workers to trench water indicate a potential for significant exposures based on samples at one location (Trench III-2).

Trespassers

Risks associated with potential exposure of trespassers to on-site soil were evaluated indirectly using exposure estimates for ESOI Facility workers. This streamlines the risk assessment and is conservative because soil exposures associated with trespasser activities would be lower than these routine worker exposures. The refined risk estimates for ESOI Facility workers, show that the high end risk estimates do not exceed acceptable cumulative cancer risk or HI limits. Based on the results of this evaluation, these potential exposures of on-site trespassers are not significant.

Risks associated with potential exposure of trespassers to on-site sediments and surface water were evaluated indirectly using exposure estimates for Recreational Visitors to Otter Creek. This streamlines the risk assessment and is conservative because sediment and surface water exposures associated with trespasser activities would be lower than these recreational exposures. The refined risk estimates for Recreational Visitors show that the high end risk estimates do not exceed acceptable cumulative cancer risk or HI limits. Based on the results of this evaluation, these potential exposures of on-site trespassers are not significant.

<u>Recreational Visitors</u>

Risks to Recreational Visitors at Otter Creek were evaluated for potential exposures to sediment and surface water. The results of this evaluation indicate that the potential exposures of Recreational Visitors to sediments and surface water in Otter Creek are not significant.

<u>Off-Site Residents</u>

Risks associated with potential exposure of hypothetical future residents via direct contact with soil in the agricultural field east of SWMU 6 and potential off-site inhalation exposure to vapor and particulates from on-site soil were evaluated. In addition, risks associated with vapor intrusion from ground water that may migrate off-site were also evaluated. The results of this evaluation indicate that these potential exposures of off-site residents are not significant.

<u>Off-Site Workers</u>

Risks associated with potential exposure of off-site workers via potential off-site inhalation exposure to vapor and particulates from on-site soil were evaluated; these risks were estimated indirectly using exposure estimates for off-site residents. In addition, risks associated with vapor intrusion from ground water and NAPL (at SWMU 5) that may migrate off-site were also evaluated. The results of this evaluation indicate that these potential exposures of off-site workers are not significant.

<u>Ground Water Migration</u>

In addition to the assessment of potential exposures to constituents detected in ground water based on actual ground water data collected during the RFI, the significance of potential exposures to constituents that could migrate from shallow till ground water to Otter Creek and from lower till zone ground water to the bedrock aquifer was evaluated. This evaluation of hypothetical concentrations in surface water and the bedrock aquifer associated with constituent migration from the till zones indicated that such hypothetical exposures, if to occur, are not significant.

6.0 ECOLOGICAL RISK ASSESSMENT SUMMARY

This section presents a summary of the ecological risk assessment (ERA) for the ESOI Facility that is provided in Appendix F of this Report. The ERA presented in Appendix F is consistent with the scope of work defined in the Phase II Work Plan (ENVIRON 2005b). The approach presented herein also addresses comments received from the USEPA and Ohio EPA in the April 12, 2006 Ohio EPA approval letter for the Phase II Work Plan; and, it reflects discussions with Ohio EPA staff (July 11, 2006 and January 4, 2008). Finally, the approach herein follows the CAP initiated by ESOI for the Facility with the purpose of protecting human health and the environment. The objective of this ERA is to preliminarily evaluate the likelihood that adverse ecological effects may result from exposure to environmental stressors associated with conditions at the ESOI site.

The USEPA's ERA process (1997; 1998; 2000; 2001) involves a screening level ERA (SLERA) (Steps 1 and 2) and a baseline ERA (BERA) (Steps 3 through 8), as reflected in Figure 6.1 (USEPA 1997, 2000). Steps 1 through 3a are generally aligned with the Ohio EPA (2003) ERA Levels I and II, and include elements of the Level III assessment. A SLERA and Step 3a of a BERA were performed for Otter Creek and the ESOI facility.

6.1 Screening Level Ecological Risk Assessment

The SLERA presented in Appendix F is comprised of the screening-level problem formation, the screening-level exposure assessment, the screening-level effects characterization, refined risk calculations, and the refined uncertainties analysis. Problem formulation provides the foundation for the SLERA by describing or defining the site ecological setting, sampling data reflective of current site conditions, potentially exposed ecological receptors, potentially complete pathways by which ecological receptors could be exposed to those chemicals, assessment and measurement endpoints for screening ecological risk. This information is summarized in the conceptual site model (CSM) for ecological exposures (Figure 6.2).

Information contained within the screening level problem formulation was derived from multiple sources, including the Phase I RFI Report (ENVIRON/MSG 2003) and Phase II Work Plan (ENVIRON 2005b). Phase I data include the ecological survey conducted by the Mannik and Smith Group (MSG) during early summer 2002 (ENVIRON/MSG 2003) and the assessment of sediment quality, surface water quality and biotic community composition conducted by Midwest Ecological Consultants, Inc. (MEC) during early summer 1997 (MEC

1997). Phase II data include the supplemental data investigation as agreed upon between ESOI and Ohio EPA and as presented in the Phase II Work Plan and Work Plan addenda (ENVIRON 2005b, 2006b, 2007b).

Information from both the MSG and MEC ecological surveys was considered along with information about potential hazardous waste or hazardous constituent releases to identify SWMUs and AOCs that demonstrate potentially complete wildlife exposure pathways for inclusion in the ecological data evaluation. As detailed in the Revised Phase II RFI Work Plan (ENVIRON 2005b), and summarized in Table 6.1 (Review of Potentially Complete Ecological Exposures), the following SMWUs and AOCs were identified for consideration:

- SWMU 1 – Landfill Cell F
- SWMU 5 – Millard Road Landfill
- SWMU 6 – North Sanitary Landfill
- AOC 9 – Cell M Stormwater Basin
- Investigation Area C –NPDES Outfalls and Otter Creek

As described in Table 6.1, landfill caps provide a physical barrier between wildlife and the contents of the landfills. Landfill caps, which provide clean fill of approximately 2 to 9 feet in thickness, are regularly mowed to prevent the colonization of trees that may penetrate the landfill caps. ESOI also routinely conducts visual inspections of the caps to ensure the integrity of the cap, and repairs the caps, as necessary. Therefore, significant wildlife exposure to soil within the landfill is not a complete exposure pathway, and, the delineated landfill areas are not considered in this SLERA. However, surface soil outside the delineated landfill in both SWMUs 1 and 5[18] are retained for evaluation of potential source areas to Otter Creek. In addition, ground water in the vicinity of SWMUs 1, 5, and 6 and sediment in the vicinity of SWMU 5 are evaluated as potential sources to Otter Creek. Similarly, stormwater from the NPDES outfalls and the stormwater basin in AOC 9 is evaluated as a potential source area to Otter Creek in this SLERA. Outfall 004 is also considered as a potential source to Driftmeyer Ditch.

A CSM is a visual representation of predicted relationships between ecological entities and the stressors to which they may be exposed. Complete exposure pathways between potentially site-related chemicals and wildlife are most likely to occur in Otter Creek, and as

[18] Only subsurface soil data are available for SWMU 6.

such, the ERA focused on the following assessment endpoints (a CSM for Otter Creek is presented in Figure 6.2):

- Benthic invertebrate community structure and function
- Fish community structure and function
- Survival and reproduction of aquatic-feeding bird and mammal populations

The SLERA presented in Appendix F provides a comparison of detected chemical concentrations in Otter Creek surface water and sediment, soil, shallow ground water, and surface water from the outfalls to USEPA Region V ecological screening levels (ESLs). Chemicals in Otter Creek that exceeded ESLs were retained as chemicals of potential ecological concern (COPECs) for consideration in Step 3a of the BERA. Chemicals in media other than Otter Creek (e.g., surface soil, ground water, and surface water from the outfalls) were evaluated as potential sources to Otter Creek.

6.2 Baseline Ecological Risk Assessment: Step 3A

Step 3a of the BERA presented in Appendix F considers alternative ecotoxicological benchmarks, reference concentrations, average exposure estimates, factors that limit bioavailability, and additional toxicological information to further evaluate the potential for chemicals to adversely affect aquatic organisms and aquatic-feeding wildlife. This refined screening evaluation more fully describes the COPECs occur in each relevant medium and at the locations that may have the potential to adversely affect ecological receptors. Step 3a of the BERA includes sections on refinement of identified preliminary COPECs, refined measurement endpoints, refined exposure estimates, refined effects characterization, refined risk calculations, and an uncertainties analysis.

The refinement of COPECs considers a variety of appropriate ecotoxicity screening values, including USEPA's equilibrium partitioning approaches using site-specific sediment characteristics that can mitigate bioavailablity and ultimately toxicity. In addition, Ohio EPA reference values and other criteria identified in the Phase II Work Plan are considered. While additional criteria are used to refine COPECs with regard to potential direct toxicity for macroinvertebrates, bioaccumulative COPECs are also identified and retained for food web modeling into aquatic-oriented bird and mammal populations.

In addition to the refined analysis of COPECs, the following approaches are considered for each assessment endpoint in Step 3a of the BERA:

- *Benthic invertebrate community structure and function* - Potential impacts to benthic invertebrates due to PAH and metals mixtures is considered using an equilibrium partitioning approach designed to take into account the evaluation of additive effects of chemical mixtures (USEPA 2003; 2005).

- *Fish community structure and function* - Fish community structure and function is addressed through consideration of the previously reported fish index of biological integrity, indicators of well being, and distribution of tolerant species in relation to ESOI (ENVIRON/MSG 2003).

- *Survival and reproduction of aquatic-feeding bird and mammal population* - Food web modeling is the measurement endpoint used to evaluate the survival and reproduction of bird and mammal populations. Food web modeling involves the estimation of chemical uptake via dietary ingestion, taking into account the bioaccumulation of chemicals in dietary prey. Food web modeling cannot be feasibly conducted for all species that might be present at the Facility; therefore, receptors of interest are those selected to represent the range of species that could be exposed.

6.3 Ecological Risk Assessment Conclusion

The following critical context and findings are the basis for the ecological risk assessment conclusion for the ESOI Facility:

- A SLERA and Step 3a of a BERA were performed for Otter Creek and the Facility, using well established USEPA and Ohio EPA approaches.
- Threatened and endangered species are not present at or in the vicinity of the Facility.
- Terrestrial wildlife on the Facility is predominantly protected from chemical exposures by the clean landfill caps and roadways, and while some isolated exposures to soils that may have had some isolated contact with leachate, these areas are so small that they are a only a fraction of the area that some states consider *de minimis* in terms of terrestrial wildlife ecological risks.
- Many constituents are present in surface water and sediment at concentrations that exceed the USEPA Region 5 ESLs, but ESLs are by design very conservative

screening levels, with exceedances showing that more detailed and focused risk assessment is warranted.

- Step 3a of the BERA presented a very comprehensive desk-top analysis of available information, using well accepted USEPA equilibrium partitioning, food web modeling, and other appropriate analyses related to refined exposure and effects assumptions for evaluating the potential risks associated with chemicals that exceeded ESLs. Step 3a also considered the additive toxicity of classes of compounds, such as PAHs, metals mixtures, and pesticides.
- The conclusions associated with each of these assessment endpoints were as follows:
    - *Benthic community assessment:* The overall conclusion regarding the benthic community structure and function is that the only chemical, or class of chemicals, that seems to potentially pose a risk to benthic community in the region of Otter Creek adjacent to the Facility are PAHs. Although many ESLs were exceeded, these chemicals were specifically addressed in efforts to refine COPECs. The analyses of additive impacts to benthics was performed using USEPA's equilibrium partitioning approach and those results showed that PAHs could be posing a potential impact to benthic diversity in very isolated locations, but these locations do not appear to be site-related. However, biological studies in the creek have shown that numerous organisms are present and provide a basis of food for the aquatic food web. Therefore, while the actual community composition may differ from one location to the next, there is no indication that the overall ecological service of the benthic community as a base of the food web is compromised. Finally, biotic sampling that occurred in Otter Creek between 1997 and 2002 may provide at least some limited evidence of improving conditions in the creek over time.
    - *Fish community structure and function:* The overall conclusion regarding fish community structure and function shows that fish community in Otter Creek is impaired to some degree which is indicated by the presence of mostly pollution sensitive species; however, fish are present with some degree of diversity and there is no compelling evidence that ESOI is having impact on the biological integrity or well being of the fish.

- *Survival and reproduction of aquatic-feeding bird and mammal populations:* Based on a detailed analysis of available information, it can readily be concluded that the food web modeling results show that adverse impacts are not likely to occur for birds and mammal populations exposed to the bioaccumulative chemicals in Otter Creek.

6.4 Hypothetical Discharges to Surface Water

As discussed in Section 4.16, surface water, stormwater at outfalls data were compared with criteria established for these designated uses of Otter Creek. The significance of these concentrations were further evaluated considering the site-specific assessment of potential ecological exposures along Otter Creek adjacent to the Facility (see Section 6.3). To supplement the SLERA that evaluated RFI data collected in areas of potential ecological significance, an assessment of hypothetical surface water concentrations in Otter Creek resulting from potential shallow ground water discharges during an extreme low flow event was conducted. For the purpose of assessing the potential significance of these concentrations relative to ecological based water quality criteria, these in-stream concentrations were calculated under 7Q10 low flow conditions (see Appendix C6). These predicted Creek concentrations are considered conservative upper-bound estimates since the evaluation (1) assumed infinite mass of contamination to the shallow ground water, (2) did not include fate and transport mechanisms (e.g., degradation and/or dispersion) that would reduce ground water concentrations prior to reaching the Creek, and (3) assumed the maximum concentration detected in ground water would enter the Creek along the full length of the Facility. A discussion of the modeling approach and the input parameters used in the calculations is provided in Appendix C6.

The resulting hypothetical in-stream concentrations during low flow conditions were compared with the previously identified conservative ecological screening criteria appropriate for Otter Creek. As shown in Appendix C6, the predicted concentrations for several metals, 4,4'-DDE and bis(2-ethylhexyl)phthalate exceed one or more of the screening criteria.

- With the exception of selenium, the predicted metals concentrations were primarily based on source concentrations from unfiltered ground water samples, yet the water quality criteria are based on dissolved metals, and therefore, the comparison is highly conservative and metals are not considered to be a concern for this pathway. If the mean concentration of selenium were used to represent site discharges to the Creek, then the predicted concentration only marginally exceeds the ecological criteria. Further, as discussed in the SLERA (Appendix F), USEPA is moving toward a tissue-based criterion for selenium (USEPA 2004b), since the water-based criterion is dependent on site-specific conditions, such as sulfate, heavy metals, pH, temperature, and day length (American Petroleum Institute 2005). Therefore, selenium does not merit further evaluation in surface water.

- As discussed in the SLERA (Appendix F), bis(2-ethylhexyl)phthalate is ubiquitous in the environment and is a common laboratory contaminant. In aqueous exposures, bis(2-ethylhexyl)phthalate is not toxic to aquatic organisms at concentrations up to the solubility limit. Further, this constituent was detected at a low frequency. Thus, bis(2-ethylhexyl)phthalate does not warrant further evaluation.

- The predicted in-stream 4,4’-DDT concentration is approximately one order of magnitude below the detection limit established for the RFI, suggesting that the hypothetical discharges via this pathway would not have a measurable impact on surface water. Further, 4,4’-DDT was detected at a low frequency (2 out of 27 samples) in shallow ground water along the areas that potentially discharge to Otter Creek (the concentration that contributes to the hypothetical in-stream concentrations was from a sample collected adjacent SWMU 1, where it is assumed for this evaluation that shallow ground water discharges into Gradel Ditch prior to discharge to Otter Creek). Thus, 4,4’-DDT does not warrant further evaluation.

6.5 Scientific Management Decision Point

Based on the SLERA conclusions described in Section 6.3 and Appendix F, the SLERA results are sufficient to conclude that that chemicals detected in the areas at and adjacent to the ESOI Facility do not pose ecologically significant impacts to populations, communities, or ecosystems (a primary risk management consideration according to USEPA [1999]). Therefore, there is no need for further action on the basis of ecological risk.

7.0 CONCLUSIONS

In accordance with RCRA permits issued by USEPA and Ohio EPA, ESOI initiated a Corrective Action Program to assess releases of hazardous wastes or hazardous constituents, if any, for the purpose of protecting human health and the environment. ESOI conducted an RFI to determine whether SWMUs and AOCs identified in the RCRA Permit, three additional AOCs recommended by Ohio EPA, and one additional AOC requested by USEPA have released hazardous waste or hazardous constituents that pose a significant risk to human health or the environment. During implementation of the RFI, ESOI also conducted presumptive corrective measures to address conditions at three of the landfill SWMUs, including the installation of leachate recovery systems and modification of the existing Explosive Gas Monitoring Plan. In addition, ESOI is conducting an assessment of cap enhancements and/or cap modifications for SWMU 1. The presumptive corrective measures were implemented in accordance with work plans submitted per Condition E.9 of the State RCRA Permit and approved by Ohio EPA.

RFI field investigations were conducted at 19 SWMUs/AOCs at the Facility and in Otter Creek adjacent to the Facility during the period from 2002 to 2007, to support the following objectives:

- Determine whether a significant release of hazardous constituents to soil, ground water, surface water, and sediment has occurred from the SWMUs and AOCs subject to investigation;

- Characterize the source(s) of a release and determine the nature and extent of constituents in soil, ground water, surface water, and sediment, to support a baseline risk assessments, where a significant release of hazardous constituents is confirmed; and

- Collect data to support development and evaluation of corrective measures alternatives for SWMUs and AOCs where corrective measures are determined to be warranted.

As discussed in Section 4, sufficient data were collected to identify potentially significant releases of hazardous constituents at and adjacent to the Facility, and to characterize the nature and extent of hazardous constituents as necessary to support a baseline human health risk assessment and screening level ecological risk assessment (SLERA). The baseline human health risk assessment and SLERA were conducted to identify where active corrective measures are warranted under current and reasonably expected future land and ground water uses at and around the Facility.

Because the baseline risk assessment and SLERA are based on the expectation that future land and ground water uses at the Facility will remain unchanged from current uses, all investigated SWMUs and AOCs will be retained for evaluation in a Corrective Measures Study (CMS) for limited corrective measures, which includes institutional controls, regardless of whether a significant risk to human health or the environment is identified. Where a significant risk is identified based on field conditions observed during the RFI or the results of the human health risk assessment, active corrective measures will be evaluated in the CMS, as discussed below. Based on the SLERA conclusions described in Section 6 and Appendix F, the SLERA results are sufficient to conclude that chemicals detected in the areas at and adjacent to the Facility do not pose ecologically significant risks to populations, communities, or ecosystems (a primary risk management consideration according to USEPA [1999]). Therefore, there is no need for further action on the basis of ecological risk.

Based on field observations during the RFI, the following areas will be evaluated for active corrective measures:

- SWMU 5: the presence of NAPL in a subsurface peat layer and in pore spaces in the soil layers present above and below the peat layer along the western side of this unit will be addressed in the CMS, although the RFI field investigation found no evidence that the NAPL is the result of a release from the Facility. It is possible that the NAPL is from off-site/upstream releases to Otter Creek that occurred prior to construction of the perimeter soil berm for the SWMU 5.

- SWMU 6: the presence of off-site waste extending off-site along the northern side of the landfill and the on-site surface seepage at the northeast corner of the landfill will be addressed in the CMS.

- SWMU 8: the occurrence of elevated landfill gas pressure, leachate accumulation in the unit, and NAPL seepage to ground surface will be addressed in the CMS.
- SWMU 9: the occurrence of NAPL beneath the soil cover, NAPL seepage to ground surface, and the cap drainage conditions will be addressed in the CMS.

In addition, the baseline risk assessment determined that certain SWMUs and AOCs potentially pose a significant risk to human health, which warrants active corrective measures. Specifically, the significance of potential exposure to soil, sediment, surface water, ground water, NAPL, leachate, and indoor air at and adjacent to the Facility was evaluated based on current and reasonably likely future land and ground water use. Potential receptors evaluated include: on-site and off-site routine workers; on-site and off-site maintenance workers; on-site trespassers; off-site residents; and off-site recreational visitors. Based on the data collected during the RFI, the human health risk assessment presented in Section 5 of this report evaluated whether a release of hazardous waste or constituent may cause reasonable maximum exposures to be significant enough to warrant corrective measures. Based on the risk assessment, corrective measures are warranted to address the following:

- AOC 7: potential exposure of on-site outdoor routine facility workers to NAPL within Butz Crock, if it is assumed that workers spend every outdoor work day of the entire exposure period of 25 years at this location. It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMU 5: potential exposure of on-site outdoor routine facility workers to NAPL identified in subsurface soil, if it is assumed a surficial NAPL seep occurred and that workers spend every outdoor work day of the entire exposure period of 25 years at the seep location. It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMU 8: potential exposure of on-site outdoor routine facility workers to NAPL seeps, if it is assumed that workers spend every outdoor work day of the entire exposure period of 25 years at the seeps. It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMU 9: potential exposure of on-site outdoor routine facility workers to NAPL seeps, if it is assumed that workers spend every outdoor work day of the entire exposure period of 25 years at the seeps. It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMU 8: potential exposure of on-site maintenance workers to the NAPL seep at location SWMU 8-2 (corresponding to TLW-202). It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMU 6: potential exposures of on-site outdoor routine facility workers to leachate seeps at SWMU 6, if it is assumed that workers spend every outdoor work day of the entire exposure period of 25 years at the seeps, and leachate concentrations are never diluted with stormwater runoff. It should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site activities.

- SWMUs 5 and 6: potential exposures of on-site maintenance workers to ground water. When dissolved metals data are used as more representative dermal exposure concentrations, these exposures are not significant. Therefore, risks to maintenance workers from exposure to ground water at these SWMUs are considered marginal.

- SWMU 8: potential exposures of maintenance workers that encounter shallow ground water in the vicinity of temporary well T-208 located at the northeast corner of SWMU 8. However, it should be noted that workers at the Facility are covered by the Facility's Health and Safety Policy, which has provisions for preventing significant exposures during on-site excavation activities.

Accordingly, the CMS for the Otter Creek Road Facility is anticipated to include or address the following:

- Limited corrective measures, including institutional controls, for all SWMUs and AOCs investigated during the RFI, regardless of whether a significant risk to human health or the environment was identified in the baseline human health risk assessment and SLERA.

- SWMU 1:
  - landfill cap drainage improvements (currently being studied as part of ESOI's presumptive corrective measures activities).

- SWMU 5:
  - leachate extraction and landfill gas monitoring (currently being implemented as part of ESOI's presumptive corrective measures activities).
  - the presence of NAPL in a subsurface peat layer along the western side of the landfill.
  - exposures during maintenance activities that encounter ground water

- SWMU 6:
  - leachate extraction and landfill gas monitoring (currently being implemented as part of ESOI's presumptive corrective measures activities).
  - the presence of off-site waste extending to the Gradel Ditch along the northern side of SWMU 6.
  - surface leachate seepage at the northeast corner of SWMU 6.
  - exposures during maintenance activities that encounter ground water

- SWMU 7:
  - leachate extraction and landfill gas monitoring (currently being implemented as part of ESOI's presumptive corrective measures activities).

- SWMU 8:
  - elevated landfill gas pressure.
  - leachate accumulation.
  - NAPL seepage at SWMU 8.
  - exposures during maintenance activities that encounter ground water

- SWMU 9:
  - the occurrence of NAPL beneath the soil cover and NAPL seepage to ground surface at SWMU 9.
  - surface cap drainage improvements.

- AOC 1:
  - accumulated ground water removal (currently being implemented in accordance with the agreement with the City of Toledo).

- AOC 7:
  - NAPL seepage at AOC 7.

In summary, based on the results of the RFI, ESOI is recommending that a CMS be performed in accordance with Section E.8 of the State RCRA Permit. The purpose of the CMS will be to develop and evaluate the corrective action alternative(s) and to outline one or more alternative corrective measure(s).

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