Resource Conservation and Recovery Act Facility Investigation Phase II Report

Volume I of III

General Motors Corporation
NAO Flint Operations Site
ID #MID 005 356 712
Flint, Michigan

July 14, 2006

BBL®
BLASLAND, BOUCK & LEE, INC.
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Acronyms

ACGIH	American Conference of Governmental and Industrial Hygienists
ADD	average daily dose
AOI	area of interest
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATEC	American Testing and Engineering Corporation Associates
AWQC	ambient water quality criteria
BAF	bioaccumulation factors
BBL	Blasland, Bouck & Lee, Inc.
BCa	Bias-corrected and Accelerated
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CA 750	Migration of Contaminated Groundwater Under Control
cfs	cubic feet per second
cm/sec	centimeter(s) per second
CRA	Conestoga-Rovers & Associates
CoPCs	chemicals of potential concern
CSM	Conceptual Site Model
cy	cubic yard(s)
DOCC	Description of Current Conditions
DNAPL	dense non-aqueous phase liquid
EI	Environmental Indicator
ERA	Ecological Risk Assessment
ESL	ecological screening levels
FE	Flammability and Explosivity Criteria
FOIA	Freedom of Information Act
FSP	Field Sampling Plan
G&M	Geraghty & Miller
GAI	Groundwater Acute Inhalation Criteria
GCC	Groundwater Contact Criteria
GIS	geographic information system
gpm	gallons per minute
GM	General Motors Corporation
GSI	Groundwater/Surface Water Interface Criteria
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HUD	U.S. Department of Housing and Urban Development
IDC	Industrial Direct Contact Criteria
IDW	Industrial Drinking Water Criteria
IGVIA	Industrial Groundwater Volatilization to Indoor Air Inhalation Criteria
IM	interim measure
IPSIC	Industrial Particulate Soil Inhalation Criteria
IRIS	Integrated Risk Information System

ISVIA	Industrial Soil Volatilization to Indoor Air Inhalation Criteria
IVSIC	Industrial Infinite Source Volatile Soil Inhalation Criteria
LADD	lifetime average daily dose
LNAPL	light non-aqueous phase liquid
MDEQ	Michigan Department of Environmental Quality
mg/kg	milligrams per kilogram
MNFI	Michigan Natural Features Inventory
NAAQs	National Ambient Air Quality Standards
NAO	North American Operations
NCEA	National Center for Environmental Assessment
NEDOCC	Northend Description of Current Conditions
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
NREPA	Natural Resources and Environmental Protection Act (1994 PA 451, as amended)
NTU	Nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
PA	Public Act
PAL	Project Analyte List
PCBs	polychlorinated biphenyls
PCE	Tetrachloroethene
PEL	Permissible Exposure Limit
PID	photoionization detector
ppm	parts per million
PPRTV	provisional peer reviewed toxicity values
QAPP	Quality Assurance Project Plan
RBC	Risk based criteria
RCRA	Resource Conservation and Recovery Act
RDW	Residential Drinking Water Criteria
RfC	chronic inhalation reference concentrations
RfD	USEPA-derived chronic reference doses
SRfD	USEPA-derived subchronic reference doses
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
SDG	sample delivery group
SEDOCC	Southend Description of Current Conditions
SF	slope factor
SOCDS	State of the Cities Data Systems
SVOC	semi-volatile organic compound
SMDP	scientific management decision point
TAL	Target Analyte List
TCE	Trichloroethylene
TCL	Target Compound List
TLV	Threshold Limit Value
TPH	total petroleum hydrocarbons
UCL	Upper Confidence Limit
ug/L	micrograms per liter
URF	Unit Risk Factor
USEPA	United States Environmental Protection Agency

USFWS	United States Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
1,2-DCE	1,2 Dichloroethene

1. Introduction

1.1 General

This *Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Phase II Report* (Phase II Report) presents a summary of RFI activities completed by the General Motors Corporation (GM) for the North American Operations (NAO) Flint Operations Site in Flint, Michigan (the Site). This report supersedes a report of the same title dated March 16, 2004, which was submitted to the United States Environmental Protection Agency (USEPA) on March 30, 2004 to fulfill (in part) conditions set forth under Section VI.1.b of the RCRA Section 3008(h) Administrative Order on Consent (AOC) R8H-5-00-02, effective March 2, 2000 (modified November 8, 2001) for the Site (ID #MID 005 356 712). The March 30, 2004 Report was specifically submitted to fulfill the task of completing a RFI Phase II Report (Complete Investigation of Nature and Extent of Releases and Risk Assessment).

This RFI Phase II Report has been updated to include additional data generated following the March 16, 2004 RFI Phase II Report, through the submittal to USEPA of GM's Migration of Contaminated Groundwater Environmental Indicator (EI) Report (CA 750) on September 23, 2005. This report also addresses USEPA's comments on the March 16, 2004 RFI Phase II Report, contained in the following correspondence:

- USEPA letter received by GM on September 2, 2004; and
- USEPA letter received by GM on February 1, 2005.

These comments were resolved primarily per the following:

- GM letter dated November 19, 2004, that provided responses to USEPA's September 2004 comments;
- GM/USEPA project coordination meeting in Chicago on February 17, 2005 (Minutes dated March 8, 2005);
- GM/USEPA project coordination meeting in Chicago on March 23, 2005 (Minutes dated April 13, 2005); and
- GM/USEPA project coordination meeting in Chicago on September 15, 2005 (Minutes dated September 20, 2005).

RFI Phase II activities were conducted in accordance with the *RCRA Facility Investigation Work Plan* (RFI Work Plan) prepared by Blasland, Bouck & Lee, Inc. (BBL) and submitted to the United States Environmental Protection Agency on May 30, 2001. Supplemental activities, prompted by encountered field conditions, were discussed during biweekly conference calls and quarterly coordination meetings between GM and USEPA. Summaries of each of these discussions are presented in minutes, memoranda, and quarterly progress reports submitted to the USEPA and the Michigan Department of Environmental Quality (MDEQ).

This RFI Phase II Report presents a summary of the procedures, methods, and results of the field investigations conducted between March 9, 2002 and September 23, 2005. The information includes a comparison of the RFI analytical data to generic MDEQ risk-based screening criteria to identify whether a potential release of hazardous waste or hazardous constituents has occurred from each Area of Interest (AOI) identified for further investigation in the RFI Work Plan.

Prior Site information has been presented in the following documents:

- Description of Current Conditions for Areas South of Leith Street (BBL, May 30, 2000) (Southend Description of Current Conditions [SEDOCC]);
- Description of Current Conditions for Areas North of Leith Street (BBL, November 26, 2000) (Northend Description of Current Conditions [NEDOCC]); and
- Resource Conservation and Recovery Act Facility Investigation Phase I Report (BBL, June 28, 2002) (the RFI Phase I Report).

These documents serve as the basis for much of this Phase II Report, and are incorporated by reference herein. As needed, information previously presented in the NEDOCC, SEDOCC, and RFI Phase I Report is referenced, restated, or summarized. This Phase II Report supplements the RFI Phase I Report in that the format and much of the information has been updated. Specifically, Section 4 (Investigation Results and Discussion) of the RFI Phase I Report has been updated, and is superseded by the information presented in Section 4 of this Phase II Report. Information from the RFI Phase I Report that has not changed is simply referenced.

1.2 Report Organization

This Phase II Report is organized as follows:

- Section 1 (Introduction) presents the purpose and organization of the Phase II Report.

- Section 2 (RFI Overview) presents a summary of general conditions at the Site, including a Site description, a summary of investigation activities performed during Phase II of the RFI, and an evaluation of potential interim measures (IMs) identified during Phase II of the RFI. Much of this information has not changed from the RFI Phase I Report, and is not repeated in this Phase II Report.

- Section 3 (Environmental Setting) summarizes the environmental setting of the Site, including information on regional land use and demographics, climate, geology, hydrogeology, and hydrology. Much of this information has not changed from the RFI Phase I Report, and is not repeated in this Phase II Report.

- Section 4 (Investigation Results and Discussion) presents a summary and discussion of the RFI Phase II results for each of the AOIs investigated, including areas where IMs may be proposed. The discussion for each area investigated includes a summary of the scope of the field investigations, a summary and initial screening of the RFI Phase II data, and a discussion of whether the nature and extent of screening criteria exceedences have been determined. This section supersedes similar information presented in the corresponding section of the RFI Phase I Report.

- Section 5 (Summary of AOI and Interim Measures Status) summarizes the current status of each AOI at the Site, identifying AOIs where no releases above generic screening criteria were found, AOIs where releases will likely be evaluated during risk assessment activities, and AOIs for which remedial actions will be evaluated. In addition, this section identifies AOIs that require additional investigation to assess the extent of screening criteria exceedences.

- Section 6 (Human Health Risk Evaluation), prepared by ENVIRON, integrates the results of the data evaluation, exposure assessment, and toxicity assessment to evaluate the potential risks associated with exposure to constituents at the Site.

- Section 7 (Ecological Risk Evaluation) has been prepared by Exponent, and presents a conservative evaluation of potential ecological risks associated with the Site.

- Section 8 presents Conclusions.

- Section 9 presents a list of references used in the preparation of this report.

- Tables cited in the text of the report are found at the end of the text. Figures cited in the text of the report are bound separately.

- Appendix A presents geologic boring logs and monitoring well logs for soil borings advanced and monitoring wells installed during the Phase II RFI (March 10, 2002 to September 23, 2005).

- Appendix B presents a summary of analytical data for soil samples collected during the Phase II RFI (March 10, 2002 to September 23, 2005).

- Appendix C presents a summary of analytical data for groundwater samples collected during the Phase II RFI (March 10, 2002 to September 23, 2005).

- Appendix D presents a summary of analytical data for LNAPL samples collected during the Phase II RFI (March 10, 2002 to September 23, 2005).

- Appendix E contains summaries of the results of data review and data validation for all samples collected and submitted for laboratory analyses during the Phase II RFI. The complete data deliverables provided by SGC Environmental Services, Inc. (formerly CT&E Environmental Services, Inc.) of Lundington, Michigan and Merit Laboratories, Inc. of East Lansing, Michigan, for all RFI samples are stored in BBL's project files and are available upon request.

- Appendix F presents a discussion of the transport and fate of PCBs in storm sewers.

- Appendix G includes calculations supporting the Human Health Evaluation provided by ENVIRON.

- Appendix H includes Ecological Risk Evaluation supporting information provided by Exponent.

- Appendix I presents data collected during investigations of the Site storm sewer systems.

- Appendix J presents the results of air sampling and analysis performed by GM within select areas of Factory 36 and Factory 81.

2. RFI Overview

2.1 Site Description and History

The Site is centered near 902 East Leith Street in Flint, Michigan, in Genesee County (see Figures 2-1, 2-2, and 2-3) and encompasses approximately 452 acres of land. It is generally bounded to the north by Stewart Avenue and Pierson Road, to the south by Harriet Street, to the east by James P. Cole Boulevard and CSX Railroad, and to the west by Industrial Avenue and North Street. Current operations are all conducted in the portion of the property located north of Leith Street that is referred to as the Northend. Building demolition activities are completed in the portion of the property located south of Leith Street that is referred to as the Southend, and in progress in portions of the Northend.

Additional Site description and history information can be found in Section 2 of the RFI Phase I Report.

2.2 Pre-RFI Investigations

Numerous historical investigations were performed at the Site over the years on behalf of GM by various environmental consultants. Several of these investigations involved the assessment of potential soil and groundwater impacts either within various regions of the Site or along its perimeter, while the remaining investigations involved more focused assessments of specific areas where constituents of interest were identified as being potentially released to the environment. Information concerning the pre-RFI activities is summarized in Section 2.2 of the RFI Phase I Report.

2.3 RFI Phase II Activities

During Phase II of the RFI (generally from March 10, 2002 through September 23, 2005), 83 soil borings were advanced and 127 monitoring wells were installed, of which 34 were installed as replacements for wells damaged or destroyed during demolition activities at the Site. These additional soil borings and wells were completed to further delineate the extent of potential releases of hazardous constituents above generic screening criteria at each AOI identified for further investigation during Phase I of the RFI. Tables 2-1 and 2-2 provide comprehensive summaries of the soil borings and monitoring wells installed during Phase I and Phase II of the RFI. Soil boring and monitoring well installation logs for the Phase II investigation program are included in Appendix A.

2.3.1 GIS Database and Site Survey

Data collected during Phase II of the RFI were incorporated into the geographic information system (GIS) database for the Site. Survey data for soil borings and monitoring wells were updated in the GIS database and are shown in Tables 2-1 and 2-3, respectively. More information regarding the development of the GIS is presented in Section 2.3 of the RFI Phase I Report.

2.3.2 RFI Phase II Sampling and Analysis Program

The RFI Phase II sampling program was designed to characterize the presence, nature, and extent of hazardous constituents in soil and groundwater at the Site related to potential releases from the AOIs, beyond that already performed as part of the RFI Phase I activities. Summaries of the soil, water, and light nonaqueous phase liquid (LNAPL) samples collected during the RFI Phase II are included in Tables 2-4, 2-5, and 2-6. Additional data to assess the physical subsurface environment were also collected as part of the Phase II RFI. To identify data gaps and to evaluate the potential migration pathways at the Site, all RFI data were compared with generic screening criteria, as described in Section 4.1.

Protocols for the completion of sampling and analysis activities were presented in the *Field Sampling Plan/Quality Assurance Project Plan* (FSP/QAPP) provided as Appendix C of the RFI Work Plan and in the *Health and Safety Plan* (HASP) provided as Appendix E of the RFI Work Plan.

2.3.2.1 Boring/Well/Piezometer Installation and Sample Collection

Overall, the RFI Work Plan proposed the completion of one or more of the following for each AOI:

- *Soil Borings* – proposed at locations where only soil analytical data were needed. Groundwater quality data were generally available at nearby locations;
- *Surface Soil Samples* – proposed to characterize soils within the 0- to 2-foot depth interval within unpaved areas for purposes of human health risk evaluation;
- *Soil Borings with Grab Groundwater Sample Collection* – proposed at locations where analytical data were needed for soil and groundwater (screening quality), but groundwater elevation data were not needed;
- *Soil Borings/Possible Monitoring Wells* – proposed at locations where LNAPL delineation was needed and wells may have been installed depending on observed subsurface conditions;
- *Monitoring Wells* – proposed at locations where both groundwater quality and groundwater elevation data were needed, in addition to soil data; and
- *Piezometers* – proposed at locations where only groundwater elevation data were needed.

2.3.2.2 Soil Sample Collection

Visual Sample Characterization

At each drilling location, soil samples were collected continuously in 2-foot sections for visual classification and were screened with a photoionization detector (PID). At locations where potential LNAPL presence was of concern, shake tests were completed on samples collected near the water table and at other depth intervals chosen based on PID readings and visual observations.

Analytical Sample Collection

Up to four soil samples were collected for laboratory analysis at each of the boring locations (i.e., monitoring well locations, soil boring locations, and soil boring/grab groundwater sample collection locations) in accordance with the following conventions:

- One soil sample was collected at each location from the ground surface (or immediately beneath pavement) to a depth of 2 feet (e.g., 6- to 24-inch-depth sample below 6 inches of pavement).
- One soil sample was collected from the 8- to 10-foot depth increment (for purposes of human health risk evaluation), provided that this soil interval was not saturated.
- One soil sample was collected from the 2-foot depth increment immediately above the water table (top of the saturated zone).
- One other soil sample may have been collected based on high PID readings (greater than 10 parts per million [ppm]) or visual/olfactory evidence of contamination.

In addition, in some areas soil sampling was completed to target a specific depth interval(s) at "step-out" locations to evaluate the distribution of detected constituents.

Soil samples were analyzed for analytes listed in Table 2 of the FSP/QAPP. These analytes include Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), a subset of the inorganic constituents present on the Target Analyte List (TAL) (inorganics), and several additional constituents previously detected at the Site that could impact human health. These constituents comprise the Project Analyte List (PAL) presented in Table 2 of the FSP/QAPP and are hereinafter referred to as the PAL constituents.

2.3.2.3 Groundwater Elevation Measurement and Groundwater Sample Collection

Three rounds of groundwater elevation measurements (June 2002, March 2003, and December 2004) were taken Site-wide during Phase II of the RFI to develop current groundwater elevation contour maps. In July- August 2005, groundwater elevation contour maps for four areas (AOI 09, AOI 10, AOI 36, and AOI 84) were updated to support the Environmental Indicators (EI) CA 750 (ENVIRON 2005).

Groundwater elevation measurements were made to the nearest 0.01 feet during as short a duration as possible (generally within a 24-hour period), avoiding periods of rainfall that could change groundwater elevations within a measurement round.

Multiple groundwater sampling events were performed at selected AOIs between 2002 and 2005 at permanent monitoring wells using a peristaltic pump and following low-flow groundwater sampling procedures. At the sampling locations with sufficient yield, specific-capacity testing was also completed during well purging, prior to sample collection.

Groundwater samples were analyzed for PAL constituents, including VOCs, SVOCs, PCBs (total and dissolved), and inorganics (total and dissolved). Note that at some locations where the presence or extent of specific analytes was being investigated, analyses were completed for a portion of the PAL constituents list only.

2.3.2.4 LNAPL Delineation and Sample Collection

LNAPL is present at a number of locations at the Site, and one of the RFI objectives is to define the extent of LNAPL. Flexibility was built into the RFI Work Plan to allow the drilling program to be modified as needed in the field to define LNAPL extent. Observations were made at all Site boring locations to determine if LNAPL was likely to be present. Based on the presence or absence of LNAPL indicators, a decision was made as to the need for a monitoring well at that location. Monitoring wells were installed if needed to:

- Differentiate between two distinct LNAPL types or sources in an area where LNAPL may be commingled;
- Monitor LNAPL thickness to evaluate LNAPL distribution or to monitor the progress of IMs; or
- Verify if LNAPL is present in sufficient quantity to accumulate in a well.

If LNAPL was identified at a boring location, and a monitoring well was not needed based on the above evaluation, the boring was abandoned, and supplemental boring(s) were completed as needed to define LNAPL extent.

An LNAPL sample was collected and analyzed for PAL constituents and physical characteristics if previous data were not available for a particular LNAPL area.

2.4 Interim Measures

As a result of the RFI and previous investigations, LNAPL has been identified beneath various areas of the Site. Although these LNAPL plumes have been demonstrated to be relatively stable, based on several years of routine monitoring, GM has initiated the evaluation of the need for remedial measures at these areas, and has undertaken actions to collect LNAPL in accordance with regulatory requirements. These activities include the installation of LNAPL recovery systems, and in select areas the collection of LNAPL from select individual wells.

Sections 2.4 and 5.4 of the RFI Phase I Report provide a summary of the status of Site-related IMs through the end of June 2002. This information included the following:

- IMs taken out of service;
- IMs currently in service;
- IMs under design; and
- Areas under investigation for which IMs would potentially be warranted.

Based on the additional information gathered since June 2002, covered by this Phase II Report, GM has advanced the design and construction of certain IMs, as well as the assessment of IM needs involving the other various areas under consideration. An update of this information is presented in Section 5.3 of this Phase II Report. Also, LNAPL Monitoring Reports summarizing current information have been submitted to the USEPA and MDEQ periodically since 2003. Wells exhibiting measurable amounts of free product have been monitored on a relatively frequent basis (weekly, bi-weekly, or monthly) in areas across the Site where LNAPL has been identified. Where present at a thickness greater than 0.3 feet, LNAPL has been removed by bailing. This monitoring and removal program was initiated to satisfy both the MDEQ requirement for active source removal, requirements of the AOC, and to complete the Migration of Contaminated Groundwater under Control (CA 750) EI evaluation. In each of the areas with measurable amounts of LNAPL, wells have been identified as

LNAPL wells (wells with historically measurable LNAPL accumulations) and sentinel wells (wells located along the perimeter of each LNAPL plume).

The LNAPL monitoring program was revised, in February 2003 and following the first quarter LNAPL monitoring in March 2003, to reflect current LNAPL levels in Site wells. For example, some wells previously in the monitoring program did not produce sufficient amounts of LNAPL to justify regular bailing. Also, reduction of the LNAPL monitoring frequency was considered appropriate because of soon-to-be-operational IM product recovery systems at Factory 36 and Factory 10, and the improvements to the IM at Factory 05 will provide a more efficient method of LNAPL removal than well bailing.

Additionally, per the MDEQ Natural Resources and Environmental Protection Act (NREPA) of 1994, Public Act (PA) 451, Part 213 (Part 213) underground storage tank (UST) requirements, wells RFI-16-08, RFI-16-10, 20-502, 20-503, 37-RW-North, 37-RW-South, and 31-7 are being monitored either weekly (16-08, RFI-16-10, 20-502, and 20-503) or biweekly (37-RW-North, 37-RW-South, and 31-7) and, if present, product is bailed from these wells.

Figures 2-4 and 2-5 show the locations of IMs (former and current) at the Site. Through 2003, the LNAPL program employed the following monitoring frequency protocol:

- Quarterly monitoring for LNAPL of wells located in areas with active, or anticipated, IMs. These areas included: Factory 05, Building 43 (current IM); Former Tank Farm 37 (current IM); Factory 10 Groundwater Recovery (current IM); Factory 81 (current IM); Building 87/Leith Street Overpass (current IM); Factory 36 – Southeast; Factory 10 Scrapyard; and Factory 05 Recovery Trenches.

- Monthly monitoring for LNAPL of wells located in areas not addressed by active IMs. These areas included: Building 12 Area; Factory 83/84 Area; and the Former Hamilton Avenue Tank Farm.

- Monitoring of wells currently included in the program to comply with MDEQ Part 213 UST requirements (wells RFI-16-08, RFI-16-10, 20-502, 20-503, 37-RW-North, 37-RW-South, and 31-7) on a weekly or biweekly basis, as listed above.

Following 2003, the LNAPL monitoring program was modified in response to observed Site conditions. Modifications included a reduction in the monitoring frequency to a semi-annual schedule, and a reduction in the LNAPL removal frequency to an annual schedule. Table 2-7 presents a summary of data collected during the LNAPL monitoring activities.

Additionally, since June 2002, GM has conducted a storm sewer study in parallel with the RFI activities to assess potential infiltration of LNAPL and groundwater into the Site storm sewer system and to determine potential sources of LNAPL sheens to the Flint River. Figures 2-4 and 2-5 present the locations of the storm sewers. A summary of this study and resulting information is presented in Section 4.7. Section 5.3 provides an overview of mitigation measures planned as result of the study.

3. Environmental Setting

Much of the information regarding the environmental setting (e.g., topography, climate, hydrology, geology, hydrogeology, surface water drainage) of the Site has not changed from what is presented in Section 3 of the RFI Phase I Report. This section only describes those portions of the environmental setting that have been modified or expanded upon, based on data obtained during Phase II of the RFI, including building demolition, Site-specific hydrogeology, groundwater use, land use and demographics.

3.1 Building Demolition

Several buildings, building complexes, and associated structures have been demolished while the RFI has been performed, including three located on the Northend (Buildings 07, the Building 30/30B/30E complex, and the Building 85 complex) (see Figure 2-2) and seventeen located on the Southend (Buildings 01, 02, 03, 04, 08, 09, 10, 12, 16, 17/17A, 23, 28, 29, 40, 44, 84/84B and 94/94A) (see Figure 2-3). Nine additional Northend buildings are currently idled, including Buildings 11, 15, 32, 38, 61/61A, 65, 66/66A/66C/66D, 83/83A, 85 and 97.

3.2 Site-Specific Hydrogeology

As described in the RFI Phase I Report, the hydrogeology of the Site is characterized by a shallow groundwater zone with depth to the water table typically ranging from approximately 6 to 16 feet below ground surface (bgs). Site monitoring wells have been installed within shallow overburden deposits consisting of fill, silty sand, silt, and clay.

Hydraulic conductivity values measured at shallow monitoring wells installed during the RFI in the sandy fill materials and silty sand soil units ranged from approximately 1.3×10^{-2} centimeters per second (cm/sec) to 3.3×10^{-4} cm/sec, based on specific-capacity tests (Table 3-1). Hydraulic conductivity values measured at shallow monitoring wells installed within silt and clay ranged from approximately 3.1×10^{-5} cm/sec to 3.1×10^{-6} cm/sec.

The underlying glacial till unit, at a depth of approximately 5 to 30 feet, has been characterized as an aquitard based on the unit's low hydraulic conductivity and low yield. Based on the analysis of a Shelby tube sample by a geotechnical laboratory, the vertical hydraulic conductivity of this unit is approximately 7.9×10^{-8} cm/sec.

Sitewide groundwater elevations measured in June 2002, March 2003, and December 2004 (Table 3-2) were used to prepare Sitewide groundwater elevation contour maps (Figures 3-1, 3-2, 3-3 and 3-4) and to determine the direction of groundwater flow. Additional, detailed groundwater elevation contours for several areas are shown on Figures 4-4, 4-6, 4-18, and 4-24, representing conditions in July and August 2005. The additional groundwater elevation data were collected in these areas to support the CA 750.

Generally, groundwater flow directions for these dates are similar to those observed previously, with groundwater generally flowing toward the Flint River. In the northernmost portion of the Site (Building 38 and Factory 36 areas), groundwater flows to the north-northeast. A groundwater ridge, or divide, is present in the vicinity of Stewart Avenue. Groundwater to the south of this divide appears to have an east to southeast flow component. Groundwater flows to the east and southeast in the central portion of the Site (Factory 43, Building 20 areas). In the south central and southern portions of the Site, the direction of groundwater flow is primarily

to the east-southeast. Localized fluctuations in the direction of groundwater flow patterns are observed near subsurface structures (e.g., basements) and utilities that intercept shallow groundwater. Such influences can be observed near Buildings 30 and 70 on the north side and near the former Building 09 area on the south side (shown on Figure 4-24) of the Site due to a storm sewer. Other manmade features that affect the direction of groundwater are the Leith Street Overpass and the recovery well system operating in the Building 20 Area. Groundwater flow gradients across the Site typically range from 0.01 to 0.02; however, as illustrated on Figures 3-1 and 3-2, much steeper gradients are present in localized areas of the Site due to the presence of the manmade features discussed above.

Groundwater elevations in several areas of the Site increased between 2001 and 2005. Some of this rise is likely in response to building demolition and the potential change in storm water management resulting from building demolition. Additional reasons for the rise in groundwater levels may be attributed to the removal of basement sumps and dewatering systems and subsequent recharge through former basement structures. For example, water levels measured within the Building 12 Area have risen as much as 4 to 7 feet since Building 12 was razed. Due to the rise in groundwater levels, several well screens no longer straddle the water table, as installed. Additional water table monitoring wells were installed in select demolition areas of the Site to enable continued monitoring of LNAPL thickness. Figures 2-2 and 2-3 illustrate both the locations of demolished buildings, and the wells in which measurable thickness of LNAPL has been detected.

3.3 Groundwater Use

The Saginaw Formation of bedrock, which underlies the unconsolidated glacial drift in the area of the Site at depths reported to be 60 to 80 ft bgs, was historically the primary source of groundwater in the Flint area. Several production wells in the formation were previously used for industrial and public water supply. As alternative sources of drinking water became available, these wells were taken out of service due to the poor quality of the groundwater (high hardness and dissolved solids values). There are no known active production wells in the City that use the overburden or bedrock formations as a source of groundwater (Huffman and Whited, 1993).

Currently, the City of Flint Department of Public Works supplies drinking water to the City of Flint, and Flint Township (MDEQ Website, updated October 2003). The City of Flint Department of Public Works purchases potable water from the City of Detroit, which routes water from a Lake Huron intake to the City of Flint (2002 Water Quality Report, Detroit Water and Sewerage Department). In addition, a City of Flint ordinance prohibits the installation of drinking water wells (Ordinance 9, Code of Ordinances, Chapter 46-25).

3.4 Land Use Demographics

As discussed in Section 2.1, the Site occupies approximately 452 acres located on the north side of the City of Flint and currently consists of four active manufacturing complexes (Factories 05, 10, 36, and 81), with the remainder either demolished or idled. Automobile manufacturing operations began at the Site during the early 20th (1903) century and continue today. Current Site operations, all of which occur on the Northend, include machining of ferrous and nonferrous metals, V-6 engine manufacturing, torque converter manufacturing, transmission components manufacturing, engine assembly, and industrial wastewater treatment. It is expected that industrial use of the Site will continue into the future.

The majority of the Site is located within the Flint Renaissance Zone, which is a designation established by the State of Michigan that allows for the creation of tax exempt zones designed to spur commercial and industrial growth in eleven economically distressed Michigan communities.

Current land use patterns near the Site are discussed below, along with trends in the economy, population, and housing in Flint, the City's plans for revitalization, and the implications of these factors for the future land use at the Site. The information discussed below is taken primarily from the following sources:

- U.S. Department of Housing and Urban Development (HUD) State of the Cities Data Systems (SOCDS) database located on the HUD website (www.socds.huduser.org);
- U.S. Bureau of the Census, Census 2000; and
- The City of Flint website (www.cityofflint.com).

3.4.1 Land Use Patterns

Land use in the City of Flint is divided into 15 districts, which include classes of residential, business, commercial and manufacturing uses as established within the City of Flint Zoning Ordinance (Chapter 50). Figure 3-5 illustrates the zoning districts for the Site and the properties near the Site. The Site is composed of several tax parcels most of which are zoned "G" - Heavy Manufacturing District, which is summarized from the City's Zoning Ordinance as:

"The "G" Heavy Manufacturing District is intended to accommodate those heavy industries which cannot eliminate entirely objectionable features and influences but which, nevertheless, must be provided for somewhere in the City."

Site parcels not zoned "G" include the following:

Northend

The strip of land located east of Andrew Street and north of Stewart Street (currently used for employee parking) is zoned "B" – Two-Family District, which is summarized from the City's Zoning Ordinance as:

"This district allows one and two-family homes on 5,000 square foot lots. Multi-family homes, rest homes, hospitals, and customer parking lots are allowed under special conditions."

Three lots located west of Industrial Avenue and north of Leith Street are zoned "C-1" – Multi-Family Walk-up Apartment District, which is summarized from the City's Zoning Ordinance as:

"This district allows one and two-family homes, walk-up apartment, fraternities and children's institutions outright; and offices clinics, customer parking lots and funeral homes under special conditions."

Southend

The parcel located west of Industrial Avenue, north of Hamilton Avenue and south of Oak Park is zoned "C-1" – Multi-Family Walk-up Apartment District (as described above), and "D-2" - Neighborhood Business District, which is summarized from the City's Zoning Ordinance as:

"It is the purpose of this district to provide principally for convenience goods needs of persons residing in nearby residential areas. Uses permitted outright or conditionally shall be limited to those required to satisfy basic needs for goods and services required daily or frequently."

The parcel located west of Industrial Avenue and south of Hamilton Avenue (Administration Building 1 and associated employee parking lot) is zoned "E" – Heavy Commercial Limited Manufacturing District, which is summarized from the City's Zoning Ordinance as:

"The "E" Heavy Commercial Limited Manufacturing District is intended to accommodate heavy commercial and certain light manufacturing uses which are generally incompatible with uses appropriate in retail business districts, but to not warrant an exclusive industrial classification."

The parcel located west of Industrial Avenue and south of Harriet Street is zoned "A-2" – Single Family Medium Density District, which is summarized from the City's Zoning Ordinance as:

"This district allows single-family detached dwellings on minimum 5,000-square-foot lots. This zone also allows institutional uses such as churches and schools; and two-family dwellings and home occupations under special conditions."

Zoning districts for properties near the Site include: residential districts ("A-2", "B" and "C-1"); business/commercial districts ("D-2", "D-3", "D-5" and "D-6") and manufacturing districts ("E", "F" and "G"). Note that no AOIs are located within those areas of the Site that are zoned for residential and business/commercial use. Other properties located adjacent to the Site also zoned "G" - Heavy Manufacturing District include: PPG Industries, Kasle Steel/Auto Blankers, Universal Systems, Flint Coatings, Flint Police Training Building, Consolidated Freightways, Lockhart Chemicals and the former DuPont Plant, as identified on the Site Plan (Figures 2-2 and 2-3).

3.4.2 Flint Demographics

The City of Flint's economy has historically centered on manufacturing, which peaked during the late 1960's and early 1970's. From 1980 to 1990 (the 1970 census was deemed unreliable by HUD), the percent of jobs in Flint in the manufacturing sector dropped from 52% to 43% based on information summarized in the SOCDS database located on the HUD website. In 1990, the three largest job categories in Flint were the manufacturing industry (employed 43% of working residents), professional services industry (employed 22% of working residents) and the retail trade industry (employed 12% of working residents). Although the manufacturing sector has declined, manufacturing continues to employ the majority of working residents in Flint.

Population has decreased in the City of Flint from approximately 197,000 in 1960 to 125,000 in 2000, which is a decrease of 37%. The following shows Flint's population trend from 1950 to 2000 (HUD, SOCDS).

Year	Population	Change	Percent Change
1950	163,143	0	0
1960	196,940	33,797	17%
1970	193,380	3,560	-2%
1980	159,611	33,769	-17%
1990	140,761	18,850	-12%
2000	124,943	15,818	-11%

Projections for Flint's population from 2000 to 2007 do not anticipate an increase.

The decrease in population resulted in a corresponding decrease in demand for housing in Flint. In 2000, there were approximately 55,310 housing units in Flint, of which 28,679 were owner-occupied (HUD, SOCDS). From 1970 to 2000, the number of owner-occupied residences decreased by approximately 13,500 units, while the number of rentals increased by approximately 1,300 units. Of the 55,310 housing units available in 2000, approximately 12%, or 6,560 units were vacant, which is more than double the vacancy rate in 1970 (HUD, SOCDS).

Of the housing units identified in the 2000 census, only 2% were constructed between 1990 and 2000, and only an additional 11% of the units were constructed between 1970 and 1990. Approximately 18% of the housing units are 30 to 39 years old, with 69% of the units 40 years or older (U.S. Bureau of the Census, Census 2000). Despite the slow rate of housing construction, and the current zoning (most of the Southend is zoned for heavy manufacturing), evaluation of the Southend includes residential and recreational scenarios to allow flexibility for future redevelopment. The results of this evaluation are discussed in Section 6.

4. Investigation Results and Discussion

This section presents a summary of the results of the field investigations completed during the RFI investigation completed through September 23, 2005. Since this section incorporates the results of previous investigations at each of the AOIs at the Site, along with additional information collected since the Phase I Report, prior information presented in the Phase I Report (including many of the conclusions and recommendations for additional investigations) has been superseded. This section represents a complete update to the corresponding Section 4 of the RFI Phase I Report.

The format of this Section will generally follow that of the RFI Phase I Report, except that Section 4.2 of the RFI Phase I Report, which discusses the total vs. dissolved inorganics data, is incorporated by reference herein. Discussions of each AOI follow the format of the Phase I Report, describing the scope, results, and conclusions for each AOI. Section 4.1 describes the MDEQ screening criteria used during this investigation. Section 4.2 presents a discussion of Site-specific background screening values for metals in soil. Section 4.3 presents a discussion of overall data quality. Section 4.4 presents the results of investigations of the 36 AOIs north of Leith Street described in the RFI Work Plan. Section 4.5 presents the results of investigations of the 37 AOIs south of Leith Street described in the RFI Work Plan. Section 4.6 presents the results of investigations of five new AOIs not previously described in the RFI Work Plan.

The results of the field investigations completed during the RFI are discussed in the following subsections by operational areas (Northend and Southend). Each subsection includes a description of the AOI, or area investigated, the scope of the field investigation, a summary of the results, and discussion of the results with respect to whether an exceedence of screening criteria has been identified. A more detailed description of each AOI is provided in the Southend DOCC (BBL, 2000a) and the Northend DOCC (BBL, 2000b). Figures 4-1 through 4-28 present all soil sampling locations and groundwater monitoring well locations, as well as specific Site features that include roads, buildings, fences, and railroads. These figures also present the results of analytical data screened against MDEQ criteria as described in Section 4.1. Note that due to the proximity of multiple AOIs, the AOI association of individual data points may not be obvious based on sampling point location. Tables 2-4, 2-5, and 2-6, which present lists of the soil, groundwater, and LNAPL samples collected during the investigation, also identify the AOI associated with each sample. Analytical results for soil, groundwater, and LNAPL samples collected since the RFI Phase I Report are presented in tables included in Appendices B, C, and D, respectively.

4.1 Generic Michigan Department of Environmental Quality (MDEQ) Screening Criteria

The identification of a potentially significant release at an area is based on comparison of the characterization data collected during the RFI with generic risk-based screening criteria. The approach for evaluating the soil and groundwater data is discussed below.

Surface and subsurface soil and groundwater analytical data were compared to Michigan Part 201 generic screening criteria that the MDEQ has developed under the authority of the Natural Resources and Environmental Protection Act (NREPA) (1994 PA 451, as amended). These screening criteria are presented in MDEQ's Part 201 Rules No. 18 (updated December 10, 2004). The specific screening criteria used for soil and groundwater PAL constituents in this investigation are presented in Tables B-2 and C-3 of Appendices B and C, respectively.

Surface and subsurface soil analytical data were compared to the following generic MDEQ criteria:

- Residential Direct Contact (RDC);
- Residential Soil Volatilization to Indoor Air (RSVIA);
- Residential Infinite Source Volatile Soil Inhalation (RISVSIC);
- Residential Particulate Soil Inhalation (RPSIC):
- Industrial Direct Contact (IDC);
- Industrial Soil Volatilization to Indoor Air (ISVIA);
- Industrial Infinite Source Volatile Soil Inhalation (IISVSIC); and
- Industrial Particulate Soil Inhalation (IPSIC).

Groundwater analytical data were compared to the following generic MDEQ criteria:

- Health-Based Residential Drinking Water Criteria (RDW);
- Residential Groundwater Volatilization to Indoor Air (RGVIA):
- Health-Based Industrial Drinking Water Criteria (IDW);
- Industrial Groundwater Volatilization to Indoor Air (IGVIA);
- Groundwater Contact (GCC);
- Groundwater Acute Inhalation (GAI); and
- Flammability and Explosivity (FE).

Constituents with concentrations exceeding any of these generic MDEQ Residential or Industrial criteria are included on the databox figures (Figures 4-1 through 4-28). Constituent concentrations greater than any of these criteria are identified on the databox figure with the parenthetical abbreviations above. During the field investigation, the generic Industrial criteria were used to evaluate the data from each phase of investigation and to guide the development of sampling plans for the next phase. The concentrations that are higher than these generic Industrial criteria are highlighted on the figures and discussed in Sections 4 and 5.

Groundwater samples were collected from temporary monitoring wells during the RFI to determine the need for permanent monitoring wells in certain areas, and to assist in their placement. The combined data set for the permanent and temporary monitoring wells was compared to the MDEQ criteria listed above and the results are discussed in Sections 4.4 through 4.6.

Note that as a conservative approach to screening Site data, groundwater analytical data collected at Site monitoring wells located within 500 feet of the Flint River were also compared to Groundwater/Surface Water Interface (GSI) Criteria. However, it is not believed that the GSI is accurately reflected by wells located this far from the river, and the criteria were used only as a basis to propose additional monitoring wells.

A similarly conservative approach was also followed with respect to application of the generic MDEQ Residential Drinking Water (RDW) Criteria. For screening purposes, all of the groundwater data, regardless of sampling location, were compared to the RDW to make decisions regarding additional sampling requirements.

Analytical results for the water samples collected from basements, tunnels, and sewers were compared to the generic groundwater criteria.

Determination of the extent of releases and the need for further investigative activities at an AOI or offsite area was based on the distribution of contaminant concentrations exceeding the applicable screening criteria. If soil or groundwater analytical results associated with an AOI exceeded the screening criteria, additional

investigations were completed, as necessary, to provide sufficient information to characterize the nature and extent of constituents potentially of concern. The CA750 Report was completed for the Site in September 2005.

4.2 Site-Specific Background Soil Concentrations

Background soil samples were collected during the RFI to characterize naturally occurring levels of metals in soil at the Site. Consistent with the RFI Work Plan, background soil samples were collected from thirteen locations where no manufacturing or management of production materials or wastes was known to have occurred. The locations where the background soil samples were collected are shown in Figures 2-2, 2-3, and 4-1 through 4-28. At each location, one sample was collected from 0 to 2 ft bgs. Deeper samples, to 14 ft bgs, were collected at three locations (RFI-05-09, RFI-36-01, RFI-55-01) but were not included in the background calculation because these depths were not sampled at all locations. The boring logs for these samples are provided in Appendix A and the analytical data are provided in Appendix B.

The concentrations of metals in the samples from the 0- to 2-foot below ground surface (bgs) interval are the most representative of background exposures to metals in soil because soil from this interval is expected to be encountered by the general population more often than deeper soil. The metal concentrations in background soil from this interval are summarized in Table 4-1, which also includes summary statistics describing the concentration distributions.

The upper confidence limits (UCLs) presented on these tables are nonparametric bootstrap UCLs on the mean (Efron and Tibshirani, 1998) calculated from 4,000 bootstrap replications and at a 0.05 level of significance. 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. A concentration of a metal lower than or equal to its upper confidence limit is considered to be within background levels; a concentration higher than its upper confidence limit is considered to be higher than background levels.

Table 4-1 summarizes the upper confidence limit calculations for Site-specific background metals. The detected concentrations of manganese (2100 mg/kg) and zinc (720 mg/kg) from location RFI-BG-10 were suspected to be from a different data population and as a conservative measure were excluded from the upper confidence limit calculations. Table 4-2 presents the estimates of cancer risk and hazard quotient that are associated with these background levels for the soil contact exposure scenarios for routine workers, residents, and recreational users discussed in section 6.3. These background levels of risks are not included in the Site-related risk estimates that are discussed in Section 6.

4.3 Data QA/QC Summary

This section presents a summary of the quality assurance/quality control (QA/QC) procedures performed on analytical data collected since the RFI Phase I report.

Data from 101 sample delivery groups (SDGs) for samples from all environmental media collected between March 2002 and September 2005 were reviewed for quality assurance/quality control compliance with method guidelines and project-specific requirements. Each SDG data package received from the laboratories (CT&E, Inc. of Ludington, Michigan and Merit Laboratories, Inc. of East Lansing, Michigan) was reviewed as outlined in the FSP/QAPP. Specifically included in this review was an evaluation of holding times, calibration requirements (initial and continuing), blank contamination, internal standard recovery, surrogate recovery,

matrix spike and duplicate performance, laboratory control sample recovery, field duplicate and analyte identification, as applicable. Data collected from March 2002 to May 2005 were validated by BBL, and data collected after June 2005 were validated by Conestoga-Rovers & Associates of Waterloo, Canada.

Certain data were qualified as estimated and possibly biased high or low due to minor quality control deviations. A small percentage of the data set was qualified as unreliable based on more significant quality control deviations. Completeness, defined as the percentage of measurements that are judged to be valid or usable to meet the prescribed data quality objectives for this analytical data set, was 99.7%. The completeness percentage is greater than the minimum required usability of 90 percent as specified in the FSP/QAPP. Overall, the data that were not qualified as unreliable were found to be acceptable for use as reported by the laboratory. At times, data were qualified as estimated by the data validator. For a complete explanation of qualified sample results based on the data validator's review of each SDG, refer to Appendix E.

4.4 AOIs North of Leith Street

Results of investigations of 37 AOIs north of Leith Street are detailed below.

4.4.1 AOI 38-1 (Process Waste Sumps, Trenches, and Former Hydraulic Car Lifts)

This AOI is located in the northern portion of Building 38 and consists of several process waste sumps, trenches, and former hydraulic car lifts. To assess potential impacts from hydraulic and waste oil handled in these areas, three soil borings and three monitoring wells were installed within this AOI. Two existing monitoring wells (36-101 and 38-120) were also sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-1 and 4-2.

4.4.1.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	6	19	19	19	19	--	--
Groundwater	5	5	5	5	10 + 1 Be, Tl	5	6 + 1 Tl

Duplicate samples are not included in sample totals.

4.4.1.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 38-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Thallium	0.0049	IDW (0.002)
Beryllium	0.034	IDW (0.004)
Lead	0.0065	IDW (0.004)

4.4.1.3 Conclusions

The RFI soil data from AOI 38-1 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 38-1 indicate screening criteria were exceeded for thallium, beryllium, and lead. The concentrations of beryllium and lead in the groundwater did not exceed screening criteria during the latest groundwater sampling event (October 2004). Based on these results, the extent of the exceedences in this area has been delineated; therefore, no additional investigation activities are planned.

4.4.2 AOI 36-1 (Engine Manufacturing and Metal Machining Processes)

This AOI is located in the northern and central portions of Building 36 and is associated with engine manufacturing and metal machining processes. To assess the extent of historical releases of hydraulic oils, cooling/cutting oils/fluids, and/or process waste oils, seven soil borings and 35 monitoring wells were installed in association with this AOI. In addition, existing monitoring wells 36-100, 36-120, and 36-121 were sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-3 and 4-4.

4.4.2.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	42	129 + 9 BTEX	102	81	109 + 6 As + 1 Hg	--	--
Groundwater	27	64	15	15	23 + 11 CN/Hg 1 Cr/Mn/V, and 2 As, 1 Ni	15	22 + 2 As
LNAPL	3	4	4	2	2	--	--

Duplicate samples are not included in sample totals.

4.4.2.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzene	240	IISVSIC (45) ISVIA (8.4)
Ethylbenzene	680	IDC (140) ISVIA (140)
Toluene	4,100	IDC (250) IISVSIC (3,300) ISVIA (250)
Xylenes (total)	2,480	IDC, ISVIA (150)
Arsenic	39	IDC (37)
Chromium (total)	410	IPSIC (240)
Manganese	6,730	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	0.95	IDW (0.20)
1,1-Dichloroethene	0.12	IDW (0.007)
1,2-Dichloroethane	0.0093	IDW (0.005)
cis-1,2-Dichloroethene	0.15	IDW (0.070)
Trichloroethene	0.099	IDW (0.005)
Benzene	0.36	IDW (0.005)
Vinyl Chloride	0.198	IDW (0.002)
Arsenic	0.14	IDW (0.050)
Beryllium	0.030	IDW (0.004)
Cadmium	0.021	IDW (0.005)
Chromium (total)	0.22	IDW (0.10)
Lead	0.022	IDW (0.004)
Nickel	0.13	IDW (0.10)
Vanadium	0.21	IDW (0.062)

4.4.2.3 Conclusions

The RFI soil data from AOI 36-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The extent of the VOC exceedences in this area has been sufficiently defined for purposes of GM's RFI responsibilities; therefore, no additional investigation activities are planned. Additional delineation of VOCs, chromium, and manganese to the east of AOI 36-1 is not planned, because GM has never owned or controlled the associated property. The property to the east of AOI-36-1 is owned by others.

The RFI groundwater data from AOI 36-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The extent of the VOC exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in AOI 36-1 has been delineated.

4.4.3 AOI 36-2 (Metal Chip Processing Area)

This AOI is the basement area located along the eastern side of the central portion of Building 36 and is associated with metal chip processing. LNAPL has historically been detected in this area. To assess the extent of dissolved-phase constituents and to further delineate the extent of LNAPL associated with process waste oils, four soil borings and three monitoring wells were installed at this AOI. In addition, existing monitoring wells 36-FP1, 36-FP2, and 36-FP5 were sampled due to previous criteria exceedences. Due to the presence of LNAPL at monitoring well 36-FP4, groundwater samples were collected from monitoring well 36-FP1 (located approximately 150 feet downgradient, to the northeast). The locations of these soil borings and monitoring wells are shown on Figures 4-3 and 4-4.

4.4.3.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	11	8	5	4 +3 Cr/Cr(VI) + 1 Hg	--	--
Groundwater	5	15	4	4	6 +2 CN/Hg	4	5
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.4.3.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Chromium (total)	450	IPSIC (240)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	0.24	IDW(0.20)
1,2-Dichloroethane	0.013	IDW(0.005)
Benzene	4.5	IDW (0.005)
Trichloroethene	0.035	IDW(0.005)
Vinyl chloride	0.0081	IDW(0.002)
Arsenic	0.17	IDW(0.050)
Beryllium	0.0090	IDW(0.004)

4.4.3.3 Conclusions

The RFI Phase I soil data from AOI 36-2 indicated that total chromium in soils exceeded screening criteria for hexavalent chromium. An additional sample was collected to determine the concentration of hexavalent versus trivalent chromium. These additional data indicate that hexavalent chromium concentrations in soils at this AOI were less than the screening criterion. Based on these results, no additional investigation activities are planned.

The RFI groundwater data from AOI 36-2 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of the exceedence in this area has been delineated; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been delineated.

4.4.4 AOI 36-3 (Engine Assembly, Waste Oil Collection and Processing, Former USTs)

This AOI is the basement area located beneath the southeastern corner of Building 36 and is associated with a final engine assembly area, main process waste oil collection/processing operations, and several former USTs. To investigate potential releases from this area, one soil boring and five monitoring wells were installed at this AOI. In addition, existing monitoring well 36-FP8 was sampled, and two grab water samples were collected from the basement area. The locations of these soil borings and monitoring wells are shown on Figures 4-3 and 4-4. It should be noted that redundant soil samples were inadvertently collected from adjacent soil borings RFI-36-30 and RFI-36-43, during completion of LNAPL step-out boring installations.

4.4.4.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	5	12	12	9	10	--	--
Groundwater	6	12	5	4	10 +2 CN/Hg	4	6
Basement water	1	2	2	2	1	2	2 + 2 F

Duplicate samples are not included in sample totals.

4.4.4.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 36-3 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C in the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	6.0	IDW (0.005)
Ethylbenzene	1.3	IDW (0.70)
Toluene	20	IDW (1.0)
Beryllium	0.0081	IDW (0.004)
Chromium	0.19	IDW (0.10)
Vanadium	0.38	IDW (0.062)

Basement Grab Water Samples

Analytical results for the water samples collected from basements were compared to groundwater criteria. A summary of the constituents detected in the grab water samples (basement samples) that exceeded the groundwater screening criteria is presented below. A summary of analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.014	IDW(0.005)
1,1-Dichloroethene	0.010	IDW (0.007)
cis-1,2-Dichloroethene	1.0	IDW (0.070)
Trichloroethene	0.36	IDW (0.005)
Tetrachloroethene	0.15	IDW (0.005)
Vinyl chloride	0.14	IDW (0.002)

4.4.4.3 Conclusions

The RFI soil data from AOI 36-3 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 36-3 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of the exceedences associated with VOCs and inorganic constituents has been defined; therefore, no additional investigation activities are planned.

These RFI data from the basement grab samples indicate that generic screening criteria for groundwater were exceeded for several VOCs. The VOCs detected in the basement water sample were not detected at concentrations above screening criteria in downgradient groundwater samples from monitoring wells, and are likely the result of residual contaminants on basement floor surfaces. Therefore, no additional investigation activities are planned.

4.4.5 AOI 36-4 (Former Metal Machining and Active Engine Assembly)

This AOI is located in the south-central and southeastern portions of Building 36 and is associated with former "wet" metal machining operations and several active engine assembly operations. To assess potential impacts in these areas, two monitoring wells were installed within this AOI. The locations of these monitoring wells are shown on Figures 4-3 and 4-4.

4.4.5.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	5	5	0	5	--	--
Groundwater	2	2	2	2	2 CN/Hg	2	2

Duplicate samples are not included in sample totals.

4.4.5.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 36-4 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from AOI 36-4 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.4.5.3 Conclusions

The RFI soil and groundwater data from AOI 36-4 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities will be performed.

4.4.6 AOI 36-5 (Former UST Farm and Active AST Farm)

This AOI is located immediately south of Building 36 and is associated with a former UST farm and an active contained AST farm. An IM is currently in operation in this location, as described in Section 2.4 of the RFI Phase I Report. To assess the extent of a release associated with cooling, cutting, and process waste oils in this area, two monitoring wells were installed. In addition, four existing monitoring wells (20-100, 20-102, 20-500, and 37-01) were sampled to provide perimeter dissolved-phase groundwater data. Additionally, well 20-500 was reinstalled during this RFI Phase II Investigation to replace the original well which had been destroyed.

Monitoring well 20-505D could not be located during the RFI field activities, and is believed to have been destroyed. Monitoring well 37-1, located nearby, was sampled in September 2001. This well is screened at a

depth of 6-16 feet, which overlaps a portion of the screened interval of monitoring well 20-505D of 14.8-19.8 feet. The locations of these monitoring wells are shown on Figures 4-5 and 4-6.

4.4.6.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	5	5	5	5	--	--
Groundwater	7	13	6	6	10 + 3 CN/Hg, 1 Be/Mn/Ni and 1 Mn/Ni	6	8 +1 Mn/Ni
LNAPL	2	2	2	1	1 + 1 CN/Hg	--	--

Duplicate samples are not included in sample totals.

4.4.6.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 36-5 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.044	IDW (0.005)
Vinyl chloride	0.014	IDW (0.002)
Beryllium	0.0069	IDW (0.004)
Manganese	3.7	IDW (2.5)
Nickel	0.17	IDW (0.10)

Duplicate samples are not included in sample totals.

4.4.6.3 Conclusions

The RFI soil data from AOI 36-5 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 36-5 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.7 AOI 55-1 (Industrial Wastewater Treatment Facilities)

This AOI is located around the Site's industrial wastewater treatment facilities (Buildings 55, 55A, and 55B) and is associated with process wastewater and waste oil storage facilities, clarifiers, and mixing tanks. To assess the downgradient extent of VOCs previously detected in this area, seven soil borings and six monitoring wells were installed in this area. Six existing monitoring wells (55-1, 55-2, 55-3, 55-4, 55-5, and 20-120) were also sampled due to previously detected VOC concentrations above screening criteria. Based upon results presented in the RFI Phase I Report, it was suspected that exceedences of some screening criteria in groundwater may have been due to onsite migration from offsite sources. Therefore, two monitoring wells were installed upgradient of AOI 55-1 and offsite. The locations of these soil borings and monitoring wells are shown on Figures 4-5 and 4-6.

4.4.7.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	13	27	27	27	27	--	--
Groundwater	12	32	14	11	11 + 9 CN/Hg, 1 Pb, 1 As	10	11

Duplicate samples are not included in sample totals.

4.4.7.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 55-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Groundwater Analytical Results

A summary of the constituents detected in the groundwater samples from AOI 55-1 that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,2-Dichloropropane	0.14	IDW (0.005)
Benzene	0.018	IDW (0.005)
Trichloroethene	0.107	IDW (0.005)
Vinyl chloride	0.028	IDW (0.002)
bis(2-Chloroethyl)ether	0.026	IDW (0.0083)
Arsenic	0.086	IDW (0.050)
Antimony	0.013	IDW(0.006)
Beryllium	0.61	IDW(0.004)
Cadmium	0.016	IDW(0.005)
Chromium	25.5	IDW(0.10)
Cyanide	1.1	IDW(0.20)
Lead	0.025	IDW (0.004)
Manganese	2.9	IDW (2.5)
Nickel	0.13	IDW(0.10)
Thallium	0.0041	IDW (0.002)

4.4.7.3 Conclusions

The RFI soil data from AOI 55-1 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 55-1 indicate screening criteria were exceeded for several VOCs and inorganic constituents. The exceedences present in the upgradient wells demonstrate that there is an offsite upgradient source, as discussed in Section 5.2.1. The distribution of the various VOCs show the likely influence of degradation processes, and the downgradient extent has been defined. Based on these results, no additional investigation activities are planned.

4.4.8 AOI 10-1 (Manufacturing Operations and Several Tanks)

This AOI consists of the overall area of Building 20, including its basement area, manufacturing operations, external areas, and several tanks. LNAPL has historically been detected in this area, and an IM consisting of a groundwater and LNAPL recovery and treatment system is in operation in this area, as described in Section 2.4 of the RFI Phase I Report and Section 5.3 of this report. To provide additional characterization of this AOI, five soil borings and one monitoring well were installed. Four existing monitoring wells (20-121, 20-144, 20-145, and 43-167) were also sampled. It should be noted that as proposed in a spring 2002 Groundwater Sampling

Event Scope of Work, dated June 6, 2002, monitoring well 20-145 was resampled on June 18, 2002. The results of this sampling were reported to, and discussed with, USEPA, during meetings on March 17-18, 2003, and none of the pertinent generic MDEQ criteria were exceeded. Based on these data, which were not available for inclusion in the RFI Phase I Report, additional data at downgradient monitoring well 20-171 were not needed to complete characterization and meet the groundwater monitoring objectives. The locations of these soil borings and monitoring wells are shown on Figures 4-5 and 4-6.

4.4.8.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	6	9	9	9	9 + 6 Pb	--	--
Groundwater	5	9	3	3	4 + 3 CN/Hg	3	3 + 1Ba
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.4.8.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Arsenic	40	IDC (37)
Chromium	750	IPSIC(240)
Lead	2,200	IDC (900)
Manganese	3,000	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	0.21	IDW (0.20)
1,1-Dichloroethene	0.013	IDW (0.007)
cis-1,2-Dichloroethene	0.25	IDW (0.070)
Vinyl chloride	0.0032	IDW (0.002)
Barium	33	IDW (2.0)
Lead	0.0088	IDW (0.004)

4.4.8.3 Conclusions

The RFI soil data from AOI 10-1 indicated screening criteria were exceeded for arsenic, chromium, lead, and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 10-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.9 AOI 10-2 (Solid Waste Transfer Area and Former ASTs)

This AOI consists of a solid waste transfer area and former ASTs containing process waste oils and No. 2 fuel oil, and is located east of Building 20 and south of Buildings 22 and 24. The RFI Work Plan included collection of a groundwater sample from existing well 20-104, and completion of boring RFI-10-12 to provide soil sampling data in the vicinity of open-top concrete bunkers that were used to temporarily store construction rubble and debris that sometimes contained residual oil. Monitoring well 20-104 could not be located during the RFI field activities and is presumed to have been destroyed. To provide groundwater quality data for this area, soil boring RFI-10-12 was completed as a monitoring well and sampled. The data collected for this AOI provided the information needed to meet the investigation objectives, as defined in the RFI Work Plan. This change was discussed with USEPA on October 9, 2001. Additionally, numerous step-out wells were installed to fully delineate groundwater contaminants in this area. A total of three soil borings and 15 monitoring wells were installed, including several offsite wells to the east and southeast.

The locations of these soil borings and monitoring wells are shown on Figures 4-5 and 4-6.

4.4.9.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	18	34	26	26	26 + 1 Mn	--	--
Groundwater	15	31	4	4	12 + 3 CN/Hg	4	7 + 1 Mn

Duplicate samples are not included in sample totals.

4.4.9.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Manganese	1,800	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	0.58	IDW (0.20)
1,1-Dichloroethene	0.11	IDW (0.007)
Benzene	0.017	IDW (0.005)
Chloroethane	3.3	IDW (1.7)
cis-1,2-Dichloroethene	0.15	IDW (0.070)
Methylene chloride	0.029	IDW (0.005)
Trichloroethene	0.16	IDW (0.005)
Vinyl chloride	0.060	IDW (0.002)
Arsenic	0.068	IDW (0.050)
Lead	0.0068	IDW (0.004)
Manganese	7.6	IDW (2.5)

4.4.9.3 Conclusions

The RFI soil data from AOI 10-2 indicated screening criteria were exceeded for manganese. The physical extent of the soil exceedences has been defined; therefore, no additional investigation activities are planned.
The RFI groundwater data from AOI 10-2 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of the groundwater exceedences has been defined; therefore, no additional investigation activities are planned. However, higher concentrations of select VOCs at wells RFI-10-5 and RFI-10-32, relative to upgradient wells, suggests an offsite source.

4.4.10 AOI 10-3 (Two Process Waste Oil Sumps)

This AOI consists of the basement area of Building 22, including two process waste sumps that collect leaking oil from compressors. Five soil borings and seven monitoring wells were installed to assess upgradient and downgradient conditions associated with releases of hydraulic and process waste oils. Existing monitoring well 20-103N was also sampled to provide current analytical data at locations with prior criteria exceedences. In addition, two existing monitoring wells (20-101 and 20-105) were reinstalled and sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-5 and 4-6.

4.4.10.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	13	17	13	13	16 + 3 Mn	--	--
Groundwater	10	22	6	6	12 +3 CN/Hg, 1 Mn	6	6

Duplicate samples are not included in sample totals.

4.4.10.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Manganese	2,500	IPSIC(1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	2.4	IDW(0.20)
1,1-Dichloroethane	12	IDW(2.5)
1,1-Dichloroethene	0.13	IDW(0.007)
1,2-Dichloroethane	0.017	IDW(0.005)
Chloroethane	7.4	IDW(1.7)
Vinyl chloride	0.52	IDW(0.002)
Beryllium	0.0042	IDW(0.004)
Lead	0.0049	IDW(0.004)

4.4.10.3 Conclusions

The RFI soil data from AOI 10-3 indicated that screening criteria were exceeded for manganese. The physical extent of the exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 10-3 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.11 AOI 10-4 (Scrapyard Area)

This AOI consists of the scrapyard area immediately south of Building 20 and was used for scrap material storage, vehicle dismantling, and vehicle equipment storage. LNAPL has historically been detected in this area, as part of the LNAPL area described for AOI 10-1 (Section 4.4.8). One new monitoring well was installed to assess downgradient VOCs and total petroleum hydrocarbons (TPH) associated with process waste, coolings/cuttings, transmission, and hydraulic oils. In addition, five existing monitoring wells (20-504, 20-FP6, 20-FP10, 20-FP11, and 30-100) were sampled to provide groundwater quality data at the existing LNAPL plume perimeter. Well 20-FP-11 was reinstalled during the RFI Phase II Investigation to replace the original well which was destroyed. The locations of these soil borings and monitoring wells are shown on Figures 4-9 and 4-10. An LNAPL and groundwater recovery system is currently operating in the northern portion of this AOI, as described in Section 5.3.

4.4.11.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	1	1	1	1	--	--
Groundwater	7	13	6	6	2+5 CN/Hg, 1 CN	6	6
LNAPL	2	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.4.11.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 10-4 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.0061	IDW(0.005)
Vinyl chloride	0.0023	IDW(0.002)

4.4.11.3 Conclusions

The RFI soil data from AOI 10-4 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 10-4 indicate that screening criteria were exceeded for benzene and vinyl chloride. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.12 AOI 05-1 (Former Metal Machining Chip Processing)

This AOI consists of the basement area along the southeast portion of Building 43 and is associated with a former metal machining chip processing operation. An IM is currently in operation in this area, as described in Section 5.3.

Four soil borings and three monitoring wells were installed in this area. In addition, four existing monitoring wells (20-143, 30-120, 43-166, and 43-168) were sampled to provide current groundwater quality data at the LNAPL perimeter. The locations of these soil borings and monitoring wells are shown on Figures 4-7 and 4-8.

4.4.12.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	11	11	11	11 + 4 Pb	--	--
Groundwater	5	6	5	5	3 + 5 CN/Hg	5	5
LNAPL	2	2	2	2	--	--	--

Duplicate samples are not included in sample totals.

4.4.12.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Lead	3,100	IDC (900)
Manganese	2,400	IPSIC (1,500)

Groundwater Analytical Results

The concentrations of constituents detected in the monitoring well samples from AOI 05-1 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

4.4.12.3 Conclusions

The RFI soil data from AOI 05-1 indicate that screening criteria were exceeded for lead and manganese. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 05-1 indicate that no screening criteria were exceeded. Based on these results, no further groundwater investigation will be performed.

The physical extent of LNAPL in this area has been defined.

4.4.13 AOI 05-2 (Filtration Room, Oil Room, Below-Grade Vault, and Elevator Pit)

This AOI consists of the east-central portion of Build0ing 43 and is associated with a "Filtration Room," "Oil Room," a below-grade vault, and an elevator pit. Two monitoring wells were installed to assess upgradient and downgradient conditions associated with materials handled in this area. In addition, one existing monitoring well (20-140) was sampled. The locations of these monitoring wells are shown on Figures 4-7 and 4-8.

4.4.13.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	5	5	3	5	--	--
Groundwater	3	8	3	3	5 + 3 CN/Hg, 1 Ni	4	3

Duplicate samples are not included in sample totals.

4.4.13.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 05-2 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.095	IDW(0.005)
Vinyl chloride	0.019	IDW(0.002)
Beryllium	0.0056	IDW(0.004)
Nickel	0.21	IDW(0.10)

4.4.13.3 Conclusions

The RFI soil data from AOI 05-2 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 05-2 indicate screening criteria were exceeded for trichloroethene, vinyl chloride, beryllium, and nickel. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.14 AOI 05-3 (Building 43 Basement Containing Process Waste Oil Sumps and Drains)

This AOI consists of a basement area in Building 43 beneath transmission component heat treating operations that contains process waste oil sumps and drains. To assess the downgradient extent of VOCs associated with process waste oils, four monitoring wells were installed in this area. In addition, two existing monitoring wells (43-100 and 43-101R) were sampled due to previous criteria exceedences (well 43-101 was reinstalled during this RFI Phase II investigation). The locations of these monitoring wells are shown on Figures 4-7 and 4-8.

4.4.14.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	5	11	11	8	11	--	--
Groundwater	6	11	6	6	3 +5 CN/Hg	6	6

Duplicate samples are not included in sample totals.

4.4.14.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 05-3 do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.029	IDW(0.005)
Arsenic	0.084	IDW(0.050)

4.4.14.3 Conclusions

The RFI soil data from AOI 05-3 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 05-3 indicate screening criteria were exceeded for trichloroethene and arsenic. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.15 AOI 05-4 (Metal Forming Operations and Recirculation Trenches and Sumps)

This AOI consists of the "Cold Former Room" and is associated with various metal forming operations and recirculation trenches and sumps. One monitoring well (RFI-05-03) was installed in this area to assess potential releases at this AOI. In addition, one existing monitoring well (43-103) was sampled to provide additional downgradient groundwater quality data. The locations of these monitoring wells are shown on Figures 4-7 and 4-8.

4.4.15.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	0	3	--	--
Groundwater	2	2	2	2	2 CN/Hg	2	2

Duplicate samples are not included in sample totals.

4.4.15.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 05-4 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from AOI 05-4 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.4.15.3 Conclusions

The RFI soil and groundwater data from AOI 05-4 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities will be performed.

4.4.16 AOI 05-5 (Active Process Machinery, Collection Trenches, and Sumps)

This AOI is in the northern portion of Building 43 and consists of active process machinery, collection trenches, and sumps for both "wet" and "dry" operations. Three monitoring wells and one soil boring were installed within this AOI. One piezometer was installed to provide upgradient groundwater elevation data at this AOI. In addition, existing monitoring well 43-220 was sampled. Monitoring wells 43-120 and RFI-05-11 were not sampled as planned in the RFI Work Plan because monitoring well 43-120 was destroyed and RFI-05-11 was installed but not sampled due to the presence of LNAPL. Monitoring well RFI-05-08R was sampled as a replacement well for monitoring well 43-120. Based on groundwater elevation data RFI-05-08R is representative of offsite upgradient conditions. One piezometer was installed to provide upgradient groundwater elevation data at this AOI. The locations of these soil borings, monitoring wells, and piezometers are shown on Figures 4-7 and 4-8.

4.4.16.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	5	13	13	13	13	--	--
Groundwater	4	5	4	4	4 +3 CN/Hg, 1 Ni	4	4
LNAPL	3	1	1	3	--	--	--

Duplicate samples are not included in sample totals.

4.4.16.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 05-5 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Arsenic	0.070	IDW(0.050)
Nickel	0.22	IDW(0.10)

4.4.16.3 Conclusions

The RFI soil data from AOI 05-5 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 05-5 indicate screening criteria were exceeded for arsenic and nickel. The extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.17 AOI-05-6 (Active Process Machinery, Collection Trenches, and Sumps)

This AOI is in the southern portion of Building 43. It consists of active process machinery, collection trenches, and sumps for both "wet" and "dry" operations. Seven soil borings, five monitoring wells, and one piezometer were installed in this area. In addition, four existing monitoring wells (30-140, 43-140, 43-141, and 43-242) were sampled. Monitoring wells RFI-05-13 and RFI-05-14 were not sampled as indicated by the RFI Work Plan due to the presents of LNAPL in the monitoring wells. The locations of these soil borings, monitoring wells, and piezometers are shown on Figures 4-7 and 4-8.

4.4.17.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	11	17	17	17	17 + 4 Pb	--	--
Groundwater	8	20	7	7	5 +6 CN/Hg, 2 Mn	7	7
LNAPL	2	2	2	2	0	--	--

Duplicate samples are not included in sample totals.

4.4.17.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Lead	3,500	IDC(900)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
cis-1,2-Dichloroethene	0.081	IDW(0.070)
Trichloroethene	0.25	IDW(0.005)
Vinyl chloride	0.019	IDW(0.002)
Manganese	3.1	IDW(2.5)

4.4.17.3 Conclusions

The RFI soil data from AOI 05-6 indicate that screening criteria were exceeded for lead. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 05-6 indicate that screening criteria were exceeded for several VOCs and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.18 AOI 03-1 (Quenching and Cooling Oil Systems)

This AOI consists of the overall area of the former Factory 03 building complex, including various quenching and cooling oil systems used for various metal forging, quenching, and cooling operations. Past investigations of this area have indicated impacts to underlying soil and groundwater resulting from releases from associated operations. An IM was implemented in this area, as described in Section 2.4 of the RFI Phase I Report. To assess the presence of residual contamination, ten soil borings and five monitoring wells were installed. In addition, seven existing monitoring wells (03-101, 03-109, 13-111, 13-114, 03-02, 70-100, and 70-109) were sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-9 and 4-10.

4.4.18.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	15	11	11	11	11 +10 Mn	--	--
Groundwater	12	18	11	11	2 +11 CN/Hg	11	11
LNAPL	1	1	1	0	0	--	--

Duplicate samples are not included in sample totals.

4.4.18.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	15	IDC(8.0)
Manganese	4,700	IPSIC(1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.064	IDW(0.005)
Vinyl chloride	0.0091	IDW(0.002)
Arsenic	0.090	IDW(0.050)
Beryllium	0.043	IDW(0.004)
Selenium	0.19	IDW(0.050)

4.4.18.3 Conclusions

The RFI soil data from AOI 03-1 indicate that screening criteria were exceeded for benzo(a)pyrene and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 03-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.19 AOI 81-1 (Metal Machining, Chip, Cooling, and Cutting Oil Filtration and Processing, a Hydraulic Elevator, Process Waste Sumps and Tanks, a Drum Storage Area, and an Active Hazardous Waste Accumulation Area)

This AOI consists of the basement area beneath the southern and central portions of Building 71B and is associated with three metal machining chip/cooling and cutting oil filtration/processing operations, as well as an inactive hydraulic elevator, several process waste sumps and tanks, a drum storage area, and an active hazardous waste accumulation area. Seven soil borings, two monitoring wells, and two soil boring/temporary wells were installed in this area. The locations of these soil borings and monitoring wells are shown on Figures 4-11 and 4-12.

4.4.19.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	8	8	8	8 + 4 Pb	--	--
Groundwater	4	7	3	3	4 +1 CN/Hg	3	4

Duplicate samples are not included in sample totals.

4.4.19.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Lead	69,000	IDC(900) IPSIC(44,000)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Vinyl chloride	0.012	IDW(0.002)
Arsenic	0.091	IDW(0.050)
Lead	0.010	IDW(0.004)

4.4.19.3 Conclusions

The RFI soil data from AOI 81-1 indicate that screening criteria were exceeded for lead. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 81-1 indicate that screening criteria were exceeded for vinyl chloride, arsenic, and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.20 AOI 81-2 (Active Metal Welding and Machining and Torque Converter Assembly)

This AOI consists of active metal welding and machining, and torque converter assembly operations performed in Buildings 70, 70B, 71, 72, 73, 73A, 73B, and 74. LNAPL was historically detected in an area to the east of Buildings 73, 73A, and 73B. To assess this AOI, 14 soil borings, seven monitoring wells, and two soil boring/temporary wells were installed. In addition, four existing monitoring wells (70-102, 70-160, 70-163, and

70-165) were sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-11 and 4-12.

4.4.20.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	22	25	26	25	26 +2 Cr(VI), 4 Pb/Mn, and 2 As	--	--
Groundwater	11	15	8	8	10 + 6 CN/Hg, 2 Pb	8	8
LNAPL	1	1	1	0	0	--	--

Duplicate samples are not included in sample totals.

4.4.20.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	47,000	IDC(460) ISVIA(460) IISVSIC(4,500)
1,1-Dichloroethane	7,000	IDC(890) ISVIA (430) IISVSIC(2,500)
1,1-Dichloroethene	10	ISVIA(0.33) IISVSIC(3.7)
Trichlorotrifluoroethane	64,000	IDC(560) ISVIA(560)
Arsenic	56	IDC(37)
Lead	3,100	IDC(900)
Manganese	1,800	IPSIC(1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Lead	0.055	IDW(0.004)
Manganese	3.2	IDW(2.5)

4.4.20.3 Conclusions

The RFI soil data from AOI 81-2 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned. It should be noted that high concentrations of chlorinated solvent contamination was found at soil boring RFI-81-38 to be associated with fill material used to fill a former process pit structure. Concrete refusal was encountered at this location at a depth of 5 feet below the floor surface, and this location is contained within an active manufacturing area not linked to the contamination found.

The RFI groundwater data from AOI 81-2 indicate that screening criteria were exceeded for lead and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.21 AOI 81-3 (Former Foundry Operations, an Elevator Pit, Metal Machining Areas, and a Forklift Battery Charging Area)

This AOI is the basement area of Building 70 and is associated with former foundry operations, an elevator pit along the west side of Building 70A, areas of "wet" metal machining in eastern portions of Building 73, and a forklift battery charging area in the northwest corner of Building 69. To assess potential releases from this area, two soil borings, one soil boring/temporary well, and five monitoring wells were installed. In addition, existing monitoring well 86-100 was sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-11 and 4-12.

4.4.21.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	17	17	17	17 +1 Cr VI	--	--
Groundwater	7	20	5	5	10 +3 CN/Hg	5	9

Duplicate samples are not included in sample totals.

4.4.21.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 81-3 do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Cis-1,2 Dichorethene	0.162	IDW (0.07)
Trichloroethene	0.032	IDW(0.005)
Vinyl chloride	0.065	IDW(0.002)
Barium	2.5	IDW(2.0)
Cadmium	0.0098	IDW(0.005)
Lead	0.047	IDW(0.004)
Manganese	3.3	IDW(2.5)
Nickel	0.24	IDW(0.10)
Zinc	6.0	IDW(5.0)

4.4.21.3 Conclusions

The RFI soil data from AOI 81-3 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 81-3 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.22 AOI 81-4 (Air Compressor Operations)

This AOI consists of the basement areas of Buildings 69A and 69B and is associated with facility air compressor operations. Past operations in these basements involved the draining of oils from facility air compressor operations. One monitoring well was installed at this AOI to assess potential releases from this AOI. The location of this monitoring well is shown on Figures 4-11 and 4-12.

4.4.22.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	4	1	1	1 CN/Hg	1	1

Duplicate samples are not included in sample totals.

4.4.22.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 81-4 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Tetrachloroethene	0.011	IDW(0.005)

4.4.22.3 Conclusions

The RFI soil data from AOI 81-4 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 81-4 indicate that screening criteria were exceeded for tetrachloroethene. Resampling results confirmed the presence of tetrachloroethene at this location (the most recent sample results indicated a concentration less than the screening criteria); however, the physical extent of the exceedence has been defined. Based on these results, no additional investigation activities are planned.

4.4.23 AOI 81-5 (Existing and Former ASTs)

This AOI consists of a containment area for several existing and former ASTs which contain(ed) diesel fuel and automatic transmission fluid. One soil boring/temporary well was installed at this AOI to assess potential releases from this AOI. The location of this soil boring is shown on Figures 4-13 and 4-14.

4.4.23.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.4.23.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 81-5 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater sample from AOI 81-5 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.4.23.3 Conclusions

The RFI soil and groundwater data from AOI 81-5 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities will be performed.

4.4.24 AOI 21-1 (Former Metal Chip Briquetting Operations and Current Metal Welding and Tool Grinding Operations)

This AOI is the overall area of Building 21 and the area immediately southeast of Building 21 and is associated with former metal chip briquetting operations and current metal welding/tool grinding operations. Three soil boring/temporary wells and one monitoring well were installed to assess the extent of constituents associated with cooling/cutting oils. The locations of these soil borings and monitoring wells are shown on Figures 4-13 and 4-14.

4.4.24.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	4	9	9	9	9	--	--
Groundwater	4	6	5	4	2 + 1 Mn	4	4

Duplicate samples are not included in sample totals.

4.4.24.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 21-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.012	IDW(0.005)
Vinyl chloride	0.0032	IDW(0.002)
Pentachlorophenol	0.0021	IDW(0.001)
Manganese	9.2	IDW(2.5)

4.4.24.3 Conclusions

The RFI soil data from AOI 21-1 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 21-1 indicate that screening criteria were exceeded for trichloroethene, vinyl chloride, pentachlorophenol, and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.25 AOI 65-1 (Air Compressor Station and a Main Process Waste Pump Station)

This AOI consists of the overall area of Building 65 and is associated with a facility air compressor station and a main process waste pump station for the Site's industrial wastewater treatment system. One monitoring well was installed to assess potential releases in this area. The location of this monitoring well is shown on Figures 4-15 and 4-16.

4.4.25.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	3	1	1	1 +1 CN/Hg	1	1

Duplicate samples are not included in sample totals.

4.4.25.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 65-1 do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.046	IDW(0.005)

4.4.25.3 Conclusions

The RFI soil data from AOI 65-1 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 65-1 indicate that screening criteria were exceeded for trichloroethene. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.4.26 AOI 83/84-1 (Former and Existing Machining Operations)

This AOI consists of areas of various former and existing machining operations in Buildings 11 (both "wet" and "dry" operations). One soil boring and two monitoring wells were installed to assess potential releases in this area. The locations of these soil borings and monitoring wells are shown on Figures 4-15 and 4-16.

4.4.26.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	6	6	3	6	--	--
Groundwater	2	2	3	2	1 +3 CN/Hg	2	2

Duplicate samples are not included in sample totals.

4.4.26.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 83/84-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from AOI 83/84-1 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

4.4.26.3 Conclusions

The RFI soil and groundwater data from AOI 83/84-1 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities will be performed.

4.4.27 AOI 83/84-2 (Former and Existing Machining Operations)

This AOI consists of areas of various former and existing machining operations in Building 32 (including two basements) (both "wet" and "dry" operations). A prior release within this AOI has been documented. In addition, LNAPL was detected in monitoring wells installed in this AOI. To assess this area, 18 soil borings and six monitoring wells were installed. The locations of these soil borings and monitoring wells are shown on Figures 4-15 and 4-16.

LNAPL has also been observed floating on standing water in a tunnel beneath Buildings 32 and 66.

4.4.27.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	24	40	40	37	47 + 6 Pb	--	--
Groundwater	3	5	3	3	4 + 2 CN/Hg, 1 Be	3	3
LNAPL	3	2	2	3	2	--	--

Duplicate samples are not included in sample totals.

4.4.27.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzo(a)anthracene	81	IDC (80)
Benzo(a)pyrene	66	IDC (8.0)
Dibenz(a,h)anthracene	17	IDC (8.0)
Arsenic	47	IDC(37)
Chromium	2,400	IPSIC (240)
Lead	6,500	IDC (900)
Manganese	3,500	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
cis-1,2-Dichloroethene	0.075	IDW(0.070)
Vinyl chloride	0.069	IDW(0.002)
Arsenic	0.10	IDW(0.050)
Beryllium	0.023	IDW(0.004)

4.4.27.3 Conclusions

The RFI soil data from AOI 83/84-2 indicate that screening criteria were exceeded for several PAHs and inorganic constituents. The physical extent of these exceedences has been adequately defined for RFI purposes, given the physical constraints associated with the presence of large manufacturing equipment in the vicinity of this AOI. Therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 83/84-2 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.28 AOI 83/84-3 (Former and Existing Machining Operations)

This AOI consists of areas of various former and existing machining operations in Buildings 66A/66D (both "wet" and "dry" operations). Twelve soil borings, one soil boring/temporary well, and one monitoring well were installed to assess potential exceedences from this area. In addition, existing monitoring well 11-140 was sampled to provide additional upgradient groundwater quality data. The locations of these soil borings and monitoring wells are shown on Figures 4-15 and 4-16.

4.4.28.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	12	2	2	2	2 +14 Pb	--	--
Groundwater	3	3	3	3	2 +2 CN/Hg	3	3

4.4.28.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Lead	42,000	IDC(900)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Beryllium	0.011	IDW(0.004)
Lead	0.017	IDW(0.004)

4.4.28.3 Conclusions

The RFI soil data from AOI 83/84-3 indicate that screening criteria were exceeded for lead. The physical extent of this exceedence has been adequately defined for purposes of the RFI; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 83/84-3 indicate that screening criteria were exceeded for beryllium and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.29 AOI 83/84-4 (Former Machining Operations and an Inactive Rail Loading Area)

This AOI consists for former "wet" metal machining operations in the central portion of Building 66, including three process oil collection/recirculation sumps, and an inactive rail loading area (including associated sumps along the north side of Building 66C). Two soil borings, one soil boring/temporary well, and eight monitoring wells were installed to assess potential exceedences and the extent of LNAPL in this area. The locations of these soil borings and monitoring wells are shown on Figures 4-15 and 4-16.

4.4.29.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	11	22	22	22	22	--	--
Groundwater	2	2	2	2	1	2	2
LNAPL	2	2	2	3	2	--	--

Duplicate samples are not included in sample totals.

4.4.29.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 83/84-4 do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Arsenic	0.11	IDW(0.050)
Beryllium	0.14	IDW(0.004)
Lead	0.0081	IDW(0.004)

4.4.29.3 Conclusions

The RFI soil data from AOI 83/84-4 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 83/84-4 indicate that screening criteria were exceeded for arsenic, beryllium, and lead. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

LNAPL was detected during installation of monitoring well RFI-83/84-07 and in RFI-85/84-45

4.4.30 AOI 83/84-5 (Former Process Trenches and Pits, and an Inactive Heat Treating Tunnel)

This AOI consists of various inactive or former process trenches and pits and an inactive heat treating tunnel located in Building 66. One soil boring/temporary well was installed to assess potential releases in this area. In addition, existing monitoring well 11-120 was sampled to provide additional upgradient groundwater quality data. The locations of the soil boring and monitoring well are shown on Figures 4-15 and 4-16.

4.4.30.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	2	2	2	2	2 CN/Hg	2	2

Duplicate samples are not included in sample totals.

4.4.30.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 83/84-5 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from AOI 83/84-5 do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.4.30.3 Conclusions

The RFI soil and groundwater data from AOI 83/84-5 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities will be performed.

4.4.31 AOI 83/84-6 (Forklift Battery Charging Area and Associated Trench and Pit, and a Drum Storage Area)

This AOI consists of a forklift battery charging area and an associated trench and pit in the central portion of Building 83A and a drum storage area in the southern portion of Building 83 used for metal working fluids and corrosion inhibitors. One soil boring was installed to assess potential exceedences in this area. The location of this soil boring is shown on Figures 4-15 and 4-16.

4.4.31.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	0	3	--	--

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Groundwater	0	0	0	0	0	0	0

Duplicate samples are not included in sample totals.

4.4.31.2 Results

The concentrations of constituents detected in soil were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in soil samples that exceeded the screening criteria are presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	8.3	IDC (8.0)

4.4.31.3 Conclusions

The RFI soil data from AOI 83/84-6 indicate that screening criteria were exceeded for benzo(a)pyrene. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.4.32 AOI 83/84-7 (Underground Storage Tanks)

This AOI consists of Tanks 50 through 58 identified on the 1973 Site Drawing as described in the RFI Phase I Report and Tanks 88-1 through 88-4, and 88-11 identified on the 1991 Site Drawing as described in the RFI Phase I Report. A prior release(s) from these tanks has been documented. One monitoring well was installed to assess the extent of the prior release. In addition, existing monitoring wells 88-2, 88-7, 88-8, and 88-9 were sampled. The locations of these monitoring wells are shown on Figures 4-15 and 4-16.

4.4.32.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	5	13	5	5	2 +5 CN/Hg	5	6

Duplicate samples are not included in sample totals.

4.4.32.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 83/84-7 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.16	IDW(0.005)
cis-1,2-Dichloroethene	0.088	IDW(0.070)
Methylene Chloride	0.01	IDW(0.005)
Toluene	2.3	IDW(1.0)
Trichloroethene	0.035	IDW(0.005)
Vinyl chloride	0.15	IDW(0.002)

4.4.32.3 Conclusions

The RFI soil data from AOI 83/84-7 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 83/84-7 indicate that screening criteria were exceeded for several VOCs. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.4.33 AOI 85-1 (Elevator Pit and Engine Test Area)

This AOI consists of an elevator pit along the north-central side of Building 85 and is associated with trenches and a basement vault area related to the engine test area in the eastern portion of the building. One soil boring/temporary well and seven monitoring wells were installed to assess potential releases in this area. The locations of these monitoring wells are shown on Figures 4-13 and 4-14.

4.4.33.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	20	20	20	20	--	--
Groundwater	8	13	8	8	7 +4 CN/Hg	8	7
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.4.33.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 85-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Tetrachloroethene	0.022	IDW(0.005)
Trichloroethene	0.093	IDW(0.005)
Beryllium	0.007	IDW(0.004)
Selenium	0.080	IDW(0.050)
Vanadium	0.13	IDW(0.062)

4.4.33.3 Conclusions

The RFI soil data from AOI 85-1 indicate that no screening criteria were exceeded. Soil associated with this AOI has been adequately characterized for purposes of the RFI; therefore, no further soil investigation will be performed.

The RFI groundwater data from AOI 85-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

LNAPL was detected during installation of temporary well RFI-85-02. A permanent well (RFI-85-02R) was subsequently installed at this location. LNAPL has not been observed in RFI-85-02R during any of the subsequent groundwater sampling events.

4.4.34 AOI 86-1 (Hazardous Waste Drum Accumulation Area, Process Waste Sump and Pump Station, Waste Transport Vehicle Storage Area, and Former USTs)

This AOI is the overall area of Building 86 and areas immediately southeast and west of Building 86, collectively associated with a hazardous waste drum accumulation area, a process waste pumping station, a waste transport vehicle storage area, and a former UST farm.

An IM was formerly operated in this area to address a free product release from the former UST farm, as described in Section 2.4 of the RFI Phase I Report. This system was successful in recovering free-phase LNAPL in this area, hence operation has been discontinued. However, during 2003, LNAPL was observed at two monitoring wells (RFI-86-02 and RFI-86-03) located east of the AOI. Six soil borings, two soil boring/temporary wells, and eleven monitoring wells were installed in this area to assess the extent of constituents associated with gasoline, process waste oils, and other oils. In addition, five existing monitoring wells (86-3, 87-FP2, 87-FP3, 87-FP4, and 87-FP5) were sampled due to historical criteria exceedences. Monitoring wells RFI-02-08 and RFI-86-01R were reinstalled. The locations of these soil borings and monitoring wells are shown on Figures 4-13 and 4-14.

4.4.34.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	18	27	27	27	27 +1 Mn and 8 As	--	--
Groundwater	20	41	15	14	9 +10 CN/Hg	14	14
LNAPL	2	3	3	3	3	--	--

Duplicate samples are not included in sample totals.

4.4.34.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Arsenic	190	IDC(37)
Manganese	3,200	IPSIC(1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1-Dichloroethene	0.027	IDW(0.007)
1,2-Dichloroethane	0.0054	IDW(0.005)
Benzene	0.0079	IDW(0.005)
Chloroethane	14	IDW(1.7)
cis-1,2-Dichloroethene	0.45	IDW(0.070)
Methylene chloride	0.0093	IDW(0.005)
Tetrachloroethene	0.041	IDW(0.005)
Trichloroethene	2.0	IDW(0.005)
Vinyl chloride	0.43	IDW(0.002)
Beryllium	0.0098	IDW(0.004)
Lead	0.010	IDW(0.004)
Manganese	2.8	IDW(2.5)

4.4.34.3 Conclusions

The RFI soil data from AOI 86-1 indicate that screening criteria were exceeded for arsenic and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 86-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL in this area has been defined.

4.4.35 AOI 07-1 (Former Coal Yard)

This AOI consists of a former coal yard immediately north of former Building 07 and several other process facilities along the north side of Building 07. Four soil borings, two soil boring/temporary wells, two monitoring wells, and one replacement monitoring well were installed in this area to assess potential releases. In addition, existing monitoring well 07-02 was sampled to provide upgradient groundwater quality data. The locations of these soil borings and monitoring wells are shown on Figures 4-13 and 4-14.

4.4.35.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	8	14	14	14	14	--	--
Groundwater	5	7	4	4	2 CN/Hg	4	4

Duplicate samples are not included in sample totals.

4.4.35.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 07-1 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Vinyl chloride	0.0033	IDW(0.002)

4.4.35.3 Conclusions

The RFI soil data from AOI 07-1 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 07-1 indicate that screening criteria were exceeded for vinyl chloride. The physical extent of this exceedence has been defined; therefore no additional investigation activities are planned.

4.4.36 AOI 07-2 (Inactive Lime "Slaker House" and Inactive Lime Slurry Tank)

This AOI consists of an inactive lime "Slaker House" and adjacent inactive lime slurry tank adjacent to the southwest corner of former Building 07. One soil boring was installed to assess the extent of constituents associated with caustics and/or other materials in this area. Soil samples collected from RFI-07-05 showed no detected concentrations above the pertinent generic MDEQ criteria. A temporary well was installed at this soil boring location; however, insufficient water accumulated in the well to allow sampling. Groundwater samples were collected downgradient to the south (RFI-86-16R) and west (RFI-86-14) as part of the investigation of AOI-86-1. Based on the absence of soil impacts immediately adjacent to the AOI and downgradient water-quality data, impacts from the AOI were not identified. The location of this soil boring is shown on Figures 4-13 and 4-14.

4.4.36.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	0	0	0	0	0	0	0

Duplicate samples are not included in sample totals.

4.4.36.2 Results

The concentrations of constituents detected in soil were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 07-2 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

4.4.36.3 Conclusions

The RFI soil data from AOI 07-2 indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.4.37 AOI 07-3 (Two Elevator Pits and a Bulk Acid AST)

This AOI consists of two elevator pits in the north-central and south-central portions of Building 07 and a bulk acid AST in the southeast corner of Building 07. One soil boring, one soil boring/temporary well, and one monitoring well were installed in this area to assess potential releases. In addition, existing monitoring well 07-01 was sampled to provide upgradient groundwater quality data. The locations of these soil borings and monitoring wells are shown on Figures 4-13 and 4-14.

4.4.37.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	8	8	8	8	--	--
Groundwater	3	4	3	3	2 +1 CN/Hg, 1 Be	3	4

Duplicate samples are not included in sample totals.

4.4.37.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 07-3 do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Beryllium	0.016	IDW(0.004)

4.4.37.3 Conclusions

The RFI soil data from AOI 07-3 indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 07-3 indicate screening criteria were exceeded for beryllium. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.5 AOIs South of Leith Street

Results of investigations of 37 AOIs south of Leith Street are detailed below.

4.5.1 AOI Group 94-A (Sumps and Trenches in Oil Change Pits and Chemical Storage Areas)

This AOI Group is associated with former Building 94 and relates to sumps and trenches in oil change pits and chemical storage areas. One soil boring/temporary well and one monitoring well were installed to assess potential releases from this area. The location of the soil boring and monitoring well are shown on Figures 4-17 and 4-18.

4.5.1.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	4	4	4	4	--	--
Groundwater	2	1	3	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.1.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 94-A do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Di-n-butylphthalate	0.013	GSI (0.0097)
Cyanide	0.0053	GSI (0.0052)

4.5.1.3 Conclusions

The RFI soil data from AOI 94-A indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 94-A indicate that screening criteria were exceeded for di-n-butylphthalate and cyanide. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.5.2 AOI Group 94-B (Process Sump and Trench)

This AOI group is associated with former Building 94 and relates to a sump in the "South Lube Pit" and a trench that discharged to the process wastewater system. One soil boring and five monitoring well were installed in this area to assess potential releases from this area. The location of these soil borings are shown on Figures 4-17 and 4-18.

4.5.2.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	9	9	9	9	--	--
Groundwater	5	9	1	1	1	0	0

Duplicate samples are not included in sample totals.

4.5.2.2 Results

The concentrations of constituents detected in soil were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 94-B do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1-Dichloroethene	0.0075	IDW (0.007)
Trichloroethene	0.95	IDW (0.005) GSI (0.029)

4.5.2.3 Conclusions

The RFI soil data from AOI 94-B indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 94-B indicate that screening criteria were exceeded for 1,1-dichloroethene and trichloroethene. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.3 AOI Group 94-C (Hydraulic Oil Storage Areas)

This AOI is associated with former Building 94 and relates to sumps, trenches, and hydraulic lift cylinders in hydraulic oil storage areas. Two soil borings/temporary wells were installed to assess potential releases from this area. The locations of these soil borings are shown on Figures 4-17 and 4-18.

4.5.3.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	4	4	4	4	--	--
Groundwater	2	2	2	2	0	2	2

Duplicate samples are not included in sample totals.

4.5.3.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 94-C do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Arsenic	0.052	IDW (0.050)

4.5.3.3 Conclusions

The RFI soil data from AOI 94-C indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 94-C indicate that screening criteria were exceeded for arsenic. The downgradient extent has been defined. Based on these results, no additional investigations are planned.

4.5.4 AOI Group 94-D (Pit for a Cable-Operated Car Elevator)

This AOI is associated with former Building 94A and relates to a pit for a cable-operated car elevator. One monitoring well was installed to assess potential releases from this area. The location of this monitoring well is shown on Figures 4-17 and 4-18.

4.5.4.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	1	1	0

Duplicate samples are not included in sample totals.

4.5.4.2 Results

The concentrations of constituents detected in soil were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 94-D do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater sampled collected from AOI-94-D do not exceed the screening criteria. A summary of groundwater data is presented in Appendix C of this report.

4.5.4.3 Conclusions

The RFI soil and groundwater data from AOI 94-D indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.5 AOI Group 94-E (Car-Loading Machinery and Hydraulic Oil Observed on Floor)

This AOI Group is associated with former Building 03 and relates to a car-loading device and hydraulic oil on the floor. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-17 and 4-18.

4.5.5.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.5.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 94-E do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 94-E groundwater sample do not exceeded screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.5.3 Conclusions

The RFI soil and groundwater data from AOI 94-E indicate that no screening criteria were exceeded. Based on these results, no additional investigations are planned.

4.5.6 AOI Group 84-A (Elevator Pits, Sumps, a Machine Shop, Hydraulic Cylinders, and a Hydraulic Lift)

This AOI Group is associated with former Buildings 84 and 23 and relates to pits for cable-operated elevators, sumps, a machine shop area, hydraulic cylinders, and a hydraulic lift. Two soil boring/temporary wells and one monitoring well were installed to assess potential releases from this area. The locations of these soil borings and monitoring wells is shown on Figures 4-17 and 4-18.

4.5.6.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	7	7	7	7	--	--
Groundwater	3	3	4	3	1	3	3

Duplicate samples are not included in sample totals.

4.5.6.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 84-A do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples from AOI 84-A that exceeded the screening criteria area presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Cyanide	0.071	GSI (0.020)
Silver	0.00024	GSI (0.00020)

4.5.6.3 Conclusions

The RFI soil data from AOI 84-A indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

Cyanide and silver were detected above GSI criteria at several of the AOI monitoring wells; however, the recently obtained data for monitoring wells located closer to the river did not show GSI exceedences for those constituents. Therefore, no additional investigation activities are planned.

4.5.7 AOI Group 84-B (Sumps, Floor Drains, a Pit, a Flooded Basement, and a Below Grade Vault)

This AOI Group is associated with former Building 84 and relates to sumps, floor drains, a pit, a basement flooded with water, and a below grade vault. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-17 and 4-18.

4.5.7.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.7.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 84-B do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 84-B groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.7.3 Conclusions

The RFI soil and groundwater data from AOI 84-B indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.8 AOI Group 84-C (Sumps, a Trench, and an Oil/Water Separator Pit)

This AOI Group is associated with former Building 84 and relates to sumps, a trench, and an oil/water separator pit near a car wash. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-17 and 4-18.

4.5.8.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.8.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 84-C do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 84-C groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.8.3 Conclusions

The RFI soil and groundwater data from AOI 84-C indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.9 AOI Group 84-D (Former UST Farm, an AST Farm, and Drum Storage Area)

This AOI Group is associated with former Building 84 and relate to a former UST farm immediately north of former Building 84; a recessed AST farm located north of the UST farm; and a drum storage area. A prior release from this area has been documented. An IM consisting of soil excavation was performed in this area to address the prior release, as described in Section 2.4 of the RFI Phase I Report.

As part of RFI Phase II activities, monitoring well 84-6R (a replacement well for 84-6, which was damaged during demolition activities) was sampled to assess the potential for residual contamination in this area. Based on the results of this resampling, 19 step-out monitoring wells were installed. The locations of these monitoring wells are shown on Figures 4-17 and 4-18.

4.5.9.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	17	11	11	11	--	--
Groundwater	21	28	3	3	3+4 CN/Hg, 1 CR total, Ni	3	5

Duplicate samples are not included in sample totals.

4.5.9.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 84-D do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	1.44	IDW (0.005)
1,1 Dicholoethene	0.008	IDW (0.007)
Cis 1,2 Dicholoethene	0.332	IDW (0.07)
Tricholoethene	0.258	IDW (0.005)
Vinyl Chloride	0.124	IDW (0.002)
Beryllium	0.26	IDW(0.004)
Chromium	0.45	IDW (0.10)
Nickel	0.91	IDW (0.10)

4.5.9.3 Conclusions

The RFI soil data from AOI 84-D indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 84-D indicate that screening criteria were exceeded for several VOCs and inorganics. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.10 AOI Group 17-A (Elevator Pit)

This AOI group is associated with former Building 17 and relates to a pit for a cable-operated elevator. One soil boring/temporary well was installed to assess potential releases from this area. In addition, a monitoring well was installed in this area to assess regional groundwater characteristics at this AOI Group. The location of these soil borings and monitoring wells are shown on Figures 4-17 and 4-18.

4.5.10.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	4	4	4	4	--	--
Groundwater	2	3	2	2	2+1 CN/Hg, 1 Sb, Se, Ag	2	3

Duplicate samples are not included in sample totals.

4.5.10.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 17-A do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Selenium	0.011	GSI (0.0050)
Silver	0.00045	GSI (0.00020)

4.5.10.3 Conclusions

The RFI soil data from AOI 17-A indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 17-A indicate that screening criteria were exceeded for selenium and silver. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.11 AOI Group 02-A (Process Wastewater Sump)

This AOI group is associated with former Building 02 and relates to a sump for a process wastewater station. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-19 and 4-20.

4.5.11.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.11.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 02-A do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 02-A groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.11.3 Conclusions

The RFI soil and groundwater data from AOI 02-A indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.12 AOI Group 02-B (Elevator Pit)

This AOI group is associated with former Building 02 and relates to a pit for an elevator. One soil boring/temporary well and 11 monitoring wells were installed to assess potential releases from this area and delineated LNAPL. The location of the soil boring and monitoring well are shown on Figures 4-19 and 4-20.

4.5.12.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group (including duplicate samples) are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	9	19	19	19	19	--	--
Groundwater	7	8	1	1	1	1	1
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.5.12.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 02-B do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C.

Groundwater Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Acetone	47	IDW (2.1)
Manganese	3.0	IDW (2.5)

4.5.12.3 Conclusions

The RFI soil data from AOI 02-B indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 02-B indicate that the screening criteria for acetone and manganese were exceeded. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

LNAPL was detected during the RFI Phase II activities at monitoring well RFI-02-14. The physical extent of this LNAPL has been defined.

4.5.13 AOI Group 02-C (Sump in the Materials Laboratory)

This AOI group is associated with former Building 02 and relates to a sump in the Materials Laboratory. One soil boring/temporary well (RFI-02-03) and three soil borings were installed to assess potential exceedences from this area. The location of these soil borings are shown on Figures 4-19 and 4-20.

4.5.13.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	5	2	2	2	2 + 3 Pb, 1 Cr VI	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.13.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Total chromium	390	IPSIC (240)
Lead	2,000	IDC (900)

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 02-C groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.13.3 Conclusions

The RFI soil data from AOI 02-C indicate that screening criteria were exceeded for chromium and lead. The physical extent of these releases has been defined; therefore, no additional investigation activities are planned. The 0-2 foot depth interval at RFI-02-03 was resampled for chromium (total) and chromium VI to speciate the chromium (total) concentration at this location. The speciated chromium concentrations did not exceed the valence specific criteria for chromium III or VI.

The RFI groundwater data for AOI 02-C indicate that no screening criteria were exceeded. Based on these results, no further groundwater investigation will be performed.

4.5.14 AOI Group 02-D (Press Machine Pit)

This AOI group is associated with former Building 02, and relates to a pit for a large press machine. One soil boring/temporary well was installed to assess potential exceedences from this area. The location of this soil boring is shown on Figure 4-19 and 4-20.

4.5.14.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.14.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 02-D do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 02-D groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.14.3 Conclusions

The RFI soil and groundwater data from AOI 02-D indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.15 AOI Group 02-E (Former UST)

This AOI group is associated with former Building 02 and relates to a former UST. One monitoring well was installed to assess potential releases from this area. The location of this monitoring well is shown on Figures 4-19 and 4-20.

4.5.15.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group (including duplicate samples) are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	2	1	1

Duplicate samples are not included in sample totals.

4.5.15.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 02-E do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 02-E groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

4.5.15.3 Conclusions

The RFI soil and groundwater data from AOI 02-E indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.16 AOI Group 02-F (Hydraulic Oil AST and Pump)

This AOI group is associated with former Building 02 and relates to a hydraulic oil AST and a pump used for the operation of the "Hydraulic Anchor Pac Area." One soil boring and two monitoring wells are installed to assess potential releases from this area. The locations of the soil boring and monitoring wells are shown on Figures 4-19 and 4-20.

4.5.16.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	8	8	8	8	--	--
Groundwater	2	2	1	1	4 + 1 Mn	1	2

Duplicate samples are not included in sample totals.

4.5.16.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 02-F do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Manganese	3.7 J	IDW (2.5)

4.5.16.3 Conclusions

The RFI soil data from AOI 02-F indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 02-F indicate that screening criteria were exceeded for manganese. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.5.17 AOI Group 23-A (Process Waste Sumps, Dock Levelers, and Basements Used for Heat Treat Process Water)

This AOI group is associated with former Building 23 and relates to sumps discharging to the process waste system, dock levelers, and basements used for treatment of water used in the heat treat process. Two monitoring wells were installed to assess potential releases from this area. In addition, a grab sample of residual LNAPL and water was collected from the basement area. The locations of these monitoring wells are shown on Figures 4-19 and 4-20.

An abandoned utility tunnel adjacent to former Building 23 was noted to contain an approximately one-inch-thick layer of oil floating on standing water. Removal of this oil has been performed as described in Section 5.3.

4.5.17.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	3	3	3	3	--	--
Groundwater	2	2	6	2	1+2 CN/Hg	2	2
LNAPL	1	1	1	1	1 Pb	--	--
Basement Water Grab Samples	1	1	1	1	--	--	--

Duplicate samples are not included in sample totals.

A grab sample was collected from the water contained in the basement of former Building 23 and is included in the count of samples with the groundwater.

4.5.17.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 23-A do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of constituents that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and in Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Pentachlorophenal	0.003	IDW (0.001)

Basement Water Grab Samples Analytical Result

Analytical results for the water samples collected from basements were compared to groundwater criteria. A summary of the constituents detected in the grab water samples (basement samples) that exceeded the groundwater screening criteria is presented below. A summary of analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzo(a)anthracene	0.011	IDW(0.0085) GCC(0.0094)
Benzo(a)pyrene	0.011	IDW(0.0050) GCC(0.0020)
Benzo(b)fluoranthene	0.066	IDW(0.0020) GCC(0.0020)
Benzo(k)fluoranthene	0.0088	IDW(0.0050) GCC(0.0050)
Chrysene	0.010	IDW(0.0050) GCC(0.0050)
Indeno(1,2,3-cd)pyrene	0.017	IDW(0.0020) GCC(0.0020)
Lead	0.0077	IDW(0.004)

4.5.17.3 Conclusions

The RFI soil data from AOI 23-A indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 23-A indicate that screening criteria were exceeded for pentachlorophenol. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI data from the basement grab sample indicate that generic screening criteria for groundwater were exceeded for several SVOCs and lead. The water in the basement is likely the result of precipitation that has accumulated since the building was demolished, and the LNAPL present floating on the surface of this water is likely residual remaining in the basement following building demolition activities. It is not likely that this LNAPL is the result of infiltration into the basement from the surrounding area, since the only known subsurface presence of LNAPL in this area is associated with the former Building 12 area, which is more than 200 feet upgradient. LNAPL has not been observed in soil borings or any temporary monitoring wells located between the Building 12 area and the basement. Also, corresponding groundwater exceedences were not noted in the vicinity of this basement. No additional investigation activities in this area are planned.

4.5.18 AOI Group 29-A (Elevator Pit and Observed Oil Staining)

This AOI group is associated with former Building 29 and relates to a pit for a cable-operated elevator and former work pads with oil staining. One soil boring/temporary well and two soil borings were installed to assess potential releases in this area. The location of these soil borings are shown on Figures 4-19 and 4-20.

4.5.18.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	3	2	2	2	2 + 2 Pb	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.18.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Lead	1,500	IDC (900)

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 29-A groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.18.3 Conclusions

The RFI soil data from AOI 29-A indicate that screening criteria were exceeded for lead. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 29-A indicate that no screening criteria were exceeded. Based on these results, no further groundwater investigation will be performed.

4.5.19 AOI Group 12-A (Press Pits, Sumps, Trenches, Traps, and Floor Staining)

This AOI group is associated with former Building 12 and relates to several press pits and associated sumps, pits, trenches, traps, and floor staining. Three soil borings, six soil boring/temporary wells, and 15 monitoring wells were installed to assess potential releases and delineate LNAPL from this area. In addition, a grab sample of the water in the basement area was collected, and existing monitoring well 04-121 was sampled to provide upgradient groundwater quality. The locations of these soil borings and monitoring wells are shown on Figures 4-19 and 4-20.

4.5.19.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	24	48	48	48	48 +9 Pb	--	--
Groundwater	13	14	14	12	5 + 2 CN/Hg	9	9
LNAPL	2	2	2	2	2	--	--
Basement Water Grab Sample	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.5.19.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Chromium	360	IPSIC (260)
Lead	11,000	IDC (900)
Manganese	2,200	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents that exceeded the MDEQ Part 201 Industrial Criteria are presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Tetrachloroethene	0.0057	IDW(0.005)
Vinyl Chloride	0.040	IDW (0.002)
Arsenic	0.06	IDW (0.05)
Beryllium	0.27	IDW (0.004)
Cadmium	0.007	IDW (0.005)
Chromium	0.12	IDW (0.1)
Lead	0.059	IDW (0.004)
Nickel	0.12	IDW (0.1)
Thallium	0.004	IDW (0.002)
Vanadium	0.14	IDW(0.062)

Basement Water Grab Sample Analytical Results

Analytical results for the water samples collected from basements were compared to groundwater criteria. A summary of the constituents detected in the grab water samples (basement samples) that exceeded the groundwater screening criteria is presented below. A summary of analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
bis(2-Ethylhexyl)phthalate	0.024	IDW (0.006)
Lead	0.0079	IDW (0.004)

4.5.19.3 Conclusions

The RFI soil data from AOI 12-A indicate that screening criteria were exceeded for chromium, lead, and manganese. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 12-A indicate screening criteria were exceeded for tetrachloroethene, vinyl chloride, and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI data from the basement grab sample indicate that generic screening criteria for groundwater were exceeded for bis(2-ethylhexyl)phthalate and lead. The water in the basement was likely the result of precipitation that had accumulated since the building was demolished. Bis(2-ethylhexyl)phthalate criteria were

also exceeded in groundwater samples near this basement, but are likely attributed to sample equipment (tubing) contamination (refer to Section 5.2.3 of the RFI Phase I Report). Lead was not detected at concentrations above screening criteria in downgradient groundwater samples from monitoring wells. The basement area was filled with crushed concrete as part of the building demolition activities, performed subsequent to the sampling of the basement water. No additional investigation activities are planned.

LNAPL was detected during the RFI Phase II activities in this area. The physical extent of this LNAPL has been defined.

4.5.20 AOI Group 12-B (Truck Loading Dock Drain and Sump)

This AOI group is associated with former Building 12 and relates to a drain within a truck loading dock, and leading to a sump that discharged to the process wastewater system. One soil boring, one soil boring/temporary well, and six monitoring wells were installed to assess potential exceedences and delineate LNAPL from this area. The locations of these soil borings and monitoring wells are shown on Figures 4-19 and 4-20.

4.5.20.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	4	10	10	10	10	--	--
Groundwater	2	3	2	2	1+1 CN/Hg	2	2
LNAPL	2	2	2	2	2+1 CN/Hg	--	--

Duplicate samples are not included in sample totals.

4.5.20.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of constituents in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Manganese	1,900	IPSIC (1,500)

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 12-B groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D.

4.5.20.3 Conclusions

The RFI soil and groundwater data from AOI 12-B indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

LNAPL was detected during the RFI Phase II activities in this area. The physical extent of this LNAPL has been defined.

4.5.21 AOI Group 12-C (Sump In Battery Charging Area, Deep Steam Pipe, and a Utility Pit Containing Oil and Water)

This AOI group is associated with former Building 12 and relates to a sump that collected runoff from a battery charging area, a deep steam pipe, and an old utility pit with oil and water present. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-19 and 4-20.

4.5.21.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.5.21.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 12-C do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Vanadium	0.076	IDW (0.062)

4.5.21.3 Conclusions

The RFI soil data from AOI 12-C indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 12-C indicate that screening criteria were exceeded for vanadium. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.5.22 AOI Group 12-D (Abandoned, Flooded Utility Tunnel)

This AOI group is associated with former Building 12 and relates to an abandoned, flooded utility tunnel running north from east of former Building 12, under Division Street, to the former powerhouse area. This is the same tunnel described for AOI Group 23-A (Section 4.5.17). One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-19 and 4-20.

4.5.22.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.22.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 12-D do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 12-D groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.22.3 Conclusions

The RFI soil and groundwater data from AOI 12-D indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.23 AOI Group 04-A (Process Waste Room and Waste Pit)

This AOI group is associated with former Building 04 and relates to the "Process Waste Room" and the "Foam Depressor Process Waste Pit 3," both of which discharged to the process wastewater system. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-21 and 4-22.

4.5.23.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.23.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 04-A do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
cis-1,2-Dichloroethene	0.13	IDW (0.070)
Trichloroethene	0.059	IDW (0.005)

4.5.23.3 Conclusions

The RFI soil data from AOI 04-A indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 04-A indicate screening criteria were exceeded for cis-1,2-dichloroethene and trichloroethene. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.24 AOI Group 04-B (Elevator Pits)

This AOI group is associated with former Building 04 and relates to a pit for a passenger elevator and two pits for freight elevators. Two soil boring/temporary wells were installed to assess potential releases from this area. The location of these soil borings are shown on Figures 4-21 and 4-22.

4.5.24.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	5	5	5	5	--	--
Groundwater	2	2	2	2	0	2	2

Duplicate samples are not included in sample totals.

4.5.24.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 04-B do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 04-B groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.24.3 Conclusions

The RFI soil and groundwater data from AOI 04-B indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.25 AOI Group 04-C (Elevator Pit)

This AOI group is associated with former Building 04 and relates to a pit for a cable-operated elevator. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-21 and 4-22.

4.5.25.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.25.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 04-C do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 04-C groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.25.3 Conclusions

The RFI soil and groundwater data from AOI 04-C indicate that no screening criteria were exceeded. Based on these results, no additional activities are planned.

4.5.26 AOI Group 04-D (Former USTs)

This AOI group is associated with former Building 04 and relates to former USTs located immediately south of Building 04. An IM was implemented in this area to address a release of oil, as described in Section 2.4 of the RFI Phase I Report. No additional soil borings or monitoring wells were installed in this area; however, five existing downgradient monitoring wells (04-1, 04-2, 04-3, 04-4, and 04-5) were sampled. The locations of these monitoring wells are shown on Figures 4-21 and 4-22.

4.5.26.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	0	0	0	0	0	--	--
Groundwater	5	7	5	6	6 CN/Hg	5	5

Duplicate samples are not included in sample totals.

4.5.26.2 Results

The concentrations of constituents detected in groundwater were compared with the screening criteria as discussed in Section 4.1.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 04-D groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

4.5.26.3 Conclusions

The RFI groundwater data from AOI 04-D indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.27 AOI Group 16-A (Vehicle Fill-Up Station, Automatic Transmission Pump House, and a Gas Pump Station)

This AOI group is associated with former Building 16 and relates to a deep pit that collected fluid runoff of cars in a vehicle fill-up station, an automatic transmission pump house containing a gravity floor drain, and a gas pump station for cars in the finishing stage. One monitoring well was installed to assess potential releases from this area. The location of this monitoring well is shown on Figures 4-21 and 4-22.

4.5.27.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	1 CN/Hg	1	1

Duplicate samples are not included in sample totals.

4.5.27.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 16-A do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 16-A groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.27.3 Conclusions

The RFI and groundwater soil data from AOI 16-A indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.5.28 AOI Group 16-B (Elevator Pit)

This AOI group is associated with former Building 16 and relates to pit for a hydraulic elevator. One soil boring/temporary well was installed to assess potential releases from this area. The location of this soil boring is shown on Figures 4-19 and 4-20.

4.5.28.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	3	3	3	3	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.28.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 16-B do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 16-B groundwater sample do not exceed applicable screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.5.28.3 Conclusions

The RFI soil and groundwater data from AOI 16-B indicate that no screening criteria were exceeded. Based on these results, no additional activities are planned.

4.5.29 AOI Group 16-C (Hydraulic Oil, Former AST, and Former USTs)

This AOI group is associated with former Building 16 and relates to hydraulic oil with external AST that was used for hydraulic lift to a Dumpster and former USTs located along the side of former Building 16. Two soil boring/temporary wells and one monitoring were initially installed in this area. Following these initial investigation activities, a confirmed release notice was submitted, detailing a release from USTs 113, 114, and 115. Subsequently, ten soil borings and nine monitoring wells were installed in this area. The locations of these soil borings and monitoring wells are shown on Figures 4-21 and 4-22.

4.5.29.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	13	26	22	22	22	--	--
Groundwater	10	15	10	9	4 + 5 CN/Hg	8	7+2 Pb
LNAPL	4	3	3	3	3	--	--

Duplicate samples are not included in sample totals.

4.5.29.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in soil samples from AOI 16-C do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Result

A summary of the constituents that exceeded the MDEQ Part 201 Industrial Criteria are presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.21	IDW (0.005)
Beryllium	0.044	IDW (0.004)
Selenium	0.18	IDW (0.050)

4.5.29.3 Conclusions

The RFI soil data from AOI 16-C indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

The RFI groundwater data from AOI 16-C indicate that screening criteria were exceeded for benzene, beryllium, and selenium. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

LNAPL was detected in this AOI during investigation activities. This LNAPL was determined to be associated with several USTs identified in this area. A confirmed release was documented for these USTs, and their removal was conducted under Parts 211 and 213 of NREPA. The physical extent of LNAPL in this area has been defined.

4.5.30 AOI Group 16-D (Former UST and Process Wastewater Sump)

This AOI group is associated with former Building 16 and relates to a former UST and a sump that discharged to the process wastewater system. One soil boring/temporary well was installed to assess potential exceedences from this area. The location of this soil boring is shown on Figures 4-19 and 4-20.

4.5.30.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	1	2	2	2	2	--	--
Groundwater	1	1	1	1	0	1	1

Duplicate samples are not included in sample totals.

4.5.30.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 16-D do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 16-D groundwater sample do not exceed screening criteria. A summary of groundwater analytical data is presented in Appendix D.

4.5.30.3 Conclusions

The RFI soil and groundwater data from AOI 16-D indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

4.5.31 AOI Group 40-A (Former UST Farm)

This AOI group is associated with former Building 40 and relates to a former UST farm located between Buildings 02 and 40. A prior release from this area has been documented. One soil boring/temporary well was installed to further assess the downgradient extent of residual contamination in this area. In addition, six existing monitoring wells (40-1, 40-2, 40-3, 40-4, 40-5, and 40-6) were sampled to provide current groundwater quality data. Monitoring well 40-7 was not sampled as planned in the RFI Work Plan, because the well was destroyed during building demolition activities, and the replacement well 40-7R2 exhibited the presence of measurable LNAPL. Nearby and downgradient borings/wells (RFI-40-05 through -09) were sampled to meet the groundwater monitoring objectives for the AOI, as discussed with USEPA on April 4, 2002. Subsequently, seven soil borings, four monitoring wells, and three additional replacement wells were installed in this area. The location of these soil borings and monitoring wells are shown on Figures 4-19, 4-20, 4-21, and 4-22.

4.5.31.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	15	34	37	34	34	--	--
Groundwater	13	23	9	9	10 +6 CN/Hg, 1 As/CN/Pb	8	10
LNAPL	1	1	1	1	1		

Duplicate samples are not included in sample totals.

4.5.31.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of constituents in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of this RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	36	IDC(8.0)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	5.5	IDW (0.005)
Ethylbenzene	0.80	IDW (0.70)
Arsenic	0.44	IDW (0.050)
Beryllium	0.19	IDW (0.004)
Cyanide	0.44	IDW (0.20)
Lead	0.0064	IDW(0.004)

4.5.31.3 Conclusions

The RFI soil data from AOI 40-A indicate that screening criteria were exceeded for benzo(a)pyrene. The physical extent of this exceedence has been defined; therefore, no additional investigation activities will be performed.

The RFI groundwater data from AOI 40-A indicate that screening criteria were exceeded for several VOCs and inorganic constituents. The physical extent of the exceedences has been defined; therefore, no additional investigation activities are planned.

LNAPL was detected during RFI Phase II investigation activities in this area. The physical extent of LNAPL has been defined.

4.5.32 AOI Group 40-B (Elevator Pit)

This AOI group is associated with former Building 40 and relates to a pit for an elevator. Two monitoring wells were installed to assess potential releases from this area. The locations of the monitoring wells are shown on Figures 4-21 and 4-22.

4.5.32.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	4	4	4	4	--	--
Groundwater	2	3	1	1	1 CN/Hg	1	1

Duplicate samples are not included in sample totals.

4.5.32.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 40-B do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
cis-1,2-Dichloroethene	0.093	IDW(0.070)
Trichloroethene	0.10	IDW (0.005)
Vinyl chloride	0.0078	IDW(0.002)

4.5.32.3 Conclusions

The RFI soil data from AOI 40-B indicate that no screening criteria were exceeded. Based on these results, no further soil investigation will be performed.

The RFI groundwater data from AOI 40-B indicate screening criteria were exceeded for several VOCs. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.5.33 AOI Group 40-C (Elevator Pit)

This AOI group is associated with former Building 40 and relates to a pit for a cable-operated elevator. Two monitoring wells were installed to assess potential releases from this area. The locations of these wells are shown on Figures 4-21 and 4-22.

4.5.33.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	4	2	2	2	--	--
Groundwater	2	4	1	1	1+1 CN/Hg	1	1

Duplicate samples are not included in sample totals.

4.5.33.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 40-C do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

The concentrations of constituents detected in the AOI 40-C groundwater sample that exceeded the screening criteria are presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	0.12	IDW (0.005)
Vinyl chloride	0.0030	IDW(0.002)
Beryllium	0.0052	IDW(0.004)

4.5.33.3 Conclusions

The RFI soil data from AOI 40-C indicate that no screening criteria were exceeded. Based on these results, no further activities are planned.

The RFI groundwater data from AOI 40-C indicate that screening criteria were exceeded for trichloroethene, vinyl chloride, and beryllium. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.34 AOI Group 40-D (Flooded Basement/Tunnel Area)

This AOI group is associated with former Building 40 and relates to a basement/tunnel area flooded with water. A grab sample was collected from the groundwater within the basement/tunnel. One monitoring well was installed to assess potential exceedences from this area. In addition, four existing monitoring wells (40-301, 40-302, 40-304, and 40-305) were sampled, and one existing monitoring well (40-303) was reinstalled and sampled. A grab sample was collected from the water contained in the basement/tunnel connecting former Buildings 16 and 40, and is included in the count of samples. The locations of these monitoring wells are shown on Figures 4-21 and 4-22.

The report titled *Cleanup and Disposal of PCB Remediation Waste, Building 40 Tunnel and Basement* (BBL, 2004) (Building 40 Trench/Basement Remediation Report) describes work completed to investigate the tunnel and presents a plan for remediation. This report was submitted to the USEPA on January 7, 2004, and conditionally approved by USEPA via letter dated September 13, 2005. The basement and tunnel area were filled in accordance with the remediation plan in May 2006. The only remaining actions planned to address this area include the implementation of institutional controls (e.g., deed restriction).

4.5.34.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	2	6	6	6	6	--	--
Groundwater	6	15	5	5	3 + 3 CN/Hg, 2 Be/Pb	5	6 +1 Be/Pb
Basement water	1	1	1	1	1	1	1

Duplicate samples are not included in sample totals.

4.5.34.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from AOI 40-D do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of the report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Vinyl chloride	0.0058	IDW (0.002)
Lead	0.0092	IDW (0.004)

Basement Grab Water Samples

Analytical results for the water samples collected from basements were compared to groundwater criteria. Concentrations of constituents detected in the grab water samples (basement samples) do not exceed the groundwater screening criteria. A summary of analytical data is presented in Appendix C of this report.

4.5.34.3 Conclusions

The RFI soil data from AOI 40-D indicate that no screening criteria were exceeded. Based on these results, no further activities are planned.

The RFI groundwater data from AOI 40-D indicate that screening criteria were exceeded for vinyl chloride and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The basement and tunnel area were filled in accordance with the remediation plan in May 2006. The only remaining actions planned to address this area include the implementation of institutional controls (e.g., deed restriction).

4.5.35 AOI Group 44-A (Sumps, Pits, Trenches, Drains, Floor Stains, and ASTs)

This AOI group is associated with former Buildings 44, 04, and 08 and relates to several sumps, pits, trenches, drains, stains, ASTs, and other observed areas. Four soil borings, three soil boring/temporary wells, and three monitoring wells were installed to assess potential releases from this area. In addition, three existing monitoring wells (04-120, 04-140, and 04-160) were sampled to provide current groundwater quality data. During the investigations, monitoring well RFI-44-06 was found to be dry and was reinstalled. The locations of these soil borings and monitoring wells are shown on Figures 4-21 and 4-22.

4.5.35.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	8	16	16	16	16 + 3 Mn	--	--
Groundwater	9	11	9	13	3 + 4 CN/Hg + 1 CN	10	10

Duplicate samples are not included in sample totals.

4.5.35.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituent that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Manganese	5,000	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents that exceeded the MDEQ Part 201 Industrial Criteria are presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzo(a)anthracene	0.014	IDW (0.0085) GCC (0.0094)
Benzo(a)pyrene	0.015	IDW (0.005) GCC (0.002)
Benzo(b)fluoranthene	0.016	IDW (0.002) GCC (0.002)
Benzo(g,h,i)perylene	0.0079	IDW (0.005) GCC (0.005)
Benzo(k)fluoranthene	0.014	IDW (0.005) GCC (0.005)
Chrysene	0.016	IDW (0.005) GCC (0.005)
Indeno(1,2,3-cd)pyrene	0.0079	IDW (0.002) GCC (0.002)
Total PCBs	0.0011	IDW (0.0005)
Antimony	0.042	IDW(0.006)
Chromium	0.38	IDW(0.10)
Lead	0.075	IDW(0.004)
Nickel	0.51	IDW(0.10)
Selenium	0.052	IDW (0.050)

4.5.35.3 Conclusions

The RFI soil data from AOI 44-A indicate that screening criteria were exceeded for manganese. Several step-out locations to define the physical extent of this exceedence could not be sampled due to the presence of concrete in those specific depth intervals. Further sampling to further define those conditions is not practical due to the pervasive subsurface concrete.

The RFI groundwater data from AOI 44-A indicate that screening criteria were exceeded for several PAHs, total PCBs, and several inorganics. The physical extent of the exceedences for total PCBs and inorganics has been defined. The physical extent of the exceedences of PAHs was to be investigated by sampling groundwater from monitoring well RFI-44-06; however, this well was dry. Replacement well RFI-44-06R was sampled for SVOCs, and no PAHs were detected. Based on these results, no further investigations are planned for this area.

4.5.36 AOI Group 09-A (Former USTs, Floor Trenches, and Former AST)

This AOI group is related to a floor trench/UST that discharged to the process wastewater system, floor trenches over a holding tank in the "vehicle wash area," a concrete containment for a former AST, and a former UST, all located in or near former Building 09. Twenty-one soil borings, two soil boring/temporary wells, and eight monitoring wells were installed to assess potential screening criteria exceedences in this area. In addition, existing non-GM monitoring wells MW-21, MW-22, MW-23, MW-24, MW-25, and MW-26 were sampled. Monitoring wells RFI-09-01 and RFI-09-04 were reinstalled. The locations of these soil borings and monitoring wells are shown on Figures 4-23 and 4-24.

4.5.36.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	31	23	26	24	18 + 1Ba/Pb, 16 Pb, and 15 Mn	--	--
Groundwater	16	28	4	4	2 + 1 Pb/Mn, 1 Sb/Se, 3 Pb, 2 Pb/Mn, 1 Sb/Se/Pb, and 1 Sb	4	4 + 1 Pb/Mn, 1 Pb
LNAPL	1	1	1	1	1	--	--

Duplicate samples are not included in sample totals.

4.5.36.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	57	IDC (8.0)
Dibenzo(a,h)anthracene	11	IDC (8.0)
Lead	120,000	IDC (900) IPSIC (44,000)
Manganese	8,300	IPSIC (1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
1,1,1-Trichloroethane	0.258	IDW(0.2)
Trichloroethene	0.184	IDW (0.005)
Vinyl chloride	0.0038	IDW (0.002)
Antimony	0.016	IDW(0.006)
Lead	0.026	IDW (0.004)

4.5.36.3 Conclusions

The RFI soil data from AOI 09-A indicate that screening criteria were exceeded for benzo(a)pyrene, dibenzo(a,h)anthracene, lead, and manganese. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 09-A indicate that screening criteria were exceeded for 1,1,1-trichlorethane, trichloroethene, vinyl chloride, antimony, and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

4.5.37 AOI Group 09-B (Hamilton Avenue Tank Farm)

This AOI Group is associated with the Former Building 31/Hamilton Avenue Tank Farm. Ten soil borings, one soil boring/temporary well, and 21 monitoring wells were installed to assess potential screening criteria exceedences and to delineate LNAPL in this area. In addition, six existing monitoring wells (31-5, 31-6, 31-8,

MW-22, MW-23, and MW-24) were sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-23 and 4-24.

4.5.37.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	25	47	42	44	40 + 6Ba/Pb,	--	--
Groundwater	28	53	11	12	14 + 5 CNHg, 4 Sb/Se, 1 As/Pb, 1 CN and 2 Ba/Sb/Se	12	13 + 1 Ba/Pb, 1 CN, and 1 Sb/Se
LNAPL	2	2	2	2	2	--	--

Duplicate samples are not included in sample totals.

4.5.37.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

A summary of the constituents detected in soil samples that exceeded the screening criteria is presented below. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	13	IDC(8.0)
Lead	1,200	IDC(900)
Manganese	1,800	IPSIC(1,500)

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	1.21	IDW (0.005)
Ethylbenzene	1.0	IDW (0.70)
Methylene chloride	0.0074	IDW (0.005)
Xylenes (Total)	0.053	GSI (0.035)
Total PCBs	0.0017	IDW (0.005)
Antimony	0.0068	IDW (0.006)
Arsenic	0.061	IDW (0.050)
Barium	1.5	GSI (0.82)
Lead	0.0058	IDW (0.004)
Selenium	0.052	IDW (0.050)

Only data collected from within 500 feet of the Flint River is compared to GSI criteria.

4.5.37.3 Conclusions

The RFI soil data from AOI 09-B indicate that screening criteria were exceeded for benzo(a)pyrene, manganese, and lead. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The RFI groundwater data from AOI 09-B indicate that screening criteria were exceeded for several VOCs, total PCBs, and several inorganic constituents. Based on groundwater elevation data collected in July 2005, the groundwater in this area appears to be discharging to the sewer. The physical extent of these exceedences has been defined; therefore, no additional investigation activities are planned.

The physical extent of LNAPL detected in monitoring well 31-7 has been defined; therefore, no additional investigation activities are planned.

4.6 Other AOIs

This section describes additional areas not associated with AOIs previously described in the RFI Work Plan. Four of these areas (the Former Aeration Lagoons Area, the Harriet Street Area, Administration Building Area, and Former Building 94 Employee Parking Lot Area) were initially investigated for the purpose of potential property transfers. Subsequent investigations in these areas were conducted under this RFI. The remaining area (Former Employee Parking Lot Located North of Oak Park) was investigated in 2005 in anticipation of a potential leasing opportunity. The investigation activities associated with these areas are discussed below.

4.6.1 Former Aeration Lagoons Area

This AOI consists of the former Aeration Lagoons and the vacant area immediately south of the former Aeration Lagoons. Six soil borings and three soil boring/temporary wells were installed to assess potential releases in this

area. In addition, four existing monitoring wells (GM-1, GM-4, GM-11, and GM-12) were sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-27 and 4-28.

4.6.1.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	9	14	14	43	14	--	--
Groundwater	7	8	8	4	2	4	8

Duplicate samples are not included in sample totals.

4.6.1.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from the former Aeration Lagoons Area do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report. It should be noted that the initial soil sampling effort performed in this area (locations WL-B1, -B2, B3, -B4/TW1, -B5/TW-2, -B6/TW-3 shown on Figure 4-27) did not initially include the analysis of PCBs. However, samples from multiple depths at each of these initial borings were later collected and analyzed for PCBs (2-foot depth intervals representing the full depth of each boring), after PCBs were identified in drill cuttings from the original borings. Although PCBs were detected in a total of four of these samples, the detected concentrations were all less than 1 ppm, averaging only 0.4 ppm. PCBs were not detected in any of the subsequent RFI soil samples collected within this area (locations RFI-07-12, RFI-07-13, and RFI-07-14 shown on Figure 4-27).

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from the former Aeration Lagoons Area do not exceed the screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.6.1.3 Conclusions

The RFI soil and groundwater data from the former Aeration Lagoons Area indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.6.2 Harriet Street Area USTs

This AOI consists of a 2.3-acre fenced, vacant lot at the southwestern corner of Harriet Street and Industrial Avenue. As part of an investigation related to potential property transfer, several USTs were discovered on the property. The activities associated with the investigation, and the removal of the USTs, are described in a document entitled *Underground Storage Tank Closure Report - Harriet Street Property* (BBL, December 2001). Sixteen soil borings, four soil boring/temporary wells, and one monitoring well were installed to assess potential releases from this area. The locations of these soil borings and monitoring wells are shown on Figures 4-25 and 4-26.

4.6.2.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	18	19	15	34	6	--	--
Groundwater	5	5	4	2	0	0	2

Duplicate samples are not included in sample totals.

4.6.2.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from the Harriet Street Property area do not exceed screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.044	IDW(0.005)

4.6.2.3 Conclusions

The RFI soil data for the Harriet Street Property Area indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

The RFI groundwater data from the Harriet Street Property Area indicate that screening criteria were exceeded for benzene; however, activities related to this exceedence have been conducted as part of the UST removals in the report described above. Based on these results, no additional investigation activities are planned.

4.6.3 Former Administration Building Area (Transformer Yard, Soil Stockpile Area, and Former USTs)

This area consists of the former Administration Building (Building 01), employee parking lot and immediate surroundings. During a review of the property for potential property transfer, three potential areas of concern (PAOC) were identified. PAOC 1 was identified as a transformer yard. PAOC 2 was identified on the basis of a currently disturbed area of soil and historical VOC detections from a soil stockpile; the soil was excavated during underground utility installation activities. Additionally, there is an underground tunnel that connected a gasoline pump on the Administration Building property to the Hamilton Avenue Tank Farm. PAOC 3 was identified because of the presence of a former commercial, non-GM filling station with two gasoline tanks. Because of the potential presence of the two gasoline tanks at PAOC 3, a geophysical survey was completed in November 2001. The geophysical survey identified an anomaly that may be the two underground storage tanks. A test pitting program was implemented to determine the source of the geophysical anomaly and USTs were not found. One soil boring/temporary well and four monitoring wells were installed in this area. The locations of these soil borings and monitoring wells are shown on Figures 4-25 and 4-26.

4.6.3.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	4	11	11	11	11	--	--
Groundwater	4	6	2	2	2	2	2

Duplicate samples are not included in sample totals.

4.6.3.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from the Administration Building Area do not exceed the screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

A summary of the constituents detected in groundwater samples that exceeded the screening criteria is presented below. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report and Appendix C of this report.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/L)	Screening Criteria Exceeded (concentration)
Benzene	0.087	IDW(0.005)

4.6.3.3 Conclusions

The RFI soil data from the Administrative Building area indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

The RFI groundwater data from the Administration Building Area indicate that screening criteria were exceeded for benzene. The physical extent of this exceedence has been defined; therefore, no additional investigation activities are planned.

4.6.4 Former Building 94 Employee Parking Lot

This AOI consists of the former Building 94 Employee Parking Lot. Five soil borings and two soil boring/temporary wells were installed to assess potential releases in this area. In addition, existing monitoring well 94-100 was sampled. The locations of these soil borings and monitoring wells are shown on Figures 4-17 and 4-18.

4.6.4.1 Scope

The number of sampling locations for each medium and the numbers of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	7	14	14	18	9	--	--
Groundwater	2	2+ 1 formaldehyde	2	2	0	2	2

Duplicate samples are not included in sample totals.

4.6.4.2 Results

The concentrations of constituents detected in soil and groundwater were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from the former Building 94 Employee Parking Lot Area do not exceed the applicable screening criteria; however, PCBs were detected at one location at concentrations exceeding residential screening criteria. A summary of soil analytical data is presented in Appendix C of the RFI Phase I Report and Appendix B of this report.

Groundwater Analytical Results

The concentrations of constituents detected in the groundwater samples from the former Building 94 Employee Parking Lot Area do not exceed the applicable screening criteria. A summary of groundwater analytical data is presented in Appendix D of the RFI Phase I Report.

4.6.4.3 Conclusions

The RFI soil and groundwater data from the former Building 94 Employee Parking Lot area indicate that no release exceeding the screening criteria has occurred; however, two additional soil borings (EP 94-02C and EP 94-02D) were installed and sampled for PCBs to delineate the residential criteria exceedence of PCBs. No additional investigation activities are planned.

4.6.5 Former Employee Parking Lot North of Oak Park

This area consists of the former employee parking lot located north of Oak Park and west of the former Building 12. Twelve soil borings were installed to assess potential releases in this area. The location of these soil borings is shown on Figure 4-19.

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	12	12	3	0	0	--	--
Groundwater	0	0	0	0	0	0	0

Duplicate samples are not included in sample totals.

4.6.5.1 Results

The concentrations of constituents detected in soil were compared with the screening criteria as discussed in Section 4.1.

Soil Analytical Results

The concentrations of constituents detected in the soil samples from the former Employee Parking Lot North of Oak Park do not exceed the screening criteria. A summary of the soil analytical data is presented in Appendix B of this report.

4.6.5.2 Conclusions

The RFI soil data from the former Employee Parking Lot North of Oak Park indicate that no screening criteria were exceeded. Based on these results, no additional investigation activities are planned.

4.7 Storm Sewer Investigation

The Site operates under the requirements of its National Pollutant Discharge Elimination System (NPDES) permit, which regulates surface water discharges. The Site storm sewer system includes over 20 miles of onsite storm sewers, which provide drainage across the Site and discharges into the nearby Flint River through 17 outfalls (Outfalls 001 through 013, 004A, 005A, 007A, and 100). In addition, these discharges include non-GM drainage flow from other portions of the City of Flint, both upstream and downstream of certain portions of the Site storm sewer system. Under its current NPDES permit, GM is permitted to discharge treated wastewater via Outfall 100 to the Flint River. Figures 2-4 and 2-5 include a general layout and orientation of the storm sewers and outfalls.

Dissolved-phase constituents have been detected at select outfalls (based on analytical testing). Additionally, visible sheens have been observed at Outfalls 002 through 006. Oil sheens are successfully controlled using floating oil booms. Sheens behind the booms are periodically collected using a vacuum truck.

The storm sewer networks associated with Outfalls 002 through 006 and Outfall 011 have been investigated as part of work performed over the past several years. These activities are summarized below, with additional details provided in Appendix I. The remaining Site storm sewer networks, 001, 004A, 005A, 007, 007A, 008, 009, 010, 012, 013, and 100, have not exhibited any Site-related effects warranting investigation.

4.7.1 Scope

In 1996 and 1997, GM conducted a storm sewer investigation that focused on storm sewers tributary to Outfalls 003, 004, and 005. These storm sewers provide drainage for most of the northern portion of the Site (area north of Leith Street). Investigation activities included an initial storm sewer Site reconnaissance, storm sewer sediment sampling, a storm sewer cleaning program, and placement of absorbent booms in select manholes to assess the presence and relative amount of LNAPL. Water samples were analyzed for VOCs, SVOCs, total and dissolved PCBs, and TPH. The results of this investigation along with information from other sources, including RFI activities and ongoing compliance monitoring activities conducted by GM personnel, provided evidence that the observed LNAPL sheens and detected dissolved-phase constituents are potentially from the infiltration of groundwater into the storm sewer.

Additional activities were performed from June through August 2002 on the storm sewer systems associated with Outfalls 002 through 006. These activities, which were performed to provide information to support the selection and design of corrective measures to control the infiltration of impacted groundwater into the storm sewer, included:

- Storm sewer system flow assessment using in-line flow meters at selected manholes to establish baseline hydraulic conditions;
- Sample collection and analysis at selected manholes to evaluate the concentration and mass loading of dissolved-phase constituents;

- Visual inspection of the water surface at sewer manholes to evaluate the presence and distribution of LNAPL;
- Internal inspection of storm sewers by videotaping selected stretches of pipe to observe structural conditions; and
- Groundwater elevation monitoring and comparison with storm sewer invert elevations, to evaluate localized drawdown in and around potentially impacted sections of the storm sewer system.

A focused, smaller-scale investigation was conducted along the system of Outfall 011 to assess potential impacts to the system from an adjacent free- and dissolved-phase BTEX plume (refer to Section 4.5.37 and Figures 4-23, 5-2, and 5-6). Grab samples and instantaneous flow measurements were collected at two locations along this system in the area of potential impact.

4.7.2 Results

The storm sewer flow assessment provided base flows (i.e., flow during dry weather conditions) occurring during the study period (June through August 2002). Base flows ranged from approximately 8 gpm at manhole 3-20 (Outfall 003) to approximately 250 gpm at manhole 5-4 (Outfall 005). In addition to the total system flow, instantaneous flows were measured from selected manholes during sampling events.

In addition to measuring flows, sampling for select parameters was performed at select manholes to provide data for calculating mass loading. Grab samples were collected during two dry weather and one wet weather periods. Grab samples of water from the sewer systems were analyzed for PAL VOCs and PCBs (Outfalls 003, 004, and 005). Constituents, including bromodichloromethane, chloroform, and dibromochloromethane were detected in each of the outfall systems indicating a potable water component. Low levels of VOCs were detected sporadically along each of the outfall systems.

Low levels of PCBs were also detected in some water samples collected from the Outfalls 003 and 004 storm sewers. Exponent EcoSciences of Bellevue, Washington performed, on behalf of GM, an analysis of the significance of the migration pathway and the potential for PCBs to affect the Flint River. A copy of this report is provided as Appendix F.

Video inspection of selected stretches of pipe provided evidence of historical groundwater infiltration in each of the studied outfall systems. Evidence of historical groundwater infiltration into outfall systems 002, 003, 004, and 005 was observed as mineral deposits at pipe joints. Isolated sections of outfall systems 004 and 005 also exhibited gaps or damage in the walls of the pipe.

Piezometers were installed across selected portions of pipe in outfall systems 003, 004, and 005. In each case, the results of the piezometer study indicate the water table is influenced by infiltration into the storm sewer along select sections. The Outfall 004 and 005 systems are situated in and near the Leith Street underpass constructed below the surrounding grade using concrete retaining walls. Hydrogeological data reveal this as an area with a depression in the groundwater table (see Figures 3-1 and 3-2).

No piezometers were installed in the 002 system because groundwater levels observed in existing monitoring wells indicated the sewer to be located above the groundwater table for most of the length of sewer line. However, localized water-level measurements indicate that the water table does intersect the storm sewer immediately upstream of manhole 2-20, providing the potential for infiltration of impacted groundwater in this area into the sewer. This section of sewer was subject to video reconnaissance in March 2005. During the course of these activities, no visual evidence of LNAPL infiltration was observed. While infiltration was

evident in the study area, an oily sheen was not observed. This suggests that significant amounts of LNAPL may not be in contact with the storm sewer in this area. The limits of the plume shown on Figure 5-1 are inferred from observations of LNAPL in local monitoring wells. Therefore, the actual limits of the plume could be more discontinuous (i.e., including gaps without LNAPL). However, water levels in this area have fluctuated over a range of approximately three feet, potentially rising above the top of a portion of the storm sewer in this area. During periods when the water table was near or above the top of the pipe, LNAPL infiltration, if present, would be effectively stopped.

Routine outfall inspections conducted by GM personnel and occasional inspections conducted by BBL staff have occasionally revealed very light sheens at Outfall 002 at the Flint River. However, a substantial drainage area drains to the portion of the storm sewer system downstream of manhole 2-20, including city street catchbasins located offsite of GM property, which provides other possible sources.

4.7.3 Conclusions

The results of the storm sewer investigation activities performed to date indicate that free-phase LNAPL and dissolved-phase constituents are infiltrating into select portions of the sewers associated with Outfalls 002 through 006, and dissolved-phase constituents are infiltrating into select portions of the sewers associated with Outfall 011. Other possible sources include surface runoff, abandoned tunnels and basements, and sources upstream and downstream of the plant. To mitigate potential onsite sources of these constituents, GM has developed, and is implementing various interim measures, which are described in Section 6 of Appendix I of this document.

The potential for PCBs present in the Site storm sewer system to migrate to and adversely impact the Flint River is judged to be low. There does not appear to be any significant historical effect, and the potential for future effects can be expected to be further reduced by ongoing source control measures implemented as part of the RCRA CA (see Appendix F). However, discussions between USEPA and GM concerning the need for further investigation of the Flint River are ongoing, and will continue beyond the submission of this report.

5. Summary of AOI Investigation and Interim Measures

5.1 AOI Investigation Summary

Table 5-1 presents a summary of the RFI activities completed to investigate each AOI, and the analytical data collected.

5.1.1 AOIs Exhibiting No Screening Criteria Exceedences

Among the AOIs investigated during the RFI, the following were found to exhibit no exceedences of industrial screening criteria. This determination was based on a conservative approach in which the highest concentration of each constituent at an AOI was compared with, and did not exceed, generic MDEQ screening criteria for any constituent in soil or groundwater:

Factory 36 Area
- AOI 36-4

Factory 05 Area
- AOI 05-4

Factory 81 Area
- AOI 81-5

Factory 83/84 Area
- AOI 83/84-1
- AOI 83/84-5

Building 07 Area
- AOI 07-2

Buildings 03, 17, 28, 84 and 94 Area
- AOI 94-D
- AOI 94-E
- AOI 84-B
- AOI 84-C

Buildings 02, 12, 23 and 29 Area
- AOI 02-A
- AOI 02-D
- AOI 02-E
- AOI 12-D

Buildings 04, 08, 16, 40 and 44 Area
- AOI 04-B
- AOI 04-C
- AOI 04-D
- AOI 16-A
- AOI 16-B
- AOI 16-D

Former Aeration Lagoons Area

Former Building 94 Employee Parking Lot

5.1.2 AOIs Exhibiting Soil Screening Criteria Exceedences

Among the AOIs investigated during the RFI, the following were found to exhibit exceedences of industrial screening criteria in soil samples. This determination was based on a conservative approach in which the highest concentration of each constituent at an AOI was compared with generic MDEQ screening criteria for any constituent in soil:

Factory 36 Area
- AOI 36-1
- AOI 36-2

Factory 10 Area
- AOI 10-1
- AOI 10-2
- AOI 10-3

Factory 05 Area
- AOI 05-1
- AOI 05-6

Factory 03 Area
- AOI 03-1

Factory 81 Area
- AOI 81-1
- AOI 81-2

Factory 83/84 Area
- AOI 83/84-2
- AOI 83/84-3
- AOI 83/84-6

Building 07, 21, 85, and 86 Area
- AOI 86-1

Buildings 02, 12, 23 and 29 Area
- AOI 02-C
- AOI 29-A
- AOI 12-A
- AOI 12-B

Buildings 04, 08, 16, 40 and 44 Area
- AOI 40-A
- AOI 44-A

Building 09 Area
- AOI 09-A
- AOI 09-B

5.1.3 AOIs Exhibiting Groundwater Screening Criteria Exceedences

Among the AOIs investigated during the RFI, the following were found to exhibit exceedences of industrial screening criteria in groundwater samples. This determination was based on a conservative approach in which the highest concentration of each constituent at an AOI was compared with generic MDEQ screening criteria for any constituent in groundwater:

Building 38 Area
- AOI 38-1

Factory 36 Area
- AOI 36-1
- AOI 36-2
- AOI 36-3
- AOI 36-5

Factory 10 Area
- AOI 10-1
- AOI 10-2
- AOI 10-3
- AOI 10-4
- AOI 55-1

Factory 05 Area
- AOI 05-2
- AOI 05-3
- AOI 05-5
- AOI 05-6

Factory 03 Area
- AOI 03-1

Factory 81 Area
- AOI 81-1
- AOI 81-2
- AOI 81-3
- AOI 81-4

Building 07, 21, 85, and 86 Area
- AOI 21-1
- AOI 85-1
- AOI 86-1
- AOI 07-1
- AOI 07-3

Factory 83/84 Area
- AOI 83/84-2
- AOI 83/84-3
- AOI 83/84-4
- AOI 65-1
- AOI 83/84-7

Buildings 03, 17, 28, 84 and 94 Area
- AOI 94-A
- AOI 94-B
- AOI 94-C
- AOI 84-A
- AOI 84-D

- AOI 17-A

Buildings 02, 12, 23 and 29 Area
- AOI 02-B
- AOI 02-F
- AOI 23-A
- AOI 12-A

Buildings 04, 08, 16, 40 and 44 Area
- AOI 04-A
- AOI 16-C
- AOI 40-A
- AOI 40-B
- AOI 40-C
- AOI 40-D
- AOI 44-A

Building 09 Area
- AOI 09-A
- AOI 09-B

Building 01 Area

Harriet Street Area

5.2 Sitewide Groundwater Quality

Due to the number and location of the Site AOIs, upgradient groundwater quality and the distribution of select constituents have been evaluated on a Sitewide basis, as discussed below.

5.2.1 Upgradient Groundwater Quality

A series of historical and new monitoring wells are located along the upgradient Site perimeter. Upgradient monitoring wells include 04-120, 04-121, 04-140, 11-120, 11-140, 36-120, 38-120, 36-121, 43-141, RFI-05-8R, RFI-55-01, RFI-55-11 and RFI-55-12 (Figures 2-2 and 2-3). The groundwater data for these wells were compared to the generic screening criteria, and no concentrations above criteria were identified with the exception of exceedences noted at monitoring wells RFI-55-11 and RFI-55-12.

RFI Phase II investigation activities included the installation of monitoring wells RFI-55-11 and RFI-55-12 within Stewart Avenue, adjacent to the former Pro-Met property, which is located at the northwest corner of the intersection of Stewart Avenue and Andrews Street. Data obtained through a Freedom of Information Act (FOIA) request indicated that plating operations were conducted at the former Pro-Met property beginning in 1958, and that prior investigations indicated impacts to soil and groundwater by both metals and organic compounds associated with plating operations.

Groundwater samples collected from these two wells indicated concentrations exceeding the Michigan Part 201 Generic Industrial Screening Criteria of the following analytes:

- VOCs: 1,2-dichloropropane, trichloroethene, and vinyl chloride;
- SVOC: bis(2-chloroethyl)ether; and
- Inorganics: antimony, arsenic, beryllium, cadmium, chromium, cyanide, lead, nickel, and thallium.

These analytical results suggest that groundwater flowing to the Site is impacted by a source area located on the former Pro-Met property. Groundwater monitoring data collected downgradient of the former Pro-Met property, at monitoring well 55-4, show the presence of trichloroethene (0.044 mg/L), 1,2-dichloropropane (0.13 mg/L), and bis(2-chloroethyl)ether (0.023 mg/L) at concentrations above the Generic MDEQ Industrial Drinking Water Criteria.

5.2.2 Sitewide Distribution of LNAPL

The estimated extents of LNAPL observed at the Site during 2005 are presented on Figures 5-1 and 5-2 for the Northend and Southend of the Site, respectively, and are shown by yellow shading. LNAPL was observed on the Northend near Buildings 10, 20, 30, 32, 36, 43, 70, 83, and 86. LNAPL was observed on the Southend near the former Buildings 02, 09, 12, 16, and 40.

5.2.3 Sitewide Distribution of Constituents in Groundwater at Concentrations Above Generic Screening Criteria

The distribution of constituents detected in groundwater at concentrations above generic MDEQ screening criteria are presented on Figures 5-1 and 5-2 for the Northend and Southend of the Site, respectively. These figures provide an overview of the areas with VOC, SVOC, and inorganic concentrations in groundwater above generic screening criteria. The distribution of VOCs and SVOCs in groundwater is shown by blue shading and inorganics are shown by green shading (or hatching).

One SVOC constituent (bis(2-ethylhexyl)phalate) detected in groundwater samples collected from temporary wells installed at the Site during May 2001 was found to be caused by the tubing utilized to collect the samples; therefore, the concentrations are not indicative of actual groundwater quality for these sample locations.

Total PCBs had been detected in a groundwater sample collected from one well located on the Southend of the Site during the September 2001 sampling event. The September 2001 groundwater sample collected from monitoring well 31-5, located in the Bldg 09 Area, had a reported PCB concentration of 0.0017 mg/L. PCBs have not detected in groundwater samples collected subsequent to the 2001, including the sample collected from monitoring well 31-5 during the June 2002 sampling event (analytical method detection limit for PCBs was 0.00011 mg/L).

Isoconcentration maps of select chlorinated VOCs were also prepared for the Northend and Southend of the Site (Figures 5-3 and 5-4, respectively) to further illustrate the distribution of these constituents in groundwater at concentrations above IDW criteria. The chlorinated compounds selected for illustration include trichloroethene, cis-1,2-dichloroethene, 1,1,1 trichloroethane, vinyl chloride, and tetrachloroethene. The isoconcentration lines for these compounds along with the associated generic MDEQ IDW criteria for each compound are shown.

Two additional isoconcentration maps for the Northend and Southend of the Site (Figures 5-5 and 5-6, respectively) were prepared to illustrate the distribution of benzene, toluene, ethylbenzene, and xylene (BTEX) constituents in groundwater. Benzene, toluene, and ethylbenzene were detected at concentrations above generic IDW criteria in the Northend of the Site. Benzene and ethylbenzene were detected at concentrations above the generic health-based IDW criteria at the Southend of the site.

A more detailed description of the distribution of the dissolved constituents in groundwater at concentrations exceeding the generic MDEQ screening criteria at the Northend and Southend areas of the Site follows. Additional discussion on the characterization of the extent of releases to groundwater is presented in the CA750 Report (ENVIRON 2005) that was approved by USEPA.

5.2.3.1 Northend Distribution of Constituents in Groundwater

Figure 5-1 identifies 26 areas on the Northend of the Site with inorganics concentrations in groundwater above the generic MDEQ screening criteria. The inorganics detected above the criteria include: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, cyanide, lead, manganese, nickel, selenium, thallium, vanadium, and zinc.

Figure 5-3 presents the isoconcentration map of select chlorinated VOCs on the Northend of the Site illustrating the distribution of these constituents in groundwater at concentrations above IDW criteria. Trichloroethene was identified in several areas in the Northend at concentrations ranging to a maximum of 2 mg/L at monitoring well 87-FP3 and vinyl chloride was also identified in several areas with concentrations ranging to a maximum of 0.52 mg/L at monitoring well 20-101R. Cis-1,2-dichloroethene was identified in four areas with concentrations ranging to a maximum of 0.45 mg/L at monitoring well 87-FP3. 1,1,1 Trichloroethane was identified at three locations at concentrations ranging to a maximum of 2.4 mg/L at monitoring well 20-101R. Tetrachloroethene was identified in two areas with concentrations ranging to a maximum of 0.041 mg/L at monitoring well 87-FP3.

Figure 5-5 presents the isoconcentration map of dissolved benzene, toluene, and ethylbenzene in groundwater at concentrations above IDW criteria on the Northend of the Site. Benzene was identified in six areas on the Northend at concentrations ranging to a maximum of 6.0 mg/L at monitoring well RFI-36-43. Toluene and ethylbenzene was identified in one area of the Northend at concentrations of 1.3 mg/L and 20 mg/L, respectively at monitoring well RFI-36-43.

5.2.3.2 Southend Distribution of Constituents in Groundwater

Figure 5-2 identifies 10 areas on the Southend of the Site with inorganics concentrations in groundwater above the generic MDEQ screening criteria. The inorganics detected above the criteria include: antimony, arsenic, beryllium, cadmium, chromium, cobalt, cyanide, lead, manganese, nickel, selenium, thallium, and vanadium.

Figure 5-4 presents the isoconcentration map of select chlorinated VOCs on the Southend of the Site illustrating the distribution of these constituents in groundwater at concentrations above IDW criteria. Trichloroethene was identified in four areas in the Southend at concentrations ranging to a maximum of 0.95 mg/L at monitoring well RFI-94-02R. Vinyl chloride was identified in two areas with concentrations ranging from non-detect to a maximum of 0.124 mg/L at monitoring well RFI-84-08D. Cis-1,2-dichloroethene was identified in two areas with concentrations ranging to a maximum of 0.322 mg/L at monitoring well 84-07S. Tetrachloroethene was identified in one area with a concentration of 0.0057 mg/L at monitoring well RFI-12-03.

Figure 5-6 presents the isoconcentration map of dissolved benzene and ethylbenzene in groundwater at concentrations above IDW criteria on the Southend of the Site. Benzene was identified in seven areas on the Southend at concentrations ranging to a maximum of 5.5 mg/L at monitoring well RFI-40-15. Ethylbenzene was identified in AOI-09B in monitoring well 31-8 at a maximum concentration of 1 mg/L.

5.3 Interim Measures Status Summary

Based on the additional information gathered since June 2002, GM has advanced the design and construction of certain IMs. The following sections provide an update of this information. The status of IMs not discussed in the following sections remains unchanged from that indicated in the RFI Phase I Report. Final remedial action for the Site will be evaluated in the CMP.

As noted in previous sections of this report, various LNAPL plumes have been observed at the Site. Although these LNAPL plumes have been demonstrated to be relatively stable, based on several years of routine monitoring and as shown on Figures 5-3 through 5-6, GM has undertaken actions to collect LNAPL in accordance with regulatory requirements, until final remedial actions are more fully evaluated in the CMP.

These activities are summarized below for select areas.

5.3.1 Factory 10 Scrapyard Area

In 1991, free product was detected on the water table beneath and south of Building 20 within the Factory 10 Area (see Figures 2-4, 4-6, and 5-3). Fractions of this product included both water-soluble and insoluble phases of oil containing PCBs. In May 1997, GM installed a groundwater collection and treatment system designed to collect and treat soluble product and affected groundwater from this area. Treated groundwater is discharged to the Site storm sewer system under a National Pollutant Discharge Elimination System (NPDES) permit. The treatment system is currently operating at a flow rate of up to approximately 20 gallons per minute (gpm).

Subsurface investigations performed in and around the Scrapyard Area south of Factory 10 identified the presence of free product containing PCBs on the surface of groundwater outside the southeastern corner of Factory 10 and in the adjacent scrapyard area to the south, outside the influence of the LNAPL collection system installed in 1997. As a result, a second product recovery system consisting of a recovery trench, four manholes, and pumps for both product recovery and groundwater drawdown has been constructed further downgradient to recover the PCB-containing LNAPL and create hydraulic control at the downgradient plume edge.

The collection trench, sumps, manholes, and product piping of this new IM were installed in January and February 2003. The new recovery trench is composed of two segments: one is approximately 30 feet long and the other is approximately 210 feet long. Both trench segments are approximately 20 feet deep and 1.5 feet wide, and contain a perforated pipe lateral and pea stone backfill. Product and groundwater are pumped from four 4-foot diameter recovery manholes equally spaced along the trench. Collected groundwater and product are treated in the groundwater treatment system in Building 20, because of its PCB handling capability.

GM will continue to operate this system until final remedial action for this area is evaluated in the CMP.

5.3.2 Factory 05 Area Product Recovery Trenches

As described in the RFI Phase I Report, investigations performed in 1994 in response to suspected oil releases in Building 43 (Factory 05 Area) detected LNAPL on the water table along the southeast side of Building 43 (see Figures 2-4 and 4-8). To address the LNAPL, three recovery trenches were installed as IMs in the Building 43 area in early 1995. These recovery trenches are each approximately 14 feet deep, 3 feet wide, 100 feet long, and backfilled with gravel. Product is recovered from these trenches via 30-inch-diameter recovery wells installed

near the midpoint of each recovery trench. Automated belt skimming devices in the recovery wells collect product from the recovery trenches (with approximately 60% groundwater and 40% product) and transfer it to a temporary storage tote. Recovered water is periodically allowed to flow back into the recovery well and the recovered product is later drummed for disposal.

GM will continue to operate this system until final remedial action for this area is evaluated in the CMP.

5.3.3 Factory 36 Area Exterior Product Recovery System

Free product has been detected on the water table immediately downgradient of a basement area in the southeastern portion of the Factory 36 Area (see Figures 2-4 and 4-4). This free product is believed to result from former releases associated with the former chip processing operations performed within this basement area.

A groundwater and LNAPL recovery system has been constructed along the east side of Building 36, and was placed into operation in 2005. The purpose of this IM is to control potential offsite migration of LNAPL and Site-related constituents and to collect free-phase LNAPL. This system consists of three 12-inch diameter wells (installed in 24-inch diameter boreholes) and pumps for both product recovery and groundwater drawdown. The recovery wells are approximately 20 feet deep. Product and groundwater are recovered from the wells via product recovery pump(s) and groundwater submersible pump(s), respectively. Collected fluids are transferred to a new treatment system that is housed in an enclosure located in the area of the wells and ultimately discharged to the Site storm sewer system (Outfall 002) under an NPDES permit.
GM will continue to operate this system until final remedial action for this area is evaluated in the CMP.

5.3.4 Building 12 Area

Evidence of LNAPL was recently discovered in wells located in the northwestern and eastern portions of the former Building 12 (see Figures 2-5 and 4-20). Two stand-alone LNAPL collection systems were installed in July 2003 at wells RFI-12-02 and RFI-12-11D for the purpose of controlling the migration of potential LNAPL in this area. These systems consisted of a pneumatic product skimming pump powered by nitrogen supplied in liquid nitrogen tanks and a battery-powered, solar-charged controller. Collected product was stored in tanks located at each well head. Due to the high viscosity of the LNAPL in this area, these systems failed to collect any reasonable amount of LNAPL. As such, they have been terminated and dismantled. Final remedial action for this area will be evaluated in the CMP.

5.3.5 Building 40 Tunnel

The Building 40 tunnel connected former Building 16 with former Building 40 and was used to transport car parts between the two buildings (see Figures 2-5 and 4-22). The tunnel was constructed in 1920, oriented in an east-west direction, and was approximately 260 feet long by 15 feet wide and 8.5 feet high. The top of the tunnel roof was approximately 8 feet below grade. In the 1980s, the use of this tunnel was discontinued and the tunnel became flooded with water. In 2002, as part of an extensive program of building demolition in the southern portion of the Site, Building 40 (except for its basement, which is now exposed at the ground surface) and Building 16 were demolished along with the surrounding area.

The tunnel, which was located under the former Building 40 basement, was submerged with water, and the water level was approximately 2 feet above the floor of the exposed basement. In 1991, floating oil was observed on the floor of the basement and floating on the surface of the water flooding the tunnel below the basement. PCBs have been detected in samples of this oil, but the results have been variable. The source of this oil is unknown. The basement floor was cleaned in August 1992 using a foam-applied aqueous-based solvent to extract PCBs from the concrete floor and the lower 2 feet of the basement walls. Inspections of the tunnel, performed using a diver, revealed small amounts of oil floating on the surface of the water. Oil observed during the most recent inspection conducted in June 2003 was removed by the diver using absorbent pads and booms.

The report titled *Cleanup and Disposal of PCB Remediation Waste, Building 40 Tunnel and Basement* (BBL, 2004) describes work performed at the Building 40 tunnel and provides the plan for remediation of the tunnel. In May 2006, in accordance with the plan, the basement floor at former Building 40 was broken and allowed to collapse to the floor of the tunnel. Crushed concrete, and other appropriate fill material, were then used to fill the basement and tunnel to the level of the surrounding ground. The water level was monitored during filling activities to avoid flooding of the surrounding area from the displacement of the water with the fill. This approach was consistent with demolition activities conducted Site-wide. The only remaining actions planned to address this area include the implementation of institutional controls (e.g., deed restriction).

5.3.6 Building 32/66 Tunnel Product Recovery

Based on available mapping obtained from GM, the abandoned tunnel system of Buildings 32 and 66 is T-shaped and approximately 8 feet high by 5 feet wide and 450 feet long, with one branch to the west midway down its length and another branch to the east at the northend (see Figures 2-4 and 4-16). This currently inactive tunnel was used for conveying steam and other process fluids about Factory 83/84. The primary access point is located in the basement of Building 32. Other access points exist through the top of the tunnel, but are not suitable for entry. Currently, there is standing water in the tunnel, and patches of LNAPL floating on the water surface.

On October 29, 2002, a sample of water in the tunnel was collected for characterization prior to disposal at the onsite industrial wastewater treatment facility, and was found to contain PCBs (Aroclors 1254 and 1260) at 12.6 ug/L. Given the presence of PCBs in the water, onsite disposal was not an option. It was suspected that this sample may contain some of the LNAPL layer. A sample of the floating LNAPL was subsequently collected and analyzed by SGS Environmental in Ludington, Michigan. This sample did not exhibit the presence of PCBs at a detection limit of 1.0 milligrams per kilogram (mg/kg). Due to these data inconsistencies, further investigation of the tunnel was performed.

A sample of the pipe insulation within the tunnel was collected on December 12, 2002 and was found to contain 15% asbestos. The pipe insulation has deteriorated, and asbestos fibers can be seen commingled with the LNAPL layer.

On September 22, 2003, an investigation of the tunnel was performed to confirm the presence of PCBs. The investigation was halted 128 feet into the tunnel because hanging pieces of concrete were observed, and the integrity of the tunnel ceiling and walls could not be confirmed. There was no obvious source of the LNAPL layer observed during the investigation. Staining on the walls or ceiling was not observed and machinery or equipment typically associated with PCB use was not observed. PCBs have not been detected in the LNAPL samples collected in this investigation, nor were they detected in the LNAPL sample collected on October 29, 2003. The detected concentrations of PCBs in the water and LNAPL are below 50 parts per million (ppm)

However, the concentrations of lead and mercury in the LNAPL were at a level that would cause the LNAPL to be classified as a RCRA hazardous waste if the LNAPL was removed.

Current exposure to the water and LNAPL in the tunnel is unlikely as the tunnel is inactive, its access is restricted, and the only potential exposure pathway is contact with water and LNAPL during potential future building demolition activities. The detected concentrations of contaminants in water samples collected from the tunnel are below MDEQ generic screening criteria. The presence of LNAPL in this tunnel will be further evaluated in the CMP.

5.3.7 Abandoned Utility Tunnel adjacent to Former Building 23

During storm sewer reconnaissance activities, an abandoned utility tunnel was observed to be present along the south side of Leith Street, with a portion also running north-south along Division Street. This tunnel was observed to have an approximate 1-inch thick layer of LNAPL floating on approximately 1.5 to 2 feet of water. The tunnel is approximately 600 feet in length (see Figures 2-5 and 4-20). To address this LNAPL, GM decided to remove it using a vacuum truck. Prior to removing the LNAPL from the tunnel, 5 access holes were constructed through the top of the tunnel spaced equally along its length. The purpose of these access points was to facilitate removal of LNAPL while minimizing the need to enter the tunnel. A pre-cast manhole cover was installed at each access hole.

The LNAPL floating on the water surface has been pumped during five separate mobilizations occurring between October 1 and December 19, 2003. During each event, oil with some water was pumped from the new and existing access points using a vacuum truck. Also, during the last event, a separate pump was used to circulate water from one end of the tunnel to the other to create sufficient flow to move the oil to the access points where it was collected by the vacuum truck. Based on visual observation, most of the oil appears to have been removed. The total amount of oil removed was approximately 900 gallons. This basement and tunnel area will be further evaluated in the CMP.

5.3.8 Storm Sewer IM Activities

GM has developed, and is implementing, a storm sewer mitigation strategy that includes the following:

- Identify suspect areas of the Site storm sewers that may be affecting water quality conditions at the permitted outfalls. This identification is based on: a) previous storm sewer investigation activities, b) recent RFI findings, and c) NPDES monitoring data.

  This element of the mitigation strategy has been completed and is summarized in Appendix I.

- Develop conceptual corrective measures to mitigate potential releases of free- and dissolved-phase constituents into the storm sewer/outfall systems. These controls may include sewer rehabilitation measures to reduce the direct hydraulic connection between areas of impacted groundwater and storm sewers. In combination, these controls will also include supplemental groundwater controls to avoid further migration of impacted groundwater.

  This element of the mitigation strategy is ongoing and is summarized in Appendix I.

- Implement a series of focused investigations to provide design-related information to support the final design of the corrective measures.

  The results of completed investigation activities area presented in Appendix I.

- Develop a final corrective measure design.

  Interim measures are currently being performed to address LNAPL sheens observed at the Flint River outfalls (outfalls 002 through 006). These interim measures are discussed in Appendix I. The final remedy for these outfalls will be evaluated in the CMP.

- Implement the corrective measures.

This element of the mitigation strategy will be undertaken following completion of the final design activities described in the above item. In addition, GM has performed emergency response actions to address recent releases of free-phase material at Outfalls 006 (October 10, 2002) and Outfall 004 (May 10, 2003). These releases were immediately reported to the National Response Center (NRC) of the City of Flint, as well as the Michigan Department of Environmental Quality (MDEQ) and the USEPA, and are described in Appendix I. These releases were mostly contained by floating oil absorbent booms, and the oil was collected using a vacuum truck. Also, on July 20, 2004, the Outfall 006 storm sewer was permanently plugged at GM's property line near the railroad tracks.

6. Human Health Risk Assessment

6.1 Introduction

Section 4 discussed the scope of the RFI field investigation for each AOI that was investigated, and compared the Site characterization data with conservative risk-based screening criteria to identify whether a potentially significant release of hazardous constituents to the environment may have occurred. The human health risk assessment discussed in this section evaluates the potential significance of reasonable maximum exposures to affected environmental media under current and reasonably expected future land use at and around the Site. The methods used in the risk assessment are based on USEPA risk assessment guidance.

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) shown in Table 6-1. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Site 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 data discussed in Sections 3 and 4, respectively. The scenarios for potential human exposure are further discussed in Section 6.3.

Discussion of the human health risk assessment is organized as follows:

- The preparation of data used in the risk assessment is discussed in Section 6.2, Data Collection and Preparation.
- The scenarios for potential human exposure are discussed in Section 6.3, Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.
- Toxicity information for the chemicals included in the risk assessment is summarized in Section 6.4, Toxicity Assessment.
- The risks for potentially exposed populations identified in Section 6.3 are quantified and their significance is discussed in Section 6.5, 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 6.6, Summary and Conclusions.

6.2 Data Collection and Preparation

6.2.1 Data Collection

The objectives of data collection during the RFI and strategies for determining when additional data collection is necessary were described in the RFI Work Plan and the minutes for subsequent meetings and conference calls. The scope of the RFI field investigation and a summary of the data collection activities are discussed in the DOC and summarized in Section 2 of this report. In addition to data collected under the RFI Work Plan and

addenda, soil and groundwater characterization data were collected from four additional areas that were not identified in the RFI Work Plan and were initially investigated for the purpose of potential property transfers as discussed in Section 4.6. These data are also included in the risk assessment. The scope of field investigations and collection of the data for potential property transfers is summarized in Section 4.6.

6.2.2 Data Preparation

Validation of data was performed in accordance with the QAPP in the RFI Work Plan. All soil, groundwater, borehole water, LNAPL, storm sewer water, and basement and tunnel water data discussed in Section 4 were validated. 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 are used in further evaluations.

- Concentrations of chemicals analyzed under multiple methods, for the same sample, are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a multiple method pair, the average of the detected concentration and one-half the sample quantitation limit are used in further evaluations.

- Concentrations of metals in soil that are at or below the Site-specific background concentrations discussed in Section 4.2 are considered to be within background levels. Concentrations higher than the background levels are conservatively considered to be Site-related, and are used in the calculation of Site-related risks. As a conservative assumption, all concentrations of organic constituents are assumed to be Site-related. Please note that offsite contamination of organic constituents is suspected north of Factory 36 and in AOIs 10-2 and 55-1, as discussed in Sections 4.4.2.3, 4.4.9.3, and 4.4.7, respectively.

The soil, groundwater, LNAPL, storm sewer water, and basement and tunnel water data are used in the risk assessment. Borehole water data are not used because they were collected primarily to support the field investigation and they do not necessarily represent groundwater quality in the aquifers. No constituent that was detected in soil, groundwater, LNAPL, storm sewer water, or basement and tunnel water is excluded from the risk assessment, except as noted above.

The complete data (including R-qualified data and separate results for each sample of a duplicate pair) are provided in Appendices B through D and I. Summaries of the data validation results are provided in Appendix E.

6.3 Exposure Assessment

This section discusses the potential exposures that are relevant under current and reasonably expected future land use at and around the Site. The exposure setting, potentially exposed populations, and exposure pathways are discussed in Sections 6.3.1 through 6.3.3, respectively.

For the potential exposures discussed in this section, exposure is quantified as a dose, which is defined as follows:

$$Dose = Concentration \cdot Intake$$

The dose for evaluating cancer risk is averaged over a lifetime and is called a lifetime average daily dose (LADD). For evaluating long-term (or chronic) noncancer effects, the dose is averaged over the period of exposure and is called an average daily dose (ADD).

The concentration term in the dose equation refers to the concentration in an environmental medium to which a population is exposed over a specified period. 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 6.3.4. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 6.3.5.

6.3.1 Exposure Setting

The environmental setting at and around the Site, including climate, geology, hydrogeology, land cover, surface water bodies, water supply, and groundwater use, are discussed in the RFI Phase I Report and Section 3 of this report, and not repeated in this section.

6.3.2 Potentially Exposed Populations

Based on the discussion of land use at and around the Site in Section 3, the potentially exposed populations at and around the Site under current and reasonably expected future land use include the following:

Current	Onsite: Northend	Routine Workers
		Maintenance Workers
		Trespassers
	Onsite: Southend	Maintenance Workers
		Trespassers
	Offsite	Routine Workers
		Maintenance Workers
		Recreational Users
	Onsite: Northend	Routine Workers
		Maintenance Workers
		Trespassers

Future	Onsite: Southend	Routine Workers
		Maintenance Workers
		Trespassers
		Redevelopment Construction Workers
		Recreational Users (e.g., parks)
		Residents

The offsite area (areas outside of the current GM property boundary) east of the Site is currently zoned commercial/industrial, with a small strip of land adjacent to the Flint River zoned for residential. As discussed in Section 3.3, the areas east of the Site are expected to remain predominantly for commercial/industrial use. The offsite areas north and west of the Site are zoned residential, business/commercial, or manufacturing. Therefore, potentially exposed offsite populations include routine workers, maintenance workers, and residents, as well as recreational users at the Flint River.

6.3.3 Exposure Pathways

The exposure pathways discussed in this section are summarized in the conceptual site model shown in Table 6-1. Exposure pathways for onsite receptors are discussed in Section 6.3.3.1, and exposure pathways for offsite receptors are discussed in Section 6.3.3.2.

6.3.3.1 Potential Onsite Exposures

Onsite receptors include routine workers, maintenance workers, and trespassers. Potential future onsite receptors at the Southend also include redevelopment workers, recreational users, and residents. The types of potential exposures for each receptor are discussed below.

Routine Workers

The largest receptor population at the Site consists of workers who are engaged in routine manufacturing. Routine workers are engaged in commercial and/or industrial activities that generally take place indoors. 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 also could be exposed to constituents in the subsurface from soil, groundwater, and LNAPL if the constituents were to volatilize and migrate through cracks in the building foundation into indoor air.

Exposure of routine workers via groundwater use is not evaluated because groundwater is not used as a potable or non-potable water supply at the Site or in the vicinity, and future potable or non-potable use is not reasonably expected, as discussed in Section 3.3.

Maintenance Workers

Currently, workers who are involved with occasional construction or maintenance activities at the Site follow proper health and safety procedures to minimize exposure. However, future workers conducting occasional subsurface construction or maintenance activities could contact surface and subsurface soil in

paved and unpaved areas of the Site. These subsurface activities are expected to be of limited size and duration (e.g., installation or repair of underground utilities, or removal or repair of pavement). Potential routes of exposure to surface and subsurface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

Maintenance workers also could be exposed to LNAPL and LNAPL-containing soil in the smear zone at AOIs 02-B, 03-1, 05-1, 05-5, 09-B, 10-1, 10-4, 12-A, 12-B, 12-C,16-C, 23-A, 36-1, 36-2, 36-5, 40-A, 81-2, 83/84-2, 83/84-4, 85-1, and 86-1. Each of these AOIs contains at least one location in which measurable LNAPL has been detected in the past, although the plume does not necessarily cover a large portion of the AOI's area. The most potentially significant routes of exposure to LNAPL are expected to include dermal contact and inhalation of vapor. Potential routes of exposure to LNAPL-containing smear zone soil would include incidental ingestion, dermal contact, and inhalation of vapor.

In excavations that encounter groundwater, which is typically found 6 ft or deeper below ground surface (bgs) at and around the Site, maintenance workers could be exposed to shallow groundwater (utility lines are typically 10 ft bgs at and around the Site). Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor.

In addition, while workers are engaged in building or storm sewer maintenance, they could be exposed to standing water and/or LNAPL in the storm sewers or in areas where basements or tunnels intersect the shallow water table. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor. It should be noted that current workers performing these activities follow proper health and safety procedures to minimize exposure.

Trespassers

Potential exposure of trespassers onsite is possible, although fencing and security personnel control access to the Site. These controls make trespassing unlikely, and would limit the duration of any unauthorized access as well as the types of activities while onsite. While onsite, trespassers could come into contact with 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 evaluated indirectly using exposure estimates for routine workers. This streamlines the risk assessment and is conservative because trespasser exposures to soil would be lower than routine worker exposures to soil (ENVIRON 2003).

Redevelopment Construction Workers

Workers conducting construction activities during future redevelopment at the Southend could be exposed to soil, LNAPL, and groundwater. Potential routes of exposure to these media for the redevelopment workers are the same as for maintenance workers, discussed above.

Recreational Users

Potential exposure of non-residential recreators is possible at portions of the Southend if these areas are developed as parks or athletic fields. These recreational users could come into contact with soil in unpaved areas. Potential routes of exposure to constituents in soil are via incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

Recreational exposures to soil in this risk assessment are evaluated using exposure estimates for residents. This streamlines the risk assessment and is conservative because recreational exposures to soil would be lower than residential exposures to soil. As discussed later, these conservative risk estimates can be modified with a fraction contact term that is appropriate for recreational users, as necessary (see Section 6.5.2.6).

Residents

Potential exposure of residents is possible at portions of the Southend if these areas are redeveloped for residential use. Potential routes of exposure to soil, LNAPL, and groundwater for these residents are expected to be the same as for routine workers, discussed above.

6.3.3.2 Potential Offsite Exposures

Offsite receptors include routine workers, maintenance workers, recreational users, and residents. The types of potential exposures for each receptor are discussed below.

Routine Workers

Presently, no groundwater plume is beneath any of the offsite buildings; therefore current exposure of offsite routine workers is not possible. Offsite workers could be exposed to constituents in groundwater present underneath offsite buildings in the future 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 groundwater at the AOIs that are located at the downgradient of the Site where the groundwater has migrated or is likely to migrate offsite.

Exposure of routine workers via groundwater use is not expected because groundwater is not a current or reasonably expected future water supply in the vicinity of the Site.

Maintenance workers

Workers performing construction that extends to groundwater could be exposed to constituents in shallow groundwater in areas where the groundwater is within typical excavation depths. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor. These potential exposures are evaluated in this risk assessment by using exposure estimates for onsite maintenance workers. This streamlines the risk assessment and is conservative because onsite exposures via vapor intrusion are expected to be higher than that for offsite maintenance workers due to higher exposure concentrations onsite as compared to exposure concentrations offsite.

Recreational Users

Recreational users could be exposed to constituents in groundwater via contact with nearby downgradient surface water in the Flint River where groundwater could enter directly and/or enter via onsite storm water sewers that intercept groundwater. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor during occasional recreational activities. Recreational users also could be exposed to constituents in groundwater through consumption of fish from the Flint River.

Residents

Presently, exposure of offsite residents is not possible as there are no residential buildings along the downgradient Site boundary west of the Flint River. Offsite residents could be exposed to constituents in groundwater present underneath offsite buildings in the future 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 in groundwater at the AOIs that are located at the downgradient of the Site where the groundwater has migrated or is likely to migrate offsite.

Exposure of future residents via groundwater use is not expected because groundwater is not a current or reasonably expected future water supply in the vicinity of the Site, as discussed in Section 3.3.

Offsite receptors could also be exposed to constituents in soil at the Site via wind erosion and transport offsite. In this risk assessment, potential airborne exposures of offsite receptors are conservatively evaluated using exposure estimates for onsite workers. This approach streamlines the risk assessment and is conservative because airborne exposures offsite are expected to be lower than exposure onsite due to much greater air dispersion between an onsite emission source and offsite receptors as compared to air dispersion directly over an emission source (ENVIRON 2003).

6.3.4 Estimation of Exposure Concentrations

Soil

Reasonable maximum exposures (RME) are conservatively estimated in this risk assessment by first using the maximum detected concentrations at any depth in each area to calculate bounding estimates of cumulative cancer and noncancer risks for each area. If these bounding estimates of RME risks do not exceed 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), then further calculations are not necessary.

If a bounding estimate at an area in the Northend exceeds a trigger for corrective measures, then the estimate is refined by calculating upper-bound risks by potential receptor. The maximum soil concentrations from the two feet below ground surface and from the ten feet below ground surface are used for estimating the upper-bound risks for routine workers and maintenance workers, respectively, if necessary.

If a bounding estimate at an area in the Southend exceeds a trigger for corrective measures, then the estimate is refined by calculating point-by-point risks using the maximum concentrations at each location, as discussed in Section 6.4.2. Every chemical detected in soil at the Southend of the Site was included in the point-by-point risk calculations. Since not every chemical was analyzed in a soil sample at a particular location, a surrogate concentration was assigned to the location if the chemical has concentrations at other locations that could contribute significantly to the cumulative cancer and/or noncancer risk estimates for any of the exposure scenarios identified for further evaluation. Appendix G describes the procedure used to select conservative concentrations for the risk calculations for each boring location.

The use of maximum concentrations for many constituents introduces more conservatism than necessary for RME estimates because it assumes constant simultaneous worst-case exposure to many constituents, when the 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 6.5.3.

Other Media

Exposure concentrations for groundwater, basement water, tunnel water, sewer water, and LNAPL are conservatively estimated using the highest detected concentrations in these media at each area to streamline risk calculations. However, as discussed above, the use of maximum concentrations introduces more conservatism than necessary for RME estimates. In addition, the maximum concentrations in unfiltered and filtered water samples (when both were analyzed) are conservatively used to evaluate all exposure routes even though filtered concentrations are more appropriate for calculating risks for the dermal and inhalation exposure routes. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 6.5.3.

Currently vinyl chloride has been detected infrequently in groundwater and generally at relatively low concentrations at the Site. PCE, TCE, and/or 1,2-DCE are the predominant contaminants in groundwater in most of these areas. As a sensitivity analysis, potential exposures to these chemicals in groundwater are evaluated for the groundwater plume in the Building 36 area where the concentrations of chlorinated VOCs are among the highest and the degradation of these chemicals to vinyl chloride is likely to occur. The groundwater exposure concentration of vinyl chloride is conservatively estimated by assuming total conversion of the highest concentrations of PCE, TCE, and 1,2-DCE (cis and trans) in the Building 36 plume to vinyl chloride. The results of this sensitivity analysis are discussed in Section 6.5.3.

6.3.4.1 Fate and Transport Models

The following models are used to estimate exposure concentrations for the exposure scenarios discussed in Section 6.3.3. 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 G.

Vapor Intrusion into Buildings

Indoor air concentrations resulting from migration of vapors from soil, groundwater, or LNAPL into a building are estimated using the model described by Johnson and Ettinger (1991), which USEPA recommends for screening-level evaluations (USEPA 2004). The calculations in this risk assessment use default building characteristics recommended by MDEQ (2002) and generic soil properties recommended by USEPA (2004) that are representative of the soil types at the Site. The MDEQ building characteristics are considered conservative for the evaluation of current conditions because the buildings currently at the Site are much larger in size than the commercial building assumed in the MDEQ guidance. A discussion of the model and the input parameters used in the assessment is provided in Appendix G.

Vapor Emission from Exposed Water

The model for estimating vapor emissions from exposed water surfaces, such as excavations that encounter groundwater, is based on mass-transfer coefficients recommended in USEPA guidance (USEPA 1995c). A discussion of the model and the input parameters used in the calculation is provided in Appendix G.

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 1996), is provided in Appendix G.

Vapor Emission from LNAPL and Smear Zone Soil

Vapor emissions from smear zone soil that may be exposed in excavations are estimated in the same manner as emissions from exposed soil. Vapor emissions from exposed LNAPL that may pool in the bottom of excavations 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 G.

Air Dispersion

Air concentrations are estimated using USEPA's SCREEN3 air dispersion model (USEPA 1995b). The area-source algorithm in SCREEN3 is used with default and region-specific meteorological parameters to estimate maximum 1-hour concentrations at ground level. The source area for each receptor is as follows: maintenance workers are based on a 15 by 15 foot excavation, routine workers and residents are based on 0.5 acres, and redevelopment workers are conservatively based on 180 acres (i.e., the area of the entire Southend).

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, redevelopment 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 1995). 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).

Dust Emission

Emission of respirable soil particulates (PM10) for routine worker and resident exposures to outdoor soil are calculated using the wind-erosion model recommended by USEPA (1996) 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/utility and redevelopment 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 PM10 (50 ug/m3) is used in the assessment of redevelopment construction worker exposures, and the 24-hour average NAAQS for PM10 (150 ug/m3) is used in the assessment of maintenance/utility worker exposures. It was conservatively assumed that the PM10 concentration would be at these limits every day for the entire assumed periods of exposure.

Steady-State Mass Loading

A mass balance approach was used to estimate the steady-state mass loading to surface water that could result from groundwater and/or storm sewer water entering the Flint River. The mass balance approach

conservatively assumes that constituents do not degrade during migration from the source to the Flint River, and all concentrations measured along sewers are Site-related even though the sewers collect water from offsite sources. A discussion of the modeling approach and the input parameters used in the calculations is provided in Appendix G.

Uncertainties inherent in the models and assumptions used in estimating exposure concentrations are discussed in Section 6.5.3.

6.3.5 Estimation of Intakes

The exposure factors for evaluating the exposure scenarios summarized in the CSM and discussed in Section 6.3.3 are discussed in this section. In this risk assessment, standard default exposure factors recommended by USEPA for estimating reasonable maximum exposures 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.

6.3.5.1 Routine Workers

In this risk assessment, potential exposure of routine workers to soil is conservatively evaluated using the standard default exposure factors that USEPA (1991a) recommends for estimating RME. 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 and Duration

Routine workers are assumed to be at the Site for 250 days per year for 25 years. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that workers are actually in contact with soil, as routine workers spend the majority of their time indoors. USEPA has recommended the use of these values 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).

Although it is recognized that the use of the default exposure factors, rather than Site-specific factors (e.g., the fraction contact term < 1), results in overestimation of RME risks at the Site, this approach streamlines the risk assessment. The assessment is also streamlined because the added conservatism in these risk estimates allows them to be used as conservative estimates for other receptors (e.g., trespassers). In this risk assessment, the risk estimates for routine workers are used to evaluate potential exposures of trespassers to soil because the exposure to these receptors are expected to be lower than those evaluated (ENVIRON 2003).

6.3.5.2 Maintenance Workers

Potential exposure of maintenance workers to soil is evaluated using the risk estimates for routine workers, as discussed in Section 6.3.5.1. The exposure factors used for evaluating potential exposure of constructions workers to groundwater, LNAPL, smear zone soil, storm sewer water, basement water, and tunnel water, during excavations associated with occasional maintenance or construction activities are as follows:

Soil Ingestion Rate

A soil ingestion rate of 200 mg/day is used for workers performing maintenance work that involves excavation into the 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 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).

Groundwater Ingestion Rate

A rate of 0.005 L/hour is used for incidental ingestion of groundwater during construction work in excavations that extend into groundwater. This rate is 10% of the rate that USEPA (1989) recommends for

ingestion while swimming, and represents a very conservative estimate of incidental groundwater ingestion that could occur while workers are in an excavation pit.

Groundwater and LNAPL Dermal Contact Rates

The exposed skin surface area of 3,300 cm^2 is based on 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 groundwater or LNAPL 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 groundwater and LNAPL are estimated following USEPA guidance (1992, 2004).

Exposure Frequency and Duration

The number of days of construction that involves actual excavation into the water table is assumed to be 50 days, which is assumed to occur at a frequency of 5 days/year for a period of 10 years. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that workers are actually in contact with groundwater and LNAPL (as opposed to the total time for maintenance or construction, which typically includes time not associated with excavation). The assumption of 5 days/year can represent the excavation time for a few small repairs per year or one larger repair. The duration of 10 years is more than twice the length of time that workers typically work at one location (USEPA 1997b).

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).

6.3.5.3 Redevelopment Construction Workers

The exposure factors used for evaluating potential exposure of redevelopment workers to soil, groundwater, LNAPL, smear zone soil, basement water, and tunnel water, during excavations associated with redevelopment construction activities are the same as those for maintenance workers discussed in Section 6.3.5.2, except as follows:

Exposure Frequency and Duration

Redevelopment construction workers are assumed to contact soil for up to 250 days for 1 year. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time workers are actually in contact with soil at any one location, as discussed in Appendix G.

The number of days of for redevelopment that involves actual excavation into the water table is assumed to be 5 days for 1 year. The assumption of 5 days can represent the excavation time for a few small excavations or one larger excavation that require workers actually in contact with groundwater and LNAPL (as opposed to the total time for redevelopment, which typically does not involve direct contact with groundwater or LNAPL).

6.3.5.4 Trespassers

Potential exposure of trespassers to soil is evaluated using the risk estimates for routine workers, based on the exposure factors discussed in Section 6.3.5.1.

6.3.5.5 Residents

Soil Ingestion Rate

The standard USEPA-recommended ingestion rates of 100 and 200 mg/day are used for assessing exposure to adults and children, respectively (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 2,800 and 5,700 cm^2 and the soil-to-skin adherence factors of 0.2 and 0.7 mg/cm^2 are the USEPA-recommended skin area and adherence factor for evaluating high-end contact with soil by adults and children, respectively (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 and Duration

Residents are assumed to be exposed to soil at the Site for 350 days per year for 30 years (6 years as children and 24 years as adults). This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that residents would actually in contact with soil. USEPA has recommended the use of these values for evaluating high-end residential exposures (USEPA 1991a).

Body Weight

The body weights of 70 kg and 15 kg are the standard USEPA-recommended body weights for assessing exposure to adults and children, respectively (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).

6.3.5.6 Recreational Users

Potential exposure of land recreational users to soil (e.g., park visitors) is evaluated using the risk estimates for residents, based on the exposure factors discussed in Section 6.3.5.5.

Potential exposure of recreational users via contact with surface water and consumption of fish in the Flint River is evaluated by comparing estimated concentrations in surface water with state and federal surface water quality criteria, and MDEQ Part 201 generic residential drinking water criteria for chemicals without surface water quality criteria.

Uncertainties associated with the exposure factors used in estimating chemical intakes are discussed in Section 6.5.3.

6.4 Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals, and the dose-response relationship between exposure and the occurrence of adverse effects. Toxicological information used in the risk assessment is derived from two categories of sources. The toxicity values used in deriving Site-specific soil and groundwater screening criteria, and the associated estimates of cumulative cancer and noncancer risks, were compiled from the following USEPA's hierarchy of sources, updated in December 2003 (USEPA 2003c):

1. Integrated Risk Information System (IRIS)
2. Provisional Peer Reviewed Toxicity Values (PPRTV)
3. Additional USEPA sources

When a toxicity value is not available from the first two sources, other USEPA sources of toxicity values were consulted. Provisional Toxicity Values from the National Center for Environmental Assessment (NCEA) that are not in the PPRTV database are preferred over values from HEAST (Health Effects Assessment Summary Tables; USEPA 1997a) when they represent more recent agency guidance. When a toxicity value was not available from these sources, 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 G and are discussed below.

6.4.1 Toxicity Values for Carcinogens

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

As shown in Appendix G, USEPA has designated some of the constituents as Group B2 or Group C, which means that USEPA acknowledges that there is either inadequate 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 highly conservative.

USEPA-derived cancer slope factors (SFs) and inhalation unit risk factors (URFs) for the constituents evaluated in the risk assessment and their sources are shown in Appendix G. 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.

6.4.2 Toxicity Values for Noncarcinogens

Constituents designated by USEPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Constituents not designated as belonging to any cancer group are potential carcinogens and/or noncarcinogens. USEPA-derived chronic and subchronic reference doses (RfDs and SRfDs, respectively) and chronic and subchronic inhalation reference concentrations (RfCs and SRfCs, respectively) for these constituents and their sources are shown in Appendix G. As discussed in Section 6.3.5.3, the redevelopment construction worker is the only receptor population with subchronic exposure (i.e., the exposure duration is less than 7 years).

The oral reference doses and inhalation reference concentrations 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 toxicity values 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 toxicity values, and the association of these doses and concentrations to potential adverse health consequences. Nonetheless, these reference doses and reference concentrations are used here as conservative assessment tools.

6.4.3 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, RfDs, and SRfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values are made in this route-to-route extrapolation based on USEPA guidance (USEPA 2004b).

The USEPA sources of toxicity values listed above do not provide inhalation toxicity values (URFs, RfCs, and SRfCs) 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 6.5.3.

6.5 Risk Characterization

The health significance of the potential exposures identified in Section 6.3 is discussed in the following subsections. Section 6.5.1 describes the methods for quantifying cancer risks and noncancer hazard indices. Section 6.5.2 discusses the risk estimates and the significance of potential exposures. Uncertainties in the risk assessment are discussed in Section 6.5.3.

6.5.1 Cancer Risk and Noncancer Hazard Index

The cancer risk associated with potential exposure to a carcinogenic chemical 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 inhalation 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 to a noncarcinogenic chemical 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 inhalation 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 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 corrective measures are warranted for a particular area of the Site (61 FR 19432, May 1, 1996; USEPA 1991b). The risk estimates and results of the comparison to the USEPA-established limits are discussed in the following sections.

6.5.2 Risk Estimates for Potentially Exposed Populations

6.5.2.1 Onsite Routine Workers

The significance of risks associated with potential exposure of routine workers to onsite soil, groundwater, and LNAPL is discussed below.

Soil

Potential exposure of routine workers to exposed outdoor soil was first evaluated using bounding estimates of RME cumulative cancer and noncancer risks to streamline the risk assessment, as explained in Section 6.3.4. 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.

The bounding estimates of Site-related cumulative cancer and noncancer risks were compared to USEPA's cancer risk and HI limits of 10^{-4} and 1, respectively. The bounding estimates of Site-related cumulative cancer risk and HI for potential exposure of routine workers to exposed outdoor soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 6-2. The table shows that the risk estimates for the following areas investigated during the RFI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1:

Northend AOIs

- AOI 03-1 - Quenching and Cooling Oil Systems;
- AOI 05-1 - Former Metal Machining Chip Processing;
- AOI 05-2 - Filtration Room, Oil Room, Below-Grade Vault, and Elevator Pit;
- AOI 05-3 - Building 43 Basement Containing Process Waste Oil Sumps and Drains;
- AOI 05-4 - Metal Forming Operations, Recirculation Trenches and Sumps;
- AOI 05-5 - Active Process Machinery, Collection Trenches, and Sumps;
- AOI 05-6 - Active Process Machinery, Collection Trenches, and Sumps;

- AOI 07-1 - Former Coal Yard;
- AOI 07-2 - Inactive Lime "Slaker House" and Inactive Lime Slurry Tank;
- AOI 07-3 - Two Elevator Pits and a Bulk Acid AST;
- AOI 10-1 - Manufacturing Operations and Several Tanks;
- AOI 10-2 - Solid Waste Transfer Area and Former ASTs;
- AOI 10-3 - Two Process Waste Oil Sumps;
- AOI 10-4 - Scrapyard Area;
- AOI 21-1 - Former Metal Chip Briquetting Operations and Current Metal Welding and Tool Grinding Operations;
- AOI 36-2 - Metal Chip Processing Area;
- AOI 36-3 - Engine Assembly, Waste Oil Collection and Processing, Former USTs;
- AOI 36-4 - Former Metal Machining and Active Engine Assembly;
- AOI 36-5 - Former UST Farm and Active AST Farm;
- AOI 38-1 - Process Waste Sumps, Trenches, and Former Hydraulic Car Lifts;
- AOI 55-1 - Industrial Wastewater Treatment Facilities;
- AOI 65-1 - Air Compressor Station and a Main Process Waste Pump Station;
- AOI 81-1 - Metal Machining, Chip, Cooling, and Cutting Oil Filtration and Processing, Hydraulic Elevator, Process Waste Sumps and Tanks, a Drum Storage Area, and an Active Hazardous Waste Accumulation Area;
- AOI 81-3 - Former Foundry Operations, an Elevator Pit, Metal Machining Areas, and a Forklift Battery Charging Area;
- AOI 81-4 - Air Compressor Operations;
- AOI 81-5 - Existing and Former ASTs;
- AOI 83/84-1 - Former and Existing Machining Operations;
- AOI 83/84-3 - Former and Existing Machining Operations;
- AOI 83/84-4 - Former Machining Operations and an Inactive Rail Loading Area;
- AOI 83/84-5 - Former Process Trenches and Pits, and an Inactive Heat Treating Tunnel;
- AOI 83/84-6 - Forklift Battery Charging Area and Associated Trench and Pit, and a Drum Storage Area;
- AOI 83/84-7 - Underground Storage Tanks;
- AOI 85-1 - Elevator Pit and Engine Test Area;
- AOI 86-1 - Hazardous Waste Drum Accumulation Area, Process Waste Sump and Pump Station, Waste Transport Vehicle Storage Area, and Former USTs; and
- Former Aeration Lagoons Area.

Southend AOIs

- AOI 02-A - Process Waste Sump;
- AOI 02-B - Elevator Pit;
- AOI 02-C - Sump in the Materials Laboratory;
- AOI 02-D - Press Machine Pit;
- AOI 02-E - Former UST;
- AOI 02-F - Hydraulic Oil AST and Pump;
- AOI 04-A - Process Waste Room and Waste Pit;
- AOI 04-B - Elevator Pits;
- AOI 04-C - Elevator Pit;
- AOI 09-B - Hamilton Avenue Tank Farm;

- AOI 12-A - Press Pits, Sumps, Trenches, Traps, and Floor Staining;
- AOI 12-B - Truck Loading Dock Drain and Sump;
- AOI 12-C - Sump in Battery Charging Area, Deep Steam Pipe, and a Utility Pit Containing Oil and Water;
- AOI 12-D - Abandoned, Flooded Utility Tunnel;
- AOI 16-A - Vehicle Fill-Up Station, Automatic Transmission Pump House, and a Gas Pump Station;
- AOI 16-B - Elevator Pit;
- AOI 16-C - Hydraulic Motor, Former AST, and Former USTs;
- AOI 16-D - Former UST and Process Wastewater Sump;
- AOI 17-A - Elevator Pit;
- AOI 23-A - Process Waste Sumps, Dock Levelers, and Basements Used for Heat Treat Process Water;
- AOI 29-A - Elevator Pit and Observed Oil Staining;
- AOI 40-B - Elevator Pit;
- AOI 40-C - Elevator Pit;
- AOI 40-D - Flooded Basement/Tunnel Area;
- AOI 44-A - Sumps, Pits, Trenches, Drains, Floor Stains, and ASTs;
- AOI 84-A - Elevator Pits, Sumps, a Machine Shop, Hydraulic Cylinders, and a Hydraulic Lift;
- AOI 84-B - Sumps, Floor Drains, a Pit, a Flooded Basement, and a Below Grade Vault;
- AOI 84-C - Sumps, a Trench, and an Oil/Water Separator Pit;
- AOI 84-D - Former UST Farm, an AST Farm, and Drum Storage Area;
- AOI 94-A - Sumps and Trenches in Oil Change Pits and Chemical Storage Areas;
- AOI 94-B - Process Sump and Trench;
- AOI 94-C - Hydraulic Oil Storage Areas;
- AOI 94-D - Pit for a Cable-Operated Car Elevator;
- AOI 94-E - Car-Loading Machinery and Hydraulic Oil Observed on Floor;
- Former Administration Building Area (Transformer Yard, Soil Stockpile Area, and Former USTs);
- Former Building 94 Employee Parking Lot;
- Harriet Street Area (USTs); and
- Former Employee Parking (FEP) Lot North of Oak Park.

In addition, the estimates of cancer risk and noncancer HQ associated with background levels of metals in soil (see Section 4.2) are shown in Table 4-2. The estimates of risks associated with background metal concentrations are low relative to the risk limits, and are not included in the Site-related risk estimates shown on Table 6-2.

As shown in Table 6-2, the bounding estimates of Site-related cumulative cancer risk and HI exceed the cancer risk limit and/or the HI limit for the following areas:

Northend AOIs

- AOI 36-1 - Engine Manufacturing and Metal Machining Processes;
- AOI 81-2 - Active Metal Welding and Machining and Torque Converter Assembly; and
- AOI 83/84-2 - Former and Existing Machining Operations.

Southend AOIs

- AOI 09-A - Former USTs, Floor Trenches, and Former AST; and
- AOI 40-A - Former UST Farm.

For areas at the Northend (AOIs 36-1, 81-2, and 83/84-2) where the bounding estimate of cancer risk or HI was higher than the USEPA limits, further calculations were conducted, as shown in Table 6-3. Since routine workers only directly contact surface soil, the exposure concentration in each area was first limited to the maximum concentrations detected in surface (0-2 ft bgs) samples in each AOI. The bounding estimates for routine worker exposure to surface soil do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1 at AOI 36-1 and AOI 83/84-2.

For AOI 81-2, the concentrations of 1,1-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane from RFI-81-38 (1-3 foot depth) are high enough that they had to be excluded from the risk calculations in order for the cumulative cancer and noncancer risk estimates to be within the acceptable limits. Table 6-3 shows the risk estimates for AOI 81-2 that exclude these concentrations. These risk estimates do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1. AOI 81-2 is covered by operational building floors. Location RFI-81-38 is included in the Due Care Plan, which has been implemented to ensure that worker activity in this area would follow proper health and safety procedures to prevent unacceptable exposures until soil in this area is addressed.

As an efficient means of providing robust risk-related information that could be used flexibly by GM, USEPA, and any developers for evaluating land reuse options for the Southend areas, risk estimates for routine workers were calculated for each of the soil boring locations within the following three parcels in the Southend, as shown on Figure 6-1:

- Parcel 1 - area bounded by Leith Street, the employee parking lots and the park, Hamilton Avenue, and the CSX property;
- Parcel 2 - area bounded by the GM property boundary, the CSX property, Hamilton Avenue, and James P. Cole Boulevard; and
- Parcel 3 - area bounded by Hamilton Avenue, Industrial Avenue, the GM property boundary, and the CSX property.

The boundaries for these parcels are based on the GM property lines and obvious physical structures (e.g., railroad tracks and major roadways) that represent boundaries (shown on Figure 2-3) between previous Site operations that may have caused soil contamination. Of the remaining parcels at the Southend shown on Figure 6-1, Parcels 4 and 5 were not evaluated during the RFI as no AOIs were identified in these parcels in the Southend DOCC (BBL 2000), and the only soil samples collected were used to characterize background concentrations for metals. Parcels 6, 7, and 8 all have acceptable bounding risks for routine workers (see Table 6-2 and Appendix G).

The estimates of cumulative cancer and noncancer risks for exposure of routine workers to soil at each soil boring locations in Parcels 1, 2, and 3 are shown in Appendix G. These calculations considered all detected constituents, except lead, which was evaluated separately, as discussed below. The soil boring locations with estimates of cumulative cancer risk higher than 10^{-4} or HI higher than 1 are listed on Table 6-4 and also shown on Figure 6-2. Each polygon on Figure 6-1 is a Thiessen polygon of a sampling location, and contains all points which are closer to that sampling location than any other sampling location. It is generated by tessellating the parcel with the perpendicular bisectors of the line segments connecting each sampling location to the nearest sampling locations. A location is considered to not have soil conditions that

warrant corrective measures if its upper-bound cumulative cancer risk and HI estimates do not exceed 10^{-4} or 1, respectively.

The results in Figure 6-2 and Table 6-4 show that there are only 2 boring locations (RFI-09-03 and RFI-40-12) with a potentially significant cumulative cancer risk estimate and no locations with a potentially significant HI estimate for routine worker direct contact. The risk estimates for potential exposure at these areas are then refined using area-weighted risk estimates that are based on logical exposure units. Specifically, area-weighting was accomplished by tessellating a ½-acre exposure unit that is centered around each location. In this approach, each point is assigned the risk estimate of its nearest sampling location, as shown in Appendix G. The area-weighted approach ensures that sampling locations that best represent where workers would likely spend most of their time are not underrepresented in exposure estimates. However, using area-weighted risk estimates to represent exposure of routine workers is still conservative, since they are still based on the default exposure factors, rather than Site-specific factors (e.g., the fraction contact term < 1 for indoor workers). The estimates of cumulative cancer risk and HI for this scenario are summarized in Appendix G, which shows that all areas have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

USEPA (2003b) and MDEQ (2002) both evaluate the significance of lead exposures using blood lead level as an index of exposure, rather than in terms of cancer risk or noncancer HQ. The MDEQ industrial direct contact criterion of 900 mg/kg for lead has been developed using a blood lead model to be protective of potential exposures to soil lead in industrial settings. As USEPA discussed in a recent rulemaking (40 CFR Part 745, January 5, 2001), the soil lead screening level should be compared with the arithmetic mean concentration of lead within the area where potential exposures are assumed to occur in order to be consistent with the principles underlying the blood lead modeling approaches used in deriving the screening level.

Table 6-5 compares the mean Site-related lead concentrations in surface soil (0-2 feet bgs) and the mean of maximum deep soil concentrations by locations at each AOI with the lead screening criterion of 900 mg/kg. These mean concentrations include all soil lead data collected at an AOI during the RFI. Five AOIs (09-A, 12-A, 81-1, 83/84-2, and 83/84-3) have mean lead concentrations in the deep soil that exceed the screening criterion. The mean lead concentrations in surface soil at AOIs 09-A and 83/84-3 also exceed the screening criterion. However, there is no complete pathway for current exposure of routine workers to surface soil at AOI 83/84-3 as it is covered by building floors.

Evaluation of the Northend AOIs has determined that elevated lead concentrations at a limited number of discrete locations in AOI 81-1 (RFI-81-01, RFI-81-02, RFI-81-36, and RFI-81-37), AOI 83/84-2 (RFI-83/84-14 and RFI-83/84-23), and AOI 83/84-3 (RFI-83/84-05) caused the mean concentration for the AOI to exceed the criterion. These discrete areas are relatively small, as they were delineated to within 200 feet during the RFI. The mean lead concentrations in soil, after removing these locations, are 244, 857, and 831 mg/kg in the deep soil column for AOIs 81-1, 83/84-2, and 83/84-3, respectively, and 756 mg/kg in the shallow soil at AOI 83/84-3, all of which are lower than the screening criterion. The soil from the locations discussed above under existing building floors and has been included as part of the Due Care Plan to ensure that worker activity in these areas follows proper health and safety procedures to prevent unacceptable exposures until soil in these areas is addressed.

Evaluation of soil lead data from all depths at the Southend was performed on a point-by-point basis by categorizing points relative to the screening criterion. The results for samples where the lead concentration is higher than 900 mg/kg are summarized on Table 6-6 and the boring locations exceeding these screening levels are highlighted in Figure 6-5. Eleven boring locations have lead concentrations higher than 900

mg/kg (RFI-02-03, RFI-09-01, RFI-09-02, RFI-09-15, RFI-09-16, RFI-09-18, RFI-09-44, RFI-09-56, RFI-12-02, RFI-12-31, and RFI-29-01). Two other boring locations (RFI-09-01R and RFI-12-35) are also highlighted in Figure 6-5 because lead was not analyzed at these locations, but their assigned surrogate concentrations based on measured lead concentrations from the nearest locations exceed 900 mg/kg. Most of the samples with lead concentrations higher than the industrial screening criterion were collected within the top four feet below ground surface (bgs), as noted in Table 6-6. At RFI-12-02, the maximum lead concentration was detected at a sample depth of 6-8 feet bgs, and the surface sample (0.7-2 feet bgs) had a lead concentration of 5.1 mg/kg, below the lead screening criterion of 900 mg/kg. Therefore, routine worker exposure to lead in soil at RFI-12-02 is not expected to occur.

Routine workers could be exposed to constituents in the subsurface to the extent that such constituents volatilize and migrate through building foundation cracks into indoor air, as discussed in Section 6.3.3.1. Maximum detected concentrations for all constituents at the areas investigated during the RFI are compared to conservative screening criteria derived from appropriate occupational air standards for indoor air inhalation in industrial buildings that are governed by OSHA regulations, and are discussed in Appendix G. As shown in Table 6-7, the sums of the ratios of soil concentrations to the vapor intrusion screening criteria are much less than 1, which are compliant with the OSHA requirements for indoor air inhalation in industrial buildings, in all areas except AOIs 36-1 and 81-2, where the ratio sums are 0.5 and 0.4 respectively. Indoor air sampling was conducted by the facility's industrial hygiene staff in these two areas to further evaluate the potential for vapor intrusion. None of the volatile constituents in soil under these areas was detected in the indoor air samples, as shown in Appendix J. These data show that no vapor intrusion is actually occurring to a measurable degree in these areas.

The vapor intrusion pathway is also evaluated for future commercial/industrial buildings that may not be governed by OSHA regulations. Bounding estimates of cumulative cancer risk and HI were calculated using maximum concentrations of all constituents detected at all the areas investigated during the RFI. Details of the vapor intrusion modeling calculations are provided in Appendix G. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-7, which shows that all areas except AOIs 36-1 and 81-2 have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1. As discussed above, the buildings in these areas are currently governed by OSHA regulations, and they are compliant with the OSHA requirements. However, further evaluation is recommended to eliminate the exposure pathway in future buildings (e.g., engineering controls) in these areas if they will not be subject to OSHA regulations.

Since all areas at the Southend have acceptable bounding risk estimates of indoor air exposures to vapors from soil, no point-by-point analysis is needed for this scenario.

Groundwater

Routine workers could be exposed to constituents in groundwater to the extent that such constituents volatilize and can migrate through cracks in building foundations into indoor air, as discussed in Section 6.3.3.1. To evaluate this pathway, the maximum concentrations in groundwater are compared to the conservative screening criteria for indoor air inhalation in industrial buildings that are governed by OSHA regulations and are discussed in Appendix G. As shown in Table 6-7, the sums of the ratios of groundwater concentrations to the vapor intrusion screening criteria are much less than 1, which are compliant with the OSHA requirements for indoor air inhalation in industrial buildings, in all areas.

The vapor intrusion pathway is also evaluated for future commercial/industrial buildings that may not be governed by OSHA regulations. Bounding estimates of cumulative cancer risk and HI were calculated

using maximum concentrations of all constituents detected at the areas investigated during the RFI. Details of the vapor intrusion modeling calculations are provided in Appendix G. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-7, which shows that no area has estimates that exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

LNAPL

As discussed in Section 6.3.3.1, routine workers could be exposed to constituents in the subsurface LNAPL via volatilization and migration through cracks in building foundations into indoor air. This exposure pathway is conservatively evaluated by comparing the indoor air concentrations that are estimated using the vapor intrusion screening-level model discussed in Section 6.3.4.2 with appropriate occupational air standards, as shown in Appendix G. The source vapor concentrations used in the vapor intrusion model are calculated using Raoult's law by assuming that the vapor concentrations are in equilibrium with the LNAPL concentrations. The model parameters used for calculating the indoor air concentrations are the same as those used for the groundwater vapor intrusion modeling calculations. The occupational air standards used are Michigan Occupational Health Standards (MICIS 2001), Permissible Exposure Limits (PELs) established by the OSHA (NIOSH 1997), or Threshold Limit Values (TLVs) recommended by the American Conference of Government Industrial Hygienists (ACGIH 2005). Details of the vapor intrusion modeling calculations as discussed in Appendix G. As shown in Table 6-8, the sums of the estimated indoor air concentrations to the occupational air standards are much less than 1, which is complaint with the OSHA requirements for indoor air inhalation in industrial building.

The vapor intrusion pathway is also evaluated for future commercial/industrial buildings that may not be governed by OSHA regulations. Bounding estimates of cumulative cancer risk and HI were calculated using maximum concentrations of all constituents detected at the areas investigated during the RFI. Details of the vapor intrusion modeling calculations are provided in Appendix G. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-8, which shows that no area has estimates that exceed the cancer risk limit of 10^{-4} or the HI limit of 1, except for AOI 36-1.

6.5.2.2 Onsite Maintenance Workers

The significance of risks associated with potential exposure of maintenance workers to onsite soil, groundwater, LNAPL, storm sewer water, basement water, and tunnel water is discussed below.

Soil

Potential exposure of maintenance workers to soil is evaluated directly using the exposure factors in Section 6.2.5.2. The bounding estimates of Site-related cumulative cancer risk and HI for potential exposure of maintenance workers to exposed outdoor soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 6-2. No onsite areas have estimates that exceed the cancer risk limit of 10^{-4} or the HI limit of 1. Since all areas at the Southend have acceptable bounding risk estimates, no point-by-point analysis is needed for this scenario.

Potential exposure of maintenance workers to lead in soil is evaluated the same way as routine workers. The results are discussed in Section 6.5.2.1, and are not repeated here.

Groundwater

Estimates of risks for potential exposure of maintenance workers to groundwater are calculated in Appendix G. The highest detected constituent concentrations in groundwater are used as the exposure concentrations for all areas. Risks are estimated using the conservatively derived screening criteria for evaluating potential exposure of maintenance workers who might occasionally contact groundwater. The criteria, which are discussed in Appendix G, include potential exposures to groundwater through dermal contact, incidental ingestion, and inhalation of vapors. The bounding estimates of cumulative cancer risk and HI for potential exposure of maintenance workers to onsite groundwater are summarized in Table 6-9, which shows that all onsite areas have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

LNAPL and Smear Zone Soil

As noted in Section 4, subsurface soil at AOIs 02-B, 03-1, 05-1, 05-5, 09-B, 10-1, 10-4, 12-A, 12-B, 12-C, 16-C, 23-A, 36-1, 36-2, 36-5, 40-A, 81-2, 83/84-2, 83/84-4, 85-1, and 86-1 contains LNAPLs at the water table. LNAPL data were also collected from the storm sewer and Outfall #4 during the RFI. Bounding estimates of cumulative cancer risks and HIs are calculated for potential exposure of maintenance workers during excavation associated with occasional maintenance activities via direct contact with the LNAPLs and/or smear zone soil and inhalation of vapors from exposed LNAPL and/or smear zone soil. The calculations are provided in Appendix G and discussed below.

As shown on Table 6-10, the upper-bound estimates of cumulative cancer risk and HI for each exposure pathway for each LNAPL area do not exceed USEPA's risk limits of 10^{-4} or 1, respectively, except at AOIs 09-B and 36-1. At AOIs 09-B and 36-1, the cancer and noncancer risks for potential exposure of maintenance workers to smear zone soil do not exceed USEPA's risk limits, but the cancer and noncancer risks for potential exposure to LNAPL via inhalation of vapors from the LNAPL exceed USEPA's acceptable limits. These risk estimates assume that maintenance workers do not wear any personal protective equipment during excavations. These AOIs are currently being addressed as part of the Interim Measures as discussed in Section 5.3. Furthermore, the Due Care Plan has been implemented at the Site to ensure that any planned construction activity in all LNAPL areas would follow proper health and safety procedures to minimize exposure.

Storm Sewer Water

As discussed in Section 4, storm sewer water data were collected at several locations across the Site during the RFI. Bounding estimates of cumulative risk and HI for potential exposure of maintenance workers to constituents in storm sewer water are evaluated using the maximum concentrations of chemicals in the storm sewer water samples and the screening criteria for evaluating potential exposure of maintenance workers to groundwater discussed in Appendix G.

Estimates of risks for potential exposure of maintenance workers to storm sewer water are calculated in Appendix G. The highest detected constituent concentrations in storm sewer water are used as the exposure concentrations in the calculations. The bounding estimates of cumulative cancer risk and HI for potential exposure of maintenance workers to storm sewer water are summarized in Table 6-11, which shows that the risk estimates do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Basement and Tunnel Water

As discussed in Section 4, basement and tunnel water was collected from four AOIs at the Site, including AOIs 12-A, 23-A, 36-3, and 40-D. Bounding estimates of cumulative risk and HI for potential exposure of maintenance workers to constituents in basement and tunnel water are evaluated using the maximum

concentrations of chemicals in basement and tunnel water samples and the screening criteria for evaluating potential exposure of maintenance workers to groundwater discussed in Appendix G.

Estimates of risks for potential exposure of maintenance workers to basement and tunnel water are calculated in Appendix G. The highest detected constituent concentrations in basement and tunnel water are used as the exposure concentrations in the calculations. The bounding estimates of cumulative cancer risk and HI for potential exposure of maintenance workers to basement and tunnel water are summarized in Table 6-11, which shows that the risk estimates do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

6.5.2.3 Trespassers

Potential exposure of trespassers to soil is evaluated indirectly using exposure estimates for routine workers, as explained in Section 6.3.3. This streamlines the risk assessment and is conservative because trespasser exposures would be lower than routine worker exposures. Therefore, the risk and HI estimates for trespassers are expected to be no higher than the estimates discussed in Section 6.5.2.1.

6.5.2.4 Redevelopment Construction Workers

The significance of risks associated with potential exposure of redevelopment construction workers to soil, groundwater, and LNAPL at the Southend of the Site is discussed below.

Soil

Potential exposure of redevelopment construction workers to soil was first evaluated using bounding estimates of RME cumulative cancer and noncancer risks to streamline the risk assessment, as explained in Section 6.3.4. The initial estimates were calculated using maximum Site-related concentrations for all constituents detected in soil at an area. The bounding estimates of Site-related cumulative cancer and noncancer risks were compared to USEPA's cancer risk and HI limits of 10^{-4} and 1, respectively. The bounding estimates of Site-related cumulative cancer risk and HI for potential exposure of redevelopment construction workers to soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 6-12. The table shows that the risk estimates for the following areas investigated during the RFI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1:

- AOI 02-A - Process Waste Sump;
- AOI 02-B - Elevator Pit;
- AOI 02-C - Sump in the Materials Laboratory;
- AOI 02-D - Press Machine Pit;
- AOI 02-E - Former UST;
- AOI 02-F - Hydraulic Oil AST and Pump;
- AOI 04-A - Process Waste Room and Waste Pit;
- AOI 04-B - Elevator Pits;
- AOI 04-C - Elevator Pit;
- AOI 12-B - Truck Loading Dock Drain and Sump;
- AOI 12-C - Sump in Battery Charging Area, Deep Steam Pipe, and a Utility Pit Containing Oil and Water;

- AOI 12-D - Abandoned, Flooded Utility Tunnel;
- AOI 16-A - Vehicle Fill-Up Station, Automatic Transmission Pump House, and a Gas Pump Station;
- AOI 16-B - Elevator Pit;
- AOI 16-C - Hydraulic Motor, Former AST, and Former USTs;
- AOI 16-D - Former UST and Process Wastewater Sump;
- AOI 17-A - Elevator Pit;
- AOI 23-A - Process Waste Sumps, Dock Levelers, and Basements Used for Heat Treat Process Water;
- AOI 29-A - Elevator Pit and Observed Oil Staining;
- AOI 40-A - Former UST Farm;
- AOI 40-B - Elevator Pit;
- AOI 40-C - Elevator Pit;
- AOI 40-D - Flooded Basement/Tunnel Area;
- AOI 84-A - Elevator Pits, Sumps, a Machine Shop, Hydraulic Cylinders, and a Hydraulic Lift;
- AOI 84-B - Sumps, Floor Drains, a Pit, a Flooded Basement, and a Below Grade Vault;
- AOI 84-C - Sumps, a Trench, and an Oil/Water Separator Pit;
- AOI 84-D - Former UST Farm, an AST Farm, and Drum Storage Area;
- AOI 94-A - Sumps and Trenches in Oil Change Pits and Chemical Storage Areas;
- AOI 94-B - Process Sump and Trench;
- AOI 94-C - Hydraulic Oil Storage Areas;
- AOI 94-D - Pit for a Cable-Operated Car Elevator;
- AOI 94-E - Car-Loading Machinery and Hydraulic Oil Observed on Floor;
- Former Administration Building Area (Transformer Yard, Soil Stockpile Area, and Former USTs);
- Former Building 94 Employee Parking Lot; and
- Harriet Street Area (USTs).

As shown in Table 6-13, the bounding estimates of Site-related cumulative cancer risk and HI exceed the HI limit for the following areas:

- AOI 09-A - Former USTs, Floor Trenches, and Former AST;
- AOI 09-B - Hamilton Avenue Tank Farm;
- AOI 12-A - Press Pits, Sumps, Trenches, Traps, and Floor Staining; and
- AOI 44-A - Sumps, Pits, Trenches, Drains, Floor Stains, and ASTs.

For areas at the Southend (Parcels 1, 2, and 3) where the bounding estimate of cancer risk or HI was higher than the USEPA limits, further calculations were conducted. As an efficient means of providing robust risk-related information that could be used flexibly by GM, USEPA, and any developers for evaluating land reuse options for the Southend areas, risk estimates for redevelopment construction workers were calculated for each of the soil boring locations within Parcels 1, 2, and 3, using the same approach discussed in Section 6.5.2.1.

The estimates of cumulative cancer and noncancer risks by soil boring locations are shown in Appendix G, and the locations with estimates of cumulative cancer risk higher than 10^{-4} or HI higher than 1 are listed on Table 6-13, and also shown on Figure 6-3. The results show that there is no boring location with the cumulative cancer risk estimate above the risk limit and 6 boring locations (RFI-09-04, RFI-09-24, RFI-09-25, RFI-09-49, RFI-44-05, and RFI-86-01) with potentially significant HI estimates for site redevelopment

workers. The risk estimates for potential exposure at these areas are then refined using area-weighted risk estimates that are based on logical exposure units. Specifically, area-weighting was accomplished by tessellating the exposure unit that is centered around each location. In this approach, each point is assigned the risk estimate of its nearest sampling location, as shown in Appendix G. The total area of each of these exposure areas is less than 3 acres, which is considered reasonable for potential redevelopment construction workers. The area-weighted approach ensures that sampling locations that best represent where workers would likely spend most of their time are not underrepresented in exposure estimates. However, using area-weighted risk estimates to represent exposure of redevelopment construction workers is still conservative, since they are still based on the default exposure factors, rather than Site-specific factors. The estimates of cumulative cancer risk and HI for this scenario are summarized in Appendix G, which shows that all areas have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Potential exposure of redevelopment construction worker to lead in soil is evaluated the same was routine workers. The results are discussed in Section 6.5.2.1, and are not repeated here.

Groundwater

Estimates of risks for potential exposure of redevelopment workers to groundwater are calculated in Appendix G. The highest detected constituent concentrations in groundwater are used as the exposure concentrations for all areas. Risks are estimated using the conservatively derived screening criteria for evaluating potential exposure of redevelopment workers who might occasionally contact groundwater. The criteria, which are discussed in Appendix G, include potential exposures to groundwater through dermal contact, incidental ingestion, and inhalation of vapors. The bounding estimates of cumulative cancer risk and HI for potential exposure of redevelopment workers to onsite groundwater are summarized in Table 6-15, which shows that all onsite areas have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

LNAPL and Smear Zone Soil

As noted in Section 4, subsurface soil at AOIs 09-B, 12-A, 12-B, 16-C, and 23-A contains LNAPLs at the water table at the Southend. Bounding estimates of cumulative cancer risks and HIs are calculated for potential exposure of redevelopment workers during excavation associated with redevelopment construction activities via direct contact with the LNAPLs and/or smear zone soil and inhalation of vapors from exposed LNAPL and/or smear zone soil. The calculations are provided in Appendix G and discussed below.

As shown on Table 6-15, the upper-bound estimates of cumulative cancer risk and HI for each exposure pathway for each LNAPL area do not exceed USEPA's risk limits of 10^{-4} and 1, respectively, except AOI 09-B where the noncancer HI for potential exposure to LNAPL via inhalation of vapors from the LNAPL exceed USEPA's acceptable limit. These estimates of risks assume that redevelopment construction workers do not wear any personal protective equipment during excavations. The Due Care Plan has been implemented at the Site to ensure that any planned construction activity in the LNAPL areas would follow proper health and safety procedures to minimize exposure. This AOI is currently being addressed as part of the Interim Measures as discussed in Section 5.3.

6.5.2.5 Onsite Residents

The significance of risks associated with potential exposure of future residents to soil, groundwater, and LNAPL is discussed below.

Soil

Potential exposure of residents to soil was first evaluated using bounding estimates of RME cumulative cancer and noncancer risks to streamline the risk assessment, as explained in Section 6.3.4. The initial estimates were calculated using maximum Site-related concentrations for all constituents detected in soil at an area. The bounding estimates of Site-related cumulative cancer and noncancer risks were compared to USEPA's cancer risk and HI limits of 10^{-4} and 1, respectively. The bounding estimates of Site-related cumulative cancer risk and HI for potential exposure of residents to soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 6-12. The table shows that the risk estimates for the following areas investigated during the RFI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1:

- AOI 02-A - Process Waste Sump;
- AOI 02-B - Elevator Pit;
- AOI 02-C - Sump in the Materials Laboratory;
- AOI 02-D - Press Machine Pit;
- AOI 02-E - Former UST;
- AOI 02-F - Hydraulic Oil AST and Pump;
- AOI 04-A - Process Waste Room and Waste Pit;
- AOI 04-B - Elevator Pits;
- AOI 04-C - Elevator Pit;
- AOI 12-B - Truck Loading Dock Drain and Sump;
- AOI 12-C - Sump in Battery Charging Area, Deep Steam Pipe, and a Utility Pit Containing Oil and Water;
- AOI 12-D - Abandoned, Flooded Utility Tunnel;
- AOI 16-A - Vehicle Fill-Up Station, Automatic Transmission Pump House, and a Gas Pump Station;
- AOI 16-B - Elevator Pit;
- AOI 16-C - Hydraulic Motor, Former AST, and Former USTs;
- AOI 16-D - Former UST and Process Wastewater Sump;
- AOI 17-A - Elevator Pit;
- AOI 23-A - Process Waste Sumps, Dock Levelers, and Basements Used for Heat Treat Process Water;
- AOI 29-A - Elevator Pit and Observed Oil Staining;
- AOI 40-B - Elevator Pit;
- AOI 40-C - Elevator Pit;
- AOI 40-D - Flooded Basement/Tunnel Area;
- AOI 44-A - Sumps, Pits, Trenches, Drains, Floor Stains, and ASTs;
- AOI 84-A - Elevator Pits, Sumps, a Machine Shop, Hydraulic Cylinders, and a Hydraulic Lift;
- AOI 84-B - Sumps, Floor Drains, a Pit, a Flooded Basement, and a Below Grade Vault;
- AOI 84-C - Sumps, a Trench, and an Oil/Water Separator Pit;
- AOI 84-D - Former UST Farm, an AST Farm, and Drum Storage Area;
- AOI 94-A - Sumps and Trenches in Oil Change Pits and Chemical Storage Areas;
- AOI 94-B - Process Sump and Trench;
- AOI 94-C - Hydraulic Oil Storage Areas;
- AOI 94-D - Pit for a Cable-Operated Car Elevator;

- AOI 94-E - Car-Loading Machinery and Hydraulic Oil Observed on Floor;
- Former Administration Building Area (Transformer Yard, Soil Stockpile Area, and Former USTs);
- Harriet Street Area (USTs); and
- Former Employee Parking (FEP) Lot North of Oak Park.

As shown in Table 6-12, the bounding estimates of Site-related cumulative cancer risk and HI exceed the HI limit for the following areas:

- AOI 09-A - Former USTs, Floor Trenches, and Former AST;
- AOI 09-B - Hamilton Avenue Tank Farm;
- AOI 12-A - Press Pits, Sumps, Trenches, Traps, and Floor Staining;
- AOI 40-A - Former UST Farm; and
- Former Building 94 Employee Parking Lot.

For areas at the Southend (Parcels 1, 2, and 3) where the bounding estimate of cancer risk or HI was higher than the USEPA limits, further calculations were conducted. As an efficient means of providing robust risk-related information that could be used flexibly by GM, USEPA, and any developers for evaluating land reuse options for the Southend areas, risk estimates for residents were calculated for each of the soil boring locations within Parcels 1, 2, and 3, using the same approach discussed in Section 6.5.2.1

The estimates of cumulative cancer and noncancer risks by soil boring locations are shown in Appendix G, and the locations with estimates of cumulative cancer risk higher than 10^{-4} or HI higher than 1 are listed on Table 6-17, and also shown on Figure 6-4. The results show that there are 8 boring locations (RFI-09-03, RFI-09-19, RFI-09-39, RFI-09-45, RFI-09-45R, RFI-40-12, RFI-40-16, and RFI-40-17) with potentially significant cumulative cancer risk estimates, 8 boring locations (RFI-09-02, RFI-09-38, RFI-09-05, RFI-12-31, RFI-12-35, RFI-86-12, EP-02, and EP 94-02A) with potentially significant HI estimates for residents, and 2 locations with both (RFI-86-07 and RFI-86-17).

The risk estimates for potential exposure at these areas are then refined using area-weighted risk estimates that are based on logical exposure units. Specifically, area-weighting was accomplished by tessellating a ½-acre exposure unit that is centered around each location. In this approach, each point is assigned the risk estimate of its nearest sampling location, as shown in Appendix G. The area-weighted approach ensures that sampling locations that best represent where residents would likely spend most of their time are not underrepresented in exposure estimates. The estimates of cumulative cancer risk and HI for this scenario are summarized in Appendix G, which shows that RFI-09-03, RFI-09-05, RFI-09-19, RFI-09-39, RFI-12-31, RFI-12-35, RFI-40-12, RFI-40-16, and RFI-40-17 have estimates that do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1. Further action (e.g. limited excavation, engineering control, or deed restriction) is recommended to eliminate or restrict access to the remaining areas (RFI-09-02, RFI-09-38, RFI-09-45, RFI-09-45R, RFI-86-07, RFI-86-12, RFI-86-17, EP-02, and EP94-02A).

Evaluation of soil lead data from all depths at the Southend was performed on a point-by-point basis by categorizing points relative to the residential screening criterion (400 mg/kg). The results are summarized on Table 6-17 and the boring locations exceeding these screening levels are highlighted in Figure 6-5. Twenty-six boring locations (including four locations with assigned surrogate concentrations) have lead concentrations in surface soil higher than 400 mg/kg. For one location, RFI-40-09, the evaluations for residential exposure to lead is refined based on area-weighted concentrations for the highest detected concentrations of lead. As discussed above, area-weighting was accomplished by tessellating an exposure area of approximately ½ acre (or 22,000 square feet) centered around a location, as shown in Appendix G.

The area-weighted average concentration in the ½ acre around RFI-40-09 is 190 mg/kg, less than the residential screening criterion. Further action (e.g. limited excavation, engineering control, or deed restriction) is recommended to eliminate or restrict residential exposure to the other areas listed on Table 6-17.

Since all areas at the Southend have acceptable bounding risk estimates of indoor air exposures to vapors from soil (shown on Table 6-18), no point-by-point analysis is needed for this scenario.

Groundwater

Residents could be exposed to constituents in groundwater to the extent that such constituents volatilize and can migrate through cracks in building foundations into indoor air, as discussed in Section 6.3.3.1. The vapor intrusion pathway is evaluated for future potential residential buildings at the Southend portion of the Site after redevelopment. Bounding estimates of cumulative cancer risk and HI were calculated using maximum concentrations of all constituents detected at the areas investigated during the RFI. Details of the vapor intrusion modeling calculations are provided in Appendix G. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-19, which shows that no area has estimates that exceed the cancer risk limit of 10^{-4} or the HI limit of 1 for residential buildings.

LNAPL

As discussed in Section 6.3.3.1, residents could be exposed to constituents in the subsurface LNAPL via volatilization and migration through cracks in building foundations into indoor air. The vapor intrusion pathway is evaluated for future potential residential buildings at the Southend of the Site after redevelopment. Bounding estimates of cumulative cancer risk and HI were calculated using maximum concentrations of all constituents detected at the areas investigated during the RFI. Details of the vapor intrusion modeling calculations are provided in Appendix G. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-20, which shows that no area has estimates that exceed the cancer risk limit of 10^{-4} or the HI limit of 1, except for AOI 09-B.

6.5.2.6 Onsite Recreational Users

As discussed in Section 6.3.3.1, potential recreational user exposures to surface soil would be lower than that of residents at the Southend. Therefore, the potential exposures of recreational users are evaluated using the risk estimates for residents discussed in Section 6.5.2.5. The estimates of cumulative cancer and noncancer risk based on maximum concentrations exceed USEPA's limits of 10^{-4} and 1, respectively, at certain locations shown on Table 6-12. Risk estimates for these locations are adjusted using a Site-specific exposure time of 2 hours per day for recreational exposures, and still conservatively assuming the same exposure frequency and duration as residents (i.e., 350 days and 30 years). This assumption is incorporated into the risk calculations using a "fraction contacted" term of 2/16 (or 0.125). For the soil ingestion and dermal contact routes, the daily soil ingestion and dermal contact rates discussed above for residents are considered to apply over the 16 hours when people are awake and have potential for contact with soil or soil-derived household dust. As such, a fraction contacted term of 2/16 (or 0.125) is used to prorate these daily rates to the hourly rate for 2 hours per event. Table 6-20 shows that only 1 location (RFI-09-03) would have unacceptable cumulative cancer risk for recreational users. As shown on Figure 6-4, the area around this location was characterized during the RFI to be less than 200 square feet. Further action (e.g. limited excavation, engineering control, or deed restriction) is recommended to eliminate or restrict potential future recreational user exposure in this area.

6.5.2.7 Offsite Receptors

As discussed in Section 6.3.3.2, potential exposures of offsite routine workers, maintenance workers, and residents to soil and groundwater are evaluated indirectly using the risk estimates for onsite receptors. In addition, potential exposures of recreational users to surface water in the Flint River are evaluated as discussed below.

Soil

As discussed in Section 6.3.3.2, offsite workers and residents may be exposed to constituents in onsite soil via wind dispersion of airborne dust and vapors. Potential exposure of these receptors is evaluated indirectly using exposure estimates for onsite routine workers at the Northend. This approach streamlines the risk assessment and is conservative because airborne exposures offsite are expected to be lower than exposure onsite due to much greater air dispersion between an onsite emission source and offsite receptors as compared to air dispersion directly over an emission source (ENVIRON 2003). It is also conservative because onsite routine worker exposure includes the dermal contact and ingestion exposure routes, which are not relevant for offsite receptors.

The estimates of cumulative cancer risk and HI for onsite routine worker soil contact at the Northend are summarized in Tables 6-2 and 6-3, which show that these estimates do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Groundwater

As discussed in Section 6.3.3.2, potential offsite maintenance worker exposure to groundwater would be lower than that of an onsite maintenance worker. Therefore, the potential exposure of offsite maintenance workers are evaluated using the risk estimates for onsite maintenance workers discussed in Section. 6.5.2.2. The estimates of cumulative cancer risk and HI based on maximum concentrations by AOI are summarized in Table 6-10, which shows that they do not exceed USEPA's cancer risk limit of 10^{-4} or the HI limit of 1.

The vapor intrusion pathway for potential exposure of offsite routine workers to constituents in groundwater migrating offsite is evaluated using the vapor intrusion modeling calculations provided in Appendix G. The evaluation assumes that current and future offsite commercial/industrial buildings are not governed by OSHA regulations, that soil properties and building characteristics offsite are similar to those onsite. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-18 for the Southend AOIs and Table 6-21 for the Northend AOIs, which shows that they do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

The vapor intrusion pathway for potential exposure of offsite residents to constituents in groundwater migrating offsite is evaluated using the vapor intrusion modeling calculations provided in Appendix G. The evaluation assumes that soil properties and future offsite residential building characteristics offsite are similar to those assumed onsite. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 6-18 for the Southend AOIs and Table 6-21 for the Northend AOIs, which shows that they do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Surface Water

As discussed in Section 6.3.3.2, potential offsite recreational users could be exposed to constituents in groundwater and/or storm sewer water via contact with nearby downgradient surface water in the Flint

River. Surface water concentrations are estimated using the mass balance approach discussed in Section 6.3.4 for constituents that exceed the MDEQ GSI criteria in groundwater and/or were detected in the storm sewer water samples. The highest detected constituent concentrations at monitoring wells selected for GSI criteria comparison (discussed in Section 4) are conservatively used as the concentrations in groundwater in the mass loading calculation for the receiving water. The mass loading from the storm sewer outfalls are estimated using data collected for the facility's NPDES permits and at various locations along the sewer networks during the RFI as discussed in Section 4. A discussion of this evaluation is provided in Appendix G.

The estimated surface water concentrations are compared against Michigan Water Quality Standards and Federal Ambient Water Quality Criteria (AWQC) for surface water used as human drinking water sources and MDEQ Part 201 generic residential drinking water criteria for groundwater for chemicals without State or Federal surface water quality standards. Table 6-22 presents the bounding estimates of surface water concentrations resulting from groundwater and storm sewer water discharging to the Flint River. As shown in Table 6-22, none of the constituent concentrations exceed the criteria except PCBs. For PCBs, the MDEQ and Federal surface water quality criteria are at least three orders of magnitude lower than the target detection limit of 0.2 ug/L, and the PCB concentration in the discharge is less than the MDEQ residential drinking water criterion. Therefore, water discharging from groundwater and the sewers into the Flint River is not expected to have significant impact on the water quality of the Flint River (see also Appendix F).

6.5.3 Uncertainty Analysis

6.5.3.1 Exposure Concentrations

As discussed in Section 6.3.4, all exposure concentrations for soil in this risk assessment are based on the highest concentrations detected in soil at each area or location. This approach inflates the cumulative cancer risk and HI estimates since these estimates are based on maximum concentrations. As explained in Section 6.3.4, 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 above discussion regarding soil exposure concentrations also applies to groundwater exposure concentrations for the excavation scenario, since workers would not be expected to contact groundwater with the maximum concentrations of every constituent during every onsite and offsite excavation.

As discussed in Section 6.3.4, the exposure concentration of vinyl chloride in the groundwater plume in the Building 36 area is conservatively estimated by assuming total conversion of PCE, TCE, and 1,2-DCE (cis and trans) to vinyl chloride, as a sensitivity analysis. The assumption that all parent chemicals are completely transformed to vinyl chloride without any vinyl chloride degradation to ethene or ethane is unrealistic. Most chlorinated VOCs, including PCE and TCE, degrade via reductive dechlorination, which occurs under anaerobic conditions. The formation of vinyl chloride from 1,2-DCE and other chlorinated VOCs occurs predominantly under aerobic conditions. However, the transformation of vinyl chloride to ethene or ethane also occurs under aerobic conditions. In fact, the rate of degradation of vinyl chloride to ethene and ethane is often much higher than the rate of vinyl chloride formation, so that relatively little vinyl chloride typically accumulates in groundwater.

According to data compiled in the literature, the typical kinetic rate constants for the formation of vinyl chloride from 1,2-DCE and other chlorinated VOCs range from approximately 1 to 3 per year, while the typical kinetic

rate constant for the degradation of vinyl chloride is at least 10 per year (Suarez and Rifai 1999). This means that groundwater conditions that are conducive to the formation of vinyl chloride would be expected to be even more conducive to degradation of vinyl chloride. Therefore, the assumption of total conversion of PCE, TCE, and 1,2-DCE (cis and trans) to vinyl chloride without vinyl chloride degradation is highly conservative. The estimates of cumulative cancer risk and HI based on total conversion of the highest concentrations of PCE, TCE, and 1,2-DCE to vinyl chloride in the Building 36 plume are slightly higher than those presented in Section 6.5.2.2 but do not exceed 10^{-4} and 1, respectively. It should be noted that this highly conservative approach for vinyl chloride is intended to provide a gross upper-bound of maximum possible exposure in the event that PCE, TCE, and 1,2-DCE undergo some degree of degradation before arriving at potential points of exposure.

For the exposure scenarios that involve vapor intrusion, the use of maximum concentrations for all constituents also overstates the RME risk for individual buildings. This is because not all constituent have their highest concentrations at one location and not every building is located at a maximum concentration. However, these bounding estimates are useful for identifying constituents and exposures pathways for which significant risk is possible, so that risk-based concentration limits for such constituents and pathways can be used to identify specific locations where significant exposures could occur, as demonstrated in Section 6.5.2.1.

Most exposure concentrations that are based on mathematical modeling of constituent transfer from soil or groundwater 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 groundwater. In addition, the model estimates are conservative because they generally do not account for the reduction of constituent concentrations in the soil or groundwater as constituent 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 the risk estimates discussed in Section 6.5.

6.5.3.2 Exposure Factors

As discussed in Section 6.3.5, most of the exposure factors used in the risk assessment are high-end (i.e., 90^{th} to 95^{th} 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 90^{th} 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 generic default 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 routine workers are exposed to soil for an entire work day at each area, but workers at commercial/industrial sites generally spend only a part of the work day at a particular part of the Site.

Maintenance Worker exposure to soil and groundwater, and LNAPL and smear zone soil at the Northend of the Site was also evaluated using a more conservative exposure factor of 45 days for inhalation, at the request of USEPA. The results of this sensitivity analysis are shown in Tables 6-23 and 6-24. This sensitivity analysis shows that the only AOIs where bounding estimates of HI are higher than 1 are AOIs 03-1, 36-1, 81-2, and 83/84-2 for exposure to soil and AOI 36-3 for exposure to groundwater (Table 6-23). For exposure to LNAPL and smear zone soil, this sensitivity analysis, shown in Table 6-24, shows that the only additional AOI where potential risks could exist is AOI 10-4.

6.5.3.3 Extrapolated Toxicity Values

As discussed in Section 6.4.3, 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, pharmacokinectic 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, RfDs, and SRfDs were converted to inhalation URFs, RfCs, and SRfCs in this risk assessment. Use of these extrapolated inhalation toxicity values reduces the potential for underestimating inhalation risks, but could introduce uncertainty.

6.5.3.4 Risk Characterization

The summation of cancer risks and HQs for multiple constituents, as described in Section 6.5.1, 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.

Conservative estimates of risks are not combined across different media. This would have been more conservative than necessary according to EPA guidance, because an individual is unlikely to face the high-end (and sometimes upper-bound) estimates of risk for each medium at the same time and continuously. In addition, combining the conservative estimates of risk across different routes of exposure and/or different media (e.g., soil and vapor emitted from soil) in many cases "double counts" exposure because the conservative estimates do not account for conservation of mass when estimating multi-route and/or cross-media exposures.

6.6 Summary and Conclusions

The significance of potential exposures to Site-related concentrations of constituents in onsite soil, groundwater, LNAPL, storm sewer water, and basement and tunnel water is evaluated based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use. The evaluation uses the RFI data that were discussed in Section 4 and methods that are consistent with USEPA risk assessment guidance. The significance of potential exposures is determined by comparing estimates of Site-related cumulative cancer and noncancer risks with a 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).

Current operations at the Site are all conducted in the Northend. Building demolition activities are completed in the Southend and are in progress in portions of the Northend. Groundwater that is affected by releases from the

Site extends offsite where current land use is commercial/ industrial. Receptors at the Site and the downgradient areas include the following:

Current	Onsite: Northend	Routine Workers
		Maintenance Workers
		Trespassers
	Onsite: Southend	Maintenance Workers
		Trespassers
	Offsite	Routine Workers
		Maintenance Workers
		Recreational Users
		Residents
Future	Onsite: Northend	Routine Workers
		Maintenance Workers
		Trespassers
	Onsite: Southend	Routine Workers
		Maintenance Workers
		Trespassers
		Redevelopment Construction Workers
		Recreational Users (e.g., parks)
		Residents
	Offsite	Routine Workers
		Maintenance Workers
		Recreational Users (Flint River)
		Residents

The potential exposures evaluated for these receptors are summarized in the conceptual site model shown in Table 6-1. The upper-bound and refined risk estimates by receptor and exposure medium are shown on Tables 6-2 through 6-22. The results of refined point-by-point risk estimates for the Southend (Parcels 1, 2, and 3) are also illustrated on Figure 6-6. Results of the evaluation are summarized below for each receptor population.

Onsite Routine Workers

The risk assessment evaluated potential exposures to outdoor soil at the Site via incidental ingestion, dermal contact, and inhalation of vapors and particulates. The conservative estimates of Site-related cumulative cancer risk and HI for these areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, and the lead concentration is less than MDEQ Part 201 criterion of 900 mg/kg except for several locations identified in the risk assessment. For the Northend, several VOC concentrations from RFI-81-38 (1-3 foot depth) in AOI 81-2 were excluded from the risk calculations in order for the cumulative cancer and noncancer risk estimates to be within the acceptable limits. In addition, elevated lead concentrations at a limited number of discrete locations in AOI 81-1 (RFI-81-01, RFI-81-02, RFI-81-36, and RFI-81-37), AOI 83/84-2 (RFI-83/84-14 and RFI-83/84-23), and AOI 83/84-3 (RFI-83/84-05) caused the mean concentration for the AOI to exceed the criterion and were excluded in the final evaluation. These locations are included as part of the Due Care Plan and will be addressed in the corrective measure study. For the Southend, the lead concentrations at a number of locations are higher than 900 mg/kg. As shown on Figure 6-6, the area represented by each of these locations is relatively small compared to the area of each parcel.

Exposure via inhalation of soil, groundwater, and LNAPL constituents, assuming that they volatilize and migrate through cracks in building foundations, was also evaluated using conservative vapor intrusion modeling. Soil, groundwater and LNAPL exposures are compliant with OSHA requirements for indoor air inhalation in industrial buildings in all areas.

The vapor intrusion pathway for exposures via inhalation of soil, groundwater, and LNAPL constituents was also evaluated for future commercial/industrial buildings that may not be governed by OSHA regulations. The bounding estimates of Site-related cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, in all areas except for exposures to constituents in soil at AOIs 36-1 and 81-2 and exposures to constituents in LNAPL at AOIs 36-1. Further evaluation is recommended to eliminate the exposure pathway in future buildings (e.g., engineering controls) in these areas if they will not be subject to OSHA regulations.

Therefore, constituent concentrations in onsite soil, groundwater, and LNAPL do not pose a significant risk to routine workers, except for the areas identified above to be included as part of the Due Care Plan and addressed by the corrective measure study.

Onsite Maintenance Workers

The risk assessment evaluated the significance of potential exposures to onsite soil during occasional construction/maintenance activities via incidental ingestion, dermal contact, and inhalation of vapors and particulates. The conservative estimates of Site-related cumulative cancer risk and HI for these areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in soil do not pose a significant risk to maintenance workers.

The risk assessment also evaluated the significance of potential exposures to constituents in groundwater via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI for each of the areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in groundwater do not pose a significant risk to maintenance workers.

Potential exposures to smear zone soil and LNAPL during excavations at AOIs where LNAPL is present were evaluated in addition to other soil exposures. The risk assessment evaluated the significance of potential exposures to smear zone soil and LNAPL via incidental ingestion of smear zone soil, dermal contact with smear zone soil and LNAPL, and inhalation of smear zone soil and LNAPL vapors. The estimates of cumulative cancer risk and HI for this scenario also do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, except for AOIs 09-B and 36-1. At these areas, the cancer and noncancer risks for potential exposure to LNAPL via inhalation of vapors from the LNAPL exceed USEPA's acceptable limits. These AOIs are currently being addressed as part of the Interim Measures as discussed in Section 5.3. Furthermore, the Due Care Plan has been implemented at the Site to ensure that any planned construction activity in the LNAPL areas would follow proper health and safety procedures to minimize exposure. Therefore, constituent concentrations in the smear zone soil and LNAPL at each of the areas do not pose a significant risk to maintenance workers.

The risk assessment also evaluated the significance of potential exposures to constituents in storm sewer water and basement and tunnel water via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI for all areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in storm sewer water and basement and tunnel water do not pose a significant risk to maintenance workers.

Trespassers

The risk assessment evaluated the significance of potential exposures of trespassers to onsite soil by using the risk estimates for routine workers, which is a conservative and streamlined approach. Since the constituents in onsite soil do not pose a significant risk to routine workers as noted above, they also does not pose a significant risk to trespassers.

Redevelopment Construction Workers

The risk assessment evaluated the significance of potential exposures to onsite soil during redevelopment construction activities at the Southend of the Site via incidental ingestion, dermal contact, and inhalation of vapors and particulates. The conservative estimates of Site-related cumulative cancer risk and HI for these areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in soil do not pose a significant risk to redevelopment construction workers.

The risk assessment also evaluated the significance of potential exposures to constituents in groundwater via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI for each of the areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in groundwater do not pose a significant risk to redevelopment construction workers.

Potential exposures to smear zone soil and LNAPL during excavations at AOIs where LNAPL is present were evaluated in addition to other soil exposures. The risk assessment evaluated the significance of potential exposures to smear zone soil and LNAPL via incidental ingestion of smear zone soil, dermal contact with smear zone soil and LNAPL, and inhalation of smear zone soil and LNAPL vapors. The estimates of cumulative cancer risk and HI for this scenario do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, except AOI 09-B where the noncancer HI for potential exposure to LNAPL via inhalation of vapors exceed USEPA's acceptable limit. This AOI is currently being addressed as part of the Interim Measures as discussed in Section 5.3. Furthermore, the Due Care Plan has been implemented at the Site to ensure that any planned construction activity in the LNAPL areas would follow proper health and safety procedures to minimize exposure. Therefore, constituent concentrations in the smear zone soil and LNAPL at each of the areas do not pose a significant risk to redevelopment construction workers.

Onsite Residents

The risk assessment evaluated potential exposures to outdoor soil at the Southend of the Site via incidental ingestion, dermal contact, and inhalation of vapors and particulates. The conservative estimates of Site-related cumulative cancer risk and HI for these areas do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively except for the areas around the locations shown on Table 6-16 and Figure 6-6. Residential exposure to lead in soil is acceptable in all areas except those around the locations shown on Table 6-17 and Figure 6-6. Further action (e.g. limited excavation, engineering control, or deed restriction) is recommended to eliminate or restrict potential future residential exposure in these areas.

Exposure via inhalation of soil, groundwater, and LNAPL constituents, assuming that they volatilize and migrate through cracks in building foundations, was also evaluated using conservative vapor intrusion modeling. For inhalation exposure to constituents in soil, groundwater and LNAPL in areas at the Southend of the Site, the conservative estimates of Site-related cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1.

Therefore, constituent concentrations in onsite soil, groundwater, and LNAPL do not pose a significant risk to potential residents, except for the areas identified above.

Onsite Recreational Users

The risk assessment evaluated potential exposures to outdoor soil at the Southend of the Site via incidental ingestion, dermal contact, and inhalation of vapors and particulates. The conservative estimates of Site-related cumulative cancer risk and HI for these locations do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively, except at RFI-09-03. As shown on Figure 6-4, the area around this location was characterized during the RFI to be less than 200 square feet. Further action is recommended to eliminate or restrict potential future recreational user exposure in this area.

Therefore, constituent concentrations in the soil at each of the areas do not pose a significant risk to recreational users, except at RFI-09-03.

Offsite Routine Workers

The risk assessment evaluated the significance of potential exposures of offsite routine workers to soil by using the risk estimates for onsite routine workers, which is a conservative and streamlined approach. Since the constituents in onsite soil do not pose a significant risk to onsite routine workers as discussed in Section 6.5.2.1, they also do not pose a significant risk to offsite routine workers.

The risk assessment evaluated the significance of potential inhalation exposures of offsite routine workers to constituents in groundwater. The conservative estimates of Site-related cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in groundwater do not pose a significant risk to offsite routine workers.

Offsite Maintenance Workers

The risk assessment evaluated the significance of potential exposures of offsite maintenance workers to groundwater by using the risk estimates for onsite maintenance workers, which is a conservative and streamlined approach. Since the constituents in onsite soil do not pose a significant risk to onsite maintenance workers as discussed in Section 6.5.2.2, they also do not pose a significant risk to offsite maintenance workers.

Offsite Recreational Users

The risk assessment evaluated the significance of potential exposures of recreational users to constituents in groundwater and/or storm sewer water via contact with nearby downgradient surface water in the Flint River. None of the estimated surface water concentrations exceed the criteria except PCBs. However, the MDEQ and federal surface water quality criteria for PCBs are at least three orders of magnitude lower than the target detection limit of 0.2 ug/L, and the PCB concentrations in the discharge are less than the MDEQ residential drinking water criteria. Therefore, water discharging from groundwater and the sewers into the Flint River is not expected to have significant impact on the water quality of the Flint River.

Offsite Residents

The risk assessment evaluated the significance of potential exposures of offsite residents to soil by using the risk estimates for onsite routine workers, which is a conservative and streamlined approach. Since the

constituents in onsite soil do not pose a significant risk to onsite routine workers as discussed in Section 6.5.2.1, they also do not pose a significant risk to offsite residents.

The risk assessment evaluated the significance of potential inhalation exposures of future offsite residents to constituents in groundwater migrating offsite. The conservative estimates of Site-related cumulative cancer risk and HI do not exceed the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. Therefore, constituent concentrations in groundwater do not pose a significant risk to future offsite residents.

7. Ecological Risk Evaluation

This section presents a screening-level ecological risk assessment (ERA) as described by USEPA guidance (USEPA, 1997, 2001). The initial elements of a screening-level ERA are characterization of the environmental setting and contaminants, and identification of complete exposure pathways (USEPA 1997). This document addresses those elements for the Site. A screening-level exposure assessment and risk characterization was also conducted to address risk for receptors with potentially complete exposure pathways.

The objective of a screening-level ERA is to provide a defensible conclusion that negligible ecological risk exists, or that certain contaminants and exposure pathways can be eliminated from further consideration in the ERA process (USEPA 1997). The pathways assessment is a critical step in this process, because it can be used to determine that complete exposure pathways do not exist and could not exist in the future, and therefore, present or future ecological impacts are negligible. For example, many sites are located in highly industrialized areas where there could be few, if any, ecological receptors, or where Site-related impacts might not be distinguishable from non-Site-related impacts (e.g., habitat loss due to development, non-Site-related anthropogenic chemicals such as hydrocarbons associated with highway runoff). The EPA guidance (USEPA 1997) states that a screening-level ERA may conclude that:

- There is adequate information to conclude that ecological risks are negligible, and therefore, no need exists for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ERA process will continue; and
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

If a screening assessment supports the first decision (i.e., negligible risk), the ERA process ends there, with appropriate documentation to support the decision.

The process used in this assessment included a Site visit to characterize habitats and identify potential exposure pathways for ecological receptors, and a habitat assessment decision matrix to screen site and habitat characteristics for those areas at or near the Site that may provide terrestrial and aquatic habitats. The matrix approach was used to determine which habitat-bearing areas and pathways would need to be assessed in the ERA process, if any, and to determine the areas where ecological impacts are negligible because complete exposure pathways do not exist. Areas of the Site where there is a likelihood of release and a reasonable potential for complete exposure pathways were carried forward for the screening-level exposure and risk analyses. Areas of the Site where there is minimal potential for complete exposure pathways require no further assessment in the ERA process.

7.1 Habitat Characterization and Pathways Assessment

Habitat assessment is the first task in an ERA. The objective of the habitat assessment in an ERA under RCRA Corrective Action is to identify areas of a facility where potential ecological receptors may be exposed to Site-related constituents. Note that the term “ecological receptor” and other terms of art used in this document are used as defined in existing EPA guidance for ecological risk assessment, including USEPA (1997, 2001). This section presents the results of a habitat characterization and an evaluation of potential pathways of exposure for ecological receptors.

Background information on the Site was obtained from the RFI Phase I Report (BBL, June 28, 2002), the SEDOCC (BBL, May 30 2000), the NEDOCC (BBL, November 26, 2000), and personal communication regarding the wetland determination for the former wastewater aeration lagoons (Marschall 2001 and Horney 2001, included in Appendix H).

7.1.1 Site Visit and Habitat Characterization

Dr. Nicholas Gard, an ecologist with Exponent, visited the Site on June 14, 2001, to conduct the habitat assessment. He was accompanied by Robert Metcalf, of GM Worldwide Facilities Group, and Derek Kaiding, of BBL. The Site visit included a tour by vehicle and foot of most areas of the Site, to observe ecological features that are important in identifying potential exposure pathways for ecological receptors to constituents of potential concern that may be present in environmental media at the facility.

The intent of the habitat assessment was to evaluate, for further consideration in the ERA process, those areas that are identified as containing constituents of potential ecological concern, habitat for ecological receptors, and complete exposure pathways. Areas that have no evidence of a release or do not support habitat for ecological receptors, and thus clearly do not pose any ecological risk, would be eliminated from further ecological assessment.

The Site has been in constant production since the early 1900s. The Site is heavily industrialized, and most of the property consists of buildings that are or were used in the production of automotive components, as well as other associated facilities such as parking areas and demolished building slabs. Some of the factory buildings are no longer used for production purposes and are inactive and unoccupied. The areas around the factory buildings are typically paved or covered with gravel. Small, unmaintained patches of grassy or weedy vegetation are growing at various locations near buildings or parking areas, such as the unpaved area behind Factory 81 Area (refer to Photograph 1, provided in Appendix H). The only wildlife seen in the industrial parts of the Site during the Site visit were common urban bird species, including rock doves (*Columba livia*) and European starlings (*Sturnus vulgaris*). Habitat characteristics of the industrial parts of the Site were not evaluated further.

The Site is bounded primarily by industrial, commercial, and residential developed areas (refer to Figure 2-1). The Flint River and Interstate 475 border the Site to the east. Because of the developed nature of the land bounding the Site, (Figure 1 in Appendix F), there are no areas where potential offsite migration of contaminants is an ecological concern, with the exception of the Flint River, which is discussed in Section 7.1.1.1.

Only a very small portion of the land within the Site is undeveloped or currently undisturbed. Almost all the land within the confines of the Site has been developed, excavated, regraded, filled, or otherwise disturbed as a result of past and current plant operations. Only the wastewater aeration lagoon area and adjacent vacant lot were found to provide habitat for ecological receptors. The vacant lot and the wastewater aeration lagoon area lie at the northwest corner of the intersection of Leith Street and James P. Cole Boulevard (refer to Figure 2-2). The area is bounded on the west and north by industrial properties owned by GM and other companies. To the west of this area is a short-grass verge and Interstate I-475.

Table 7-1 summarizes the status of the areas of ecological interest at the Site and provides the rationale for targeting specific areas for habitat characterization and eliminating others from further investigation in the ERA process. As can be seen from the table, two areas were selected for habitat assessment—the first step in the ecological pathways assessment process—because they potentially provide habitat resources. The areas that were selected for habitat assessment are:

- The vacant lot on the facility that is located at the northwest corner of the intersection of Leith Street and James P. Cole Boulevard (hereafter referred to as the "vacant lot"); and
- The former wastewater aeration lagoon that is adjacent to the vacant lot (hereafter referred to as the "wastewater aeration lagoon").

Other areas of the Site were excluded from further ecological assessment, because they do not provide habitat (i.e., no ecological receptors would be present) and/or no complete exposure pathways are present.

7.1.1.1 Flint River

The Flint River, which flows near portions of the eastern Site boundary, provides ecological habitat for aquatic and riparian flora and fauna. However, previous Site sampling has documented that groundwater discharging to the Flint River does not contain monitored constituents at unacceptable concentrations. Groundwater quality with respect to potential discharges to the Flint River is discussed in the September 2005 CA750 Report. Groundwater quality at the Site is discussed in Section 5.2 and is illustrated on Figures 5-1 through 5-6. Existing sediment and fish data for the Flint River are presented in Appendix F. In addition, in April 2005 MDEQ, accompanied by EPA, conducted sediment sampling in the Flint River at locations upstream, adjacent to, and downstream of the GM facility. The sediment samples were analyzed for inorganics, PCBs, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Low levels of PCBs, metals, and PAHs were detected. Subsequently, a sediment investigation of the Flint River was undertaken by ARCADIS BBL and Exponent in 2006 on behalf of GM. A screening level ecological risk assessment (SLERA) was conducted to address USEPA concerns regarding potential ecological impacts resulting from stormwater discharges from the facility to the Flint River. This assessment was provided to USEPA as an appendix to the *Flint River Sediment Investigation Report* (ARCADIS BBL 2007).

Storm sewers that drain portions of the GM facility also drain industrial, commercial, and residential areas outside the boundaries of the Site. In addition, numerous storm-sewer outfalls that are unrelated to the Site drain into the Flint River in the vicinity of the Site. Tributary drainages and runoff from industrial, commercial, and residential properties, as well as roads and railroads in the Flint metropolitan area, contribute to the sediment and contaminant load of the Flint River in the vicinity of the GM facility. Thus, there are multiple, indistinguishable sources of contaminants to the river. Consistent with observations in other urban watersheds, this combination of sources is expected to result in low-level concentrations of constituents in sediment such as those seen in the MDEQ and GM Flint River data sets.

7.1.1.2 Vacant Lot

The vacant lot is approximately 12 acres and is almost entirely covered with grass, which was less than 6 in. tall at the time of the Site visit. The vacant lot is mowed 3 or 4 times per year, which limits vegetation growth. Several isolated, tall trees were scattered throughout the field, but there were no stands of trees that would constitute a wooded area. A few clumps of shrubs were also sparsely scattered across the lot. Several gravel roads loop through the vacant lot to provide access to a metering station at the southeast corner of the wastewater aeration lagoon area. The intended future use of this area is for light industrial and/or commercial development. The only wildlife that was seen in the area during the Site visit was a red-tailed hawk (*Buteo jamaicensis*) that was perched at the top of one of the trees. No nest was seen in the trees to suggest that this bird was nesting at that location.

The limited structural diversity of the vacant lot indicates that it is not likely to support a large diversity of wildlife species. The lot is a probable habitat for small rodent species, such as voles, mice, and shrews, although even for these species, habitat quality would be reduced by periodic mowing, which would eliminate cover and reduce food resources. The short-grass field does not offer substantial cover to larger mammals, such as raccoons (*Procyon lotor*), nor would it provide nesting habitat for most birds, other than some ground-nesting species, such as killdeers (*Charadrius vociferous*). The absence of a wooded area precludes habitat for birds and mammals that rely on tree cover for nesting and foraging. However, limited numbers of common urban bird species could nest in the few trees scattered over the vacant lot. A population of small mammals, if it occurs in the vacant lot, could provide some food resources to individuals of higher trophic-level species, particularly avian predators. The presence of the red-tailed hawk in the field suggests that some raptors may use the field to forage for prey. However, given the limited size of the field and its relative isolation from other similar habitats, it is unlikely to support a population of raptors when the home-range size requirements for these large birds are taken into consideration. For a species such as the red-tailed hawk, it is unlikely that even an individual bird would be able to obtain all necessary food resources from an area the size of the vacant lot.

No AOIs were identified related to the vacant lot or other areas north of Leith Street in the RFI Phase I Report (BBL 2002). However, soil samples that were collected as part of the RFI (Figure 4-27) show the presence of some volatile and semi-volatile organic compounds, metals, and low concentrations of PCBs in soil in the vicinity of the vacant lot. Therefore, this area was retained for further evaluation in the ERA.

7.1.1.3 Wastewater Aeration Lagoon Area

The wastewater aeration lagoons are former industrial water bodies that have been inactive since 1988. Since the time of the Site visit in 2001, one of the former lagoons, the west lagoon, was filled in with crushed concrete from the demolition of facility buildings in 2003 (Photograph 2, Appendix H), and therefore, only one lagoon remains today. When in operation, the lagoons' primary function was to reduce the biochemical oxygen demand and chemical oxygen demand of process water in preparation for discharge to the Flint River, and later to the City of Flint sanitary sewer system. Currently, the remaining lagoon is fed only by precipitation and surface-water runoff, and possible future use may be for stormwater retention.

After the lagoons were taken out of service, accumulated sludge material was removed from the lagoons and disposed of offsite in the mid-1990s. Post-removal sampling indicated that these lagoons met required cleanup criteria, and the lagoons were not identified as an AOI in the RFI Phase I Report (BBL 2002). Therefore, it can be assumed that there is no current likelihood of release from the lagoons. Furthermore, there is at present no known hydrologic connection from the existing wastewater aeration lagoon to any non-industrial water body, because discharge was redirected to the City of Flint sanitary sewer system per a sewer use permit executed with the City of Flint.

At the time of the Site visit, the lagoons were about one-third full of water, and the blades of the mechanical aerators were exposed well above the water level (Photograph 3). The banks of the lagoons are steeply sloped and are covered with rocks and cobble about 3–5 in. in diameter. In places, the banks of the lagoons are heavily vegetated with herbaceous weeds and sapling trees (Photograph 4, Appendix H), particularly willows. Weedy vegetation and patches of shrubs cover the area on top of the berms that surround the lagoons.

A request for jurisdictional determination was made to the MDEQ, Land and Water Management Division, in September 2001, for the wastewater aeration lagoons (Marschall 2001, included in Appendix H). The Shiawassee District Office responded that the lagoons and their wetland fringes fall outside the regulatory provisions set forth in Parts 301 and 303 of NREPA (Horney 2001, included in Appendix H). The wetland

determination review documented the dominant plant species associated with the lagoons, including boxelder, cattail, ash, willow, elm, goldenrod, trefoil, and others.

Numerous red-winged blackbirds (*Agelaius phoeniceus*) were observed perched on reeds fringing the aeration lagoons. Although no nests were seen, the nature of the habitat and the behavior of the birds suggest that they may have been breeding at the lagoon. Canada geese (*Branta canadensis*) were seen on the surface of the second lagoon, but this lagoon no longer exists, as noted above. No other wildlife was seen around the lagoons; however, signs of wildlife (raccoon and possibly muskrat) were noted during the wetland determination review (Marschall 2001, pers. comm.). Large numbers of small fish (estimated at 1–3 cm long) were seen in the shallow water at the edge of the lagoons. No attempt was made to look for larger fish within the water or fish that may have been present in deeper portions of the lagoons. Although the presence of forage-size fish indicates a potential food source for fish-eating wildlife, the limited spatial extent of the lagoons suggests that only low numbers of individuals of predatory species would forage at the lagoons. In addition, any predatory species foraging at the lagoon area would probably obtain only a portion of their total diet from this location, given its size in relation to home-range sizes of higher trophic-level species. The presence of much more extensive foraging habitat along the nearby Flint River also suggests that the lagoon area would not be preferred habitat for upper-trophic-level predators.

7.1.2 Special-Concern Species and Sensitive Habitats

USEPA guidance (USEPA 1997) states that sensitive environments and species should be identified as part of a screening-level risk assessment. These environments include habitat known to be used by state or federal designated or proposed endangered or threatened species, critical habitat for endangered or threatened species, national or state river reach designated as Recreational or Scenic, and wetlands.

On November 24, 2003, Exponent contacted the Michigan Natural Features Inventory (MNFI) to request information on any federal- or state-listed endangered, threatened, or special-concern species within the vicinity of the facility. The results of MNFI's review are provided in Appendix H. No unique ecological sites, candidate, or threatened or endangered species were identified in the Site vicinity (MNFI 2003). One special-concern (not legally protected) plant species was identified as occurring within the area defined by the Flint North, Michigan U.S. Geological Survey 7.5-minute topographic quadrangle (on which the Site is located)—twinleaf (*Jeffersonia diphylla*). This plant's habitat—rich, damp, open deciduous forest like that found in floodplains—is not available at the Site.

A request was also submitted to the U.S. Fish and Wildlife Service (FWS) for any available information regarding threatened or endangered species in the vicinity of the facility. The FWS responded that their records do not indicate the presence of any federally listed or proposed threatened and endangered species, candidate species, or critical habitat near the Site. This finding precludes the need for any further action under Section 7 of the Endangered Species Act of 1973, as amended. A copy of the correspondence with the FWS is provided in Appendix H.

7.1.3 Evaluation of Ecological Habitats and Exposure Pathways

A habitat assessment decision matrix (Table 7-2) was developed to screen the Site and habitat characteristics for those areas that provide terrestrial and aquatic habitats—the vacant lot and wastewater aeration lagoons. This matrix was used to determine which habitat-bearing areas and pathways would need to be assessed further in an ERA, if any. Under the matrix approach, the following conditions must be met for an area to be considered

habitat in the context of an ERA at a RCRA Corrective Action site, and for that area to be carried forward for evaluation:

- Surface-water bodies:
  - There is a likelihood of a hazardous constituent release to the water body (as documented or inferred from information in the NEDOCC);
  - The water body is of sufficient size and hydroperiod for use by potential ecological receptors to be a reasonable possibility;
  - The water body is sufficiently accessible that potential ecological receptors realistically may use it; and
  - The water body will continue to support habitat into the foreseeable future.
- Terrestrial habitats:
  - There is a likelihood of a hazardous constituent release to the area (as documented or inferred from information in the NEDOCC);
  - The area is of sufficient size for use by potential ecological receptors to be a reasonable possibility;
  - The area is sufficiently accessible that potential ecological receptors realistically may use it; and
  - The current and likely future use of the area does not fall into one of the three "developed" habitat categories as defined by the matrix (i.e., developed areas [buildings, etc.], paved or graveled areas, or landscaped and intensively maintained areas).

The Site has been developed for industrial use since the early 1900s. Areas that provide potentially suitable habitat for wildlife are limited to the undeveloped vacant lot and the former wastewater aeration lagoons north of Leith Street. Based on observations made during the Site visit, some conclusions can be made regarding the suitability of these undeveloped parts of the Site as habitat for wildlife species. Both areas have characteristics that would make them likely to support at least some wildlife species, but also have characteristics that minimize their ecological habitat value.

Table 7-2 presents the results of the decision matrix for these areas. The only industrial water body present at the Site is the former wastewater aeration lagoon, and no non-industrial (i.e., natural) surface-water features, such as ponds, streams, or marshes, exist onsite. Developed terrestrial areas, such as buildings, paved areas, or landscaped areas, are not evaluated for ecological risk. The only semi-natural field habitat is that of the vacant lot north of Leith Street, and no forest habitats exist onsite. The vacant lot was retained for further evaluation due to the presence of surface soil contaminants.

7.1.4 Identification of Chemicals of Potential Concern

No AOIs were identified related to the vacant lot or other areas north of Leith Street in the RFI Phase I Report (BBL 2002). However, soil samples were collected from various locations within this area as part of the RFI. Chemistry data from these soil samples were screened against sets of available ecological benchmarks and background values to identify chemicals of potential concern (CoPCs) in Table 7-3. Screening was performed

only with data for the surficial soil (0- to 0.5-ft) layer. One sample from the 0- to 2-ft interval, RFI-07-14, was also included in the screening as representative of surficial soil. Only one surface soil sample from the vicinity of the vacant lot was analyzed for inorganics, SVOCs, and VOCs; this sample was from location RFI-07-14, located just east of the Storage Lot (Figure 4-27). Surficial soil samples from six locations within the former aeration lagoon and vacant lot vicinity (WL-B1A, WL-B2A, WL-B3A, WL-B4A, WL-B5A, and WL-B6A; Figure 4-27) were analyzed for PCBs. Results of the data screening are provided in Table 7-3. Detection limits for chemicals that were undetected in the surface soil samples were also screened against ecological benchmarks using one-half the detection limit in Table 7-4. Chemicals with maximum soil concentrations that exceed their ecological benchmark values (and background for inorganics) were retained as CoPCs for the screening-level exposure and risk characterization (Section 7.2).

Maximum concentrations of seven metals (arsenic, cobalt, nickel, selenium, thallium, vanadium, and zinc) exceed EPA Region 5 ecological screening levels (ESLs). Of these, two chemicals (vanadium, and zinc) also exceed one or more other screening values, as does manganese, for which no Region 5 ESL currently exists. However, in the case of both manganese and thallium, benchmark exceedences occur on the basis of estimated metals concentrations, as values for both metals are J-flagged in the one available surficial soil sample. Despite exceeding the Region 5 ESLs, maximum concentrations of arsenic, cobalt, nickel, thallium, and vanadium are below Site-specific and Michigan default background values, while selenium is only slightly higher than background. This indicates that the ESLs for these metals may be overly conservative (i.e., they are lower than Site-specific and regional background concentrations). No semi-volatile organic compounds exceed screening values. Maximum PCB concentrations exceed the EPA Region 5 ESL, which is equivalent to the standard detection limit for PCBs in soils, but not the Oak Ridge National Laboratory benchmark for phytotoxicity. No screening values were available for the detected volatile organic compounds (methyl acetate and methyl cyclohexane). Volatile organic compounds (e.g., methyl cyclohexane) are short-lived compounds once they are released into the environment. Most volatile organic compounds are readily metabolized by ecological receptors, and are therefore generally not bioaccumulative. Uptake by living organisms and accumulation in their tissues are not important fate processes for these chemicals. Therefore, the chemicals that were retained as CoPCs for analysis in the screening-level exposure assessment and risk characterization include the inorganic chemicals that exceeded screening and background values—manganese, selenium, and zinc—and PCBs.

For many undetected chemicals, there is uncertainty whether they could elicit adverse ecological effects as the detection limits for these chemicals exceed ESLs, preventing the ability to screen these chemicals out of further consideration in the ecological risk evaluation process. Therefore, the data for chemicals that were not detected were also screened using one-half the detection limit (Table 7-4). One-half the detection limit for 1,2-dibromo-3-chloropropane; 2,4-dimethylphenol; 2,4-dinitrophenol; 2,6-dinitrotoluene; 2-chloronaphthalene; hexachlorobutadiene; naphthalene; pentachlorophenol; and total PCBs exceeded the soil screening levels. Detection limits for the volatile and semi-volatile constituents ranged from 0.17 to 0.79 mg/kg. Of these chemicals where one-half the detection limit exceeded the ESL, only PCBs are bioaccumulative. Therefore, total PCBs were retained for further analysis, because of their bioaccumulative nature. Detected concentrations of PCBs also exceeded screening levels.

The vacant lot area is not known to have been used for any facility operations, and therefore, the presence of several chemicals at concentrations above screening benchmarks may reflect regional background or anthropogenic sources, especially as most metals occur at concentrations less than, or comparable to, Site-specific and regional background levels.

7.1.5 Results for Vacant Lot

No AOIs were identified for the vacant lot in the RFI Phase I Report (BBL 2002), and there are no releases associated with this area, although several metals and PCBs occur at concentrations that exceed EPA Region 5 ESLs (Table 7-3). The presence of some chemicals at concentrations above screening benchmarks likely reflects regional patterns, especially since concentrations are generally comparable to background levels. The undeveloped vacant lot of the Site does not constitute high-quality habitat for wildlife species, and the intended future use of this area of the Site is light industrial and/or commercial development. Regular mowing on the vacant property of the Site has halted development of the vegetation community in an early successional stage that lacks the structural diversity that is characteristic of oldfield habitats or fields that are in the process of reverting to a mixed wooded/open field habitat. The vacant lot, therefore, also lacks the diversity of wildlife species that occur in the different habitat types found in more natural environments. The Site visit to view this area, though of short duration, did not reveal the presence of many species. Small mammals, which are commonly found in many types of habitats, are likely to be present, although it is doubtful whether they would occur at a density or diversity similar to those that would be found in less disturbed oldfield habitats. A food chain based on small mammals may be supported on this vacant lot, with avian predators occupying the top level in the food chain. However, the limited size of the field (approximately 12 acres), its relative isolation from other natural habitats, and the limited prey base suggest that, at most, several individual birds may derive part of their prey from the location, but that conditions are not appropriate for the maintenance of a population of top-level predators. Exposure at the vacant lot area was therefore assessed for a representative small mammal, the short-tailed shrew, in Section 7.2, Screening-Level Exposure Estimate and Risk Characterization.

7.1.6 Results for Wastewater Aeration Lagoons

From the Site visit, it appears that the standing water in the wastewater aeration lagoon area has created conditions favorable for the use of the area by some aquatic species and emergent vegetation. Standing water, in combination with the relatively dense vegetation that borders the ponds in places, has created favorable conditions for wildlife species that forage in or around pond-like habitats. Thus, a pond-associated ecological community appears to be present in this area. There are potentially complete exposure pathways to higher trophic-level species at the lagoon area, because fish-eating wildlife could forage on fish that were observed in the ponds. However, it is unlikely that substantial numbers of fish-eating birds or mammals would forage at the existing lagoon, given the limited spatial extent of open water habitat. Habitats associated with the nearby Flint River constitute higher quality habitat for aquatic species and aquatic-dependent wildlife. A review of Site history and a Site investigation conducted by Conestoga-Rovers and Associates (Marschall 2001, included in Appendix H) in May 2001 concluded that the lagoons do not meet the jurisdictional criteria used by the State of Michigan for defining a wetland, and they can be closed, filled, or converted to an alternative use without obtaining a permit from the Land and Water Management Division of the MDEQ. In a subsequent review, MDEQ (Horney 2001, included in Appendix H) concurred with this determination.

In 1988, both lagoons were taken offline, and discharge was redirected to the City of Flint sanitary sewer system under a sewer use permit. The sludge in the lagoons was excavated in 1994. Post-removal sampling indicated that the remaining soil met cleanup criteria, and the lagoons were not identified as an AOI in the Phase I RFI Report (BBL 2002). Therefore, there is no likelihood of release, and there are no complete exposure pathways. The west lagoon was filled in 2003 and the east lagoon may be slated for future use for stormwater retention. The following construction activities are planned for converting the former lagoon for stormwater retention use:

- Install a traveling screen in the existing storm sewer to facilitate debris removal from stormwater being diverted to the former lagoon.

- Clear and grub all vegetation (e.g., trees and shrubs) growing along the backs of the existing lagoon.
- Excavate the southeast half of the existing lagoon to create the operating portion of the retention pond (increase depth of existing lagoon at least 2 feet).
- Move material excavated from the operating portion of the retention pond to the northwest half of the existing lagoon, limiting its capacity to collect and retain precipitation.
- Connect discharge sewer line from the existing outlet structure to the existing storm sewer system.

The internal design review is currently underway for these activities. The conversion of the former wastewater aeration lagoon into a stormwater retention pond will eliminate any potential ecological habitat that currently may exist there. Thus, any current exposure pathways at the wastewater aeration lagoon will be eliminated. It is therefore recommended that the wastewater lagoon area not be carried forward for further evaluation in the ERA process.

7.2 Assessment and Measurement Endpoints

USEPA (1997) guidance states "assessment endpoints focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the site." According to USEPA (1997) guidance, the selection of assessment endpoints depends on:

- The contaminants present and their concentrations
- Mechanisms of toxicity of the contaminants to different groups of organisms
- Ecologically relevant receptor groups that are potentially sensitive or highly exposed to the contaminant and attributes of their natural history
- Potentially complete exposure pathways

Manganese, selenium, zinc and PCBs are CoPCs in soils at the vacant lot. Wildlife may be exposed to these CoPCs in the vacant lot through ingestion of CoPCs accumulated in the tissues of terrestrial plants and soil invertebrates and incidental ingestion of contaminated soils. However, the vacant lot provides minimal habitat for population of birds and mammals and fragmented habitat for animals with large foraging areas, such as hawks and songbirds. Certain small mammals with small foraging areas may find the habitat in the vacant lot suitable for foraging. For example, the short-tailed shrew (*Blarina brevicauda*) is an insectivore with a small home range (<1 hectacre) and inhabits nearly all terrestrial habitats. As an insectivore, the shrew represents a receptor group that is highly exposed to contaminants in soil and soil invertebrates. Also, the short-tailed shrew has high food intake rate as compared to other small mammals and birds. Omnivorous or herbivorous mammals and birds will likely have similar if not lower exposures to chemicals than the shrew. Therefore, the shrew was selected as the mammalian receptor in vacant lot assessment. This species is considered to be a realistic choice as being representative of insectivorous mammals because it is likely to inhabit the area around the Site and be exposed to contaminants in soil and soil invertebrates.

Soil invertebrates and terrestrial plants were not selected as ecological resources for the vacant lot because this area is highly disturbed and as a result it lacks a diverse assemblage of vegetation and soil invertebrates. As discussed in Section 7.1.1.2, regular mowing on the vacant lot has halted development of the vegetation community in an early successional stage. The vacant lot is almost entirely covered with grass, which was less

than 6 in. tall at the time of the Site visit. Several isolated, tall trees were scattered throughout the field, but there were no stands of trees that would constitute a wooded area. While the highly disturbed nature of the vacant lot prevents the development of diverse communities of vegetation and soil invertebrates as ecological resources, populations of certain types of vegetation and soil invertebrates may exist and present an exposure pathway to small mammals; it is this pathway that is evaluated in this ERA.

To summarize, based on the contaminants present, mechanism of toxicity, habitat characteristics, ecologically relevant receptor groups, and potentially complete exposure pathways, the assessment endpoints selected for this ERA are as follows:

- Survival and reproduction of wildlife, as represented by the short-tailed shrew, that use the vacant lot.

The assessment endpoint is selected in accordance with USEPA (1997) guidance. It represents ecologically relevant receptor group that is the most highly exposed to the hazardous constituents, and it also considers the potentially complete exposure pathways at the Site.

The measurement endpoint used to evaluate the assessment endpoint is as follows:

- The total dietary exposure (mean concentrations of CoPCs in soil and soil invertebrates) to the short-tailed shrew, estimated by using simplified food-web models.

7.3 Screening-Level Exposure Estimate and Risk Calculation

Manganese, selenium, zinc, and PCBs were retained as CoPCs after the data screening. Therefore, exposure to these chemicals was assessed in the screening-level exposure estimate and risk calculation. The screening process concludes with a scientific management decision point (SMDP) where it is determined that: (1) ecological threats are negligible; (2) the ecological risk assessment should continue to determine whether a risk exists; or (3) there is a potential for adverse ecological effects, and a more detailed ecological risk assessment, incorporating more Site-specific information, is needed (USEPA 1997).

In the screening-level exposure estimate, the concentrations of hazardous constituents to which ecological receptors are exposed were estimated using a simple food-web model. In the risk calculation, risk was estimated by comparing the exposure estimates from the food-web model to threshold toxicity reference values (TRVs), to develop quantitative risk estimates called hazard quotients (HQs). HQs are the ratio of the measured or predicted exposure concentrations to the TRV,

$$HQ = \frac{IR_{chemical}}{TRV}$$

where:

HQ = hazard quotient (unitless)

$IR_{chemical}$ = ingestion rate of the chemical (mg/kg body weight-day)

TRV = toxicity reference value.

HQs less than 1.0 indicate that the chemical is unlikely to cause adverse ecological effects. HQs above 1.0 indicate some potential for adverse ecological effects but do not necessarily signify unacceptable risk. Other pieces of information, such as sources of uncertainty and Site-specific exposure information, are weighted in the risk evaluation and the interpretation of the ecological significance of HQs. At the conclusion of the risk characterization, a decision is made that either the ecological risk evaluation is adequate to determine that ecological threats are negligible, or the process should continue to a more detailed, baseline ecological risk assessment (USEPA 1997).

7.3.1 Representative Receptor—Short-Tailed Shrew

To quantitatively assess risk to an ecological community or feeding guild, it is necessary to select a representative receptor or receptors. The diversity of potentially exposed species and the lack of fundamental knowledge of the interactions between contaminants and many exposed species preclude assessment of risk to all species. According to USEPA guidance, selection of representative receptors may be based on a number of factors, including the following (USEPA 1997):

- Species that are known to be present at the Site;
- Species that are likely to be highly exposed;
- Species that are typical of the community or guild they represent in their behavior, physiology, or sensitivity to CoPCs; and
- Species for which adequate data exist to allow assessment of exposure and risk.

Risk assessments for representative receptors are therefore interpreted to apply not only to the species assessed, but to other species in the community or guild that are represented. The short-tailed shrew (*Blarina brevicauda*), an insectivorous mammal, was selected as the representative receptor to evaluate ecological risk at the Site.

The short-tailed shrew is a small, insectivorous mammal that occurs throughout the north-central and northeastern United States and portions of southern Canada. Existing studies indicate that short-tailed shrew consume primarily worms, insects, slugs, and snails (Hamilton 1941; Whitaker and Ferraro 1963). Other mammals and plant material have also been detected in these stomach-content studies. Dietary exposure for the short-tailed shrew in this assessment is assumed to be 100 percent earthworms. Exposure parameters for short-tailed shrew are presented in Table 7-5.

Guilday (1957) investigated body weights in wild-caught shrews from Pennsylvania and reported that adult female body weight ranged from 12 to 22.5 g, and mean weights ranged from 15.25 to 17.4 g. The minimum adult female body weight from this study, 12 g, will be used in the model. Shrews appear to have a relatively high consumption rate, given their small body size. Using the allometric equation for insectivorous mammals developed by Nagy (2001) (g dry matter intake per day = $0.373 \times$ g body weight$^{0.622}$), the food ingestion rate for short-tailed was estimated to be 0.0017 kg/day on a dry-weight basis.

No estimates of incidental soil/sediment ingestion were identified in the scientific literature for the short-tailed shrew. Therefore, the estimated soil/sediment ingestion rate of 9.4 percent of the total daily food consumption rate reported for opossum by Beyer and Fries (2003) will be used as a surrogate. This is equivalent to 0.00016 kg soil/day, assuming a food consumption rate of 0.0017 kg dry food/day, as calculated above.

Several investigators have reported home-range size for short-tailed shrew, and the size of their home range depends in part on the density of prey (Blair 1940; Blair 1941; Buckner 1966; Platt 1976). The range of values reported by these authors is 0.027 to 0.59 hectares for adult females. The terrestrial portion of the study area is

approximately 12 acres (4.8 hectares), which is larger than the home range for shrews. Therefore, it was assumed that shrews forage entirely within the assessment area, and the area use factor is 1.

Drinking-water intake was not estimated for shrews, because no surface water is present in the assessment area. This assumes that shrews that are foraging within the assessment area obtain their daily water requirement from sources such as dew and rainfall.

7.3.2 Food-Web Model

A food-web model was used to estimate the dietary exposure of short-tailed shrew to CoPCs in soil at the Site. The food-web modeling approach used is a standard approach that is consistent with EPA's wildlife exposure guidance (U.S. EPA 1993; 61 Fed. Reg. 47552). The food-web model is a tool for estimating dietary exposure as a body-weight-normalized total daily dose. The general structure of the food-web exposure model is described by the equation:

$$IR_{chemical} = \frac{\sum_i (C_i \times M_i \times A_i \times F_i)}{W}$$

where:

$IR_{chemical}$ = total ingestion rate of chemical from all dietary components (mg/kg-body weight/day)

C_i = concentration of the chemical in a given dietary component and medium (mg/kg dry weight)

M_i = rate of ingestion of an abiotic medium (kg/day dry weight)

A_i = relative gastrointestinal absorption efficiency for the chemical in a given dietary component or medium (fraction)

F_i = fraction of the daily intake of a given dietary component or medium derived from the study area (unitless area-use factor)

W = body weight of receptor species (kg).

For species-specific input parameters, such as body weight, ingestion rate, and area-use factor, there is a range of possible values that can be used. For example, adult body weights for any species are variable and may depend on several factors, including region of the country, habitat, local climate, and the availability of food. Similarly, the feeding behavior of receptor species can vary greatly, depending on geographic location, and habitat type. For the purposes of this risk assessment, single-value point estimates are used for all food-web model exposure parameters (Table 7-5). Drinking-water ingestion was not estimated for short-tailed shrew, because there are no surface-water bodies within the assessment area, and it was assumed that shrews would obtain their daily water requirement from sources such as dew and rainwater.

The model provides an estimated total dietary exposure for hazardous constituents resulting from consumption of food and the incidental ingestion of soil on a mg/kg body-weight-day basis. The exposure estimation conservatively assumes that the entire receptor diet comes from on site (F_i = 1), and that 100% of the chemical

in ingested food is absorbed (A_i = 1). The maximum measured or estimated onsite contaminant concentration was used to estimate exposures.

7.3.3 Bioaccumulation Factors

Because concentrations of CoPCs in biota have not been measured at the Site, they were estimated for risk assessment purposes using published bioaccumulation factors (BAFs). BAFs are quantitative relationships between soil concentrations and biota, and they are derived from empirical measurement. Soil-to-earthworm BAFs were developed to estimate dietary exposure of representative receptors to CoPCs (Table 7-6). Reference BAFs were derived from published sources.

The simplest BAFs are expressed as constant ratios between biota and soil/sediment concentrations. Simple ratio BAFs predict that the relationship between soil chemistry and biological uptake is constant over all concentration levels. In fact, bioaccumulation may be highly dependent on absolute concentration, resulting in a nonlinear uptake factor. When available, nonlinear regression models offer more reliable estimates of uptake potential over a broad range of concentrations. The BAF model that was used is:

$$\log or \ln[biota] = B0 + B1 \times \log or \ln[soil]$$

where:

log *or* ln[*biota*]	=	Base 10 or natural log of the chemical concentration in plant, soil invertebrate, or aquatic prey tissue (dry weight)
*B*0 and *B*1	=	empirically derived, chemical-specific constants
log *or* ln[*soil*]	=	Base 10 or natural log of the chemical concentration in soil (dry weight).

The soil-to-earthworm BAFs were taken from Sample et al. (1998) and are shown in Table 7-6. Earthworm uptake of metals and organic substances is especially nonlinear as a function of soil concentration; therefore, the use of simple ratio BAFs was avoided, and the model described above was employed. Sample et al. (1998) used a limited number studies to develop a soil to earthworm BAF for PCBs. In addition, errors were found in the tabulation of PCB results in the earthworm bioaccumulation database in Sample et al. (1998) when compared to the primary sources. Therefore, a review of available PCB bioaccumulation measurements was performed to develop a nonlinear earthworm biouptake model. This review is presented in Appendix H. The model for dry-weight PCB nonlinear BAF is:

$$6.25 \ (\log[biota] = B0 + B1 * \log[soil])$$

The PCB BAF assumes an average earthworm moisture content of 84% (USEPA 1993).

7.3.4 Toxicity Reference Values

Mammalian TRVs for comparison to estimated dietary exposure to CoPCs were taken directly from the literature or derived from published studies on laboratory animals. The lowest possible threshold, the chronic no-observed-adverse-effect level (NOAEL), was used as a conservative estimate of the adverse-effects threshold. The NOAEL is the highest dose administered during a chronic toxicity study that did not produce adverse toxic

effects. The true effect threshold, under the tested exposure conditions, is somewhere above the NOAEL. At an exposure level equal to the NOAEL, there is no adverse effect. As the concentration increases above the NOAEL, the probability of effect increases.

Because controlled laboratory experiments are rarely conducted with wildlife species, it is typically necessary to derive TRVs by extrapolating data from related laboratory or domestic species to the representative receptors. In this assessment, source studies were selected that considered survival, growth, reproductive and developmental effects, or other critical effects that would indicate overt impacts to individual organisms that may affect population size or stability. Studies incorporating chronic exposure durations, multiple exposure levels, and statistical evaluation of test results were preferentially selected. The mammalian TRVs are summarized in Table 7-7.

7.3.5 Results of Screening-Level Exposure Estimate and Risk Calculation

Table 7-8 provides the results of the short-tailed shrew exposure estimate and risk calculation. HQs were less than 1.0 for all CoPCs, except total PCBs, which had an HQ of 7.8. This indicates that adverse ecological effects from exposure to the CoPCs in soil and prey are unlikely, but there is some potential for risk to shrews from exposure to PCBs.

7.4 Uncertainty Analysis

There are several sources of uncertainty associated with the assumptions in this screening-level ERA. These sources of uncertainty are common to the ERA process in general. There is uncertainty associated with the use of soil screening levels and toxicity reference values, the assumptions made in the selection of exposure parameters, accumulation factors, and TRVs in the food chain model; these are discussed below. The magnitude of uncertainty differs among sources and can vary with CoPC and receptor.

7.4.1 Uncertainties Associated with Ecological Screening Values and Toxicity Reference Values

The primary area of uncertainty for the ERA is associated with conservative ecological screening levels that may lead to an overestimation of risk to ecological receptors. Screening levels and TRVs are significant sources of uncertainty in ecological risk assessments for the following reasons:

- Test conditions may not accurately mimic natural exposure
- Relative sensitivity of the receptor compared to the test species may be unknown
- Identification of the no-effect threshold is imprecise and dependent on selected dose intervals
- Uncertainty factors applied in calculating some screening levels and TRVs are generalized and ignore species-specific sensitivities
- Chronic no-effect thresholds have not been measured for all hazardous constituents and may need to be estimated from low-effect thresholds or acute exposure studies.

Data gaps that exist in this ERA include lack of available screening benchmarks for some chemicals,

particularly some of the VOCs. This is largely because screening benchmarks have been developed for the contaminants that are relatively toxic, bioaccumulate, and are typically detected in the environment. Therefore, the chemicals that could not be assessed because of a data gap are less likely to pose significant risk than those for which adequate toxicity data exist. No screening values were available for the detected volatile organic compounds (methyl acetate and methyl cyclohexane). However, volatile organic compounds are short-lived compounds once they are released into the environment. Most volatile organic compounds are readily metabolized by ecological receptors, and are therefore generally not bioaccumulative. Uptake by living organisms and accumulation in their tissues are not important fate processes for these chemicals. Therefore, there is little uncertainty associated with the lack of screening levels for these chemicals.

There is uncertainty associated particularly with the PCB TRV used for the short-tailed shrew in this evaluation. There have been no controlled laboratory studies of the reproductive effects of PCBs on shrews. Therefore, a reproductive TRV must be extrapolated from a surrogate species (the mink). Shrews are highly exposed to bioaccumulative soil contaminants due to their diet and rapid metabolism, and are known to accumulate high tissue levels of PCBs (USEPA 1993). However, there is evidence that suggests shrews are not especially sensitive to PCBs, and are certainly unlikely to be as sensitive as mink and mice.

Russell (1998) fed white-footed mice and short-tailed shrews a diet containing a range of PCB concentrations and investigated numerous PCB-induced responses including induction of cytochrome P-450 enzymes, body weight, and relative liver weight. Although reproductive endpoints were not included, the study provides some basis to compare the sensitivities of the two species. At food concentrations of 25 ppm, all responses measured in white-footed mice were significantly different than controls. In contrast, with one exception, none of the endpoints were significantly different than controls for short-tailed shrews at concentrations in food up to 214 ppm (certain cytochrome P450 isozymes were significantly induced at 214 ppm). These data suggest that short-tailed shrews are approximately 10 times less sensitive to PCBs than white-footed mice.

Boonstra and Bowman (2003) recently reported healthy and abundant shrew populations in areas with mean PCB concentrations in soil as high as 38 mg/kg. Mean, whole body PCB tissue residues in shrews from this area were found to be as high as 113 mg/kg, with no apparent adverse effect on the population. While not suitable for development of a dietary TRV, this study indicates qualitatively that shrews are relatively tolerant of high PCB exposure and body burdens.

Given this information, a more appropriate study for developing a PCB TRV for the shrew would be a study by Linder et al. (1974). In that study, Linder et al. exposed rats to Aroclor 1254 and 1260 in feed for two generations and evaluated the impacts to reproduction. Reproduction was not affected in rats exposed through two generations at dietary levels of 5 ppm Aroclor 1254 (0.32 mg/kg/day) and 100 ppm Aroclor 1260. While the dietary dose of PCBs predicted for the shrew that forages in the vacant lot (1.06 mg/kg/day) would exceed this alternative TRV for PCBs (0.32 mg/kg/day), the HQ would be two-fold lower than that presented in Table 7-8.

7.4.2 Uncertainty Associated with Elevated Detection Limits

For many undetected chemicals, there is uncertainty whether they could elicit adverse ecological effects as the detection limits for these chemicals exceed soil screening levels, preventing the ability to screen these chemicals out of further consideration in the ecological risk evaluation process. Therefore, the data for chemicals that were not detected were also screened using one-half the detection limit (Table 7-4). One-half the detection limit

for 1,2-dibromo-3-chloropropane; 2,4-dimethylphenol; 2,4-dinitrophenol; 2,6-dinitrotoluene; 2-chloronaphthalene; hexachlorobutadiene; naphthalene; pentachlorophenol; and total PCBs exceeded the soil screening levels. Detection limits for the volatile and semi-volatile constituents ranged from 0.17 to 0.79 mg/kg. Of these chemicals where one-half the detection limit exceeded the soil screening levels, only PCBs are bioaccumulative. Therefore, total PCBs were retained for further analysis, because of their bioaccumulative nature. Detected concentrations of PCBs also exceeded screening levels.

7.4.3 Uncertainty Associated with Bioaccumulation Factors

Concentrations of CoPCs in biota have not been measured at the site and Site-specific soil bioaccumulation tests were not conducted for this assessment. Instead, this assessment used soil-worm BAFs derived from the literature. However, the literature-derived BAFs are recognized as being conservative, thus it is likely that estimating exposure of small mammals to CoPCs in earthworms from the literature-derived BAFs led to an over-estimate, rather than underestimate, of risk.

7.4.4 Uncertainty Associated with the Food Chain Models

There are inherent uncertainties in the use of the food chain model because the model incorporates simplifying assumptions to represent a complex ecological system. For example, food chain models assume that contaminants in food and incidentally ingested soil are completely available to the receptor. This may overestimate risk depending on the fraction of the ingested dose that is available.

The actual diet of the shrew include a larger diversity of food types than are represented in this ERA. This assessment assumes that exposure from consumption of particular prey types can be estimated on the basis of concentrations in particular food items that are representative of the prey type. For example, the food chain model for the shrew assumes that measured concentrations in the earthworms accurately represent concentrations in other soil invertebrates that the shrew may consume. Because earthworms are probably the largest and most abundant soil invertebrates in the vacant lot, estimated concentrations in these species adequately represent concentrations in prey of the shrew. However, earthworms may contain higher lipid content and hence higher levels of lipophilic contaminants, such as PCBs, than other invertebrate prey of the shrew.

There is also uncertainty in the ingestion rates of shrew. However, studies were used that present conservative estimates of quantity of food and soil in the diet (Nagy, 2001; USEPA, 1993; Beyer and Fries (2003) to reduce the likelihood of underestimating risk.

7.5 Conclusions

At the end of the screening-level exposure estimate and risk calculation step, a scientific/management decision point is reached. The weight of evidence is considered, to decide (USEPA 1997):

1. There is adequate information to conclude that ecological risks are negligible, and therefore, there is no need for remediation on the basis of ecological risk;

2. The information is not adequate to make a decision at this point, and the ecological risk assessment process will continue; or

3. The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

There is adequate information to conclude that ecological risks are negligible at the Site. The Site is an active industrial site that has been in continuous operation since the early 1900s. The Site is located in an area of mixed industrial and commercial properties and residential neighborhoods. Almost all the land within the confines of the plant property has been developed, excavated, regraded, filled, or otherwise disturbed as a result of past and current plant operations. Only a very small portion of the land within the Site is undeveloped or undisturbed. No sensitive environments or protected species are known to occur in the Site vicinity. Only the vacant lot and wastewater aeration lagoon area north of Leith Street were found to provide habitat for ecological receptors. These areas were assessed by reviewing existing information (e.g., the NEDOCC) and by habitat characterization and pathways assessment. Soil data were screened for potential ecological effects to identify CoPCs. Manganese, selenium, zinc, and total PCBs were retained as the CoPCs for further evaluation in the screening-level exposure estimate and risk calculation. CoPC exposure was estimated using a food-web model for the short-tailed shrew, as it represents ecologically relevant receptor group that is the most highly exposed to the hazardous constituents, and it also considers the potentially complete exposure pathways at the Site. The results of the risk characterization showed that HQs are less than one for exposure to organic CoPCs in earthworm prey and soil, indicating that adverse ecological effects are unlikely. The HQ for shrew exposure to PCBs is 7.8, and would be 3.3, had a more realistic PCB TRV for shrews been used, as discussed in the Uncertainty Section (Section 7.4.1). HQs above one indicate some potential for adverse ecological effects but do not necessarily signify unacceptable risk. The habitat limitations of the vacant lot likely reduce exposure to a few individual shrews. Therefore, no further ERA is recommended for the vacant lot. In addition, any available habitat is disturbed by periodic mowing and is isolated in a region that is primarily industrial/commercial. Future uses of this portion of the Site are potentially light industrial and/or commercial development.

No further ERA is recommended for the wastewater aeration lagoon area, because one lagoon has been filled and closed, and there is no potential for current release of hazardous constituents from the remaining lagoon, because sludge was removed in 1994 and subsequent soil testing met required cleanup criteria. The lagoon is an industrial water body and is not a natural surface-water feature. Aquatic habitats, if any, are limited and disturbed, and any exposure by piscivorous wildlife is expected to be limited and incidental due to the presence of higher quality habitat associated with the Flint River. Consistent with its use as an industrial water body, potential future use of the remaining lagoon is for stormwater retention. The internal design review is currently underway for construction activities to convert the former lagoon for stormwater retention use. The conversion of the former lagoon into a stormwater retention pond will eliminate any potential ecological habitat that currently may exist there. Thus, any current exposure pathways at the wastewater aeration lagoon will be eliminated.

For these reasons, there is no need for further evaluation or remediation at the Site on the basis of ecological risk.

8. Conclusions

8.1 AOI Investigation Status Summary

Sections 4 and 5 of this report describe the RFI activities completed to investigate each AOI, including a summary of the analytical data collected. Based on the current understanding of Site conditions, sufficient data have been collected to characterize subsurface conditions at all 78 AOIs. Based on the findings of the RFI (including the Human Health Risk Evaluation and the Ecological Risk Evaluation) each AOI was classified into three groups, as discussed in the following subsections.

8.1.1 AOIs Requiring No Further Action

Based on the results of the RFI, 49 of the 79 AOIs investigated were found to require No Further Action. Table 8-1 lists the 49 AOIs determined to require no further action. This determination is based on a conservative approach in which the data were compared to generic MDEQ screening criteria and were also used to complete a human health risk assessment and ecological evaluation. Based on these evaluations, AOIs in this group do not pose a potential threat to human health and the environment.

8.1.2 AOIs That Do Not Contain LNAPL and Require Action Based on the Human Health Risk Evaluation

Of the AOIs that do not contain LNAPL, eight AOIs (02-A, 02-C, 09-A, 29-A, 81-1, 83/84-3, 84-A, and Building 94 Parking Lot) were determined to require further actions based on the results of the Human Health Risk Evaluation (Section 6). Table 8-2 lists the AOIs in this group and provides a summary of the risk evaluation results for each AOI. Final remedial action for these areas will be evaluated in the CMP.

8.1.3 AOIs with LNAPL

As a result of the RFI and previous investigations, LNAPL has been identified beneath various areas of the Site. Table 8-3 presents a summary of the AOIs with LNAPL. Of the 22 AOIs shown in Table 8-3, eight AOIs (02-B, 09-B, 12-A, 12-B, 36-1, 81-2, 83/84-2, and 86-1) require further action based on the Human Health Risk Evaluation due to potential exposure to soil and/or LNAPL. The LNAPL plumes associated with the 22 AOIs listed in Table 8-3 have been demonstrated to be relatively stable based on several years of routine monitoring. As previously summarized, GM has undertaken actions to collect LNAPL as described in previous sections of this report, and/or in the RFI Phase I Report (BBL, 2002). These actions will continue until the final remedial action is more fully evaluated in the CMP.

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