MEMO

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From:
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Date:
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Arcadis Project No.:
B0064410

Subject:
Buick City Building 09 Area Document Summary
Buick City Site, Flint, Michigan

This memo presents excerpts from site documents pertaining to investigations conducted at the former Building 09 Area of the Buick City Site (Site) located in Flint, Michigan. The Building 09 Area is located in the Southend of the Site and is bounded by Hamilton Avenue, North Industrial Ave, and CSX railroad property. Full copies of the reports discussed herein can be found on the RACER Trust website at http://www.racertrust.org/Properties/Detail?Id=12950.

Figure 1 presents the approximate areas of impact in the Building 09 Area (Areas 1 - 6). Please note that **Figure 1**, when referenced throughout this memo is referring to this figure, not a figure specific to one of the reports. All other figure references are from the specific report being discussed.

Also, please note that data were compared to the applicable criteria at the time of the writing of the report; which may or may not be consistent with current criteria.

DESCRIPTIONS OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET (2001 CCR)

Excerpts from the 2001 CCR pertaining specifically to the Building 09 Area are presented in **Attachment 1**. The excerpts include a description of the areas of interest (AOI) identified in the Building 09 Area and a summary of the Hamilton Ave Tank Farm investigations, along with the associated tables and figures.

The Hamilton Avenue Tank Farm, identified as AOI 09-5 in the 2001 CCR, corresponds to Area 2 indicated on **Figure 1**. Additionally, AOI 09-4 from the 2001 CCR, corresponds to Area 3 on **Figure 1**.

2002 RCRA FACILITY INVESTIGATION PHASE I REPORT (2002 RFI PHASE I)

Excerpts from the 2002 RFI Phase I pertaining specifically to the Building 09 Area are presented in **Attachment 2**. The excerpts include a description of investigation activities completed and databox figures.

The LNAPL impacts identified in the vicinity of 31-7 are associated with the Hamilton Avenue Tank Farm, identified as AOI 09-B in the 2002 RFI Phase I, corresponding to Area 2 indicated on **Figure 1.** The soil impacts identified on **Figure 4-23** in the vicinity of RFI-09-02 correspond to Area 3 and soil impacts at RFI-09-05 correspond to Area 4 on **Figure 1**. In addition, groundwater impacts identified in the vicinity of RFI-09-04 on **Figure 4-24** correspond to Area 6 on **Figure 1**.

2006 RCRA FACILITY INVESTIGATION PHASE II REPORT (2006 RFI PHASE II)

Excerpts from the 2006 RFI Phase II pertaining specifically to the Building 09 Area are presented in **Attachment 3**. The excerpts include a description of investigation activities completed, databox figures, and the Site risk assessment text, figures, and tables. Please note that the risk assessment (presented in the Section 6 text, **Figures 6-1** through **6-6** and **Tables 6-1** through **6-24**) includes discussions of all Site impacts and is not specific to the Building 09 Area.

The soil impacts identified on **Figure 4-23** in the vicinity of RFI-09-44 and RFI-09-45 correspond to Area 1 on **Figure 1**, soil impacts in the vicinity of RFI-09-02 correspond to Area 3, soil impacts at RFI-09-05 correspond to Area 4, and soil impacts at RFI-09-56 correspond to Area 5 on **Figure 1**.

The LNAPL impacts identified in the vicinity of 31-7 are associated with the Hamilton Avenue Tank Farm, identified as AOI 09-B in the 2006 RFI Phase II, corresponding to Area 2 indicated on **Figure 1.**

In addition, groundwater impacts identified in the vicinity of RFI-09-04 and RFI-09-53 on **Figure 4-24** correspond to Area 6 on **Figure 1**.

2008 REVISED CORRECTIVE MEASURES PROPOSAL (2008 CMP)

Excerpts from the 2008 CMP pertaining specifically to the Building 09 Area are presented in **Attachment 4**. The excerpts include a description of evaluated and proposed remedies. Please note that the groundwater monitoring plan (presented in the Section 5 text) is for the entire Site. The excerpt of **Table 5-1** and **Figure 5-2** present the portion of the plan that pertains to the Building 09 Area.

The soil impacts discussed as AOI Group 09-A in the 2008 CMP correspond to Area 3 on **Figure 1.**

The soil and LNAPL impacts discussed as AOI Group 09-B in the 2008 CMP correspond to Area 1, Area 2, and Area 5 on **Figure 1**.

2010 FINAL DECISION AND RESPONSE TO COMMENT FOR SOIL AND GROUNDWATER CLEANUP AT THE SOUTHEND OF THE FORMER GENERAL MOTORS CORPORATION NORTH AMERICAN OPERATIONS (OTHERWISE KNOWN AS BUICK CITY) (2010 FINAL DECISION)

Excerpts from the 2010 Final Decision pertaining to the Building 09 Area are presented in **Attachment 5**. The Corrective Measures to Address On-Site Contamination apply to Area 1, Area 3, and Area 5. The Corrective Measures to Address Off-Site Soil Contamination apply to the off-Site impacts associated with

Area 3. The Corrective Measures to Address the LNAPL Contamination apply to Area 2. The Corrective Measures to Address Groundwater Contamination applies to Area 6.

2010-2013 CORRECTIVE MEASURES IMPLEMENTATION ANNUAL REPORTS

From 2010 to 2013 Site corrective measures activities were documented in annual reports. Due to the size of the files, excerpts for these reports are not attached. However, a summary of the section, tables, figure, and appendices pertaining to the Building 09 Area are provided below.

Report	Text Section	Tables	Figures	Appendices
2010 CMI	2.1 LIF Investigation	1 and 2	2 and 3	A
	2.2 AOI 09-B Multi-Phase Extraction Pilot Testing			
	3.3 Groundwater Quality Program	3 through 9	9 and 11	
	4.1 AOI 09-A Lead Soil Impact Delineation Activities	12, 13, and 14	13 and 14	B and C
	4.2 Maintenance of Select Surface Covers		15	D
2011 CMI	2.3 AOI 09-B System Design and Installation		3 and 4	
	2.4 Natural Source Zone Depletion Study		5	
	3.2 Annual Groundwater Sampling Event	3 though 7	8 and 10	
	4.1 AOI 09-B South Lead Soil Impact Delineation Activities	11	12	
	4.2 Maintenance of Select Surface Covers		13	C
2012 CMI	2.1 LIF Investigation		2b and 3b	
	2.2 AOI 09-B System Design and Installation			B
	2.3 Natural Source Zone Depletion Study			
	3.2 Annual Groundwater Sampling Event	7 through 12	6, 8, and 10	
	4.1 Maintenance of Select Surface Covers			E
	4.3 CSX Property Lead Impacted Soil Removal			G
2013 CMI	2.3 LNAPL Remediation - AOI 09-B Operations and Maintenance	3	4 and 5	B
	3.2 Annual Groundwater Monitoring Program	7 through 11	7 and 9	D
	4.1 Off-Site Soil Excavation Activities	12 and 13	10 and 11	E
	4.2 Select Surface Covers		12 and 13	F

2014 ANNUAL GROUNDWATER MONITORING REPORT

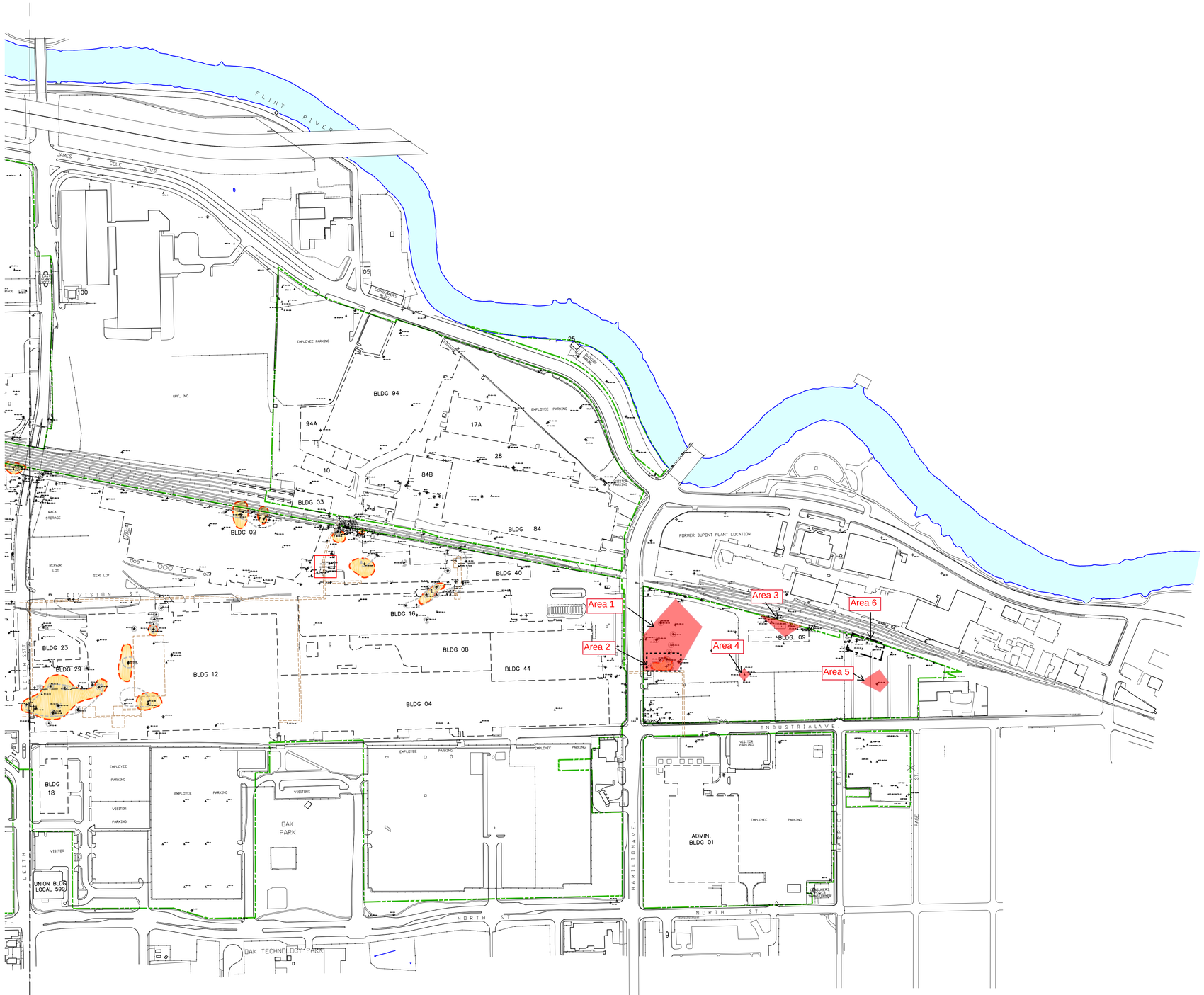
Excerpts from the 2014 Annual Groundwater Monitoring Report pertaining to the Building 09 Area are presented in **Attachment 6**. The groundwater impacts in the vicinity of RFI-09-11 correspond to Area 1 and the groundwater impacts in the vicinity of RFI-09-53 correspond to Area 6 (**Figure 1**).

2015 AOI 09-B MPE SYSTEM SHUTDOWN MEMO

The AOI 09-B System Shutdown Memo summarizes system operation and rationale to shut down the system (**Attachment 7**).

2015 ANNUAL GROUNDWATER MONITORING REPORT

Excerpts from the 2015 Annual Groundwater Monitoring Report pertaining to the Building 09 Area are presented in **Attachment 8**. The groundwater impacts in the vicinity of RFI-09-11 correspond to Area 1 and the groundwater impacts in the vicinity of RFI-09-53 correspond to Area 6 (**Figure 1**).



LEGEND:

- RACER PROPERTY BOUNDARY
- PROPERTY PREVIOUSLY OWNED BY RACER
- MONITORING WELL
- ABANDONED MONITORING WELL
- RFI SOIL BORING/GRAB GROUNDWATER SAMPLE LOCATION
- EVIDENCE OF PRODUCT OBSERVED IN SOIL
- LNAPL DETECTED INTERMITTENTLY AND/OR AT A THICKNESS <0.1 FT
- APPROXIMATE EXTENT OF HISTORICAL LNAPL
- APPROXIMATE CURRENT LIMITS OF MEASURABLE LNAPL 2013

0 250' 500'
APPROXIMATE SCALE IN FEET

NOTE:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED APRIL 2001, AT A SCALE OF 1:100. AERIAL IMAGE FROM ARCGIS 10 ONLINE MAPPING, ACCESSED 6/12/2013.
2. BASED ON INFORMATION AVAILABLE AS OF 02/15/2016.

RACER TRUST
BUICK CITY
FLINT, MICHIGAN

SITE WIDE - SOUTH END

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FIGURE
3

ATTACHMENT 1

Excerpts from –

Descriptions of Current Conditions for Areas South of Leith Street

3.3 Building 09 Area

The Building 09 Area is approximately 16 acres in size, triangular in shape, and generally bounded by the CSX Railroad tracks to the east, Industrial Avenue and the Building 01 Area to the west, and Hamilton Avenue to the north (see Figure 2). Building 09 and the related parking areas comprise the majority of this area. Building 09, constructed in 1997, is an approximately 15,000 ft^2, single-story structure used by plant maintenance for storing light construction equipment.

A total of seven AOIs have been identified within the Building 09 Area as a result of historical investigations. These AOIs, including several trench, pit, sump, and tank areas, have been designated as AOIs 09-1 through 09-7. Descriptions of these AOIs are provided in Table 2, while the corresponding locations are illustrated on Figure 4. A brief summary is provided below:

- One pit and one trench located within a material storage area in bay 1 of Building 09 have been identified as an AOI (AOI 09-1).

- One trench and an UST located within bays 3 through 14 of Building 09 have been identified as an AOI (AOI 09-2).

- One trench and an UST located within a vehicle wash area in bays 3 and 7 of Building 09 have been identified as an AOI (AOI 09-3).

- One sump area along the east side of Building 09 has been identified as an AOI (AOI 09-4). This sump is adjacent to the east side of Building 09 within a containment area associated with an AST identified below as Tank FF, which was used for fuel oil storage.

- Several ASTs/USTs have been identified within the Building 09 Area based on historical investigation activities, as well as a recent review of historical records, including Buick Motor Division Drawing No. 42361-M, dated 1973 and Flint Automotive Division Drawing No. C70444-M, dated 1991 (hereafter referred to as the 1973 Site drawing and the 1991 Site drawing, respectively and included in Appendices C and D, respectively). The

AST/UST-related AOIs for this area are briefly described in Table 2, with more details presented in Table 10. A brief summary is provided below:

- The 1973 Site drawing depicts a historical tank farm in the northwest corner of the employee parking lot at the southeast corner of Hamilton Avenue and Industrial Avenue. The 14 tanks included in this former tank farm are identified on the 1973 Site drawing as Tanks 81 through 92, 132, and 133. These tanks were reportedly removed during December 1986 as described in an August 22, 1997 Summary Report prepared by Global Environmental Engineering (Global, 1997a). This area is considered an AOI and has been designated AOI 09-5.

- The 1973 Site drawing depicts two additional ASTs, MM and FF, as having existed along the east side of Building 09. Tank MM reportedly contained No. 1 diesel oil and had a capacity of 6,000 gallons, while Tank FF reportedly contained No. 2 fuel oil and had a capacity of 12,000 gallons. The location of Tank FF appears to correlate with Tank 09-2 illustrated on the 1991 Site drawing. The location of this tank as shown on these two drawings also generally correlates with the location of the sump area identified above as AOI 09-4, adjacent to the east side of Building 09. Since this general area is considered an AOI based on the presence of the sump (AOI 09-5) described above, a separate AOI designation has not been assigned to the specific area of Tank FF. As for Tank MM, although the area of this tank was not identified as an AOI in the PR/VSI Report, this tank was identified in the 1973 Site drawing and is considered an AOI (AOI 09-6).

- An additional AOI has been identified based on historical investigation activities. This area, designated AOI 09-7, is west of Building 09. This paved area was used for storing light equipment, and exhibited staining.

4.2.1 Hamilton Avenue Tank Farm Investigation

According to Global (1997a), a total of thirteen 12,000-gallon USTs containing several different products (unleaded gasoline, anti-freeze, BOPS [solvent], power-steering fluid, 93 PS thinner, 55 PS thinner, 105 PS thinner, and No. 1 diesel oil) were associated with the Hamilton Avenue Tank Farm (referred to as AOI 09-5 in Section 3.3). This tank farm was located at the south end of the Site on the southeast corner of Hamilton Avenue and Industrial Avenue within the Building 09 Area. Ten of the USTs associated with this tank farm were installed in 1960, with the remaining two installed in 1979. These USTs were removed in 1986, and a confirmed release number (C-028-90) was assigned to the tank farm at that time.

Between July 1996 and June 1997, a total of 11 soil borings (31-1 through 31-11; see Figure 24) and five monitoring wells (31-1 [MW-1]), 31-2 [MW-2], 31-3 [MW-3], 31-4S [MW-4S], and 31-4D [MW-4D]; see Figure 24) were installed within and near the former UST area. The results of soil analysis at these locations indicated the presence of VOCs (benzene, toluene, ethylbenzene, and total xylenes [BETX], polynuclear aromatics (PNAs) (fluoranthene, fluorene, naphthalene, and 2-methylnaphthalene), metals (total lead), benzyl chloride, propylene glycol, p,m-cresol, o-cresol, di-n-butyl phthalate, and di-n-octyl phthalate. Likewise, the results of groundwater analysis in this area indicated the presence of VOCs (BETX), PNAs (naphthalene and 2-methylnaphthalene), di-n-butyl phthalate, diethyl phthalate, and 4,6-dinitro-2-methylphenol. Table 11 provides a summary of the data, with further information provided in Appendix F.

Additionally, GM has conducted groundwater monitoring in this area since 1997 as part of a Facilitywide semiannual groundwater monitoring program. As a component of this program, semiannual groundwater samples have been collected for VOCs, PCBs, and metals analysis from all five monitoring wells in this area. The results of this monitoring program are summarized in Section 4.4.

4.4 Semiannual Groundwater Investigations

As noted in Section 4.2, beginning in 1997, GM has conducted a Facilitywide semiannual groundwater monitoring program, involving a total of 14 monitoring wells within the Site. Specifically, this program has involved five wells in the Hamilton Avenue Tank Farm Area (31-1 [MW-1], 31-2 [MW-2], 31-3 [MW-3], 31-4S [MW-4S], and 31-4D [MW-4D]; see Figure 24), three wells in the Building 02/40 UST area (40-1 [MW-1], 40-2 [MW-2], 40-3 [MW-3]; see Figure 24), and six wells in the Tank Farm Area (84-1 [EW-101], 84-2 [EW-102], 84-3 [EW-103], 84-4 [EW-105], 84-6 [MW-15]; see Figure 24). This monitoring has primarily consisted of semiannual groundwater sample collection and analysis for VOCs, PCBs, and metals.

The results of this monitoring primarily indicated elevated levels of BETX in groundwater in these areas. Table 11 provides a summary of these data, with further information provided in Appendix K.

TABLE 2
GENERAL MOTORS CORPORATION
NAO-FLINT OPERATIONS - FLINT, MICHIGAN

DESCRIPTION OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET

AREAS OF INTEREST (AOIs) -- BUILDING 09 AREA

AOI Id.	AOI Type	Approximate Location (column/bay within bldg., unless otherwise noted)	AOI Description	Samples Collected?	Sample Analytical Results
Building 09 Area					
09-1	Pit	1	2'x2'x4' pit with associated floor drains.	No	
	Trench	1	12'x2'x6" trench that leads to a pit.	No	
09-2	Trench	9	145'x1'x1' floor trench leading to UST.	No	
	Tank-UST	7	Unknown size 1,000 gallon + UST. The UST connects to process waste.	No	
09-3	Trench	7	Three 2'x2'x unknown depth floor drains over holding tank in "vehicle wash area." Trench drains to 1,000+ gallon UST.	No	
	Tank-UST	7	"Vehicle wash area" holding tank, 1,000+ gallon UST.	No	
09-4	AST	East side of Building 09	Former 12,000-gallon No. 2 fuel oil AST (Tank FF on 1973 Site Drawing).	No	
	Sump	East side of Building 09	20'x20'x2' concrete containment for former 12,000-gallon fuel oil AST (Tank FF on 1973 Site Drawing).	Sample collected from sump area (3/25/99)	3" deep concrete core analyzed for metals and PCBs. No PCBs detected above laboratory analytical detection limits (0.33 mg/kg). Various metals detected.
09-5	Tank-AST	Corner of Hamilton Ave. & Industrial Ave.	Former tank farm which included Tanks 81 through 92, 132, and 133 identified on 1973 Site Drawing.	Yes	Soil and groundwater sample results contained in Global, 1997a. See Section 4.2.
09-6	Tank-AST	East of Building 09	Tanks MM identified on 1973 Site Drawing.	No	
09-7	Additional	West of Building 09	Area used to store light equipment. Staining noticed on pavement.	No	

TABLE 11
GENERAL MOTORS CORPORATION
NAO-FLINT OPERATIONS - FLINT, MICHIGAN

DESCRIPTION OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET

SUMMARY OF DETECTED CONSTITUENTS

Constituent	Total Number of Samples Taken	Number of Detection Above Laboratory Detection Limits	Concentration (parts per billion)	
			Minimum	Maximum
Hamilton Ave. Tank Farm (Global 1997a) - Soil				
Benzene	31	4	20	60
Toluene	31	10	20	51000
Ethylbenzene	31	9	30	31700
Total Xylenes	31	9	20	73000
Total Lead	31	30	1300	8400
Napthalene	31	2	400	3200
Flouranthene	31	1	400	400
Flouorene	31	1	300	300
2-Methylnaphthalene	31	2	420	1500
Phenanthrene	31	1	500	500
Benzyl Chloride	12	1	2300	2300
p,m-Cersol	8	1	1600	1600
o-Cresol	8	1	1000	1000
Di-n-butyl phthalate	8	1	900	900
Di-n-octyl phthalate	8	1	400	400
Hamilton Ave. Tank Farm (Global 1997a) - Groundwater				
Benzene	14	9	1	600
Toluene	14	9	2	149000
Ethylbenzene	14	10	2	15200
Total Xylenes	14	10	6	57600
Napthalene	14	5	12	50
Di-n-butyl phthalate	5	2	10	20
Diethyl phthalate	1	1	30	30
4,6-Dinitro-2-methylphenol	1	1	10	10
2-Methylnaphthalene	14	2	16	35
Dichlorodifluormethane	5	2	148	178

TABLE 11
GENERAL MOTORS CORPORATION
NAO-FLINT OPERATIONS - FLINT, MICHIGAN

DESCRIPTION OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET

SUMMARY OF DETECTED CONSTITUENTS

Semiannual Groundwater Monitoring (ATC, 1997, 1998a, 1998b, 1998c, and 1999) - Groundwater				
1,1,1-Trichloroethane	1	111	4	4
1,1-Dichloroethane	4	111	3	8
1,1-Dichloroethene	2	110	2	2
2-Methylnaphthalene	6	67	8	18

TABLE 11
GENERAL MOTORS CORPORATION
NAO-FLINT OPERATIONS - FLINT, MICHIGAN

DESCRIPTION OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET

SUMMARY OF DETECTED CONSTITUENTS

Constituent	Total Number of Samples Taken	Number of Detection Above Laboratory Detection Limits	Concentration (parts per billion)	
			Minimum	Maximum
Arsenic	32	80	2	30
Barium	79	80	40	210
Benzene	19	79	43	2500
Chromium	4	80	1	3
cis-1,2-Dichloroethene	2	56	3	8
Copper	18	80	10	320
Dichlorodifluoromethane	1	103	1	1
Ethylbenzene	26	79	2	10700
Lead	7	80	5	9
Methylene Chloride	2	111	2	2.3
MTBE	4	16	10	60
Naphthalene	9	67	7	39
Selenium	2	80	4.4	8.6
Silver	7	80	3.6	16
Toluene	27	79	1.5	67700
Total Xylenes	27	79	2	43200
trans-1,2-Dichloroethene	1	111	2	2
Trichloroethene	2	111	2	2
Vinyl Chloride	1	111	2	2
Zinc	72	79	10	230

Notes:

1. ATC, 1997, 1998a, 1998b, 1998c, and 1999 = Refers to Semiannual Monitoring Reports, dated April 23, 1997; November 30, 1998; January 7, 1998; May 4, 1998; and October 7, 1999 and prepared by ATC Associates, Inc.

2. Eneco, 1996 = Refers to a report entitled: "Site Investigation and Hydrogeological Report Fenceline/CSX Investigation, General Motors Corporation, NAO-Flint Operations Site, Flint, Michigan", dated March 1996 and prepared by EnecoTech Midwest Inc.

3. Global, 1997a = Refers to report entitled: "Summary Report, Building 31/Hamilton Avenue Tank Farm, GM-CLCD North, NAO Flint Operations, Flint, Michigan", dated August 22, 1997 and prepared by Global Environmental Engineering, Inc.

4. Global, 1997b = Refers to a report entitled: "Summary Report, Building 40, Tanks 071/40N - 074/40N, GM-CLCD North, NAO Flint Operations, Flint, Michigan", dated September 9, 1997 and prepared by Global Environmental Engineering, Inc.

5. Global, 1997c = Refers to a report entitled: "Initial Assessment Report, Tanks #71/40N-74/40N, GM-CLCD North, NAO Flint Operations, Flint, Michigan", dated June 12, 1997 and prepared by Global Environmental Engineering, Inc.

6. Global, 1997d - Refers to a report entitled: "Initial Assessment Report, Tank #67/02 - 70/02, GM-CLCD North, NAO Flint Operations, Flint, Michigan", dated June 12, 1997 and prepared by Global Environmental Engineering, Inc.

7. Global, 1997e = Refers to report entitled: "Summary Report, Building 02, Tanks 67/02 - 70/02, GM-CLCD North, NAO Flint Operations, Flint, Michigan, dated September 9, 1997 and prepared by Global Environmental Engineering, Inc.

8. Global, 1997f = Refers to report entitled: "Summary Report, Former Tank Farm 94 Document Review, GM-CLCD North, NAO Flint Operations, Flint, Michigan, dated October 1997 and prepared by Global Environmental Engineering, Inc.

FIRST FLOOR PLAN

0 10' 20'
GRAPHIC SCALE

09-7 TANK FARM AREA LOCATED APPROXIMATELY 400' NORTHWEST, AT THE CORNER OF HAMILTON AVENUE AND INDUSTRIAL AVENUE.

LEGEND:

- TRENCH
- SUMP
- PIT
- TANK
- ADDITIONAL
- 09-10 AOI NUMBER

NOTES:

1. BASE MAP SUPPLIED BY GENERAL MOTORS CORPORATION, POWERTRAIN DIVISION, FLINT, MICHIGAN, DRAWING NO. C71255-C, DATED 5/1/91, @ A SCALE OF 1" = 200'.
2. AOI LOCATIONS ARE APPROXIMATE, AND, AS APPROPRIATE, ARE BASED ON EITHER THE EPA'S 1987 PRELIMINARY REVIEW/VISUAL SITE ASSESSMENT REPORT, OR HISTORICAL SITE INVESTIGATION ACTIVITIES.
3. CORRELATED UNITS HAVE BEEN ASSIGNED DUPLICATIVE AOI DESIGNATIONS.

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS

DESCRIPTION OF CURRENT CONDITIONS FOR AREAS SOUTH OF LEITH STREET

BUILDING 09 AREA
AOI LOCATION PLAN

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4

X 86980X00.DWG
L: ON=*, OFF=*REF*
P: STD-POP/DL
5/24/00 SYR-54-CBM NES JER
86934010/80004/86980G05.DWG

ATTACHMENT 2

Excerpts from –

2002 RCRA Facility Investigation Phase I Report

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. Ten soil borings, two soil boring/temporary wells, and two monitoring wells were installed to assess potential screening criteria exceedances in this area. 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 locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	14	11	13	12	7 + 1Ba, 5 Pb, and 9 Mn	--	--
Groundwater	4	5	5	5	2	5	5

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.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (mg/kg)	Screening Criteria Exceeded (concentration)
Benzo(a)pyrene	57	IDC (10)
Dibenzo(a,h)anthracene	11	IDC (10)
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.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (µg/L)	Screening Criteria Exceeded (concentration)
Trichloroethene	9.3	IDW (5.0)
Vinyl chloride	3.8	IDW (2.0)
Lead	26	IDW (4.0)

4.5.36.3 Conclusions

The RFI soil and groundwater data from AOI 09-A indicate that screening criteria were exceeded. The physical extent of exceedances of PAHs has been defined; however, the physical extent of the exceedances of lead, manganese, and VOCs have not been defined. Based on these results, the following additional activities are planned:

- Three shallow soil borings (RFI-09-33 through -35) will be installed to delineate the manganese exceedance;
- Four shallow soil borings (RFI-09-36 through -39) will be installed to delineate the lead exceedance;
- Monitoring wells RFI-09-32 and MW-25 will be sampled for VOCs and inorganic constituents during the next round of groundwater sampling; and
- Monitoring well MW-26 will be sampled for VOCs during the next round of groundwater sampling.

Further action is pending the outcome of the next round of data collection.

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. Four soil borings, one soil boring/temporary well, and nine monitoring wells were installed to assess potential screening criteria exceedances 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 locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Total PCBs	Total Inorganics	Dissolved PCBs	Dissolved Inorganics
Soil	14	25	19	22	18 + 6Ba and 6Pb	--	--
Groundwater	15	16	11	11	3 + 6 CN/Hg	11	11 + 2Ba and 2Pb

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

The concentrations of constituents detected in the soil samples from AOI 09-B do not exceed the applicable screening criteria. A summary of soil analytical data is presented in Appendix C.

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.

Constituent Detected Above Screening Criteria	Maximum Concentration Detected (µg/L)	Screening Criteria Exceeded (concentration)
Benzene	930	IDW (5.0)
Total PCBs	1.7	IDW (0.5)
Antimony	6.8	IDW (6.0)
Arsenic	61	IDW (50)
Lead	5.8	IDW (4.0)
Selenium	52	IDW (50)

4.5.37.3 Conclusions

The RFI soil data from AOI 09-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 09-B indicate that screening criteria were exceeded for benzene, total PCBs, and several inorganic constituents. The physical extent of these exceedances has not been defined. Based on these results, one monitoring well (RFI-09-41) will be installed to assess the physical extent of the screening criteria exceedances. In addition, existing monitoring wells MW-22, MW-23, and MW-24 will be sampled for inorganic constituents during the next round of groundwater sampling. Further action is pending the outcome of the next round of data collection.

The physical extent of LNAPL detected in monitoring well 31-7 has not been defined. Based on these results, one monitoring well (RFI-09-40) will be installed to define the downgradient extent of LNAPL detected in this area.

RFI-09-13			
Depth:	0–2	4–6	6–8
Benzene	ND(0.037)	ND(0.044)	ND(0.044)
Carbon tetrachloride	ND(0.037)	ND(0.044)	ND(0.044)
Trichloroethene	ND(0.037)	ND(0.044)	ND(0.044)
Vinyl chloride	ND(0.037)	ND(0.044)	ND(0.044)
Lead	150	11 J	15

RFI-09-14			
Depth:	0–2	2–4	6–8
Benzene	ND(0.036)	ND(0.037)[ND(0.037)]	ND(0.046)
Carbon tetrachloride	ND(0.036)	ND(0.037)[ND(0.037)]	ND(0.046)
Trichloroethene	ND(0.036)	ND(0.037)[ND(0.037)]	ND(0.046)
Vinyl chloride	ND(0.036)	ND(0.037)[ND(0.037)]	ND(0.046)
Lead	63 J	36[29 J]	16

RFI-09-07		
Depth:	1–3	3–5
Benzene	0.019 J	0.052 J[ND(0.041)]
Carbon tetrachloride	ND(0.039)	ND(0.041)[ND(0.041)]
Trichloroethene	ND(0.039)	ND(0.041)[ND(0.041)]
Vinyl chloride	ND(0.039)	ND(0.041)[ND(0.041)]
Benzo(a)anthracene	0.0817 J	ND(0.2)[ND(0.2)]
Benzo(a)pyrene	0.0965 J	ND(0.2)[ND(0.2)]
Benzo(b)fluoranthene	0.114 J	ND(0.2)[ND(0.2)]
bis(2-Ethylhexyl)phthalate	0.18 J	ND(0.2)[ND(0.2)]
Dibenzo(a,h)anthracene	ND(0.19)	ND(0.2)[ND(0.2)]
Indeno(1,2,3-cd)pyrene	0.0466 J	ND(0.2)[ND(0.2)]
Antimony	0.23 J	ND(0.41)[0.41 J]
Arsenic	7.2 J	5.7 J[11 J(RDC)]
Lead	150 J	35 J[170 J]
Manganese	510	270[440]
Selenium	0.57 J	ND(1.6)[ND(1.8)]
Total PCBs	ND(0.039)	ND(0.04)[ND(0.041)]

RFI-09-10	
Depth:	0.8–2
Benzene	ND(0.041)
Carbon tetrachloride	ND(0.041)
Trichloroethene	ND(0.041)
Vinyl chloride	ND(0.041)
Benzo(a)anthracene	ND(0.2)
Benzo(a)pyrene	ND(0.2)
Benzo(b)fluoranthene	ND(0.2)
bis(2-Ethylhexyl)phthalate	ND(0.2)
Dibenzo(a,h)anthracene	ND(0.2)
Indeno(1,2,3-cd)pyrene	ND(0.2)
Antimony	1.0 J
Arsenic	10(RDC)
Lead	530 J(RDC)
Manganese	440 J
Selenium	0.62 J
Total PCBs	ND(0.041)

RFI-09-01	
Depth:	1–3
Benzene	ND(0.043)
Carbon tetrachloride	0.054
Trichloroethene	0.11
Vinyl chloride	ND(0.043)
Benzo(a)anthracene	0.613
Benzo(a)pyrene	0.531
Benzo(b)fluoranthene	0.596
bis(2-Ethylhexyl)phthalate	ND(0.21)
Dibenzo(a,h)anthracene	0.141 J
Indeno(1,2,3-cd)pyrene	0.391
Antimony	0.63 J
Arsenic	0.68 J
Lead	120000 DJ(RPSIC,RDC,IPSIC,IDC)
Manganese	630
Selenium	ND(1.6)
Total PCBs	0.069

RFI-09-16	
Depth:	1–3
Lead	3800(RDC,IDC)
Total PCBs	ND(0.041)

RFI-09-17
Not yet installed

RFI-09-32
Installed 3/5/02

RFI-09-08		
Depth:	1–3	5–7
Benzene	ND(0.039)	0.55
Carbon tetrachloride	ND(0.039)	ND(0.04)
Trichloroethene	ND(0.039)	ND(0.04)
Vinyl chloride	ND(0.039)	ND(0.04)
Benzo(a)anthracene	ND(0.18)	0.114 J
Benzo(a)pyrene	ND(0.18)	0.0984 J
Benzo(b)fluoranthene	ND(0.18)	0.0954 J
bis(2-Ethylhexyl)phthalate	0.136 J	0.0991 J
Dibenzo(a,h)anthracene	ND(0.18)	ND(0.19)
Indeno(1,2,3-cd)pyrene	ND(0.18)	0.0647 J
Antimony	0.18 J	0.21 J
Arsenic	3.8 J	6.9 J
Lead	4.0 J	110
Manganese	270	460
Selenium	ND(1.9)	ND(1.8)
Total PCBs	ND(0.038)	ND(0.04)

RFI-09-09		
Depth:	0.7–2.7	4.7–6.7
Benzene	ND(0.038)	ND(0.038)
Carbon tetrachloride	ND(0.038)	ND(0.038)
Trichloroethene	0.014 J	ND(0.038)
Vinyl chloride	ND(0.038)	ND(0.038)
Benzo(a)anthracene	0.0594 J	ND(0.19)
Benzo(a)pyrene	0.0576 J	ND(0.19)
Benzo(b)fluoranthene	0.0609 J	ND(0.19)
bis(2-Ethylhexyl)phthalate	ND(0.18)	0.0727 J
Dibenzo(a,h)anthracene	ND(0.18)	ND(0.19)
Indeno(1,2,3-cd)pyrene	ND(0.18)	ND(0.19)
Antimony	ND(0.42)	ND(0.36)
Arsenic	6.3 J	1.8 J
Lead	72 J	11 J
Manganese	300	72
Selenium	ND(1.7)	ND(1.4)
Total PCBs	ND(0.038)	ND(0.038)

RFI-09-06		
Depth:	0.5–2.5	2.5–4.5
Benzene	0.055	0.16
Carbon tetrachloride	ND(0.038)	ND(0.04)
Trichloroethene	ND(0.038)	ND(0.04)
Vinyl chloride	ND(0.038)	ND(0.04)
Benzo(a)anthracene	1.173 J	1.396 J
Benzo(a)pyrene	0.914 J	1.32 J
Benzo(b)fluoranthene	0.862 J	1.542 J
bis(2-Ethylhexyl)phthalate	ND(0.19)	0.102 J
Dibenzo(a,h)anthracene	ND(0.19)	ND(0.2)
Indeno(1,2,3-cd)pyrene	ND(0.19)	0.495 J
Antimony	R	R
Arsenic	7.2	4.1
Lead	88	200
Manganese	1400	1100
Selenium	ND(0.82)	0.61 J
Total PCBs	0.23	ND(0.041)

RFI-09-11		
Depth:	0.5–2.5	2.5–4.5
Benzene	ND(0.037)	ND(0.039)
Carbon tetrachloride	ND(0.037)	ND(0.039)
Trichloroethene	ND(0.037)	ND(0.039)
Vinyl chloride	ND(0.037)	ND(0.039)
Benzo(a)anthracene	0.056 J	ND(0.2)
Benzo(a)pyrene	0.0426 J	ND(0.2)
Benzo(b)fluoranthene	0.182 J	ND(0.2)
bis(2-Ethylhexyl)phthalate	ND(0.18)	ND(0.2)
Dibenzo(a,h)anthracene	ND(0.18)	ND(0.2)
Indeno(1,2,3-cd)pyrene	ND(0.18)	ND(0.2)
Antimony	ND(0.40)	ND(0.45)
Arsenic	3.4	5.4
Lead	4.8	7.7
Manganese	140 J	360 J
Selenium	ND(0.73)	ND(0.82)
Total PCBs	0.036	ND(0.04)

RFI-09-12		
Depth:	0.6–2.6	6–8
Benzene	ND(0.039)	ND(0.038)[ND(0.039)]
Carbon tetrachloride	ND(0.039)	ND(0.038)[ND(0.039)]
Trichloroethene	ND(0.039)	ND(0.038)[ND(0.039)]
Vinyl chloride	ND(0.039)	ND(0.038)[ND(0.039)]
Benzo(a)anthracene	4.81 DJ	ND(0.19)[ND(0.19)]
Benzo(a)pyrene	4.09 J(RDC)	ND(0.19)[ND(0.19)]
Benzo(b)fluoranthene	3.78 J	ND(0.19)[ND(0.19)]
bis(2-Ethylhexyl)phthalate	ND(0.19)	ND(0.19)[ND(0.19)]
Dibenzo(a,h)anthracene	0.488 J	ND(0.19)[ND(0.19)]
Indeno(1,2,3-cd)pyrene	1.61 J	ND(0.19)[ND(0.19)]
Antimony	ND(0.43)	ND(0.39)[ND(0.41)]
Arsenic	7.4	4.0[5.6]
Lead	300	6.7[8.0]
Manganese	1300 J	240 J[310 J]
Selenium	ND(0.78)	ND(0.71)[3.3]
Total PCBs	0.06	ND(0.039)[ND(0.039)]

RFI-09-27	
Depth:	0.7–2.7
Total PCBs	0.037

RFI-09-26	
Depth:	0.7–2.7
Total PCBs	0.112

RFI-09-19	
Depth:	0.5–2.5
Benzo(a)anthracene	8.6 DJ
Benzo(a)pyrene	9.17 DJ(RDC)
Benzo(b)fluoranthene	8.11 DJ
bis(2-Ethylhexyl)phthalate	ND(0.19)
Dibenzo(a,h)anthracene	ND(0.19)
Indeno(1,2,3-cd)pyrene	10.1 J

RFI-09-03		
Depth:	0.4–2	2–4
Benzene	0.029 J	ND(0.039)
Carbon tetrachloride	ND(0.039)	ND(0.039)
Trichloroethene	0.075	ND(0.039)
Vinyl chloride	ND(0.039)	ND(0.039)
Benzo(a)anthracene	50.2(RDC)	0.0476 J
Benzo(a)pyrene	56.5 J(RDC,IDC)	0.0521 J
Benzo(b)fluoranthene	56.9 J(RDC)	0.045 J
bis(2-Ethylhexyl)phthalate	ND(9.4)	ND(0.19)
Dibenzo(a,h)anthracene	11 J(RDC,IDC)	ND(0.19)
Indeno(1,2,3-cd)pyrene	22.2 J(RDC)	ND(0.19)
Antimony	0.34 J	R
Arsenic	10(RDC)	3.5
Lead	370 J	8.5 J
Manganese	310	140
Selenium	0.52 J	ND(1.5)
Total PCBs	2.1	ND(0.039)

RFI-09-20		
Depth:	0.5–2.5	
Benzo(a)anthracene	0.476	
Benzo(a)pyrene	0.617 J	
Benzo(b)fluoranthene	0.681 J	
bis(2-Ethylhexyl)phthalate	ND(0.19)	
Dibenzo(a,h)anthracene	ND(0.19)	
Indeno(1,2,3-cd)pyrene	0.238 J	

RFI-09-22		
Depth:	0–2	2–4
Manganese	160	270

RFI-09-04		
Depth:	0–2	2–4
Benzene	ND(0.038)	0.064
Carbon tetrachloride	ND(0.038)	ND(0.039)
Trichloroethene	ND(0.038)	0.017 J
Vinyl chloride	ND(0.038)	ND(0.039)
Benzo(a)anthracene	0.2 J	0.467
Benzo(a)pyrene	0.195 J	0.706
Benzo(b)fluoranthene	0.195 J	0.653
bis(2-Ethylhexyl)phthalate	0.0959 J	ND(0.19)
Dibenzo(a,h)anthracene	ND(0.18)	ND(0.19)
Indeno(1,2,3-cd)pyrene	0.15 J	0.324
Antimony	R	ND(0.40)
Arsenic	2.8	5.1
Lead	32	270
Manganese	910	8300(RPSIC,IPSIC)
Selenium	0.58 J	0.54 J
Total PCBs	0.028	ND(0.04)

RFI-09-23		
Depth:	0–2	2–4
Benzene	NS	0.034 J
Carbon tetrachloride	NS	0.24(RSVA)
Trichloroethene	NS	ND(0.039)
Vinyl chloride	NS	ND(0.039)
Benzo(a)anthracene	NS	0.0797 J
Benzo(a)pyrene	NS	0.128 J
Benzo(b)fluoranthene	NS	0.112 J
bis(2-Ethylhexyl)phthalate	NS	ND(0.19)
Dibenzo(a,h)anthracene	NS	ND(0.19)
Indeno(1,2,3-cd)pyrene	NS	0.287 J
Manganese	290	170
Total PCBs	NS	0.059

RFI-09-25		
Depth:	0–2	2–4
Manganese	3900(RPSIC,IPSIC)	510

RFI-09-24		
Depth:	0–2	2–4
Manganese	3100(IPSIC)	95[85]

RFI-09-05		
Depth:	0.5–2	6–8
Benzene	0.13[0.099]	0.024 J
Carbon tetrachloride	ND(0.037)[ND(0.036)]	ND(0.041)
Trichloroethene	0.043[0.063]	ND(0.041)
Vinyl chloride	ND(0.037)[ND(0.036)]	ND(0.041)
Benzo(a)anthracene	0.821 J[0.792 J]	ND(0.2)
Benzo(a)pyrene	0.867 J[0.841 J]	ND(0.2)
Benzo(b)fluoranthene	0.715 J[0.817 J]	ND(0.2)
bis(2-Ethylhexyl)phthalate	ND(1.8)[ND(1.8)]	ND(0.2)
Dibenzo(a,h)anthracene	ND(1.8)[ND(1.8)]	ND(0.2)
Indeno(1,2,3-cd)pyrene	0.423 J[0.466 J]	ND(0.2)
Antimony	R[R]	R
Arsenic	6.0[7.1]	6.6
Lead	100 J[140 J]	7.8 J
Manganese	380[440]	370
Selenium	ND(1.4)[ND(1.5)]	ND(1.6)
Total PCBs	10.1(RDC)[6.2(RDC)]	0.099

RFI-09-29	
Depth:	0.3–1.7
Total PCBs	0.512

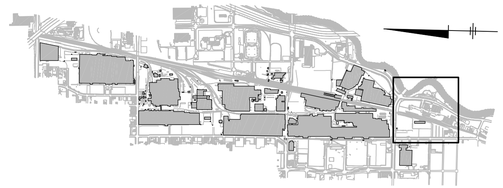
RFI-09-28		
Depth:	0.5–2.5	
Benzene	0.046	
Carbon tetrachloride	ND(0.038)	
Trichloroethene	ND(0.038)	
Vinyl chloride	ND(0.038)	
Benzo(a)anthracene	0.403 J	
Benzo(a)pyrene	0.447 J	
Benzo(b)fluoranthene	0.338 J	
bis(2-Ethylhexyl)phthalate	ND(0.18)	
Dibenzo(a,h)anthracene	ND(0.18)	
Indeno(1,2,3-cd)pyrene	0.472 J	
Total PCBs	0.089	

RFI-09-15		
Depth:	0.5–1.5	1.9–3.9
Benzene	ND(0.038)	ND(0.039)
Carbon tetrachloride	ND(0.038)	ND(0.039)
Trichloroethene	0.83	0.12
Vinyl chloride	ND(0.038)	ND(0.039)
Benzo(a)anthracene	3.42 J	1.47 J
Benzo(a)pyrene	2.92 J(RDC)	1.63 J
Benzo(b)fluoranthene	3.6 J	1.31 J
bis(2-Ethylhexyl)phthalate	R	ND(0.19)
Dibenzo(a,h)anthracene	R	ND(0.19)
Indeno(1,2,3-cd)pyrene	1.79 J	1.92 J
Lead	720(RDC)	2200(RDC,IDC)
Total PCBs	2.6	2.6

RFI-09-02		
Depth:	0.4–2	2–4
Benzene	0.007 J	0.039 J
Carbon tetrachloride	ND(0.038)	ND(0.042)
Trichloroethene	0.15	0.17
Vinyl chloride	0.047(RSVA)	0.021 J
Benzo(a)anthracene	1 J	0.169 J
Benzo(a)pyrene	1.48 J	0.146 J
Benzo(b)fluoranthene	1.57 J	0.137 J
bis(2-Ethylhexyl)phthalate	1.31 J	ND(0.2)
Dibenzo(a,h)anthracene	R	ND(0.2)
Indeno(1,2,3-cd)pyrene	R	0.0825 J
Antimony	0.29 J	R
Arsenic	4.7	5.9
Lead	6900 J(RDC,IDC)	3100 J(RDC,IDC)
Manganese	320	100
Selenium	ND(1.6)	ND(1.7)
Total PCBs	7.6(RDC)	ND(0.042)

RFI-09-18		
Depth:	1–3	
Lead	1400(RDC,IDC)	
Total PCBs	0.068	

RFI-09-21	
Depth:	0.5–2.5
Benzo(a)anthracene	0.164 J
Benzo(a)pyrene	0.201 J
Benzo(b)fluoranthene	0.165 J
bis(2-Ethylhexyl)phthalate	ND(0.19)
Dibenzo(a,h)anthracene	ND(0.19)
Indeno(1,2,3-cd)pyrene	0.253 J



SITE LOCATION

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE AOI BOUNDARY
- AOI 81-1 — AOI ID
- BASEMENT AREA
- 04-140 — HISTORICAL MONITORING WELL LOCATION
- RFI-12-13 — DECOMMISSIONED/ABONDONED MONITORING WELL
- RFI-83/84-03 — RFI SOIL BORING LOCATION
- RFI-09-02 — RFI SOIL BORING/GRAB GROUNDWATER SAMPLING LOCATION
- RFI-09-01 — RFI MONITORING WELL LOCATION
- EP 94-02C — PROPOSED SOIL BORING LOCATION
- RFI-09-41 — PROPOSED MONITORING WELL LOCATION
- AREA WHERE MEASURABLE LNAPL HAS BEEN DETECTED
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- ESTIMATED LIMITS OF MEASURABLE LNAPL
- EXCEEDS MICHIGAN PART 201 GENERIC SCREENING CRITERIA:
  IDC – INDUSTRIAL DIRECT CONTACT
  IPSIC – INDUSTRIAL PARTICULATE SOIL INHALATION

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. SAMPLE LOCATIONS ARE APPROXIMATE.
3. POTENTIOMETRIC SURFACE CONTOURS BASED ON WATER LEVEL MEASUREMENTS TAKEN SEPTEMBER 10–11, 2001.
4. CONSTITUENTS PRESENTED HERE ARE THOSE WHICH EXCEEDED ONE OR MORE MICHIGAN PART 201 GENERIC RESIDENTIAL AND/OR INDUSTRIAL SCREENING CRITERIA IN SOIL OR GROUNDWATER SAMPLES COLLECTED IN THE AREA SHOWN ON THIS FIGURE.
5. ALL CONCENTRATIONS PRESENTED IN DRY-WEIGHT MILLIGRAMS PER KILOGRAM (mg/kg).
6. ND (0.039) – CONSTITUENT NOT DETECTED. ASSOCIATED DETECTION LIMIT PRESENTED IN PARENTHESES.
7. DUPLICATE ANALYSES PRESENTED IN BRACKETS.
8. NS – SAMPLE NOT ANALYZED FOR THIS CONSTITUENT
9. J – ESTIMATED CONCENTRATION
10. RDC – EXCEEDS MICHIGAN PART 201 RESIDENTIAL DIRECT CONTACT CRITERIA.
11. RPSIC – EXCEEDS MICHIGAN PART 201 RESIDENTIAL SOIL PARTICULATE INHALATION CRITERIA.

0 150' 300'
GRAPHIC SCALE

X: 64410X00, 64410X01, 64410X02, 64410X03.DWG
LMAN: X01X02X03GREY
P: PAGESET/PLT-DL
6/25/02 SYR-54-NES RLP LAF
64410101/64410C29.DWG

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE – FLINT, MICHIGAN
RFI PHASE I REPORT

SOIL ANALYTICAL DATA BUILDING 09 AREA

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-23

MW-23	
Well	
Date:	2/27/02
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
bis(2-Ethylhexyl)phthalate	NS
Dibenzo(a,h)anthracene	NS
Indeno(1,2,3-cd)pyrene	NS
Antimony(f)	NS
Arsenic(f)	NS
Lead(f)	NS
Manganese(f)	NS
Selenium(f)	NS
Total PCBs	NS
Total PCBs(f)	NS

RFI-09-14	
Well	
Date:	10/3/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
bis(2-Ethylhexyl)phthalate	NS
Dibenzo(a,h)anthracene	NS
Indeno(1,2,3-cd)pyrene	NS
Antimony(f)	NS
Arsenic(f)	NS
Lead(f)	ND(0.4)
Manganese(f)	NS
Selenium(f)	NS
Total PCBs	NS
Total PCBs(f)	NS

MW-22	
Well	
Date:	2/27/02
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
bis(2-Ethylhexyl)phthalate	NS
Dibenzo(a,h)anthracene	NS
Indeno(1,2,3-cd)pyrene	NS
Antimony(f)	NS
Arsenic(f)	NS
Lead(f)	NS
Manganese(f)	NS
Selenium(f)	NS
Total PCBs	NS
Total PCBs(f)	NS

MW-24	
Well	
Date:	2/28/02
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
bis(2-Ethylhexyl)phthalate	NS
Dibenzo(a,h)anthracene	NS
Indeno(1,2,3-cd)pyrene	NS
Antimony(f)	NS
Arsenic(f)	NS
Lead(f)	NS
Manganese(f)	NS
Selenium(f)	NS
Total PCBs	NS
Total PCBs(f)	NS

RFI-09-13	
Well	
Date:	10/3/01
Benzene	280 D(RDW,IDW)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
bis(2-Ethylhexyl)phthalate	NS
Dibenzo(a,h)anthracene	NS
Indeno(1,2,3-cd)pyrene	NS
Antimony(f)	NS
Arsenic(f)	NS
Lead(f)	ND(0.4)
Manganese(f)	NS
Selenium(f)	NS
Total PCBs	NS
Total PCBs(f)	NS

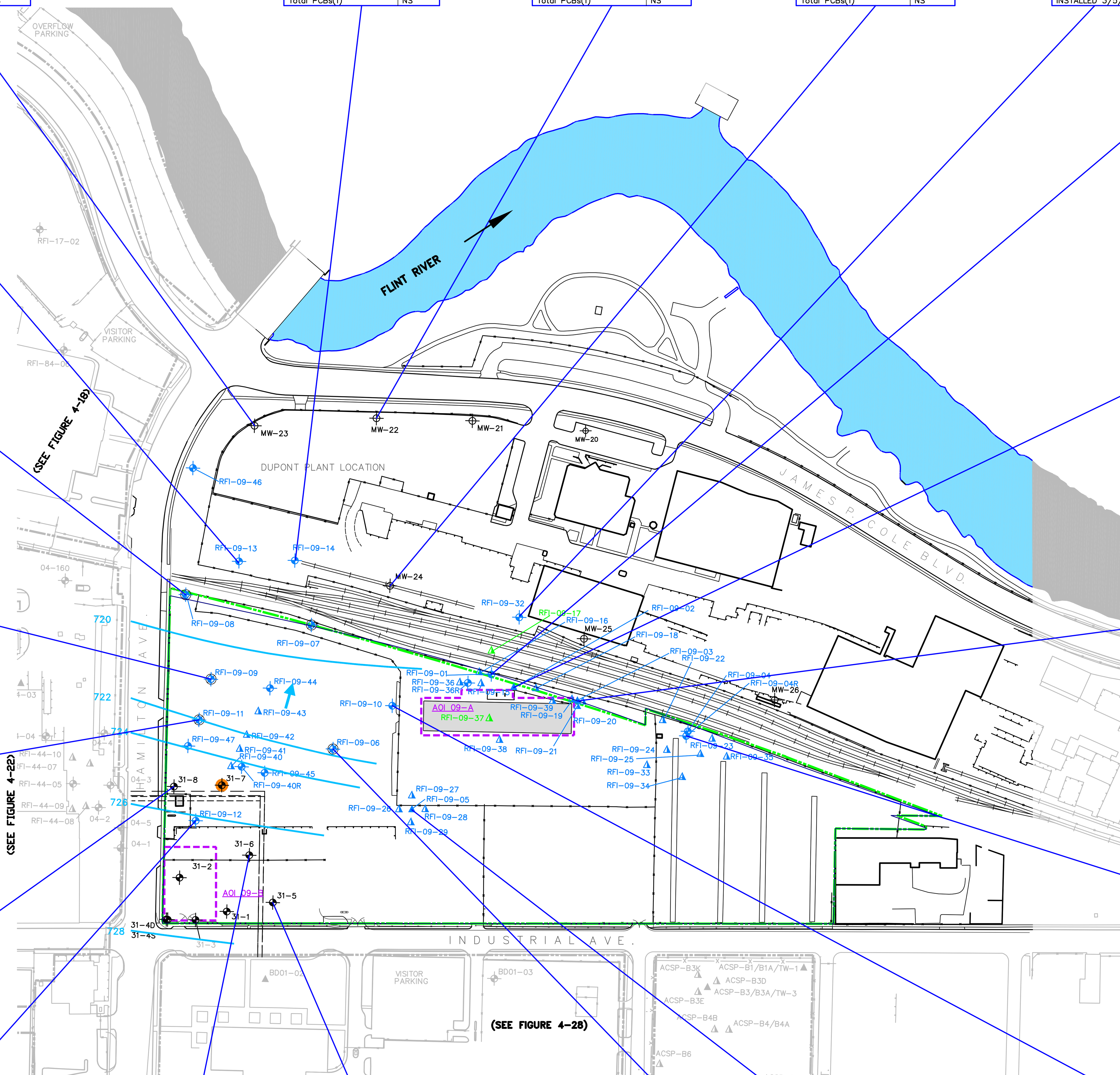
RFI-09-08	
Well	
Date:	9/14/01
Benzene	270 D(RDW,IDW)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony(f)	ND(1.2)
Arsenic(f)	7.5
Lead(f)	2.1
Manganese(f)	130
Selenium(f)	52(RDW,IDW)
Total PCBs	ND(0.16)
Total PCBs(f)	0.047

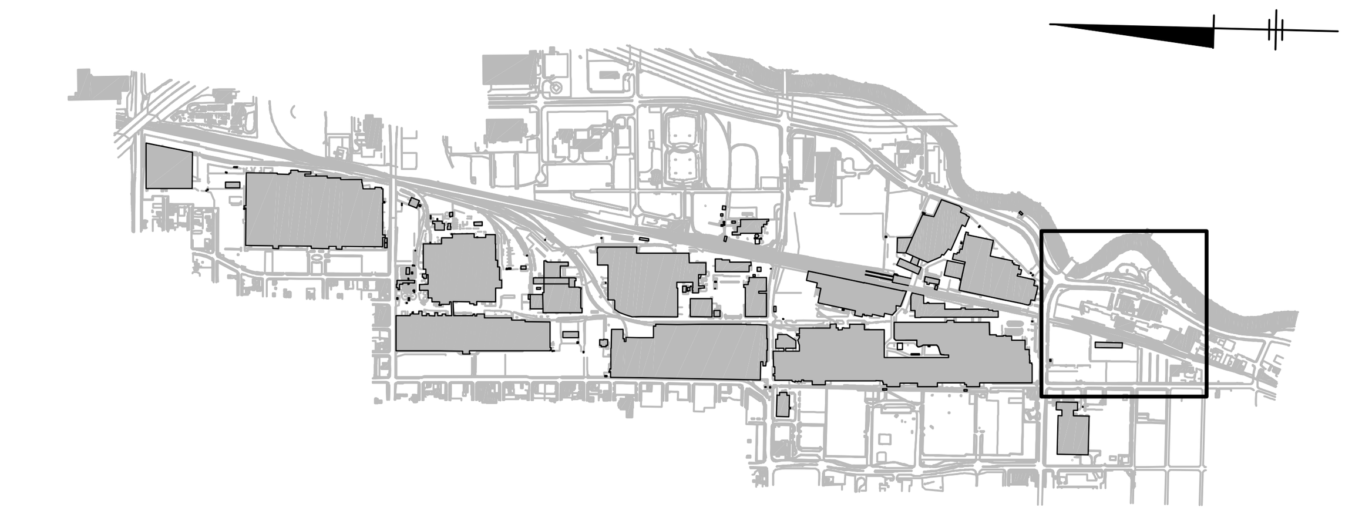
RFI-09-09	
Well	
Date:	9/17/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.1)
Benzo(a)pyrene	ND(2.1)
Benzo(b)fluoranthene	ND(2.1)
bis(2-Ethylhexyl)phthalate	ND(5.3)
Dibenzo(a,h)anthracene	ND(2.1)
Indeno(1,2,3-cd)pyrene	ND(2.1)
Antimony(f)	ND(1.2)
Arsenic(f)	2.4
Lead(f)	ND(0.4)
Manganese(f)	810
Selenium(f)	ND(1.4)
Total PCBs	0.095
Total PCBs(f)	ND(0.1)

RFI-09-11	
Well	
Date:	9/17/01
Benzene	800 D(RDW,IDW)[830 D(RDW,IDW)]
Carbon tetrachloride	ND(1.0)[ND(1.0)]
Trichloroethene	ND(1.0)[ND(1.0)]
Vinyl chloride	ND(1.0)[ND(1.0)]
Benzo(a)anthracene	ND(1.0)[ND(1.0)]
Benzo(a)pyrene	ND(2.0)[ND(2.0)]
Benzo(b)fluoranthene	ND(2.0)[ND(2.0)]
bis(2-Ethylhexyl)phthalate	ND(5.0)[ND(5.0)]
Dibenzo(a,h)anthracene	ND(2.0)[ND(2.0)]
Indeno(1,2,3-cd)pyrene	ND(2.0)[ND(2.0)]
Antimony(f)	ND(1.2)[ND(1.2)]
Arsenic(f)	3.5[2.6]
Lead(f)	0.42[ND(0.4)]
Manganese(f)	280[210]
Selenium(f)	ND(1.4)[ND(1.4)]
Total PCBs	0.24[0.26]
Total PCBs(f)	0.26[0.3]

31-8	
Well	
Date:	9/17/01
Benzene	930 D(RDW,IDW)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony(f)	ND(1.2)
Arsenic(f)	16
Lead(f)	5.8(RDW,IDW)
Manganese(f)	160
Selenium(f)	ND(1.4)
Total PCBs	ND(0.11)
Total PCBs(f)	ND(0.11)

RFI-09-32
INSTALLED 3/5/02





SITE LOCATION

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE AOI BOUNDARY
- AOI 81-1 — AOI ID
- BASEMENT AREA
- 04-140 — HISTORICAL MONITORING WELL LOCATION
- RFI-12-13 — DECOMMISSIONED/ABONDONED MONITORING WELL
- RFI-83/84-03 — RFI SOIL BORING LOCATION
- RFI-09-02 — RFI SOIL BORING/GRAB GROUNDWATER SAMPLING LOCATION
- RFI-09-01 — RFI MONITORING WELL LOCATION
- EP 94-02C — PROPOSED SOIL BORING LOCATION
- RFI-09-41 — PROPOSED MONITORING WELL LOCATION
- AREA WHERE MEASURABLE LNAPL HAS BEEN DETECTED
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- ESTIMATED LIMITS OF MEASURABLE LNAPL
- EXCEEDS MICHIGAN PART 201 GENERIC SCREENING CRITERIA:
  IDW-INDUSTRIAL DRINKING WATER
  GCC-GROUNDWATER CONTACT
  GAI-GROUNDWATER ACUTE INHALATION

RFI-09-01	
Well	
Date:	9/14/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	1.5
Vinyl chloride	3.8(RDW,IDW)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony(f)	ND(1.2)
Arsenic(f)	9.8
Lead(f)	1.4
Manganese(f)	64
Selenium(f)	11
Total PCBs	ND(0.1)
Total PCBs(f)	0.06

RFI-09-02	
Grab	
Date:	5/30/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	1.9
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(5.0)
Benzo(a)pyrene	ND(5.0)
Benzo(b)fluoranthene	ND(5.0)
bis(2-Ethylhexyl)phthalate	3.39 J
Dibenzo(a,h)anthracene	ND(5.0)
Indeno(1,2,3-cd)pyrene	ND(5.0)
Antimony(f)	ND(1.2)
Arsenic(f)	1.5
Lead(f)	26(RDW,IDW)
Manganese(f)	49
Selenium(f)	7
Total PCBs	0.14
Total PCBs(f)	ND(0.1)

RFI-09-03	
Grab	
Date:	5/29/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(5.0)
Benzo(a)pyrene	ND(5.0)
Benzo(b)fluoranthene	ND(5.0)
bis(2-Ethylhexyl)phthalate	863 D(RDW,IDW,GCC,GAI)
Dibenzo(a,h)anthracene	ND(5.0)
Indeno(1,2,3-cd)pyrene	ND(5.0)
Antimony(f)	ND(1.2)
Arsenic(f)	3.3 J
Lead(f)	0.56 J
Manganese(f)	880(RDW)
Selenium(f)	ND(1.4)
Total PCBs	0.046
Total PCBs(f)	ND(0.11)

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. SAMPLE LOCATIONS ARE APPROXIMATE.
3. POTENTIOMETRIC SURFACE CONTOURS BASED ON WATER LEVEL MEASUREMENTS TAKEN SEPTEMBER 10-11, 2001.
4. CONSTITUENTS PRESENTED HERE ARE THOSE WHICH EXCEEDED ONE OR MORE MICHIGAN PART 201 GENERIC RESIDENTIAL AND/OR INDUSTRIAL SCREENING CRITERIA IN SOIL OR GROUNDWATER SAMPLES COLLECTED IN THE AREA SHOWN ON THIS FIGURE.
5. ALL CONCENTRATIONS PRESENTED IN MICROGRAMS PER LITER (ug/L).
6. ND (1.0)-CONSTITUENT NOT DETECTED. ASSOCIATED DETECTION LIMIT PRESENTED IN PARENTHESES.
7. DUPLICATE ANALYSES PRESENTED IN BRACKETS.
8. f-FILTERED SAMPLE.
9. J-ESTIMATED CONCENTRATION.
10. RDW-EXCEEDS MICHIGAN PART 201 RESIDENTIAL DRINKING WATER CRITERIA.
11. GSI CRITERIA COMPARED TO SAMPLES LOCATED WITHIN 500 FEET OF THE FLINT RIVER.

0 150' 300'
GRAPHIC SCALE

RFI-09-04	
Well	
Date:	11/28/01
Benzene	ND(1.0)[ND(1.0)]
Carbon tetrachloride	ND(1.0)[ND(1.0)]
Trichloroethene	9.3(RDW,IDW)[9.3(RDW,IDW)]
Vinyl chloride	ND(1.0)[ND(1.0)]
Benzo(a)anthracene	ND(1.0)[ND(1.1)]
Benzo(a)pyrene	ND(2.0)[ND(2.1)]
Benzo(b)fluoranthene	ND(2.0)[ND(2.1)]
bis(2-Ethylhexyl)phthalate	ND(5.0)[ND(5.3)]
Dibenzo(a,h)anthracene	ND(2.0)[ND(2.1)]
Indeno(1,2,3-cd)pyrene	ND(2.0)[ND(2.1)]
Antimony	ND(1.2)[0.36 J]
Antimony(f)	ND(1.2)[ND(1.2)]
Arsenic	ND(1)[0.5 J]
Arsenic(f)	ND(1)[ND(1)]
Lead	ND(0.4)[ND(0.4)]
Lead(f)	ND(0.4)[ND(0.4)]
Manganese	22[22]
Manganese(f)	23[23]
Selenium	3 J[2.8 J]
Selenium(f)	4 J[4.8 J]
Total PCBs	ND(0.11)[ND(0.1)]
Total PCBs(f)	ND(0.11)[ND(0.11)]

RFI-09-12	
Well	
Date:	12/13/01
Benzene	10(RDW,IDW)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	4.73 J
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony	1 J
Antimony(f)	ND(1.2)
Arsenic	61(RDW,IDW)
Arsenic(f)	43
Lead	1.9
Lead(f)	ND(0.4)
Manganese	110
Manganese(f)	69
Selenium	4.5 J
Selenium(f)	ND(1.4)
Total PCBs	ND(0.11)
Total PCBs(f)	ND(0.11)

31-6	
Well	
Date:	9/17/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.1)
Benzo(a)pyrene	ND(2.1)
Benzo(b)fluoranthene	ND(2.1)
bis(2-Ethylhexyl)phthalate	ND(5.3)
Dibenzo(a,h)anthracene	ND(2.1)
Indeno(1,2,3-cd)pyrene	ND(2.1)
Antimony(f)	ND(1.2)
Arsenic(f)	ND(1)
Lead(f)	ND(0.4)
Manganese(f)	4.5
Selenium(f)	ND(1.4)
Total PCBs	ND(0.11)
Total PCBs(f)	ND(0.11)

31-5	
Well	
Date:	9/17/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony(f)	ND(1.2)
Arsenic(f)	ND(1)
Lead(f)	ND(0.4)
Manganese(f)	5
Selenium(f)	ND(1.4)
Total PCBs	0.29
Total PCBs(f)	1.69(RDW,IDW)

RFI-09-06	
Well	
Date:	9/13/01
Benzene	14(RDW,IDW)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony	ND(1.2)
Antimony(f)	ND(1.2)
Arsenic	16
Arsenic(f)	17
Lead	3
Lead(f)	ND(0.4)
Manganese	200
Manganese(f)	140
Selenium	1.9
Selenium(f)	14
Total PCBs	ND(0.1)
Total PCBs(f)	ND(0.14)

RFI-09-05	
Grab	
Date:	5/29/01
Benzene	0.13 J
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(5.0)
Benzo(a)pyrene	ND(5.0)
Benzo(b)fluoranthene	ND(5.0)
bis(2-Ethylhexyl)phthalate	107(RDW,IDW)
Dibenzo(a,h)anthracene	ND(5.0)
Indeno(1,2,3-cd)pyrene	ND(5.0)
Antimony(f)	ND(1.2)
Arsenic(f)	ND(1)
Lead(f)	ND(0.4)
Manganese(f)	78
Selenium(f)	14 J
Total PCBs	0.12
Total PCBs(f)	ND(0.1)

RFI-09-10	
Well	
Date:	9/13/01
Benzene	ND(1.0)
Carbon tetrachloride	ND(1.0)
Trichloroethene	ND(1.0)
Vinyl chloride	ND(1.0)
Benzo(a)anthracene	ND(1.0)
Benzo(a)pyrene	ND(2.0)
Benzo(b)fluoranthene	ND(2.0)
bis(2-Ethylhexyl)phthalate	ND(5.0)
Dibenzo(a,h)anthracene	ND(2.0)
Indeno(1,2,3-cd)pyrene	ND(2.0)
Antimony	3.1 J
Antimony(f)	6.8 J(RDW,IDW)
Arsenic	2.8
Arsenic(f)	2.4
Lead	1.3
Lead(f)	ND(0.66)
Manganese	130
Manganese(f)	110
Selenium	1.4
Selenium(f)	ND(5.6)
Total PCBs	ND(0.14)
Total PCBs(f)	ND(0.12)

X: 64410X00, 64410X01, 64410X02, 64410X03.DWG
LMAN: X01X02X03GREY
P: PAGESET/PLT-DL
6/25/02 SYR-54-NES RLP LAF
64410101/64410C41.DWG

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
RFI PHASE I REPORT

GROUNDWATER ANALYTICAL DATA BUILDING 09 AREA

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
4-24

ATTACHMENT 3

Excerpts from –

2006 RCRA Facility Investigation Phase II Report

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.

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

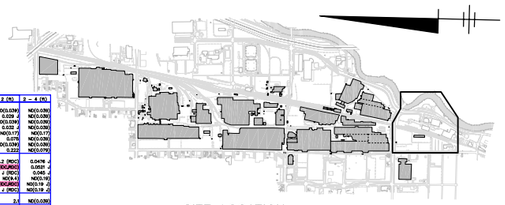
The risk assessment evaluated the significance of potential exposures of recreational users to constituents in groundwater and/or storm sewer water via contact with nearby downgradient surface water in the Flint River. None of the estimated surface water concentrations exceed the criteria except PCBs. 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.



SITE LOCATION

LEGEND

- GM PROPERTY BOUNDARY
- PROPERTY PREVIOUSLY OWNED BY GM (STILL SUBJECT TO RCRA CORRECTIVE ACTION)
- DEMOLISHED BUILDING
- BUILDING CURRENTLY IDLED
- APPROXIMATE AOI BOUNDARY
- AOI 81-1 — AOI ID
- BASEMENT/TUNNEL AREA
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL
- 04-140 — HISTORICAL MONITORING WELL LOCATION
- RFI-83/84-03 — RFI SOIL BORING LOCATION
- RFI-09-02 — RFI SOIL BORING/GRAB GROUNDWATER SAMPLING LOCATION
- RFI-09-01 — RFI MONITORING WELL LOCATION
- RFI-12-13 — DECOMMISSIONED/DESTROYED MONITORING WELL
- RFI-36-01 — RFI PIEZOMETER
- FORMER RIVER GAUGE LOCATION
- CURRENT RIVER GAUGE LOCATION
- LOCATION WHERE MEASURABLE LNAPL HAS BEEN DETECTED FROM MARCH 2004 TO JULY 2005
- LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- EXCEEDS MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA:
  - IDC – INDUSTRIAL DIRECT CONTACT
  - IPSIC – INDUSTRIAL PARTICULATE SOIL INHALATION

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED SEPTEMBER 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. FOR ALL METALS, SITE-SPECIFIC BACKGROUND CONCENTRATIONS ARE SUBTRACTED FROM THE MEASURED CONCENTRATIONS PRIOR TO COMPARING TO PART 201 CRITERIA.
4. CONSTITUENTS PRESENTED HERE ARE THOSE WHICH EXCEED ONE OR MORE MICHIGAN PART 201 GENERIC RESIDENTIAL AND/OR INDUSTRIAL SCREENING CRITERIA IN SOIL OR GROUNDWATER SAMPLES COLLECTED IN THE AREA SHOWN ON THIS FIGURE.
5. ALL CONCENTRATIONS PRESENTED IN DRY-WEIGHT MILLIGRAMS PER KILOGRAM (mg/kg).
6. ALL DEPTH IN FEET.
7. ND (0.039)–CONSTITUENT NOT DETECTED. ASSOCIATED DETECTION LIMIT PRESENTED IN PARENTHESES.
8. DUPLICATE ANALYSES SEPARATED BY SLASHES (/).
9. NS–NOT ANALYZED FOR THIS CONSTITUENT.
10. J–ESTIMATED CONCENTRATION.
11. D–CONCENTRATION BASED ON A DILUTED SAMPLE ANALYSIS.
12. R–RESULT REJECTED DURING DATA VALIDATION.
13. RDC – EXCEEDS MICHIGAN PART 201 RESIDENTIAL DIRECT CONTRACT CRITERIA
14. RPSIC – EXCEEDS MICHIGAN PART 201 RESIDENTIAL PARTICULATE SOIL INHALATION CRITERIA.
15. RSVIA – EXCEEDS MICHIGAN PART 201 RESIDENTIAL SOIL VOLATILIZATION TO INDOOR AIR CRITERIA.

0 150' 300'
GRAPHIC SCALE

JULY 2006

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE – FLINT, MICHIGAN
RFI PHASE II REPORT

SOIL ANALYTICAL DATA - FORMER BUILDING 09 AREA

BBL BLASLAND, BOUCK & LEE, INC. engineers, scientists, economists

FIGURE 4-23

X: 64410X01.DWG, X02.DWG, X03.DWG, X06.DWG
L: ON=* OFF=*REF* , GRAYX01|SHD–BUILDING, *|HIST_SB* *GRAYX03|NAPL–*, *|RFI_SS_PIEZ, *|LNAPL–SHD, GRAYX01|PROPERTY
P: PAGESET/SYR–DL
7/11/06 SYR–85–NES LAF GMS
64410112/RFI–06/64410C23.DWG

RFI-09-13	10/3/2001	6/26/2002	3/26/2003	10/4/2004
VOC				
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.01)
Benzene	0.28 D (GSI,IDW,RDW)	0.28 D (GSI,IDW,RDW)	0.45 D (GSI,IDW,RDW)	1.21 (GSI,IDW,RDW)
Carbon tetrachloride	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.01)
Ethylbenzene	0.0046	0.0053	0.0048	0.003 J
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.05)
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.01)
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.01)
Xylenes (total)	0.0414 (GSI)	0.04 (GSI)	0.0405 (GSI)	0.058 J (GSI)
Inorganic				
Antimony	NS	ND(0.0012)	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	NS	NS
Manganese	NS	NS	NS	NS
Selenium	NS	ND(0.0014)	NS	ND(0.005)
Inorganic-Dissolved				
Antimony	NS	ND(0.0012)	NS	NS
Arsenic	NS	NS	NS	NS
Lead	ND(0.0004)	NS	NS	NS
Manganese	NS	NS	NS	NS
Selenium	NS	ND(0.0024)	NS	NS

RFI-09-46	12/19/2002	4/1/2003	10/5/2004
VOC			
1,1,1-Trichloroethane	ND(0.001) /ND(0.001)	ND(0.001)	ND(0.001)
Benzene	0.7 D (GSI,IDW,RDW) /0.68 D (GSI,IDW,RDW)	0.5 D (GSI,IDW,RDW)	0.049 (IDW,RDW)
Carbon tetrachloride	ND(0.001 J) /ND(0.001)	ND(0.001)	ND(0.001)
Ethylbenzene	0.0019 /0.0018	0.0016	0.0004 J
Methylene chloride	ND(0.005) /ND(0.005)	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001) /ND(0.001)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001) /ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	0.0532 (GSI) /0.0508 (GSI)	0.0447 (GSI)	0.019 J
Inorganic			
Antimony	ND(0.0012) /ND(0.0012)	NS	NS
Arsenic	0.0022 J /0.002 J	NS	NS
Lead	0.00048 J /ND(0.0004)	NS	NS
Manganese	0.065 J /0.059 J	NS	NS
Selenium	ND(0.0016) /ND(0.0016)	NS	ND(0.005)

MW-23	2/27/2002	6/25/2002	3/20/2003	10/4/2004
VOC				
1,1,1-Trichloroethane	ND(0.001 J)	NS	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	NS	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	NS	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	NS	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	NS	ND(0.002)	ND(0.001)
Inorganic				
Antimony	NS	ND(0.0012)	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	NS	NS
Manganese	NS	NS	NS	NS
Selenium	NS	0.0007 J	NS	ND(0.005)

RFI-09-14	10/3/2001	6/26/2002	3/31/2003	10/4/2004
VOC				
1,1,1-Trichloroethane	ND(0.001)	NS	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	NS	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	NS	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	NS	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	NS	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	NS	ND(0.002)	ND(0.001)
Inorganic				
Antimony	NS	0.00071 J	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	NS	NS
Manganese	NS	NS	NS	NS
Selenium	NS	ND(0.0025)	NS	ND(0.005)
Inorganic-Dissolved				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	ND(0.0004)	NS	NS	NS
Manganese	NS	NS	NS	NS
Selenium	NS	NS	NS	NS

MW-22	2/27/2002	6/25/2002	3/20/2003
VOC			
1,1,1-Trichloroethane	ND(0.001 J)	NS	ND(0.001)
Benzene	ND(0.001)	NS	ND(0.001)
Carbon tetrachloride	ND(0.001)	NS	ND(0.001)
Ethylbenzene	ND(0.001)	NS	ND(0.001)
Methylene chloride	ND(0.005)	NS	ND(0.005)
Trichloroethene	ND(0.001)	NS	ND(0.001)
Vinyl chloride	ND(0.001)	NS	ND(0.001)
Xylenes (total)	ND(0.002)	NS	ND(0.002)
Inorganic			
Antimony	NS	ND(0.0012)	NS
Arsenic	NS	NS	NS
Lead	NS	NS	NS
Manganese	NS	NS	NS
Selenium	NS	0.00073 J	NS

RFI-09-55S	4/8/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.0005 J
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.01
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.013 J

MW-21	3/20/2003
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.002)

RFI-09-55D	4/8/2005
VOC	
1,1,1-Trichloroethane	ND(0.01)
Benzene	0.84 (IDW,RDW)
Carbon tetrachloride	ND(0.01)
Ethylbenzene	0.07
Methylene chloride	0.007 J (IDW,RDW)
Trichloroethene	ND(0.01)
Vinyl chloride	ND(0.01)
Xylenes (total)	0.35 J

RFI-09-07	6/21/2002	10/5/2004
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)
Benzene	0.052 J (IDW,RDW)	0.007 (IDW,RDW)
Carbon tetrachloride	ND(0.001)	ND(0.001)
Ethylbenzene	0.062 J	0.018
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)
Xylenes (total)	0.0719 J	0.015 J
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	ND(0.0001)	NS
PCB-Dissolved		
Total PCBs	ND(0.0001)	NS
Inorganic		
Antimony	0.00058 J	NS
Arsenic	0.002	NS
Lead	0.00096	NS
Manganese	0.044	NS
Selenium	0.00087 J	NS
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	0.0016	NS
Lead	ND(0.0004)	NS
Manganese	0.032	NS
Selenium	ND(0.0014)	NS

MW-24	2/28/2002	6/26/2002	3/20/2003
VOC			
1,1,1-Trichloroethane	ND(0.001 J)	NS	ND(0.001)
Benzene	ND(0.001)	NS	ND(0.001)
Carbon tetrachloride	ND(0.001)	NS	ND(0.001)
Ethylbenzene	ND(0.001)	NS	ND(0.001)
Methylene chloride	ND(0.005)	NS	ND(0.005)
Trichloroethene	ND(0.001)	NS	ND(0.001)
Vinyl chloride	ND(0.001)	NS	ND(0.001)
Xylenes (total)	ND(0.002)	NS	ND(0.002)
Inorganic			
Antimony	NS	0.00059 J	NS
Arsenic	NS	NS	NS
Lead	NS	NS	NS
Manganese	NS	NS	NS
Selenium	NS	ND(0.0014)	NS

RFI-09-08	9/14/2001	6/21/2002	3/21/2003
VOC			
1,1,1-Trichloroethane	ND(0.001)	ND(0.001 J)	ND(0.001)
Benzene	0.27 D (IDW,RDW)	0.0089 (IDW,RDW)	0.2 D (IDW,RDW)
Carbon tetrachloride	ND(0.001)	ND(0.001 J)	ND(0.001)
Ethylbenzene	0.062	0.0011	0.097 D
Methylene chloride	ND(0.005)	ND(0.005)	0.0074 (IDW,RDW)
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	0.267	0.00064 J	0.117
SVOC			
Benzo(a)anthracene	ND(0.001)	NS	NS
Benzo(a)pyrene	ND(0.002)	NS	NS
Benzo(b)fluoranthene	ND(0.002)	NS	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS	NS
Dibenz(a,h)anthracene	ND(0.002)	NS	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS	NS
PCB			
Total PCBs	ND(0.00016)	NS	NS
PCB-Dissolved			
Total PCBs	0.000047 J	NS	NS
Inorganic			
Antimony	NS	0.00039 J	NS
Arsenic	NS	0.0025	NS
Lead	NS	0.0014	NS
Manganese	NS	0.058	NS
Selenium	NS	0.00068 J	NS
Inorganic-Dissolved			
Antimony	ND(0.0012)	NS	NS
Arsenic	0.0075	NS	NS
Lead	0.0021	NS	NS
Manganese	0.13	NS	NS
Selenium	0.052 (IDW,RDW)	NS	NS

RFI-09-54S	4/7/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.006 (IDW,RDW)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.002
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.003 J

RFI-09-54D	4/8/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.033 (IDW,RDW)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	0.0003 J
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.0005 J

RFI-09-44	3/21/2003	10/5/2004
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	ND(0.001)
Inorganic		
Antimony	0.00037 J	NS
Arsenic	0.0017 J	ND(0.002)
Lead	0.00033 J	ND(0.003)
Manganese	0.3	NS
Selenium	ND(0.0016)	NS

RFI-09-08D	4/7/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.094 (IDW,RDW)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.164
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.362 J

RFI-09-09	9/17/2001	6/21/2002	3/21/2003
VOC			
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001)	ND(0.001)
Ethylbenzene	0.00052 J	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	0.00092 J	ND(0.002)	ND(0.002)
SVOC			
Benzo(a)anthracene	ND(0.0011)	NS	NS
Benzo(a)pyrene	ND(0.0021)	NS	NS
Benzo(b)fluoranthene	ND(0.0021)	NS	NS
bis(2-Ethylhexyl)phthalate	ND(0.0053)	NS	NS
Dibenz(a,h)anthracene	ND(0.0021)	NS	NS
Indeno(1,2,3-cd)pyrene	ND(0.0021)	NS	NS
PCB			
Total PCBs	0.000095 J	NS	NS
PCB-Dissolved			
Total PCBs	ND(0.0001)	NS	NS
Inorganic			
Antimony	NS	0.00051 J	NS
Arsenic	NS	0.003	NS
Lead	NS	0.0028	NS
Manganese	NS	0.89 (RDW)	NS
Selenium	NS	0.00074 J	NS
Inorganic-Dissolved			
Antimony	ND(0.0012)	0.0021	NS
Arsenic	0.0024	0.0021	NS
Lead	ND(0.0004)	ND(0.0004)	NS
Manganese	0.81	0.71	NS
Selenium	ND(0.0014)	0.0017 J	NS

RFI-09-09D	4/7/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.0004 J
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.0007 J
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.001 J

RFI-09-52	9/15/2003
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.002)

RFI-09-11	9/17/2001	6/21/2002	3/21/2003
VOC			
1,1,1-Trichloroethane	ND(0.001) /ND(0.001)	ND(0.001 J)	ND(0.001)
Benzene	0.8 D (IDW,RDW) /0.83 D (IDW,RDW)	1.1 D (IDW,RDW)	1 D (IDW,RDW)
Carbon tetrachloride	ND(0.001) /ND(0.001)	ND(0.001 J)	ND(0.001)
Ethylbenzene	0.065 /0.087	0.075	0.026
Methylene chloride	ND(0.005) /ND(0.005)	ND(0.005)	0.0067 (IDW,RDW)
Trichloroethene	ND(0.001) /ND(0.001)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001) /ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	0.173 /0.27	0.088	0.066
SVOC			
Benzo(a)anthracene	ND(0.001) /ND(0.001)	NS	NS
Benzo(a)pyrene	ND(0.002) /ND(0.002)	NS	NS
Benzo(b)fluoranthene	ND(0.002) /ND(0.002)	NS	NS
bis(2-Ethylhexyl)phthalate	ND(0.005) /ND(0.005)	NS	NS
Dibenz(a,h)anthracene	ND(0.002) /ND(0.002)	NS	NS
Indeno(1,2,3-cd)pyrene	ND(0.002) /ND(0.002)	NS	NS
PCB			
Total PCBs	0.00024 /0.00026	NS	NS
PCB-Dissolved			
Total PCBs	0.00026 /0.0003	NS	NS
Inorganic-Dissolved			
Antimony	ND(0.0012) /ND(0.0012)	NS	NS
Arsenic	0.0035 /0.0026	NS	NS
Lead	0.00042 /ND(0.0004)	NS	NS
Manganese	0.28 /0.21	NS	NS
Selenium	ND(0.0014) /ND(0.0014)	NS	NS

RFI-09-11D	4/7/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.19 (IDW,RDW)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.003
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.023 J

31-8	9/17/2001	6/24/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001) /ND(0.001)
Benzene	0.93 D (IDW,RDW)	0.7 D (IDW,RDW) /0.72 D (IDW,RDW)
Carbon tetrachloride	ND(0.001)	ND(0.001) /ND(0.001)
Ethylbenzene	0.61 D	1 D (IDW,RDW) /1 D (IDW,RDW)
Methylene chloride	ND(0.005)	ND(0.005) /ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001) /ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001) /ND(0.001)
Xylenes (total)	1.17	1.69 /1.7
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	ND(0.00011)	NS
PCB-Dissolved		
Total PCBs	ND(0.00011)	NS
Inorganic		
Antimony	NS	0.00041 J /ND(0.0012)
Arsenic	NS	0.022 /0.018
Lead	NS	0.0017 /0.0014
Manganese	NS	0.17 J /0.13 J
Selenium	NS	ND(0.0014) /ND(0.0014)
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	0.016	NS
Lead	0.0058 (IDW,RDW)	NS
Manganese	0.16	NS
Selenium	ND(0.0014)	NS

RFI-09-45	12/20/2002
VOC	
1,1,1-Trichloroethane	ND(0.001) /ND(0.001)
Benzene	ND(0.001) /ND(0.001)
Carbon tetrachloride	ND(0.001 J) /ND(0.001 J)
Ethylbenzene	ND(0.001) /ND(0.001)
Methylene chloride	ND(0.005) /ND(0.005)
Trichloroethene	ND(0.001) /ND(0.001)
Vinyl chloride	ND(0.001) /ND(0.001)
Xylenes (total)	ND(0.002) /ND(0.002)
Inorganic	
Antimony	0.0011 J /0.0012 J
Arsenic	0.002 J /0.0024 J
Lead	0.0009 J /0.00096 J
Manganese	0.091 /0.079
Selenium	0.0042 J /0.0066 J

RFI-09-12	12/13/2001	6/21/2002	3/21/2003
VOC			
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)	ND(0.001)
Benzene	0.01 (IDW,RDW)	0.013 J (IDW,RDW)	0.0036
Carbon tetrachloride	ND(0.001)	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	ND(0.002)	ND(0.002)
SVOC			
Benzo(a)anthracene	ND(0.001)	NS	NS
Benzo(a)pyrene	ND(0.002)	NS	NS
Benzo(b)fluoranthene	ND(0.002)	NS	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS	NS
Dibenz(a,h)anthracene	ND(0.002)	NS	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS	NS
PCB			
Total PCBs	ND(0.00011)	NS	NS
PCB-Dissolved			
Total PCBs	ND(0.00011)	NS	NS
Inorganic			
Antimony	ND(0.0012)	ND(0.0012)	ND(0.0012)
Arsenic	0.061 J (IDW,RDW)	0.049	0.056 (IDW,RDW)
Lead	0.0019 J	0.00013 J	0.00023 J
Manganese	0.11 J	0.065	0.05
Selenium	ND(0.0045)	ND(0.0014)	ND(0.0016)
Inorganic-Dissolved			
Antimony	ND(0.0012)	ND(0.0012)	NS
Arsenic	0.043	0.04	NS
Lead	ND(0.0004)	ND(0.0004)	NS
Manganese	0.069	0.051	NS
Selenium	ND(0.0014)	ND(0.0014)	NS

31-6	9/17/2001	6/21/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001 J)
Benzene	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001 J)
Ethylbenzene	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	ND(0.002)
SVOC		
Benzo(a)anthracene	ND(0.0011)	NS
Benzo(a)pyrene	ND(0.0021)	NS
Benzo(b)fluoranthene	ND(0.0021)	NS
bis(2-Ethylhexyl)phthalate	ND(0.0053)	NS
Dibenz(a,h)anthracene	ND(0.0021)	NS
Indeno(1,2,3-cd)pyrene	ND(0.0021)	NS
PCB		
Total PCBs	ND(0.00011)	NS
PCB-Dissolved		
Total PCBs	ND(0.00011)	NS
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	ND(0.001)	NS
Lead	ND(0.0004)	NS
Manganese	0.0045	NS
Selenium	ND(0.0014)	NS

31-5	9/17/2001	6/21/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	NS
Benzene	ND(0.001)	NS
Carbon tetrachloride	ND(0.001)	NS
Ethylbenzene	ND(0.001)	NS
Methylene chloride	ND(0.005)	NS
Trichloroethene	ND(0.001)	NS
Vinyl chloride	ND(0.001)	NS
Xylenes (total)	ND(0.002)	NS
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	0.00029	ND(0.00011)
PCB-Dissolved		
Total PCBs	0.00169 (IDW,RDW)	ND(0.00011)
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	ND(0.001)	NS
Lead	ND(0.0004)	NS
Manganese	0.005	NS
Selenium	ND(0.0014)	NS

RFI-09-06	9/13/2001	6/21/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001 J)
Benzene	0.014 (IDW,RDW)	0.012 (IDW,RDW)
Carbon tetrachloride	ND(0.001)	ND(0.001 J)
Ethylbenzene	0.005	0.0045
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.001)	ND(0.001)
Xylenes (total)	0.0184	0.0182
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	ND(0.0001)	NS
PCB-Dissolved		
Total PCBs	ND(0.00014)	NS
Inorganic		
Antimony	ND(0.0012)	NS
Arsenic	0.016	NS
Lead	0.003	NS
Manganese	0.2	NS
Selenium	0.0019	NS
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	0.017	NS
Lead	ND(0.0004)	NS
Manganese	0.14	NS
Selenium	0.014	NS

RFI-09-05	5/29/2001
VOC	
1,1,1-Trichloroethane	ND(0.001 J)
Benzene	0.00013 J
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.00019 J
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.00033 J
SVOC	
Benzo(a)anthracene	ND(0.005)
Benzo(a)pyrene	ND(0.005)
Benzo(b)fluoranthene	ND(0.005)
bis(2-Ethylhexyl)phthalate	0.107 (IDW,RDW)
Dibenz(a,h)anthracene	ND(0.005)
Indeno(1,2,3-cd)pyrene	ND(0.005)
PCB	
Total PCBs	0.00012
PCB-Dissolved	
Total PCBs	ND(0.0001)
Inorganic-Dissolved	
Antimony	ND(0.0012)
Arsenic	ND(0.001)
Lead	ND(0.0004)
Manganese	0.078
Selenium	0.014 J

RFI-09-10	9/13/2001	6/21/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	NS
Benzene	ND(0.001)	NS
Carbon tetrachloride	ND(0.001)	NS
Ethylbenzene	ND(0.001)	NS
Methylene chloride	ND(0.005)	NS
Trichloroethene	ND(0.001)	NS
Vinyl chloride	ND(0.001)	NS
Xylenes (total)	ND(0.002)	NS
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	ND(0.00014)	NS
PCB-Dissolved		
Total PCBs	ND(0.00012)	NS
Inorganic		
Antimony	0.0031 J	0.003
Arsenic	0.0028	0.002
Lead	0.0013	0.0019
Manganese	0.13	0.11
Selenium	0.0014	0.0005 J
Inorganic-Dissolved		
Antimony	0.0068 J (IDW,RDW)	NS
Arsenic	0.0024	NS
Lead	ND(0.00066)	NS
Manganese	0.11	NS
Selenium	ND(0.0056)	NS

RFI-09-36R	3/24/2003
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.002)

RFI-09-02	5/30/2001
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	0.0019
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.002)
SVOC	
Benzo(a)anthracene	ND(0.005)
Benzo(a)pyrene	ND(0.005)
Benzo(b)fluoranthene	ND(0.005)
bis(2-Ethylhexyl)phthalate	0.00339 J
Dibenz(a,h)anthracene	ND(0.005)
Indeno(1,2,3-cd)pyrene	ND(0.005)
PCB	
Total PCBs	0.00014
PCB-Dissolved	
Total PCBs	ND(0.0001)
Inorganic-Dissolved	
Antimony	ND(0.0012)
Arsenic	0.0015
Lead	0.026 (IDW,RDW)
Manganese	0.049
Selenium	0.007

RFI-09-56	7/6/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	0.001
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.0003 J
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.0014 J

RFI-09-03	5/29/2001
VOC	
1,1,1-Trichloroethane	ND(0.001 J)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	0.00011 J
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	0.00012 J
SVOC	
Benzo(a)anthracene	ND(0.005)
Benzo(a)pyrene	ND(0.005)
Benzo(b)fluoranthene	ND(0.005)
bis(2-Ethylhexyl)phthalate	0.863 D (GAI,GCC,IDW,RDW)
Dibenz(a,h)anthracene	ND(0.005)
Indeno(1,2,3-cd)pyrene	ND(0.005)
PCB	
Total PCBs	0.000046 J
PCB-Dissolved	
Total PCBs	ND(0.00011)
Inorganic-Dissolved	
Antimony	ND(0.0012)
Arsenic	0.0033 J
Lead	0.00056 J
Manganese	0.88 (RDW)
Selenium	ND(0.0014)

RFI-09-49R	4/3/2003	10/5/2004
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	0.0028	0.008 (IDW,RDW)
Vinyl chloride	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	ND(0.001)
Inorganic		
Antimony	NS	NS
Arsenic	NS	NS
Lead	NS	ND(0.003)
Manganese	NS	NS
Selenium	NS	NS

RFI-09-04R	6/24/2002	3/24/2003	10/5/2004	6/8/2005
VOC				
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)	0.0003 J	0.0003 J
Benzene	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001)	0.0003 J	ND(0.001)
Ethylbenzene	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)
Trichloroethene	0.0067 (IDW,RDW)	0.0055 (IDW,RDW)	0.011 (IDW,RDW)	0.009 (IDW,RDW)
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.002)	ND(0.002)	ND(0.001)	ND(0.001)
Inorganic				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	ND(0.003)	NS
Manganese	NS	NS	NS	NS
Selenium	NS	NS	NS	NS

RFI-09-57	7/6/2005
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	ND(0.001)
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.001)

RFI-09-53	4/7/2005	6/8/2005
VOC		
1,1,1-Trichloroethane	0.05	0.258 (IDW,RDW)
Benzene	0.0003 J	ND(0.005)
Carbon tetrachloride	0.0003 J	ND(0.005)
Ethylbenzene	ND(0.001)	ND(0.005)
Methylene chloride	ND(0.005)	ND(0.03)
Trichloroethene	0.035 (IDW,RDW)	0.184 (IDW,RDW)
Vinyl chloride	0.001 J	ND(0.005)
Xylenes (total)	ND(0.001)	ND(0.005)

RFI-09-58	7/22/2005
VOC	
1,1,1-Trichloroethane	ND(0.001) /ND(0.001)
Benzene	ND(0.001) /ND(0.001)
Carbon tetrachloride	ND(0.001) /ND(0.001)
Ethylbenzene	ND(0.001) /ND(0.001)
Methylene chloride	ND(0.005) /ND(0.005)
Trichloroethene	ND(0.001) /ND(0.001)
Vinyl chloride	ND(0.001) /ND(0.001)
Xylenes (total)	ND(0.001) /ND(0.001)

RFI-09-04	11/28/2001
VOC	
1,1,1-Trichloroethane	0.0016 /0.0017
Benzene	ND(0.001) /ND(0.001)
Carbon tetrachloride	ND(0.001) /ND(0.001)
Ethylbenzene	ND(0.001) /ND(0.001)
Methylene chloride	ND(0.005) /ND(0.005)
Trichloroethene	0.0093 (IDW,RDW) /0.0093 (IDW,RDW)
Vinyl chloride	ND(0.001) /ND(0.001)
Xylenes (total)	ND(0.002) /ND(0.002)
SVOC	
Benzo(a)anthracene	ND(0.001) /ND(0.0011)
Benzo(a)pyrene	ND(0.002) /ND(0.0021)
Benzo(b)fluoranthene	ND(0.002) /ND(0.0021)
bis(2-Ethylhexyl)phthalate	ND(0.005) /ND(0.0053)
Dibenz(a,h)anthracene	ND(0.002) /ND(0.0021)
Indeno(1,2,3-cd)pyrene	ND(0.002) /ND(0.0021)
PCB	
Total PCBs	ND(0.00011) /ND(0.0001)
PCB-Dissolved	
Total PCBs	ND(0.00011) /ND(0.00011)
Inorganic	
Antimony	ND(0.0012) /ND(0.0012)
Arsenic	ND(0.001) /0.0005 J
Lead	ND(0.0004) /ND(0.0004)
Manganese	0.022 /0.022
Selenium	0.003 J /0.0028 J
Inorganic-Dissolved	
Antimony	ND(0.0012) /ND(0.0012)
Arsenic	ND(0.001) /ND(0.001)
Lead	ND(0.0004) /ND(0.0004)
Manganese	0.023 /0.023
Selenium	0.004 J /0.0048 J

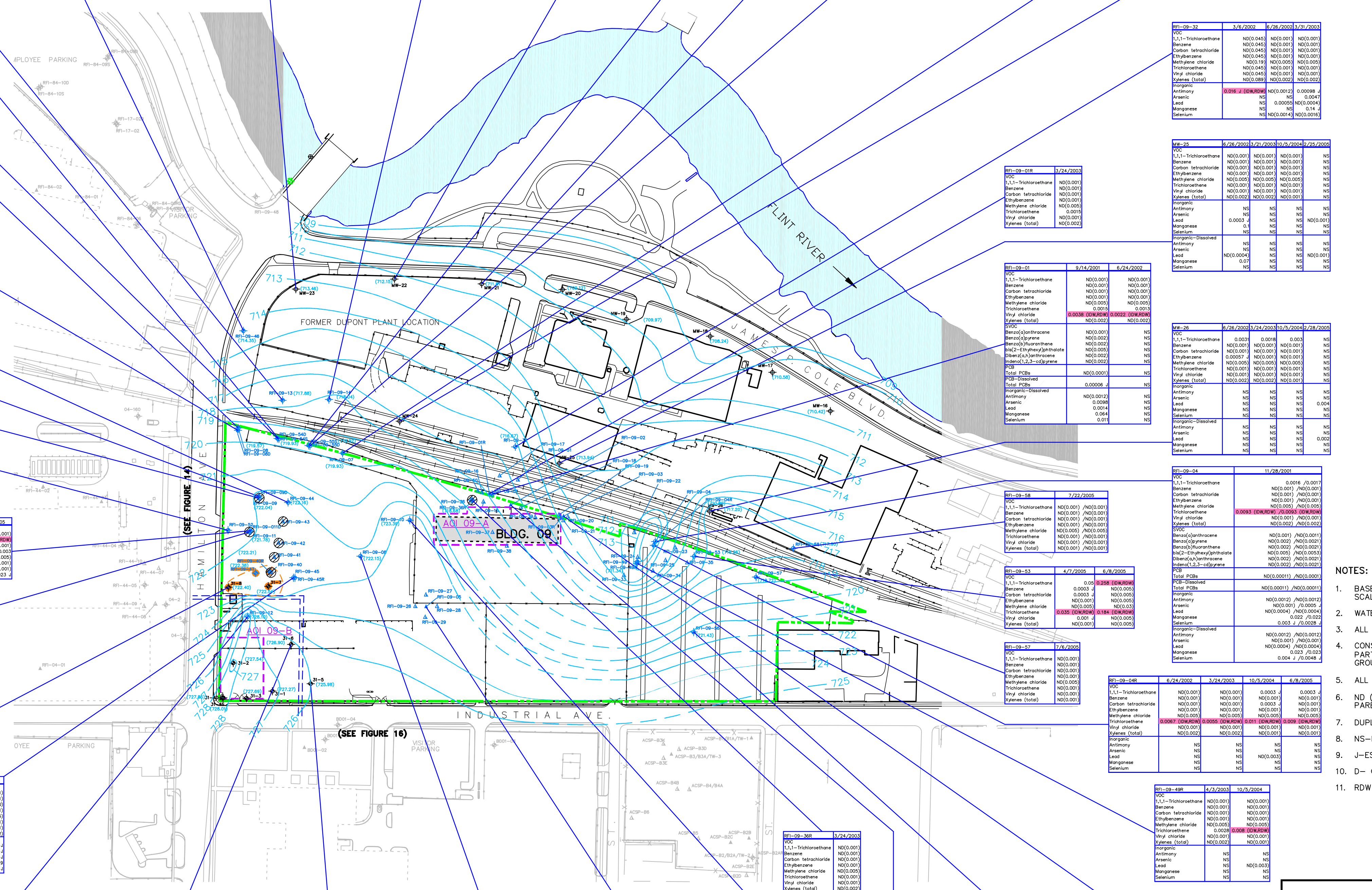
MW-26	6/26/2002	3/24/2003	10/5/2004	2/28/2005
VOC				
1,1,1-Trichloroethane	0.0031	0.0018	0.003	NS
Benzene	ND(0.001)	ND(0.001)	ND(0.001)	NS
Carbon tetrachloride	ND(0.001)	ND(0.001)	ND(0.001)	NS
Ethylbenzene	0.00057 J	ND(0.001)	ND(0.001)	NS
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)	NS
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)	NS
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)	NS
Xylenes (total)	ND(0.002)	ND(0.002)	ND(0.001)	NS
Inorganic				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	NS	0.004
Manganese	NS	NS	NS	NS
Selenium	NS	NS	NS	NS
Inorganic-Dissolved				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	NS	NS	NS	0.002
Manganese	NS	NS	NS	NS
Selenium	NS	NS	NS	NS

MW-25	6/26/2002	3/21/2003	10/5/2004	2/25/2005
VOC				
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)	ND(0.001)	NS
Benzene	ND(0.001)	ND(0.001)	ND(0.001)	NS
Carbon tetrachloride	ND(0.001)	ND(0.001)	ND(0.001)	NS
Ethylbenzene	ND(0.001)	ND(0.001)	ND(0.001)	NS
Methylene chloride	ND(0.005)	ND(0.005)	ND(0.005)	NS
Trichloroethene	ND(0.001)	ND(0.001)	ND(0.001)	NS
Vinyl chloride	ND(0.001)	ND(0.001)	ND(0.001)	NS
Xylenes (total)	ND(0.002)	ND(0.002)	ND(0.001)	NS
Inorganic				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	0.0003 J	NS	NS	ND(0.001)
Manganese	0.1	NS	NS	NS
Selenium	NS	NS	NS	NS
Inorganic-Dissolved				
Antimony	NS	NS	NS	NS
Arsenic	NS	NS	NS	NS
Lead	ND(0.0004)	NS	NS	ND(0.001)
Manganese	0.07	NS	NS	NS
Selenium	NS	NS	NS	NS

RFI-09-32	3/6/2002	6/26/2002	3/31/2003
VOC			
1,1,1-Trichloroethane	ND(0.045)	ND(0.001)	ND(0.001)
Benzene	ND(0.045)	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.045)	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.045)	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.19)	ND(0.005)	ND(0.005)
Trichloroethene	ND(0.045)	ND(0.001)	ND(0.001)
Vinyl chloride	ND(0.045)	ND(0.001)	ND(0.001)
Xylenes (total)	ND(0.089)	ND(0.002)	ND(0.002)
Inorganic			
Antimony	0.016 J (IDW,RDW)	ND(0.0012)	0.00098 J
Arsenic	NS	NS	0.0047
Lead	NS	0.00055 J	ND(0.0004)
Manganese	NS	NS	0.14 J
Selenium	NS	ND(0.0014)	ND(0.0016)

RFI-09-01R	3/24/2003
VOC	
1,1,1-Trichloroethane	ND(0.001)
Benzene	ND(0.001)
Carbon tetrachloride	ND(0.001)
Ethylbenzene	ND(0.001)
Methylene chloride	ND(0.005)
Trichloroethene	0.0015
Vinyl chloride	ND(0.001)
Xylenes (total)	ND(0.002)

RFI-09-01	9/14/2001	6/24/2002
VOC		
1,1,1-Trichloroethane	ND(0.001)	ND(0.001)
Benzene	ND(0.001)	ND(0.001)
Carbon tetrachloride	ND(0.001)	ND(0.001)
Ethylbenzene	ND(0.001)	ND(0.001)
Methylene chloride	ND(0.005)	ND(0.005)
Trichloroethene	0.0015	0.0013
Vinyl chloride	0.0038 (IDW,RDW)	0.0022 (IDW,RDW)
Xylenes (total)	ND(0.002)	ND(0.002)
SVOC		
Benzo(a)anthracene	ND(0.001)	NS
Benzo(a)pyrene	ND(0.002)	NS
Benzo(b)fluoranthene	ND(0.002)	NS
bis(2-Ethylhexyl)phthalate	ND(0.005)	NS
Dibenz(a,h)anthracene	ND(0.002)	NS
Indeno(1,2,3-cd)pyrene	ND(0.002)	NS
PCB		
Total PCBs	ND(0.0001)	NS
PCB-Dissolved		
Total PCBs	0.00006 J	NS
Inorganic-Dissolved		
Antimony	ND(0.0012)	NS
Arsenic	0.0098	NS
Lead	0.0014	NS
Manganese	0.064	NS
Selenium	0.011	NS



SITE LOCATION

LEGEND

GM PROPERTY BOUNDARY

PROPERTY PREVIOUSLY OWNED BY GM (STILL SUBJECT TO RCRA CORRECTIVE ACTION)

DEMOLISHED BUILDING

APPROXIMATE AOI BOUNDARY

AOI 81-1 — AOI ID

BASEMENT/TUNNEL AREA

ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL

736 — WATER TABLE ELEVATION CONTOUR (FT AMSL) (DASHED WHERE INFERED)

(739.13) — GROUNDWATER ELEVATION (IN FEET)

[742.02] — ANOMALOUS GROUNDWATER ELEVATION (IN FEET), NOT USED TO GENERATE GROUNDWATER ELEVATION CONTOURS

04-140 — HISTORICAL MONITORING WELL LOCATION

RFI-83/84-03 — RFI SOIL BORING LOCATION

RFI-09-02 — RFI SOIL BORING/GRAB GROUNDWATER SAMPLING LOCATION

RFI-09-01 — RFI MONITORING WELL LOCATION

RFI-12-13 — DECOMMISSIONED/DESTROYED MONITORING WELL

RFI-36-01 — RFI PIEZOMETER

FORMER RIVER GAUGE LOCATION

CURRENT RIVER GAUGE LOCATION

LOCATION WHERE MEASURABLE LNAPL HAS BEEN DETECTED FROM MARCH 2004 TO JULY 2005

LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED

LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL

EXCEEDS MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA:

IDW — INDUSTRIAL DRINKING WATER

GSI — GROUNDWATER SURFACE WATER INTERFACE

GCC — GROUNDWATER CONTACT

GAI — GROUNDWATER ACUTE INHALATION

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED SEPTEMBER 2001, AT A SCALE OF 1:100.
2. WATER TABLE ELEVATION CONTOURS MEASURED ON JULY 7, 2005.
3. ALL LOCATIONS ARE APPROXIMATE.
4. CONSTITUENTS PRESENTED HERE ARE THOSE WHICH EXCEED ONE OR MORE MICHIGAN PART 201 GENERIC RESIDENTIAL AND/OR INDUSTRIAL SCREENING CRITERIA IN SOIL OR GROUNDWATER SAMPLES COLLECTED IN THE AREA SHOWN ON THIS FIGURE.
5. ALL CONCENTRATIONS PRESENTED IN MILLIGRAMS PER LITER (mg/L).
6. ND (1.0)—CONSTITUENT NOT DETECTED. ASSOCIATED DETECTION LIMIT PRESENTED IN PARENTHESES.
7. DUPLICATE ANALYSES SEPARATED BY SLASHES (/).
8. NS—NOT ANALYZED FOR THIS CONSTITUENT.
9. J—ESTIMATED CONCENTRATION.
10. D— CONCENTRATION BASED ON A DILUTED SAMPLE ANALYSIS.
11. RDW — EXCEEDS MICHIGAN PART 201 RESIDENTIAL DRINKING WATER CRITERIA.

0 150' 300'

GRAPHIC SCALE

JULY 2006

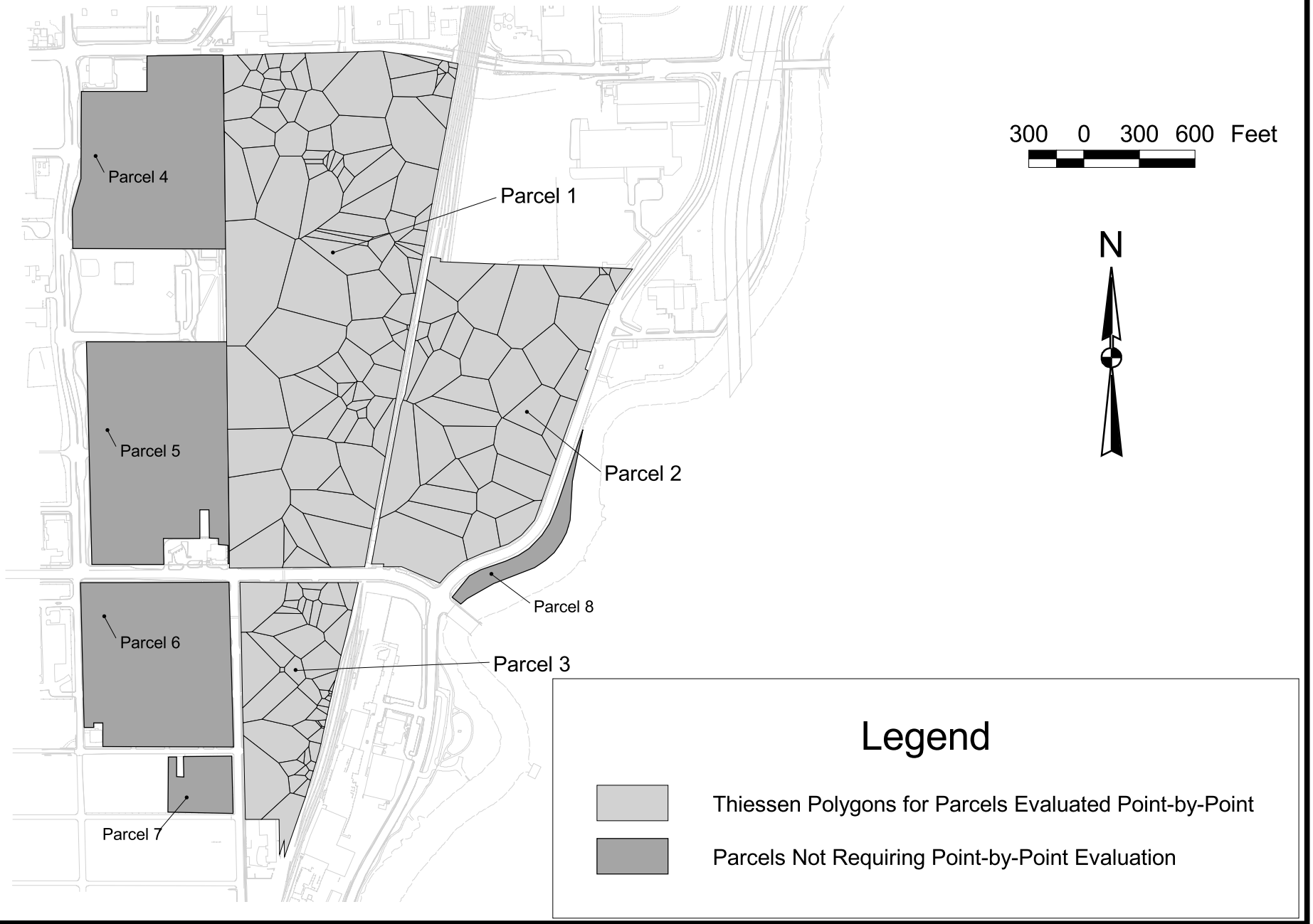
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE — FLINT, MICHIGAN
RFI PHASE II REPORT

GROUNDWATER ANALYTICAL DATA - FORMER BUILDING 09 AREA

BBL® BLASLAND, BOUCK & LEE, INC. engineers, scientists, economists

FIGURE 4-24

X: 64410X01.DWG, X02.DWG, X03.DWG, X06.DWG
L: ON=* OFF=*REF*, GRAYX01|SHD-BUILDING, *|HIST_SB*, *GRAYX03|NAPL_*, *|RFI_SS_PIEZ, *|LNAPL-SHD, GRAYX01|PROPERTY
P: PAGESET/SYR-DL
7/11/06 SYR-85-NES LAF GMS
64410112/RFI-06/64410C24.DWG



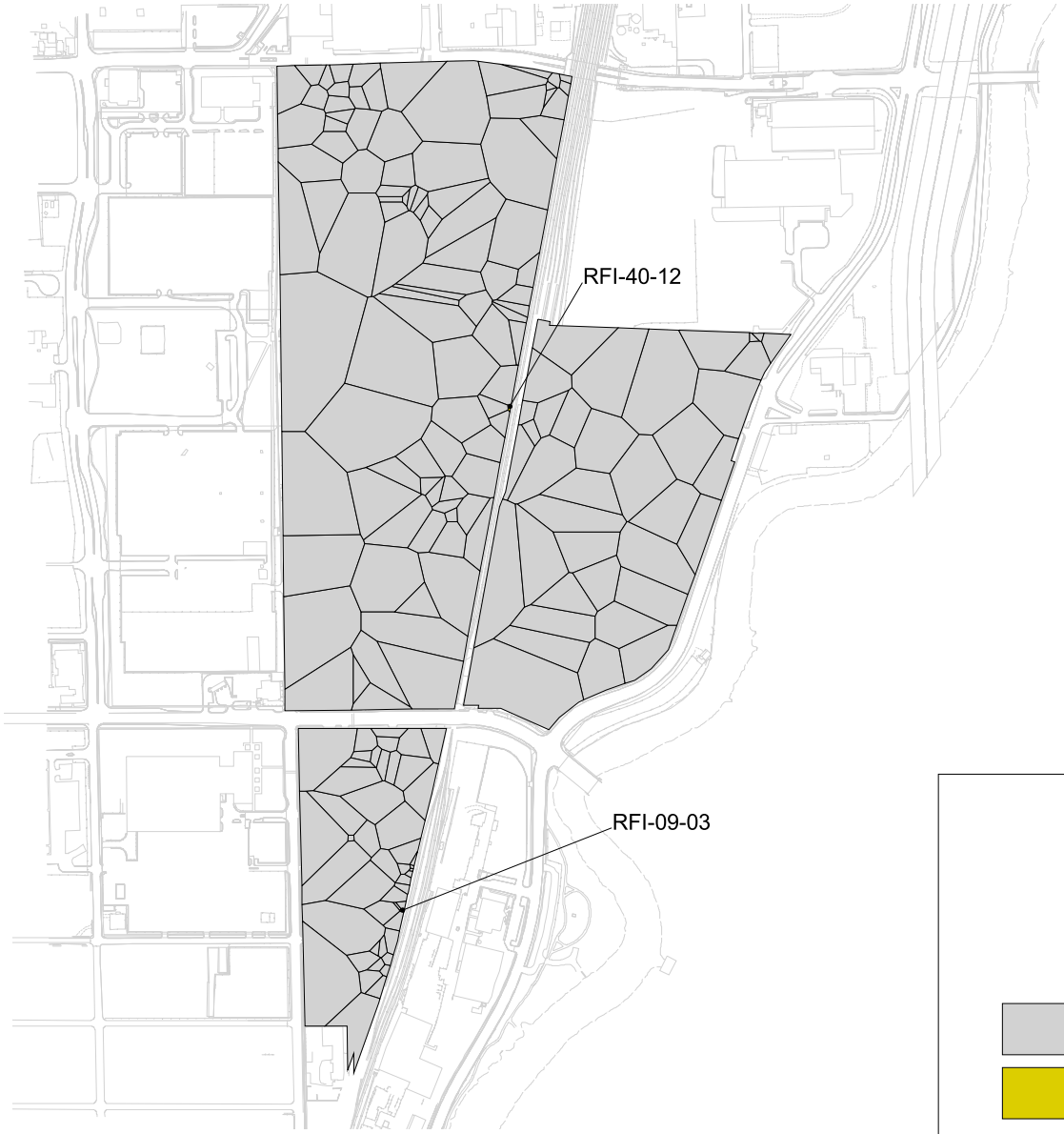
ENVIRON

Date: 7/14/2006

THIESSEN POLYGONS FOR SOUTHEND PARCELS
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-1

Arcview Plot



300 0 300 600 Feet

N

Legend

Routine Worker Soil Contact

Cumulative Cancer Risk <= 1E-4

Cumulative Cancer Risk >1E-4

ENVIRON

Date: 7/14/2006

ROUTINE WORKER SOIL CONTACT (ANY DEPTH)
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-2

Arcview Plot

300 0 300 600 Feet

N

Legend

Redevelopment Construction Worker Soil Contact

HI <= 1

HI > 1

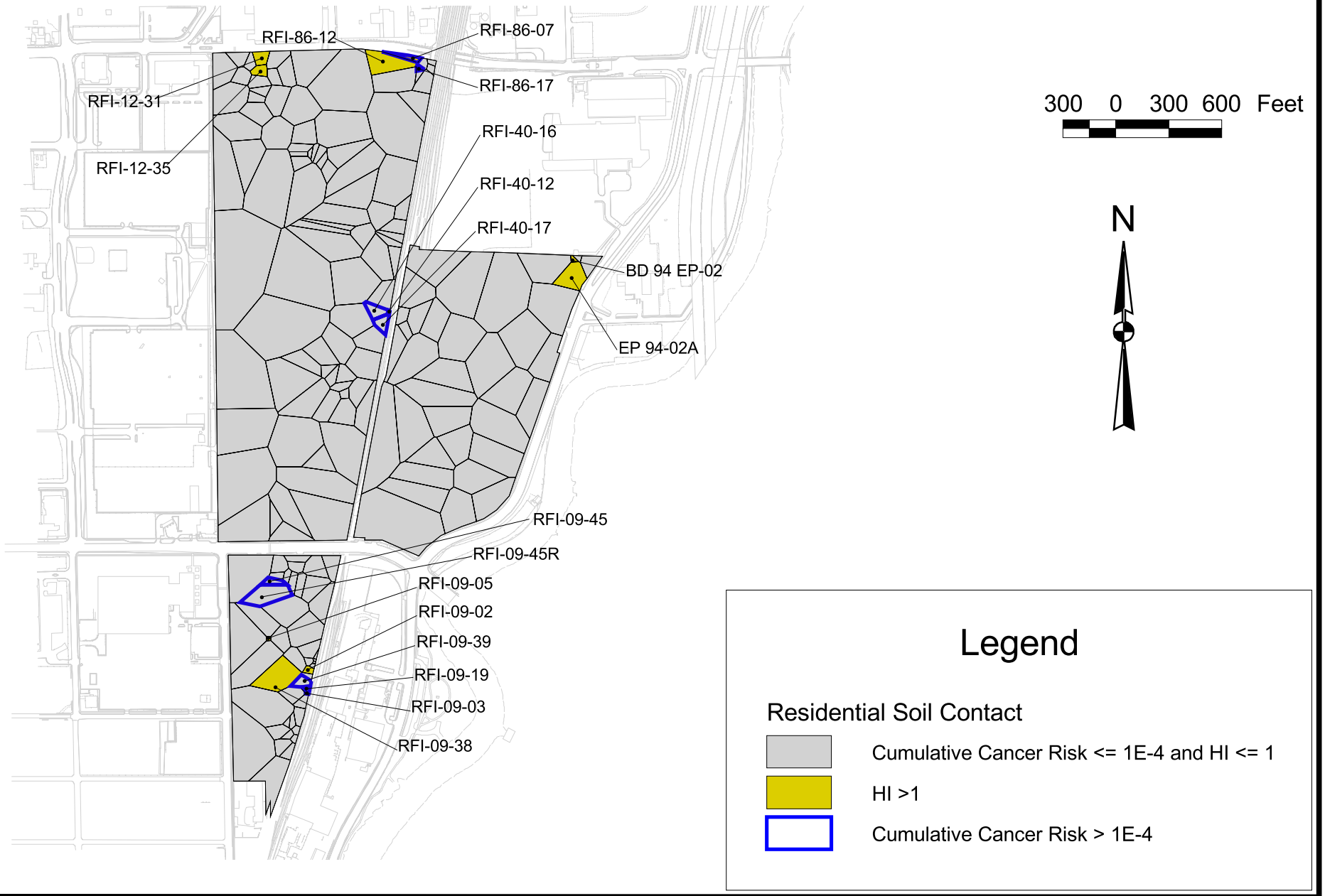
ENVIRON

Date: 7/14/2006

REDEVELOPMENT CONSTRUCTION WORKER SOIL CONTACT (ANY DEPTH)
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-3

Arcview Plot



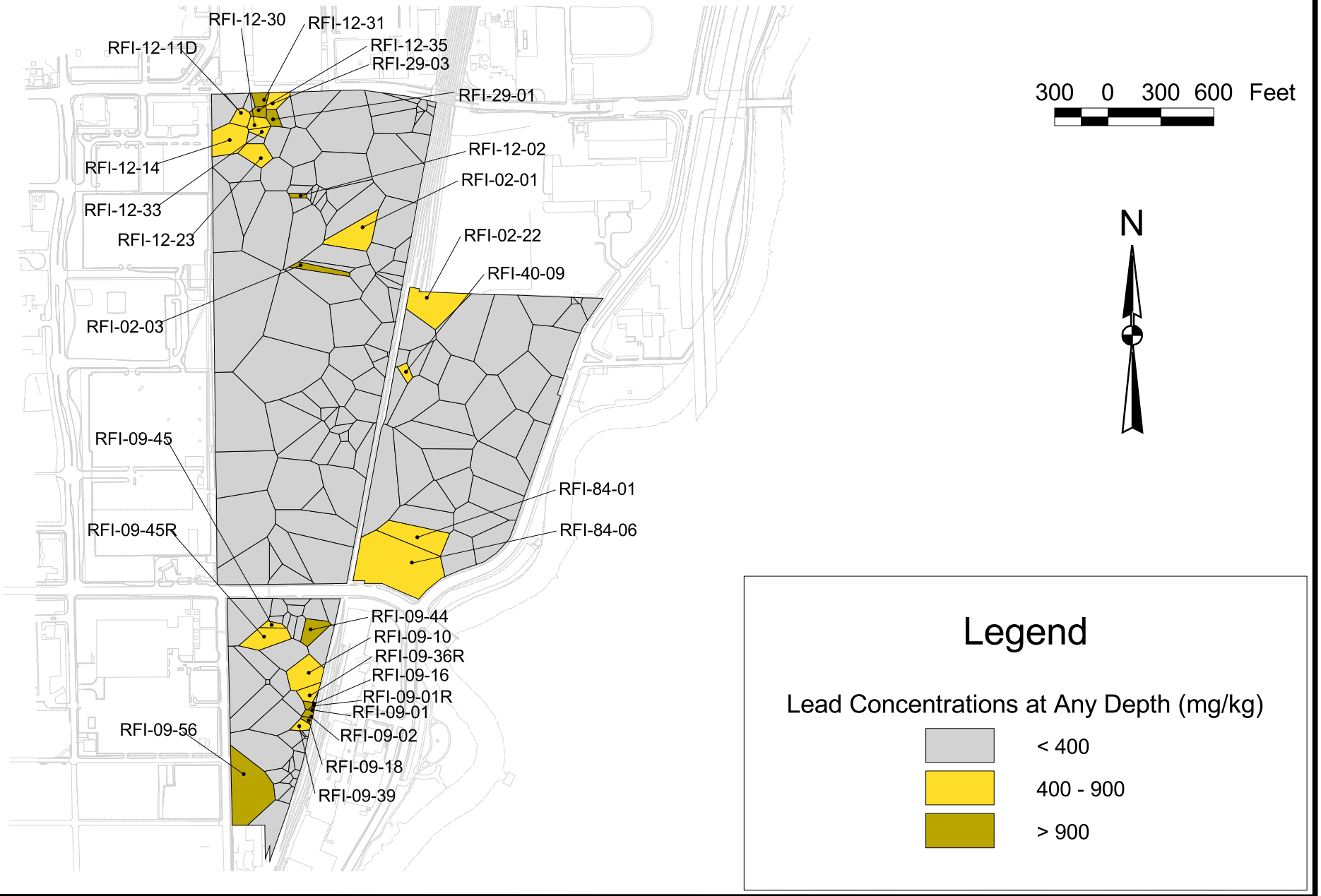
ENVIRON

Date: 7/14/2006

RESIDENTIAL SOIL CONTACT (ANY DEPTH)
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-4

Arcview Plot



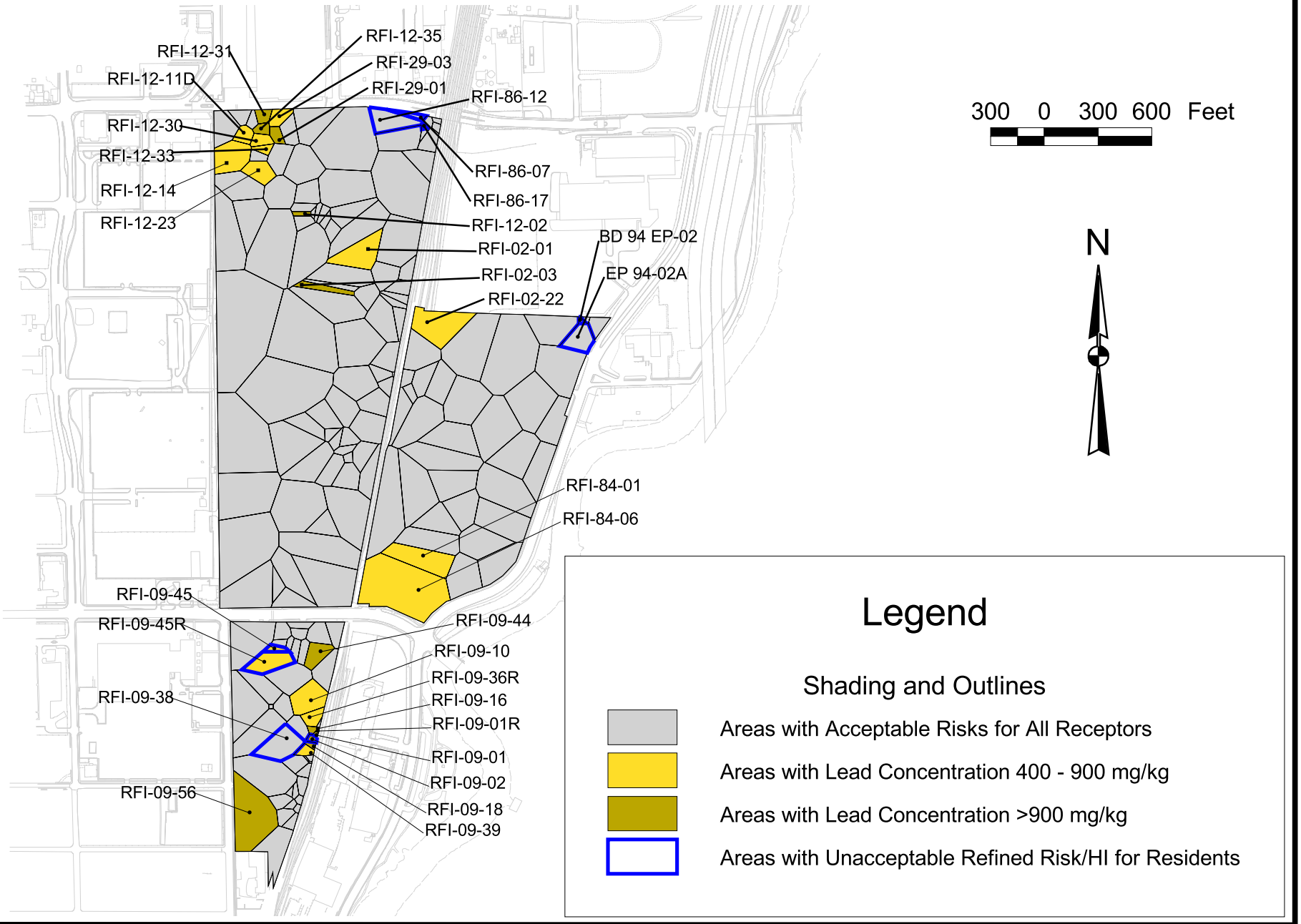
ENVIRON

Date: 7/14/2006

LEAD CONCENTRATIONS IN SOIL (ANY DEPTH)
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-5

Arcview Plot



ENVIRON

Date: 7/14/2006

AREAS WITH POTENTIALLY UNACCEPTABLE RISKS
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Figure 6-6

Arcview Plot

TABLE 6-1
CONCEPTUAL SITE MODEL - SCENARIOS FOR POTENTIAL HUMAN EXPOSURE

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Exposure Area	Receptor Population	Exposure Medium	Exposure Route	Scenario Timeframe		Comments
				Current	Future	
Onsite AOIs involving active operations	Routine Workers	surface soil	ingestion and dermal contact	Yes	Yes	Potential exposures are evaluated at areas without pavement and areas where pavement might be removed.
			inhalation of airborne particulates and vapors	Yes	Yes	
		subsurface soil	inhalation of soil vapors	Yes	Yes	Potential exposures via vapor intrusion through cracks in building foundations into indoor air are evaluated.
		groundwater	inhalation of groundwater vapors	Yes	Yes	
		LNAPL (including residual soil)	inhalation of LNAPL and residual soil vapors	Yes	Yes	
	Maintenance Workers	surface and subsurface soil	ingestion and dermal contact	Yes	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
			inhalation of airborne particulates and vapors	Yes	Yes	
		groundwater	ingestion, dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures are evaluated for construction and maintenance activities in the flooded basement/tunnel areas (AOI 36-3) in the storm water sewer, and where groundwater is shallow.
		LNAPL (including residual soil)	ingestion (residual soil only), dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
	Trespassers	surface soil	ingestion and dermal contact	Yes	Yes	Potential exposures are evaluated at areas without pavement and areas where pavement might be removed.
			inhalation of airborne particulates and vapors	Yes	Yes	
Onsite AOIs that are demolished and/or are planned for redevelopment.	Maintenance Workers	surface and subsurface soil	ingestion and dermal contact	Yes	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
			inhalation of airborne particulates and vapors	Yes	Yes	
		groundwater	ingestion, dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures are evaluated for construction and maintenance activities in the flooded basement/tunnel areas (AOIs 12-A, 23-A, 40-D), in the storm water sewer, and where groundwater is shallow.
		LNAPL (including residual soil)	ingestion (residual soil only), dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
	Trespassers	surface soil	ingestion and dermal contact	Yes	Yes	Potential exposures are evaluated at areas without pavement and areas where pavement might be removed.
			inhalation of airborne particulates and vapors	Yes	Yes	
	Routine Workers (Commercial and/or Industrial)	surface soil	ingestion and dermal contact	No	Yes	Potential exposures are evaluated at areas without pavement and areas where pavement might be removed.
			inhalation of airborne particulates and vapors	No	Yes	
		subsurface soil	inhalation of soil vapors	No	Yes	Potential exposures via vapor intrusion through cracks in building foundations into indoor air are evaluated.
		groundwater	inhalation of groundwater vapors	No	Yes	
		LNAPL (including residual soil)	inhalation of LNAPL and residual soil vapors	No	Yes	

See Note on Page 2.

TABLE 6-1
CONCEPTUAL SITE MODEL - SCENARIOS FOR POTENTIAL HUMAN EXPOSURE

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Exposure Area	Receptor Population	Exposure Medium	Exposure Route	Scenario Timeframe		Comments
				Current	Future	
Onsite AOIs that are demolished and/or are planned for redevelopment (continued).	Redevelopment Construction Workers (Southend Only)	surface and subsurface soil	ingestion and dermal contact	No	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
			inhalation of airborne particulates and vapors	No	Yes	
		groundwater	ingestion, dermal contact, and inhalation of vapors	No	Yes	Potential exposures are evaluated for construction and maintenance activities in the flooded basement/tunnel areas (AOIs 12-A, 23-A, 40-D), in the storm water sewer, and where groundwater is shallow.
		LNAPL (including residual soil)	ingestion (residual soil only), dermal contact, and inhalation of vapors	No	Yes	Potential exposures for excavation up to 10 ft below surface are evaluated.
	Recreational users (Southend Only)	surface soil	ingestion and dermal contact	No	Yes	Potential exposures are evaluated at areas without pavement and areas where pavement might be removed for future use as outdoor parks.
			inhalation of airborne particulates and vapors	No	Yes	
	Residents (Possible at Portions of the Southend Only)	surface soil	ingestion and dermal contact	No	Yes	Potential exposures are evaluated at areas that may be developed to residential areas (redevelopment plan to be determined).
			inhalation of airborne particulates and vapors	No	Yes	
		subsurface soil	inhalation of soil vapors	No	Yes	Potential exposures via vapor intrusion through cracks in building foundations into indoor air are evaluated for areas that may be developed to residential areas (redevelopment plan to be determined).
		groundwater	inhalation of groundwater vapors	No	Yes	
		LNAPL (including residual soil)	inhalation of LNAPL and residual soil vapors	No	Yes	
Offsite Areas	Routine Workers	surface and subsurface soil	ingestion and dermal contact	No	No	There is no site-related contamination of offsite soil.
			inhalation of airborne particulates and vapors	Yes	Yes	Potential airborne exposures to constituents in soil at the Site are evaluated.
		groundwater	inhalation of groundwater vapors	No	Yes	Potential exposures via vapor intrusion through cracks in building foundations into indoor air are evaluated. Potential exposure is only possible at areas downgradient of the site.
	Maintenance Workers	groundwater	ingestion, dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures during construction where groundwater is less than 10 ft below surface are evaluated. Potential exposure is only possible at areas downgradient of the site.
	Recreational users	surface water	ingestion, dermal contact, and inhalation of vapors	Yes	Yes	Potential exposures during occasional recreation at Flint River are evaluated.
		fish	ingestion	Yes	Yes	
	Residents	surface and subsurface soil	ingestion and dermal contact	No	No	There is no site-related contamination of offsite soil.
			inhalation of airborne particulates and vapors	Yes	Yes	Potential airborne exposures to constituents in soil at the Site are evaluated.
		groundwater	inhalation of groundwater vapors	No	Yes	Potential exposures via vapor intrusion through cracks in future building foundations into indoor air are evaluated. Potential exposure is only possible at areas downgradient of the site that may be developed for residential use.

Note:
All worker activities in onsite areas are currently governed by OSHA regulations.

TABLE 6-2
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR ROUTINE WORKER AND MAINTENANCE WORKER EXPOSURE TO SOIL

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Parcel	Routine Worker Soil Contact Risk	Routine Worker Soil Contact HI	Maintenance Worker Soil Contact Risk	Maintenance Worker Soil Contact HI
GM-North	03-1	--	7E-05	2E-01	2E-06	2E-01
GM-North	05-1	--	1E-05	4E-01	4E-07	1E-01
GM-North	05-2	--	1E-06	3E-04	2E-08	8E-06
GM-North	05-3	--	2E-06	2E-02	7E-08	6E-03
GM-North	05-4	--	8E-07	6E-03	2E-08	3E-04
GM-North	05-5	--	5E-07	3E-02	5E-08	3E-02
GM-North	05-6	--	9E-06	4E-02	2E-07	3E-03
GM-North	07-1	--	2E-05	5E-02	5E-07	2E-02
GM-North	07-2	--	2E-07	6E-05	3E-09	5E-06
GM-North	07-3	--	8E-06	6E-02	2E-07	1E-02
GM-North	10-1	--	2E-05	3E-01	3E-06	1E-01
GM-North	10-2	--	5E-05	4E-01	1E-06	7E-02
GM-North	10-3	--	1E-05	1E-01	5E-07	9E-02
GM-North	10-4	--	NA	NA	NA	NA
GM-North	21-1	--	7E-06	6E-02	2E-07	4E-02
GM-North	36-1	--	**4E-04**	**1E+01**	5E-06	6E-01
GM-North	36-2	--	1E-06	9E-02	1E-06	4E-02
GM-North	36-3	--	3E-06	3E-01	3E-08	7E-03
GM-North	36-4	--	8E-08	7E-03	1E-07	1E-03
GM-North	36-5	--	1E-05	2E-02	4E-07	1E-02
GM-North	38-1	--	3E-06	1E-02	6E-08	6E-03
GM-North	55-1	--	1E-05	1E-01	3E-07	5E-02
GM-North	65-1	--	2E-07	5E-05	4E-09	1E-06
GM-North	81-1	--	2E-05	2E-01	1E-06	6E-02
GM-North	81-2	--	5E-05	**2E+01**	2E-06	6E-01
GM-North	81-3	--	3E-05	1E-01	5E-07	3E-02
GM-North	81-4	--	7E-06	8E-04	1E-07	3E-05
GM-North	81-5	--	3E-06	3E-02	5E-08	2E-02
GM-North	83/84-1	--	2E-06	2E-02	2E-08	9E-04
GM-North	83/84-2	--	**4E-04**	9E-01	1E-05	3E-01
GM-North	83/84-3	--	2E-05	8E-02	3E-07	3E-03
GM-North	83/84-4	--	4E-05	2E-01	1E-06	4E-02
GM-North	83/84-5	--	3E-06	1E-03	6E-08	5E-05
GM-North	83/84-6	--	4E-05	4E-03	7E-07	1E-03
GM-North	83/84-7	--	5E-07	6E-03	8E-09	3E-04
GM-North	85-1	--	3E-06	6E-02	4E-08	3E-03
GM-North	86-1	--	9E-05	8E-01	2E-06	2E-01
GM-North	Former Aeration Lagoons	--	6E-06	1E-01	2E-07	4E-02
GM-South	02-A	1	2E-07	1E-02	8E-09	1E-03
GM-South	02-B	1	5E-06	5E-02	1E-07	2E-02
GM-South	02-C	1	8E-07	6E-02	1E-06	1E-02
GM-South	02-D	1	3E-05	5E-03	4E-07	2E-04
GM-South	02-E	1	2E-06	1E-02	4E-08	1E-03
GM-South	02-F	1	4E-07	1E-02	6E-08	1E-02
GM-South	04-A	1	7E-06	3E-03	1E-07	2E-04
GM-South	04-B	1	3E-06	7E-03	5E-08	8E-03
GM-South	04-C	1	4E-07	1E-02	6E-09	4E-04
GM-South	09-A	3	**3E-04**	8E-01	5E-06	4E-01
GM-South	09-B	3	8E-05	9E-01	2E-06	1E-01
GM-South	12-A	1	2E-05	6E-01	2E-06	1E-01
GM-South	12-B	1	1E-06	6E-02	2E-07	6E-02
GM-South	12-C	1	4E-08	1E-03	4E-10	3E-05
GM-South	12-D	1	1E-06	7E-03	3E-08	1E-02
GM-South	16-A	1	3E-06	2E-02	1E-07	5E-03
GM-South	16-B	1	3E-08	4E-03	5E-09	8E-04
GM-South	16-C	1	3E-05	2E-01	7E-07	4E-02
GM-South	16-D	1	3E-08	6E-03	2E-09	5E-03
GM-South	17-A	2	4E-06	6E-02	9E-08	3E-03

See Notes on Page 2.

TABLE 6-2
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR ROUTINE WORKER AND MAINTENANCE WORKER EXPOSURE TO SOIL

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Parcel	Routine Worker Soil Contact Risk	Routine Worker Soil Contact HI	Maintenance Worker Soil Contact Risk	Maintenance Worker Soil Contact HI
GM-South	23-A	1	2E-06	4E-03	3E-08	7E-04
GM-South	29-A	1	1E-06	5E-02	7E-07	1E-02
GM-South	40-A	1	**2E-04**	2E-01	3E-06	2E-02
GM-South	40-B	1	4E-06	1E-02	7E-08	8E-04
GM-South	40-C	1	1E-06	2E-02	3E-08	3E-02
GM-South	40-D	1	2E-06	2E-02	3E-08	1E-03
GM-South	44-A	1	7E-06	1E-01	8E-07	2E-01
GM-South	84-A	2	7E-06	4E-02	2E-07	3E-03
GM-South	84-B	2	1E-06	7E-03	4E-08	7E-04
GM-South	84-C	2	5E-06	3E-02	1E-07	2E-03
GM-South	84-D	2	3E-06	2E-02	1E-07	1E-02
GM-South	94-A	2	3E-06	3E-02	8E-08	4E-02
GM-South	94-B	2	1E-06	2E-03	2E-08	2E-04
GM-South	94-C	2	9E-07	1E-02	6E-08	1E-02
GM-South	94-D	2	4E-07	1E-03	9E-09	3E-04
GM-South	94-E	2	2E-06	1E-02	5E-08	6E-04
GM-South	Former Admin Building	6	2E-06	2E-02	5E-08	6E-03
GM-South	Build 94 Parking Lot	2	9E-06	5E-01	2E-07	2E-02
GM-South	FEP	4	2E-05	1E-02	3E-07	3E-04
GM-South	Harriet Street Area	7	7E-06	5E-01	1E-07	2E-02

Notes:

1. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI .
2. Only AOIs where constituents were detected in soil are shown.
3. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.
4. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
5. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
6. NA indicates that no organics were detected in AOI 10-4 and detected concentrations of metals in this AOI were below background levels.
7. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-3
HIGH-END CUMULATIVE CANCER RISK AND HAZARD INDEX FOR ROUTINE WORKER EXPOSURE TO SOIL

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Estimates of Bounding Risks for Surface Soil Concentrations		Estimates of High-End Risks for Surface Soil Concentrations	
	Routine Worker Cumulative Risk	Routine Worker HI	Routine Worker Cumulative Risk	Routine Worker HI
36-1	4E-05	3E-01	NA	NA
81-2	5E-05	**2E+01**	2E-05	4E-01
83/84-2	3E-05	6E-01	NA	NA

Notes:

1. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
2. NA indicates that the bounding estimates of risk were acceptable, therefore no high-end risks were calculated.
3. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
4. High-end cumulative risk estimates do not include the concentrations of 1,1-dichloroethane, 1,1,1-trichloroethane, and 1,1,2-trichloro-1,2,2-trifluoroethane from RFI-81-38 (1-3 foot depth) at AOI 81-2.
5. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-4
SOUTHEND LOCATIONS WITH UNACCEPTABLE BOUNDING CUMULATIVE CANCER RISK OR HI FOR ROUTINE WORKER SOIL CONTACT

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Parcel	AOI	Location	Estimates of Bounding Risks		Area-Weighted Estimates of Risks	
			Routine Worker Soil Contact Risk	Routine Worker Soil Contact HI	Routine Worker Soil Contact Risk	Routine Worker Soil Contact HI
3	09-A	RFI-09-03	**3E-04**	2E-01	2E-05	2E-01
1	40-A	RFI-40-12	**2E-04**	3E-01	3E-05	9E-02

Notes:

1. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.
2. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
3. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
4. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-5
MEAN LEAD CONCENTRATIONS IN SOIL BY AOI

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Mean Lead Concentration in Surface Soil (mg/kg)	Ratio of Surface Mean to Industrial Criterion	Mean Lead Concentration in Soil at any Depth (mg/kg)	Ratio of any-Depth Mean to Industrial Criterion
GM-North	03-1	2.6E+02	2.9E-01	2.3E+02	2.5E-01
GM-North	05-1	4.7E+02	5.3E-01	5.2E+02	5.7E-01
GM-North	05-2	4.7E+00	5.2E-03	5.9E+00	6.5E-03
GM-North	05-3	3.9E+01	4.4E-02	9.1E+01	1.0E-01
GM-North	05-4	1.1E+01	1.2E-02	1.1E+01	1.2E-02
GM-North	05-5	2.1E+01	2.3E-02	2.8E+01	3.1E-02
GM-North	05-6	2.1E+01	2.3E-02	3.9E+02	4.4E-01
GM-North	07-1	5.5E+01	6.1E-02	5.2E+01	5.8E-02
GM-North	07-2	1.4E+01	1.6E-02	1.4E+01	1.6E-02
GM-North	07-3	1.8E+01	2.0E-02	1.8E+01	2.0E-02
GM-North	10-1	1.7E+02	1.9E-01	2.3E+02	2.5E-01
GM-North	10-2	6.2E+01	6.9E-02	4.8E+01	5.4E-02
GM-North	10-3	6.1E+01	6.8E-02	5.5E+01	6.1E-02
GM-North	10-4	NA	NA	6.0E+00	6.7E-03
GM-North	21-1	7.1E+01	7.9E-02	7.1E+01	7.9E-02
GM-North	36-1	3.9E+01	4.4E-02	3.9E+01	4.4E-02
GM-North	36-2	2.4E+01	2.6E-02	2.4E+01	2.6E-02
GM-North	36-3	1.0E+01	1.1E-02	1.7E+01	1.9E-02
GM-North	36-4	2.6E+01	2.8E-02	2.6E+01	2.8E-02
GM-North	36-5	1.1E+02	1.2E-01	1.1E+02	1.2E-01
GM-North	38-1	1.3E+01	1.5E-02	1.5E+01	1.6E-02
GM-North	55-1	3.7E+01	4.1E-02	4.1E+01	4.5E-02
GM-North	65-1	1.2E+01	1.3E-02	1.2E+01	1.3E-02
GM-North	81-1	2.3E+02	2.6E-01	1.3E+04	**1.5E+01**
GM-North	81-2	2.5E+02	2.7E-01	2.2E+02	2.5E-01
GM-North	81-3	3.9E+01	4.4E-02	6.4E+01	7.1E-02
GM-North	81-4	1.3E+01	1.4E-02	1.3E+01	1.4E-02
GM-North	81-5	3.8E+01	4.2E-02	3.6E+02	4.0E-01
GM-North	83/84-1	8.1E+00	9.0E-03	2.3E+01	2.5E-02
GM-North	83/84-2	4.1E+02	4.5E-01	1.2E+03	**1.3E+00**
GM-North	83/84-3	4.2E+03	**4.6E+00**	4.4E+03	**4.9E+00**
GM-North	83/84-4	1.4E+02	1.5E-01	1.9E+02	2.1E-01
GM-North	83/84-5	1.3E+01	1.4E-02	1.3E+01	1.4E-02
GM-North	83/84-6	8.6E+02	9.5E-01	8.6E+02	9.5E-01
GM-North	83/84-7	3.3E+01	3.7E-02	3.3E+01	3.7E-02
GM-North	85-1	2.0E+01	2.2E-02	3.1E+01	3.4E-02
GM-North	86-1	1.2E+02	1.3E-01	1.2E+02	1.3E-01
GM-North	Former Aeration Lagoons	6.9E+01	7.7E-02	3.8E+01	4.2E-02
GM-South	02-A	7.7E+02	8.6E-01	7.7E+02	8.6E-01
GM-South	02-B	1.4E+02	1.6E-01	1.7E+02	1.9E-01
GM-South	02-C	5.8E+02	6.5E-01	5.8E+02	6.5E-01
GM-South	02-D	6.7E+00	7.4E-03	4.2E+01	4.7E-02
GM-South	02-E	1.9E+01	2.1E-02	1.2E+02	1.3E-01
GM-South	02-F	1.0E+01	1.1E-02	2.1E+01	2.4E-02
GM-South	04-A	3.2E+01	3.6E-02	3.2E+01	3.6E-02
GM-South	04-B	2.2E+01	2.4E-02	3.2E+01	3.6E-02
GM-South	04-C	8.7E+00	9.7E-03	8.7E+00	9.7E-03
GM-South	09-A	6.9E+03	**7.6E+00**	7.0E+03	**7.7E+00**
GM-South	09-B	1.9E+02	2.1E-01	2.1E+02	2.4E-01
GM-South	12-A	5.4E+02	6.0E-01	9.8E+02	**1.1E+00**
GM-South	12-B	2.4E+02	2.7E-01	2.7E+02	3.0E-01
GM-South	12-C	5.5E+00	6.1E-03	6.2E+00	6.9E-03
GM-South	12-D	2.0E+01	2.2E-02	2.0E+01	2.2E-02
GM-South	16-A	4.1E+00	4.6E-03	1.1E+01	1.2E-02
GM-South	16-B	8.6E+00	9.6E-03	1.3E+01	1.4E-02
GM-South	16-C	6.7E+01	7.4E-02	7.1E+01	7.9E-02
GM-South	16-D	7.6E+00	8.4E-03	9.4E+00	1.0E-02
GM-South	17-A	1.7E+02	1.9E-01	1.7E+02	1.9E-01

See Notes on Page 2.

TABLE 6-5
MEAN LEAD CONCENTRATIONS IN SOIL BY AOI

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Mean Lead Concentration in Surface Soil (mg/kg)	Ratio of Surface Mean to Industrial Criterion	Mean Lead Concentration in Soil at any Depth (mg/kg)	Ratio of any-Depth Mean to Industrial Criterion
GM-South	23-A	5.2E+01	5.8E-02	5.3E+01	5.9E-02
GM-South	29-A	6.9E+02	7.7E-01	6.9E+02	7.7E-01
GM-South	40-A	1.1E+02	1.2E-01	1.0E+02	1.1E-01
GM-South	40-B	1.2E+01	1.3E-02	1.2E+01	1.3E-02
GM-South	40-C	1.2E+01	1.3E-02	1.3E+01	1.4E-02
GM-South	40-D	2.3E+01	2.5E-02	2.3E+01	2.5E-02
GM-South	44-A	3.1E+01	3.5E-02	4.1E+01	4.5E-02
GM-South	84-A	3.0E+02	3.4E-01	3.0E+02	3.4E-01
GM-South	84-B	1.6E+01	1.8E-02	1.6E+01	1.8E-02
GM-South	84-C	1.4E+02	1.6E-01	1.4E+02	1.6E-01
GM-South	84-D	1.5E+02	1.7E-01	1.1E+02	1.2E-01
GM-South	94-A	4.2E+00	4.7E-03	1.0E+01	1.1E-02
GM-South	94-B	9.5E+01	1.1E-01	8.4E+01	9.3E-02
GM-South	94-C	1.3E+02	1.4E-01	1.4E+02	1.5E-01
GM-South	94-D	1.6E+02	1.8E-01	1.6E+02	1.8E-01
GM-South	94-E	7.5E+01	8.3E-02	7.5E+01	8.3E-02
GM-South	Former Admin Building	3.4E+01	3.7E-02	3.5E+01	3.8E-02
GM-South	Build 94 Parking Lot	5.0E+01	5.6E-02	5.1E+01	5.7E-02
GM-South	Harriet Street	NA	NA	1.2E+01	1.4E-02

Notes:
1. The site-specific background concentration for lead (93.5 mg/kg) was not subtracted from the concentrations when calculating ratios.
2. The industrial criterion for lead is 900 mg/kg.
3. NA indicates that no surface samples were analyzed for lead.

TABLE 6-6
MAXIMUM LEAD CONCENTRATIONS BY BORING AT SOUTHEND LOCATIONS

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Location	Max Conc (mg/kg)	Depth Interval (feet)
09-A	RFI-09-01	1.20E+05	1 - 3
09-A	RFI-09-01R *	1.20E+05	NA
12-A	RFI-12-02	1.10E+04	6 - 8
12-A	RFI-12-31	1.00E+04	0.7 - 2.7
12-A	RFI-12-35 *	1.00E+04	NA
09-A	RFI-09-02	6.90E+03	0.4 - 2
09-A	RFI-09-16	3.80E+03	1 - 3
09-A	RFI-09-56	2.65E+03	2 - 4
09-A	RFI-09-15	2.20E+03	1.9 - 3.9
02-C	RFI-02-03	2.00E+03	0.9 - 2
29-A	RFI-29-01	1.50E+03	0.6 - 2
09-A	RFI-09-18	1.40E+03	1 - 3
09-B	RFI-09-44	1.20E+03	0.7 - 2.7

Notes:

1. Only locations with lead concentrations greater than the industrial screening criterion (900 mg/kg) are shown.
2. The site-specific background concentration for lead (93.5 mg/kg) was not subtracted from concentrations presented here.
3. Locations marked with an asterisk (*) were not analyzed for lead. Concentrations at these locations were assigned by surrogate to the nearest location which was analyzed for lead. NA indicates that since no lead sample was collected, no depth interval is applicable.

TABLE 6-7
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR ROUTINE WORKER EXPOSURE TO SOIL AND GROUNDWATER BY VAPOR INTRUSION

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

		Soil Vapor Intrusion			Groundwater Vapor Intrusion		
AOI	Parcel	Vapor Intrusion Occupational Contribution from Soil	Routine Worker Soil Vapor Intrusion Risk	Routine Worker Soil Vapor Intrusion HI	Vapor Intrusion Occupational Contribution from GW	Routine Worker GW Vapor Intrusion Risk	Routine Worker GW Vapor Intrusion HI
03-1	--	2E-04	4E-06	2E-02	6E-06	5E-08	5E-04
05-1	--	8E-05	4E-06	3E-02	3E-06	3E-09	3E-04
05-2	--	5E-07	6E-11	1E-03	1E-05	8E-08	3E-04
05-3	--	1E-05	5E-07	7E-03	2E-07	8E-09	9E-05
05-4	--	3E-07	3E-16	5E-03	3E-12	NA	1E-09
05-5	--	1E-04	2E-06	1E-02	1E-06	2E-10	2E-04
05-6	--	1E-05	4E-07	5E-03	1E-05	1E-07	9E-04
07-1	--	4E-04	2E-06	7E-02	2E-06	9E-09	2E-04
07-2	--	NA	3E-11	4E-08	NA	NA	NA
07-3	--	1E-05	1E-06	4E-03	9E-09	3E-10	8E-06
10-1	--	2E-04	9E-07	5E-02	4E-06	2E-08	3E-03
10-2	--	3E-04	8E-06	3E-01	5E-05	2E-07	5E-03
10-3	--	4E-04	2E-06	1E-01	3E-04	2E-06	2E-02
10-4	--	NA	NA	NA	2E-06	1E-08	1E-04
21-1	--	3E-05	3E-07	4E-02	2E-09	2E-11	8E-08
36-1	--	5E-01	**3E-03**	**7E+01**	2E-04	1E-06	1E-02
36-2	--	2E-05	4E-08	1E-03	7E-04	5E-06	5E-02
36-3	--	4E-03	2E-05	1E+00	1E-03	6E-06	9E-02
36-4	--	3E-05	NA	1E-02	5E-08	1E-09	1E-04
36-5	--	4E-06	7E-08	3E-03	8E-06	6E-08	8E-04
38-1	--	1E-05	2E-07	6E-03	1E-06	8E-10	1E-04
55-1	--	5E-05	1E-06	4E-02	2E-05	1E-07	9E-03
65-1	--	1E-06	9E-08	1E-04	1E-07	1E-08	4E-04
81-1	--	4E-04	2E-06	1E-01	7E-06	3E-08	2E-04
81-2	--	4E-01	3E-05	**2E+02**	2E-06	3E-09	2E-04
81-3	--	8E-04	3E-05	2E-01	4E-05	2E-07	2E-03
81-4	--	3E-06	3E-07	8E-04	5E-08	7E-09	2E-05
81-5	--	4E-05	9E-07	6E-03	NA	NA	NA
83/84-1	--	2E-03	1E-05	2E-01	2E-07	2E-09	2E-05
83/84-2	--	3E-03	2E-05	3E-01	2E-06	4E-10	3E-04
83/84-3	--	2E-04	1E-09	2E-02	5E-09	4E-10	7E-06
83/84-4	--	8E-04	6E-06	6E-01	3E-09	NA	2E-05
83/84-5	--	3E-07	2E-10	8E-04	NA	NA	NA
83/84-6	--	2E-06	1E-07	2E-04	NA	NA	NA
83/84-7	--	2E-07	1E-09	6E-05	1E-04	6E-07	1E-02
85-1	--	4E-04	2E-05	2E-01	1E-06	5E-08	4E-04
86-1	--	4E-04	1E-05	9E-02	2E-04	2E-06	1E-02
Former Aeration Lagoons	--	5E-06	4E-08	3E-04	2E-11	NA	2E-09
02-A	1	NA	1E-12	NA	NA	NA	NA
02-B	1	7E-05	1E-07	1E-02	3E-07	3E-10	1E-04
02-C	1	NA	2E-13	3E-08	NA	NA	NA
02-D	1	2E-06	2E-09	2E-03	NA	NA	NA
02-E	1	1E-04	5E-07	2E-02	7E-08	5E-09	NA
02-F	1	6E-05	1E-11	4E-03	1E-06	3E-09	1E-04
04-A	1	2E-05	6E-07	2E-02	NA	NA	NA
04-B	1	1E-06	1E-07	1E-03	NA	NA	NA
04-C	1	4E-06	3E-07	5E-05	NA	NA	NA
04-D	1	NA	NA	NA	6E-07	7E-09	4E-04
09-A	3	7E-04	2E-05	9E-02	3E-06	8E-08	4E-04
09-B	3	1E-03	7E-06	2E-01	2E-04	1E-06	2E-02
12-A	1	4E-04	3E-06	2E-01	9E-07	3E-09	1E-03
12-B	1	1E-05	7E-08	1E-02	3E-08	2E-09	2E-08
12-C	1	8E-06	2E-07	4E-03	NA	NA	NA
12-D	1	4E-06	5E-07	2E-03	NA	NA	NA
16-A	1	6E-06	1E-07	3E-03	2E-09	NA	1E-06
16-B	1	8E-06	3E-07	2E-03	NA	NA	NA

See Notes on Page 2.

TABLE 6-7
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR ROUTINE WORKER EXPOSURE TO SOIL AND GROUNDWATER BY VAPOR INTRUSION

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

		Soil Vapor Intrusion			Groundwater Vapor Intrusion		
AOI	Parcel	Vapor Intrusion Occupational Contribution from Soil	Routine Worker Soil Vapor Intrusion Risk	Routine Worker Soil Vapor Intrusion HI	Vapor Intrusion Occupational Contribution from GW	Routine Worker GW Vapor Intrusion Risk	Routine Worker GW Vapor Intrusion HI
16-C	1	2E-03	1E-05	4E-01	3E-05	2E-07	3E-03
16-D	1	5E-06	1E-07	3E-03	NA	NA	NA
17-A	2	2E-04	1E-06	9E-02	4E-09	NA	1E-06
23-A	1	2E-05	3E-07	4E-03	6E-09	2E-13	2E-06
29-A	1	6E-06	8E-11	1E-03	NA	NA	NA
40-A	1	2E-03	1E-05	4E-01	9E-04	5E-06	8E-02
40-B	1	1E-05	7E-07	3E-03	4E-06	5E-08	9E-04
40-C	1	3E-04	2E-06	3E-02	2E-06	4E-08	1E-04
40-D	1	3E-05	3E-06	1E-02	4E-06	2E-08	5E-04
44-A	1	2E-05	3E-07	9E-03	3E-07	2E-08	1E-08
84-A	2	6E-05	2E-06	6E-02	6E-05	4E-07	4E-03
84-B	2	3E-08	3E-11	3E-04	NA	NA	NA
84-C	2	6E-07	3E-11	1E-04	NA	NA	NA
84-D	2	1E-04	9E-06	4E-02	3E-04	2E-06	2E-02
94-A	2	6E-07	8E-17	1E-03	NA	NA	NA
94-B	2	3E-06	6E-11	3E-04	3E-06	3E-07	3E-04
94-C	2	5E-06	3E-08	4E-03	NA	NA	NA
94-D	2	2E-06	3E-07	2E-07	2E-09	2E-10	NA
94-E	2	4E-06	3E-11	3E-03	NA	NA	NA
Former Admin Building	6	7E-06	7E-08	3E-04	1E-05	9E-08	1E-03
Build 94 Parking Lot	2	5E-06	1E-07	2E-04	4E-09	1E-11	NA
FEP	4	5E-06	2E-07	1E-02	NA	NA	NA
Harriet Street Area	7	6E-04	3E-06	4E-01	7E-06	4E-08	5E-04

Notes:

1. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI .
3. NA indicates that the medium was not sampled in that AOI, or that chemicals with risk- or occupational-based volatilization criteria were all non-detect.
4. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.

TABLE 6-8
ESTIMATED INDOOR AIR CONTRIBUTION AND BOUNDING CUMULATIVE CANCER RISK AND HI FOR ROUTINE WORKER EXPOSURE TO LNAPL BY VAPOR INTRUSION

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Routine Worker NAPL Vapor Intrusion Risk	Routine Worker NAPL Vapor Intrusion HI	Vapor Intrusion Occupational Contribution from NAPL
02-B	NA	5E-09	NA
03-1	3E-08	6E-04	5E-06
05-1	7E-09	4E-04	4E-07
05-5	3E-10	NA	4E-09
09-B	3E-05	6E-01	6E-03
10-1	NA	8E-09	NA
10-4	3E-07	8E-03	5E-05
12-A	5E-09	6E-04	5E-07
12-B	1E-08	8E-04	2E-06
12-C	1E-08	2E-04	2E-06
16-C	3E-07	3E-02	5E-06
23-A	3E-09	5E-05	6E-07
36-1	1E-04	**2E+00**	2E-02
36-2	NA	9E-03	7E-07
36-5	3E-08	2E-03	3E-06
40-A	5E-07	6E-03	8E-05
81-2	NA	9E-06	2E-08
83/84-2	4E-08	8E-04	5E-06
83/84-4	1E-07	1E-03	3E-05
85-1	1E-09	2E-04	2E-07
86-1	3E-09	6E-04	7E-07

Notes:

1. The criteria are Michigan OSHA threshold limit values (TLVs), OSHA permissible exposure limits (PELs) for chemicals without Michigan OSHA TLVs, or ACGIH TLVs for chemicals without Michigan OSHA TLVs or PELs. The criteria for 1,2,4-Trichlorobenzene are from the MDEQ Remediation and Redevelopment Division, Part 201/213 Acceptable Indoor Air Concentrations, 2003.
2. NA indicates that chemicals with the relevant toxicity values or occupational limits that could potentially volatilize were all non-detect.

TABLE 6-9
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO GROUNDWATER

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Maintenance Worker GW Contact Risk	Maintenance Worker GW Contact HI
GM-North	03-1	2E-07	1E-02
GM-North	05-1	4E-08	2E-03
GM-North	05-2	1E-07	5E-03
GM-North	05-3	7E-08	2E-03
GM-North	05-4	8E-10	1E-04
GM-North	05-5	5E-08	2E-03
GM-North	05-6	2E-07	7E-03
GM-North	07-1	2E-08	1E-03
GM-North	07-3	2E-09	4E-04
GM-North	10-1	5E-08	3E-02
GM-North	10-2	5E-07	3E-02
GM-North	10-3	3E-06	6E-02
GM-North	10-4	5E-08	2E-03
GM-North	21-1	2E-06	3E-03
GM-North	36-1	3E-06	7E-02
GM-North	36-2	1E-05	3E-01
GM-North	36-3	1E-05	5E-01
GM-North	36-4	5E-09	8E-04
GM-North	36-5	1E-07	6E-03
GM-North	38-1	6E-09	2E-03
GM-North	55-1	6E-07	1E+00
GM-North	65-1	2E-08	3E-03
GM-North	81-1	1E-07	3E-03
GM-North	81-2	2E-07	3E-03
GM-North	81-3	4E-07	1E-02
GM-North	81-4	1E-08	3E-04
GM-North	83/84-1	9E-09	5E-04
GM-North	83/84-2	6E-09	6E-03
GM-North	83/84-3	3E-08	3E-03
GM-North	83/84-4	8E-08	2E-02
GM-North	83/84-5	2E-09	2E-04
GM-North	83/84-7	1E-06	7E-02
GM-North	85-1	9E-08	5E-03
GM-North	86-1	3E-06	1E-01
GM-North	Former Aeration Lagoons	2E-08	4E-04
GM-South	02-B	5E-10	8E-03
GM-South	02-E	2E-07	3E-02
GM-South	02-F	1E-07	2E-02
GM-South	04-D	2E-07	2E-02
GM-South	09-A	2E-07	2E-02
GM-South	09-B	4E-06	3E-01
GM-South	12-A	5E-08	5E-02
GM-South	12-B	7E-08	1E-02
GM-South	16-A	5E-09	6E-04
GM-South	16-C	5E-07	2E-02
GM-South	17-A	2E-08	6E-04
GM-South	23-A	3E-08	4E-04
GM-South	40-A	1E-05	5E-01
GM-South	40-B	8E-08	6E-03
GM-South	40-C	7E-08	3E-03
GM-South	40-D	2E-07	3E-02
GM-South	44-A	8E-07	1E-01
GM-South	84-A	7E-07	2E-02
GM-South	84-D	4E-06	1E-01
GM-South	94-B	4E-07	7E-03
GM-South	94-D	1E-09	1E-04

See Notes on Page 2.

TABLE 6-9
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO GROUNDWATER

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Maintenance Worker GW Contact Risk	Maintenance Worker GW Contact HI
GM-South	Former Admin Building	2E-07	7E-03
GM-South	Build 94 Parking Lot	6E-10	1E-06
GM-South	FEP	3E-07	3E-04
GM-South	Harriet Street Area	1E-07	3E-03

Notes:
1. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.
3. Only AOIs where constituents were detected in groundwater are shown.

TABLE 6-10
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO SMEAR ZONE SOIL AND LNAPL

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Smear Zone Soil				LNAPL			Smear Zone Soil				LNAPL		
	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total
	Maintenance Worker Risk							Maintenance Worker HI						
02-B	NA	NA	NA	NA	NA	NA	NA	5E-06	2E-06	7E-06	1E-05	2E-05	1E-07	2E-05
03-1	2E-07	1E-07	2E-08	3E-07	2E-07	4E-07	6E-07	6E-05	2E-05	4E-03	4E-03	5E-04	2E-02	2E-02
05-1	5E-09	2E-09	8E-09	2E-08	2E-09	8E-08	9E-08	9E-04	4E-04	7E-05	1E-03	3E-04	1E-02	1E-02
05-5	9E-08	4E-08	1E-07	3E-07	3E-08	2E-09	3E-08	2E-02	7E-03	NA	2E-02	5E-03	NA	5E-03
09-B	2E-08	2E-10	6E-06	6E-06	2E-06	**4E-04**	**5E-04**	1E-03	1E-04	5E-01	5E-01	9E-02	**2E+01**	**2E+01**
10-1	7E-10	7E-11	NA	7E-10	4E-07	NA	4E-07	2E-05	3E-06	9E-06	3E-05	1E-01	2E-07	1E-01
10-4	7E-09	7E-10	5E-08	6E-08	4E-06	4E-06	8E-06	2E-04	2E-05	3E-02	3E-02	1E+00	2E-01	1E+00
12-A	3E-09	3E-10	4E-10	4E-09	2E-06	1E-07	2E-06	3E-04	8E-05	2E-02	2E-02	2E-01	2E-02	3E-01
12-B	1E-09	1E-10	7E-10	2E-09	7E-07	3E-07	9E-07	3E-04	8E-05	2E-02	2E-02	1E+00	3E-02	1E+00
12-C	6E-09	3E-09	1E-08	2E-08	2E-07	2E-07	3E-07	1E-03	5E-04	1E-04	2E-03	1E-01	6E-03	1E-01
16-C	6E-08	2E-08	1E-07	2E-07	3E-06	5E-06	9E-06	6E-03	2E-03	7E-01	7E-01	2E-01	1E+00	1E+00
23-A	3E-09	8E-10	6E-10	4E-09	3E-07	5E-08	3E-07	2E-04	5E-05	2E-03	2E-03	4E-01	2E-03	4E-01
36-1	5E-08	6E-11	2E-05	2E-05	4E-06	**1E-03**	**1E-03**	4E-03	2E-04	1E+00	1E+00	3E-01	**5E+01**	**6E+01**
36-2	1E-09	1E-10	NA	1E-09	6E-07	NA	6E-07	3E-05	5E-06	2E-04	2E-04	2E-01	3E-01	4E-01
36-5	6E-11	5E-12	3E-09	3E-09	3E-08	4E-07	5E-07	1E-04	5E-05	1E-02	1E-02	9E-02	5E-02	1E-01
40-A	2E-10	NA	8E-08	8E-08	2E-08	6E-06	6E-06	7E-06	NA	2E-03	3E-03	6E-04	2E-01	2E-01
81-2	NA	NA	NA	NA	NA	NA	NA	4E-06	2E-06	2E-05	3E-05	3E-05	4E-04	5E-04
83/84-2	4E-08	2E-08	5E-08	1E-07	4E-07	6E-07	1E-06	6E-03	3E-03	1E-02	2E-02	1E-01	2E-02	2E-01
83/84-4	2E-09	2E-10	2E-09	4E-09	1E-06	2E-06	4E-06	5E-05	4E-06	1E-04	2E-04	3E-01	4E-02	3E-01
85-1	2E-09	6E-10	2E-09	4E-09	3E-07	2E-08	4E-07	3E-04	1E-04	5E-03	5E-03	1E-01	5E-03	1E-01
86-1	5E-09	2E-09	7E-09	1E-08	7E-07	1E-07	8E-07	8E-04	3E-04	1E-02	1E-02	4E-01	3E-02	4E-01
Outfall 004	NA	NA	NA	NA	2E-06	9E-09	2E-06	NA	NA	NA	NA	1E-01	1E-01	2E-01
Storm Sewer (SS)	NA	NA	NA	NA	9E-08	NA	9E-08	NA	NA	NA	NA	2E-01	3E-05	2E-01

Notes:

1. NA = Risks were not calculated due to a lack of exposure or toxicity information for detected chemicals in the AOI.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations for LNAPL and estimated residual soil concentrations in each AOI.
3. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.

TABLE 6-11
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO BASEMENT, TUNNEL, AND SEWER WATER

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Matrix	Maintenance Worker Contact Risk	Maintenance Worker Contact HI
12-A	Basement Water	7E-08	1E-02
23-A	Basement Water	5E-05	5E-02
36-3	Basement Water	1E-06	6E-02
40-D	Tunnel Water	5E-07	4E-02
SS	Storm Sewer Water	2E-06	3E-01

Notes:
1. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.

TABLE 6-12
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR REDEVELOPMENT CONSTRUCTION WORKER AND RESIDENT EXPOSURE TO SOIL AT THE SOUTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Parcel	Redevelopment Construction Worker Soil Contact Risk	Redevelopment Construction Worker Soil Contact HI	Resident Soil Contact Risk	Resident Soil Contact HI
02-A	1	2E-08	6E-02	9E-07	1E-01
02-B	1	5E-07	6E-01	2E-05	2E-01
02-C	1	2E-06	2E-01	2E-06	5E-01
02-D	1	2E-06	2E-02	1E-04	1E-02
02-E	1	2E-07	8E-02	1E-05	7E-02
02-F	1	1E-07	2E-01	2E-06	5E-02
04-A	1	6E-07	7E-03	3E-05	1E-02
04-B	1	2E-07	2E-01	1E-05	3E-02
04-C	1	5E-08	8E-03	2E-06	4E-02
09-A	3	3E-05	**7E+00**	**1E-03**	**3E+00**
09-B	3	9E-06	**3E+00**	**4E-04**	**3E+00**
12-A	1	4E-06	**4E+00**	1E-04	**3E+00**
12-B	1	5E-07	1E+00	8E-06	2E-01
12-C	1	2E-08	1E-02	7E-08	2E-03
12-D	1	2E-07	2E-01	7E-06	3E-02
16-A	1	4E-07	7E-02	2E-05	1E-01
16-B	1	2E-08	3E-02	5E-08	3E-02
16-C	1	4E-06	1E+00	1E-04	6E-01
16-D	1	1E-08	1E-01	5E-08	3E-02
17-A	2	5E-07	2E-01	2E-05	2E-01
23-A	1	2E-07	3E-02	9E-06	1E-02
29-A	1	1E-06	2E-01	6E-06	3E-01
40-A	1	1E-05	1E+00	**8E-04**	7E-01
40-B	1	4E-07	2E-02	2E-05	5E-02
40-C	1	2E-07	5E-01	7E-06	6E-02
40-D	1	3E-07	4E-02	9E-06	1E-01
44-A	1	2E-06	**3E+00**	3E-05	6E-01
84-A	2	8E-07	2E-01	3E-05	2E-01
84-B	2	2E-07	9E-03	9E-06	4E-02
84-C	2	6E-07	4E-02	3E-05	2E-01
84-D	2	7E-07	3E-01	1E-05	1E-01
86-1	1	1E-05	**3E+00**	**6E-04**	**4E+00**
94-A	2	4E-07	6E-01	2E-05	2E-01
94-B	2	9E-08	1E-02	5E-06	6E-03
94-C	2	2E-07	2E-01	4E-06	7E-02
94-D	2	5E-08	8E-03	2E-06	8E-03
94-E	2	2E-07	1E-02	1E-05	6E-02
Former Admin Building	6	2E-07	1E-01	1E-05	1E-01
Build 94 Parking Lot	2	1E-06	4E-01	4E-05	**2E+00**
FEP	4	2E-06	8E-02	8E-05	2E-02
Harriet Street	7	9E-07	1E+00	3E-05	1E+00

Notes:

1. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI .
2. Only AOIs where constituents were detected in soil are shown.
3. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.
4. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
5. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
6. AOI 86-1 is part of the Northend, but contains nine soil locations on Parcel 1 in the Southend. The cumulative risk and HI for the redevelopment construction worker and resident at AOI 86-1 is based on concentrations detected in the Parcel 1 locations.
7. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-13
SOUTHEND LOCATIONS WITH UNACCEPTABLE BOUNDING CUMULATIVE CANCER RISK OR HI FOR REDEVELOPMENT WORKER SOIL CONTACT

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Parcel	AOI	Location	Estimates of Bounding Risks		Area-Weighted Estimates of Risks	
			Redevelopment Worker Soil Contact Risk	Redevelopment Worker Soil Contact HI	Redevelopment Worker Soil Contact Risk	Redevelopment Worker Soil Contact HI
3	09-A	RFI-09-04	1E-06	**6E+00**	8E-07	9E-01
3	09-A	RFI-09-49	9E-07	**2E+00**	8E-07	9E-01
3	09-A	RFI-09-25	9E-07	**2E+00**	8E-07	9E-01
3	09-A	RFI-09-24	8E-07	**2E+00**	8E-07	9E-01
1	44-A	RFI-44-05	5E-06	**3E+00**	4E-06	6E-01
1	86-1	RFI-86-01	3E-06	**2E+00**	2E-06	9E-01

Notes:

1. Parcels at the Southend are defined in Section 6.5.2.1 of the Revised RFI Phase II Report and shown on Figure 6-1.
2. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
3. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
4. Lead is evaluated in Section 6.5.2.1 of the Revised RFI Phase II Report and shown on Table 6-5.

TABLE 6-14
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR REDEVELOPMENT CONSTRUCTION WORKER EXPOSURE TO GROUNDWATER AT THE SOUTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Area	AOI	Redevelopment Worker GW Contact Risk	Redevelopment Worker GW Contact HI
GM-South	02-B	5E-11	7E-03
GM-South	02-E	2E-08	1E-02
GM-South	02-F	1E-08	8E-03
GM-South	04-D	2E-08	1E-02
GM-South	09-A	2E-08	9E-03
GM-South	09-B	4E-07	2E-01
GM-South	12-A	5E-09	5E-02
GM-South	12-B	7E-09	5E-03
GM-South	16-A	5E-10	3E-04
GM-South	16-C	5E-08	1E-02
GM-South	17-A	2E-09	2E-04
GM-South	23-A	3E-09	4E-04
GM-South	40-A	1E-06	3E-01
GM-South	40-B	8E-09	2E-03
GM-South	40-C	7E-09	2E-03
GM-South	40-D	2E-08	1E-02
GM-South	44-A	8E-08	5E-02
GM-South	84-A	7E-08	7E-03
GM-South	84-D	4E-07	8E-02
GM-South	94-B	4E-08	6E-03
GM-South	94-D	1E-10	6E-05
GM-South	Former Admin Building	2E-08	4E-03
GM-South	Build 94 Parking Lot	6E-11	1E-06
GM-South	Harriet Street Area	1E-08	2E-03

Notes:
1. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.

TABLE 6-15
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR REDEVELOPMENT CONSTRUCTION WORKER EXPOSURE TO SMEAR ZONE SOIL AND LNAPL AT THE SOUTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Smear Zone Soil				LNAPL			Smear Zone Soil				LNAPL		
	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total
	Redevelopment Construction Worker Risk							Redevelopment Construction Worker HI						
02-B	NA	NA	NA	NA	NA	NA	NA	5E-07	2E-07	4E-07	1E-06	2E-07	2E-09	2E-07
09-B	2E-09	2E-11	4E-07	4E-07	2E-07	9E-06	9E-06	9E-04	9E-05	3E-01	3E-01	5E-03	**3E+00**	**3E+00**
12-A	3E-10	3E-11	2E-11	4E-10	2E-07	3E-09	2E-07	2E-04	6E-05	1E-02	1E-02	1E-02	4E-03	2E-02
12-B	1E-10	1E-11	5E-11	2E-10	7E-08	5E-09	7E-08	2E-04	7E-05	1E-02	1E-02	2E-02	6E-03	3E-02
12-C	6E-10	3E-10	6E-10	1E-09	2E-08	3E-09	2E-08	4E-04	2E-04	6E-05	6E-04	4E-03	7E-04	4E-03
16-C	6E-09	2E-09	8E-09	2E-08	3E-07	1E-07	4E-07	5E-03	2E-03	4E-01	5E-01	9E-03	2E-01	2E-01
23-A	3E-10	8E-11	4E-11	4E-10	3E-08	9E-10	3E-08	1E-04	2E-05	1E-03	1E-03	2E-02	2E-04	2E-02
40-A	2E-11	NA	5E-09	5E-09	2E-09	1E-07	1E-07	7E-06	NA	8E-04	8E-04	6E-05	2E-02	2E-02

Notes:

1. NA = Risks were not calculated due to a lack of exposure or toxicity information for detected chemicals in the AOI.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations for LNAPL and estimated residual soil concentrations in each AOI.
3. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.

TABLE 6-16
SOUTHEND LOCATIONS WITH UNACCEPTABLE BOUNDING CUMULATIVE CANCER RISK OR HI FOR RESIDENTIAL SOIL CONTACT

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Parcel	AOI	Location	Estimates of Bounding Risks for Surface Soil Concentrations		Area-Weighted Estimates of Risks for Surface Soil Concentrations	
			Residential Soil Contact Risk	Residential Soil Contact HI	Residential Soil Contact Risk	Residential Soil Contact HI
2	Build 94 Parking Lot	BD 94 EP-02	7E-05	**2E+00**	NA	NA
2	Build 94 Parking Lot	EP 94-02A	7E-05	**2E+00**	NA	NA
3	09-A	RFI-09-02	1E-04	**2E+00**	NA	NA
3	09-A	RFI-09-03	**1E-03**	8E-01	1E-04	1E+00
3	09-B	RFI-09-05	1E-04	**3E+00**	5E-05	2E-01
3	09-A	RFI-09-19	**2E-04**	7E-01	1E-04	1E+00
3	09-A	RFI-09-38	1E-04	**2E+00**	NA	NA
3	09-A	RFI-09-39	**2E-04**	7E-02	1E-04	1E+00
3	09-B	RFI-09-45	**3E-04**	5E-01	NA	NA
3	09-B	RFI-09-45R	**2E-04**	9E-02	NA	NA
1	12-A	RFI-12-31	2E-05	**2E+00**	2E-05	1E+00
1	12-A	RFI-12-35	2E-05	**2E+00**	2E-05	1E+00
1	40-A	RFI-40-12	**8E-04**	8E-01	1E-04	3E-01
1	40-A	RFI-40-16	**2E-04**	4E-01	1E-04	3E-01
1	40-A	RFI-40-17	**2E-04**	4E-01	1E-04	3E-01
1	86-1	RFI-86-07	**3E-04**	**2E+00**	NA	NA
1	86-1	RFI-86-12	1E-04	**2E+00**	NA	NA
1	86-1	RFI-86-17	**5E-04**	**3E+00**	NA	NA

Notes:

1. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.
2. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
3. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
4. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.
5. NA indicates that area-weighted risks were not calculated for that location because its Thiessen polygon (or nearby group of Thiessen polygons with similar risk estimates) was 1/2 acre or larger.

TABLE 6-17
SOUTHEND LOCATIONS WITH LEAD CONCENTRATIONS IN SHALLOW SOIL GREATER THAN RESIDENTIAL CRITERION

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Location	Lead Concentration (mg/kg)	Depth Interval (feet)
09-A	RFI-09-01	1.20E+05	1 - 3
09-A	RFI-09-01R *	1.20E+05	NA
12-A	RFI-12-31	1.00E+04	0.7 - 2.7
12-A	RFI-12-35 *	1.00E+04	NA
09-A	RFI-09-02	6.90E+03	0.4 - 2
09-A	RFI-09-16	3.80E+03	1 - 3
09-A	RFI-09-15	2.20E+03	1.9 - 3.9
02-C	RFI-02-03	2.00E+03	0.9 - 2
29-A	RFI-29-01	1.50E+03	0.6 - 2
09-A	RFI-09-18	1.40E+03	1 - 3
09-B	RFI-09-44	1.20E+03	0.7 - 2.7
12-A	RFI-12-33	8.50E+02	1 - 2
02-A	RFI-02-01	7.70E+02	1 - 2
12-A	RFI-12-30	7.30E+02	0.7 - 2.7
84-A	RFI-84-01	6.00E+02	0.5 - 2
02-B	RFI-02-22	5.74E+02	0 - 3
09-B	RFI-09-10	5.30E+02	0.8 - 2
40-A	RFI-40-09	4.90E+02	0.7 - 2.7
29-A	RFI-29-03	4.70E+02	1 - 3
12-B	RFI-12-11D	4.60E+02	1.1 - 3.1
12-B	RFI-12-14 *	4.60E+02	NA
09-B	RFI-09-45	4.40E+02	0.5 - 2.5
09-B	RFI-09-45R *	4.40E+02	NA
09-A	RFI-09-36R	4.30E+02	0.3 - 2.3
84-A	RFI-84-06	4.30E+02	0.9 - 2
09-A	RFI-09-39	4.20E+02	0.5 - 2.5

Notes:

1. Only locations with shallow lead concentrations greater than the residential screening criterion (400 mg/kg) are shown.
2. The background concentration of lead is 93.5 mg/kg, and was not subtracted from presented concentrations.
3. Locations marked with an asterisk (*) were not analyzed for lead. Concentrations at these locations were assigned by surrogate to the nearest location which was analyzed for lead. NA indicates that since no lead sample was collected, no depth interval is applicable.
4. The area-weighted average lead concentration for a 1/2 acre lot centered on RFI-40-09 is 190 mg/kg, which is less than the residential screening criterion.

TABLE 6-18
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR RESIDENTIAL EXPOSURE TO SOIL AND GROUNDWATER BY VAPOR INTRUSION AT THE SOUTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Parcel	Soil Vapor Intrusion		GW Vapor Intrusion	
		Residential Soil Vapor Intrusion Risk	Residential Soil Vapor Intrusion HI	Residential GW Vapor Intrusion Risk	Residential GW Vapor Intrusion HI
02-A	1	4E-12	NA	NA	NA
02-B	1	3E-07	3E-02	5E-10	2E-04
02-C	1	7E-13	8E-08	NA	NA
02-D	1	6E-09	5E-03	NA	NA
02-E	1	9E-07	4E-02	1E-08	NA
02-F	1	4E-11	9E-03	7E-09	2E-04
04-A	1	1E-06	2E-02	NA	NA
04-B	1	2E-07	3E-03	NA	NA
04-C	1	5E-07	1E-04	NA	NA
04-D	1	NA	NA	1E-08	6E-04
09-A	3	3E-05	2E-01	1E-07	6E-04
09-B	3	1E-05	4E-01	3E-06	4E-02
12-A	1	5E-06	5E-01	6E-09	2E-03
12-B	1	2E-07	3E-02	4E-09	4E-08
12-C	1	6E-07	1E-02	NA	NA
12-D	1	7E-07	3E-03	NA	NA
16-A	1	4E-07	8E-03	NA	2E-06
16-B	1	4E-07	4E-03	NA	NA
16-C	1	2E-05	7E-01	4E-07	4E-03
16-D	1	4E-07	8E-03	NA	NA
17-A	2	3E-06	2E-01	NA	3E-06
23-A	1	6E-07	7E-03	6E-13	4E-06
29-A	1	2E-10	3E-03	NA	NA
40-A	1	2E-05	7E-01	1E-05	1E-01
40-B	1	1E-06	4E-03	1E-07	2E-03
40-C	1	4E-06	5E-02	8E-08	2E-04
40-D	1	6E-06	2E-02	4E-08	9E-04
44-A	1	7E-07	2E-02	5E-08	3E-08
84-A	2	5E-06	9E-02	7E-07	7E-03
84-B	2	8E-11	7E-04	NA	NA
84-C	2	9E-11	2E-04	NA	NA
84-D	2	2E-05	6E-02	4E-06	3E-02
86-1	1	8E-06	3E-01	3E-06	2E-02
94-A	2	2E-16	3E-03	NA	NA
94-B	2	2E-10	7E-04	5E-07	5E-04
94-C	2	6E-08	9E-03	NA	NA
94-D	2	6E-07	5E-07	4E-10	NA
94-E	2	1E-10	7E-03	NA	NA
Former Admin Building	6	2E-07	6E-04	2E-07	2E-03
uild 94 Parking L	2	3E-07	5E-04	4E-11	NA
FEP	4	4E-07	2E-02	NA	NA
Harriet Street	7	6E-06	8E-01	9E-08	9E-04

Notes:

1. Only AOIs at the Southend are shown. AOI 86-1 is part of the Northend, but contains nine soil locations on Parcel 1 in the Southend. The cumulative soil risk and HI at AOI 86-1 is based on concentrations detected in the Parcel 1 locations.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.
3. NA indicates that the medium was not sampled in that AOI, or that chemicals with risk-based volatilization criteria were all non-detect.
4. Parcels at the Southend are defined in Section 6.5.2.1 of the RFI Phase II Report and shown on Figure 6-1.

TABLE 6-19
ESTIMATED RESIDENTIAL CANCER RISK AND HI FROM
LNAPL VOLATILIZATION TO INDOOR AIR AT THE SOUTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Residential NAPL Vapor Intrusion Risk	Residential NAPL Vapor Intrusion HI
02-B	NA	1E-08
09-B	1E-04	1E+00
12-A	1E-08	1E-03
12-B	3E-08	2E-03
12-C	3E-08	4E-04
16-C	8E-07	6E-02
23-A	1E-08	1E-04
40-A	1E-06	1E-02

Note:

1. NA indicates that chemicals with the relevant toxicity values that could potentially volatilize were all non-detect.

TABLE 6-20
RECREATIONAL SOIL CONTACT RISK AND HI AT SOUTHEND LOCATIONS WITH UNACCEPTABLE RESIDENTIAL BOUNDING RISK ESTIMATES

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Parcel	AOI	Location	Recreator Soil Contact Risk	Recreator Soil Contact HI
2	Build 94 Parking Lot	BD 94 EP-02	9E-06	3E-01
2	Build 94 Parking Lot	EP 94-02A	9E-06	2E-01
3	09-A	RFI-09-02	2E-05	3E-01
3	09-A	RFI-09-03	**2E-04**	1E-01
3	09-B	RFI-09-05	1E-05	4E-01
3	09-A	RFI-09-19	3E-05	8E-02
3	09-A	RFI-09-38	1E-05	3E-01
3	09-A	RFI-09-39	2E-05	9E-03
3	09-B	RFI-09-45	4E-05	6E-02
3	09-B	RFI-09-45R	3E-05	1E-02
1	12-A	RFI-12-31	3E-06	3E-01
1	12-A	RFI-12-35	3E-06	3E-01
1	40-A	RFI-40-12	9E-05	1E-01
1	40-A	RFI-40-16	3E-05	5E-02
1	40-A	RFI-40-17	2E-05	5E-02
1	86-1	RFI-86-07	4E-05	3E-01
1	86-1	RFI-86-12	2E-05	2E-01
1	86-1	RFI-86-17	6E-05	3E-01

Notes:

1. Parcels at the Southend are defined in Section 6.5.2.1 of the Revised RFI Phase II Report and shown on Figure 6-1.
2. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
3. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
4. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-21
BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR RESIDENTIAL EXPOSURE TO GROUNDWATER BY VAPOR INTRUSION AT AREAS DOWNGRADIENT OF THE NORTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	GW Vapor Intrusion	
	Residential GW Vapor Intrusion Risk	Residential GW Vapor Intrusion HI
03-1	9E-08	1E-03
05-1	6E-09	4E-04
05-2	2E-07	6E-04
05-3	2E-08	2E-04
05-4	NA	3E-09
05-5	5E-10	2E-04
05-6	2E-07	2E-03
07-1	2E-08	3E-04
07-2	NA	NA
07-3	6E-10	1E-05
10-1	3E-08	5E-03
10-2	5E-07	8E-03
10-3	3E-06	3E-02
10-4	2E-08	2E-04
21-1	5E-11	2E-07
36-1	2E-06	2E-02
36-2	9E-06	9E-02
36-3	1E-05	2E-01
36-4	3E-09	2E-04
36-5	1E-07	1E-03
38-1	1E-09	2E-04
55-1	3E-07	2E-02
65-1	3E-08	8E-04
81-1	6E-08	4E-04
81-2	6E-09	4E-04
81-3	4E-07	4E-03
81-4	1E-08	2E-05
81-5	NA	NA
83/84-1	3E-09	3E-05
83/84-2	8E-10	5E-04
83/84-3	8E-10	1E-05
83/84-4	NA	5E-05
83/84-5	NA	NA
83/84-6	NA	NA
83/84-7	1E-06	2E-02
85-1	1E-07	7E-04
86-1	3E-06	2E-02
Aeration Lagoon	NA	6E-09

Notes:
1. Only AOIs at the Northend are shown.
2. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.
3. NA indicates that the medium was not sampled in that AOI, or that chemicals with risk-based volatilization criteria were all non-detect.

TABLE 6-22
ESTIMATED SURFACE WATER CONCENTRATIONS RESULTING FROM GROUNDWATER MIGRATION AND OUTFALL DISCHARGE TO FLINT RIVER

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

Chem Group	Chemical	CASRN	River Concentration Due to Groundwater Discharges (mg/L)	River Concentration Due to Sewer Outfall Discharges (mg/L)	Sum of River Concentrations from Outfall and Groundwater Discharges (mg/L)	MDEQ Cancer-Based Drinking Water Quality Standard (mg/L)	Ratio of Discharge Conc to MDEQ Cancer-Based Drinking WQS	MDEQ Non-Cancer-Based Drinking Water Quality Standard (mg/L)	Ratio of Discharge Conc to MDEQ Non-Cancer-Based Drinking WQS	Federal AWQC: Water + Organism (mg/L)	Ratio of Discharge Conc to Federal AWQC: Water + Organism	MDEQ Part 201 Residential Drinking Water Criteria (mg/L)	Ratio of Discharge Conc to Part 201 DW Criteria
VOC	Benzene	71-43-2	4.9E-04		4.9E-04	1.2E-02	4.1E-02	1.9E-02	2.6E-02	2.2E-03	2.2E-01	5.0E-03	9.8E-02
VOC	Chloroethane	75-00-3		3.2E-07	3.2E-07							4.3E-01	7.4E-07
VOC	1,1-Dichloroethane	75-34-3		4.8E-06	4.8E-06							8.8E-01	5.4E-06
VOC	cis-1,2-Dichloroethene	156-59-2		1.1E-05	1.1E-05							7.0E-02	1.6E-04
VOC	trans-1,2-Dichloroethene	156-60-5		1.0E-06	1.0E-06					1.4E-01	7.3E-06	1.0E-01	1.0E-05
VOC	1,1,1-Trichloroethane	71-55-6		2.3E-07	2.3E-07							2.0E-01	1.1E-06
VOC	Trichloroethene	79-01-6	3.8E-04	9.5E-06	3.9E-04	2.9E-02	1.4E-02			2.5E-03	1.6E-01	5.0E-03	7.9E-02
VOC	Vinyl Chloride	75-01-4		1.3E-05	1.3E-05					2.5E-05	5.4E-01	2.0E-03	6.7E-03
VOC	Xylenes (total)	1330-20-7	2.3E-05		2.3E-05							1.0E+01	2.3E-06
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	2.3E-04		2.3E-04					1.2E-03	1.9E-01	6.0E-03	3.9E-02
SVOC	Di-n-butylphthalate	84-74-2	5.2E-06		5.2E-06					2.0E+00	2.6E-06	8.8E-01	5.9E-06
SVOC	3,3'-Dichlorobenzidine	91-94-1	3.2E-06		3.2E-06					2.1E-05	1.5E-01	1.1E-03	2.9E-03
P/PCB	PCBs	1336-36-3		2.5E-05	2.5E-05	2.6E-08	**9.8E+02**			6.4E-08	**4.0E+02**	5.0E-04	5.1E-02
INORG	Cyanide (total)	57-12-5	2.9E-05		2.9E-05			6.0E-01	4.8E-05	1.4E-01	2.1E-04	2.0E-01	1.4E-04
INORG	Mercury	7439-97-6	4.9E-08		4.9E-08			1.8E+00	2.7E-08			2.0E-03	2.4E-05
INORG	Selenium	7782-49-2	3.0E-06		3.0E-06					1.7E-01	1.7E-05	5.0E-02	5.9E-05
INORG	Silver	7440-22-4	1.8E-07		1.8E-07							3.4E-02	5.4E-06

Notes:
1. Ratios greater than 1.0 are highlighted in bold.
2. The sum of groundwater discharge concentrations and the sum of sewer outfall discharge concentrations are calculated in Appendix F and discussed in Section 6.5.2.6.
3. The Michigan Water Quality Standard and Federal AWQC for PCBs are below the analytical Target Detection Limit (TDL) of 0.2 ug/L.

TABLE 6-23
SENSITIVITY ANALYSIS ON BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO SOIL AND GROUNDWATER AT THE NORTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Maintenance Worker Soil Contact Risk	Maintenance Worker Soil Contact HI	Maintenance Worker GW Contact Risk	Maintenance Worker GW Contact HI
03-1	7E-07	**2E+00**	6E-08	2E-02
05-1	2E-07	8E-01	6E-09	1E-02
05-2	2E-09	2E-04	8E-08	1E-02
05-3	2E-08	5E-02	1E-08	1E-03
05-4	5E-09	6E-05	8E-11	1E-04
05-5	5E-08	3E-01	5E-09	6E-03
05-6	1E-07	1E-02	1E-07	1E-02
07-1	1E-07	2E-01	9E-09	2E-03
07-2	4E-10	5E-06	NA	NA
07-3	5E-08	9E-02	5E-10	5E-04
10-1	2E-06	1E+00	4E-08	3E-02
10-2	4E-07	5E-01	3E-07	1E-01
10-3	2E-07	8E-01	1E-06	2E-01
10-4	NA	NA	2E-08	7E-03
21-1	7E-08	4E-01	2E-07	3E-03
36-1	1E-05	**8E+00**	1E-06	3E-01
36-2	1E-06	3E-01	8E-06	1E+00
36-3	6E-08	2E-01	1E-05	**2E+00**
36-4	1E-07	8E-03	2E-09	7E-04
36-5	2E-07	1E-01	6E-08	1E-02
38-1	8E-09	6E-02	1E-09	5E-03
55-1	2E-07	4E-01	4E-07	4E-01
65-1	7E-10	2E-05	1E-08	3E-03
81-1	7E-07	4E-01	4E-08	7E-03
81-2	1E-06	**3E+00**	2E-08	9E-03
81-3	2E-07	2E-01	2E-07	3E-02
81-4	1E-08	2E-04	6E-09	5E-04
81-5	8E-09	2E-01	NA	NA
83/84-1	4E-08	1E-02	3E-09	6E-04
83/84-2	8E-06	**2E+00**	1E-09	2E-02
83/84-3	3E-08	5E-02	4E-09	2E-03
83/84-4	4E-07	3E-01	8E-09	2E-02
83/84-5	6E-09	2E-04	2E-10	1E-04
83/84-6	8E-08	9E-03	NA	NA
83/84-7	1E-09	1E-04	7E-07	5E-01
85-1	6E-08	4E-02	6E-08	2E-02
86-1	6E-07	1E+00	2E-06	5E-01
Former Aeration Lagoons	8E-08	3E-01	2E-09	1E-04

Notes:

1. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations in each AOI.
2. Only AOIs where constituents were detected in soil or groundwater are shown.
3. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.
4. Cumulative cancer risks and HIs are based on the following exposure pathways: ingestion, dermal contact, and inhalation.
5. NA indicates that the medium was not sampled in that AOI, or that no compounds were detected above background levels.
6. Risks are based on an exposure duration of 1 year and exposure frequencies of 45 days for the vapor inhalation route, and 5 days for the ingestion and dermal routes. All other exposure factors are those used for the maintenance worker.

8. Lead is evaluated in Section 6.5.2.1 of the RFI Phase II Report and shown on Table 6-5.

TABLE 6-24
SENSITIVITY ANALYSIS ON BOUNDING CUMULATIVE CANCER RISK AND HAZARD INDEX FOR MAINTENANCE WORKER EXPOSURE TO SMEAR ZONE SOIL AND LNAPL AT THE NORTHEND

RFI PHASE II REPORT
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN

AOI	Smear Zone Soil				LNAPL			Smear Zone Soil				LNAPL		
	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total	Ingestion	Dermal Contact	Vapor Inhalation	Total	Dermal Contact	Vapor Inhalation	Total
	Maintenance Worker Risk							Maintenance Worker HI						
03-1	2E-08	1E-08	1E-08	5E-08	2E-08	4E-07	4E-07	4E-05	1E-05	4E-02	4E-02	5E-04	1E-01	1E-01
05-1	5E-10	2E-10	8E-09	9E-09	2E-10	8E-08	8E-08	4E-04	2E-04	2E-04	7E-04	1E-04	5E-02	5E-02
05-5	9E-09	4E-09	1E-07	1E-07	3E-09	2E-09	4E-09	6E-03	3E-03	NA	9E-03	2E-03	NA	2E-03
10-1	7E-11	7E-12	NA	7E-11	4E-08	NA	4E-08	3E-06	3E-07	9E-06	1E-05	3E-02	2E-07	3E-02
10-4	7E-10	7E-11	5E-08	5E-08	4E-07	3E-06	4E-06	2E-05	1E-06	3E-01	3E-01	2E-01	**2E+00**	**2E+00**
36-1	5E-09	6E-12	2E-05	2E-05	4E-07	**1E-03**	**1E-03**	2E-03	1E-04	**8E+00**	**8E+00**	2E-01	**3E+02**	**3E+02**
36-2	1E-10	1E-11	NA	1E-10	6E-08	NA	6E-08	5E-06	4E-07	4E-04	4E-04	7E-02	3E-01	3E-01
36-5	6E-12	5E-13	3E-09	3E-09	3E-09	4E-07	4E-07	1E-04	4E-05	1E-01	1E-01	2E-02	3E-01	3E-01
81-2	NA	NA	NA	NA	NA	NA	NA	4E-07	2E-07	1E-04	1E-04	3E-06	4E-03	4E-03
83/84-2	4E-09	2E-09	5E-08	6E-08	4E-08	5E-07	6E-07	3E-03	1E-03	1E-01	1E-01	4E-02	2E-01	2E-01
83/84-4	2E-10	2E-11	2E-09	2E-09	1E-07	2E-06	2E-06	2E-05	3E-07	4E-04	4E-04	2E-01	3E-01	5E-01
85-1	2E-10	6E-11	2E-09	2E-09	3E-08	2E-08	5E-08	1E-04	5E-05	4E-02	4E-02	3E-02	5E-02	8E-02
86-1	5E-10	2E-10	6E-09	7E-09	7E-08	1E-07	2E-07	4E-04	2E-04	1E-01	1E-01	2E-01	2E-01	3E-01

Notes:

1. Only LNAPL plumes in the Northend are shown.
2. NA = Risks were not calculated due to a lack of exposure or toxicity information for detected chemicals in the AOI.
3. Cumulative cancer risks and HIs are upper-bound estimates based on the maximum detected concentrations for LNAPL and estimated residual soil concentrations in each AOI.
4. Risks are based on an exposure duration of 1 year and exposure frequencies of 45 days for the vapor inhalation route, and 5 days for the ingestion and dermal routes. All other exposure factors are those used for the maintenance worker.
5. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.

ATTACHMENT 4

Excerpts from –

2008 Revised Corrective Measures Proposal

4.12 **AOI 09-A Soil**

AOI Group 09-A is related to the former Building 09, and involves a floor trench/UST that discharged to the process wastewater system, floor trenches over a holding tank in the "vehicle wash area", concrete containment for a former AST, and a former UST. The RFI soil data from AOI Group 09-A indicate that screening criteria were exceeded for benzo(a)pyrene, dibenzo(a,h)anthracene, lead, and manganese, and the RFI groundwater data indicate that screening criteria were exceeded for trichloroethene, vinyl chloride, antimony, and lead.

Based on the human health risk assessment for AOI Group 09-A documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, concentrations of lead in soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Notably, this area includes a rather localized area, centralized around offsite soil boring RFI-09-01, which contained lead at a concentration of 120,000 mg/kg. This soil boring is located on property owned by CSX Transportation, Inc. (CSX), immediately east of GM property. In addition, an offsite soil sample collected from soil boring RFI-09-03 exhibited a concentration of benzo(a)pyrene that exceeds USEPA's risk limits for residential exposure. This boring is also located on CSX property, immediately east of GM property. Therefore, the remedial goal for this area is to address the potential exposure to soil with elevated lead and benzo(a)pyrene concentrations.

4.12.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to users of the affected area. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls would include establishing a deed restriction limiting excavations in both GM's and CSX's property deed. The deed restriction would run with the properties in perpetuity, or until the area has been remediated.

4.12.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.12.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report. However, due to the high concentration of lead found at this location and the expected difficulty of obtaining the offsite deed restrictions, excavation may be more appropriate.

4.12.2 Alternative 2: Offsite Excavation and Onsite Engineering and Additional Institutional Controls above Baseline

This alternative includes the excavation and offsite disposal of approximately 900 cubic yards of soil associated with a 5,900 square-foot area. The excavation size is based on the removal of offsite soil on CSX property that contains lead concentrations exceeding 400 mg/kg (i.e., MDEQ residential direct contact criterion) and/or benzo(a)pyrene exceeding 6 mg/kg (i.e., USEPA's risk limit for residential exposure). The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

In addition, this alternative involves implementing engineering controls and additional institutional controls for soil on GM property that contain lead exceeding 900 mg/kg (i.e., MDEQ industrial direct contact criterion) and/or benzo(a)pyrene exceeding the USEPA's risk limit. The engineering controls include maintaining the surface cover consistent with existing conditions. These onsite industrial controls would provide protection from direct contact to future Site users by establishing a deed restriction limiting excavations. The deed restrictions would run with the property in perpetuity, or until the area has been remediated.

4.12.2.1 Estimated Costs

The estimated cost of this alternative is $408,000, assuming that the volume of excavation is 900 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.12.2.2 Evaluation Results

This alternative is considered to provide adequate protection from potential future risk to human health.

4.12.3 Alternative 3: Onsite and Offsite Excavation

This alternative includes the excavation and offsite disposal of approximately 1,800 cubic yards of soil associated with an area of 12,000 square feet. The size of the excavation is based on the removal of soil associated with this AOI (both onsite and offsite) that contains lead exceeding 400 mg/kg (CSX property) or 900 mg/kg (GM property), and/or benzo(a)pyrene exceeding USEPA risk limits. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.12.3.1 Estimated Costs

The estimated cost of this alternative is $621,000, assuming that the volume of excavation is 1,800 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.12.3.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 2, and would not provide significant additional protection from potential future risk to human health as compared to Alternative 2.

4.12.4 Selected Alternative

The selected alternative for this AOI is **Alternative 2: Offsite Excavation and Onsite Engineering and Additional Institutional Controls above Baseline**. Excavating surface soil is desirable due to its practicability, long-term reliability, and effectiveness. Soil on GM property would be addressed with engineering and additional controls above baseline that would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks. The potential for unacceptable risk to occur in the future would be mitigated by establishing in the deed limits on future excavation within the onsite area. Excavation of both the areas onsite and offsite (Alternative 3) would not provide significant additional protection from potential future risk to human health as compared to Alternative 2.

4.13 **AOI 09-B Soil**

AOI Group 09-B is associated with the Former Building 31/Hamilton Avenue Tank Farm. An LNAPL plume consisting primarily of gasoline has been identified and delineated in this area and is approximately 75 feet in diameter. The RFI soil data from AOI Group 09-B indicate that industrial screening criteria were exceeded for benzo(a)pyrene and lead, and the RFI groundwater data indicate that industrial screening criteria were exceeded for several VOCs, total PCBs, and several inorganic constituents.

LNAPL at this AOI is addressed in Section 4.14.

Based on the human health risk assessment for AOI Group 09-B documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, potential exposure to near-surface soil in this area exceeds 900 mg/kg for lead (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for soil at this AOI is to address lead concentrations greater than 900 mg/kg.

4.13.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations. These restrictions would run with the property in perpetuity, or until soil containing lead concentrations exceeding 900 mg/kg, have been remediated.

4.13.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.13.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.13.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The approximate area to be excavated is 42,000 square feet, and the expected depth of the excavation is 3 feet bgs. Therefore, the approximate volume of soil to be excavated is 4,650 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.13.2.1 Estimated Costs

The estimated cost of this alternative is $1,070,000, assuming that the volume of excavation is 4,650 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.13.2.2 Evaluation Results

This alternative is not considered to be cost effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.13.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways in near-surface soils (up to 3 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead, as well as for maintaining a surface cover that is consistent with current conditions.

4.14 **AOI 09-B LNAPL**

An LNAPL plume composed of gasoline located at this AOI is approximately 75 feet in diameter.

Based on the human health risk assessment for AOI Group 09-B documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure for future redevelopment construction workers to gasoline LNAPL in this area exceed USEPA's cumulative cancer risk and HI limits. The remedial goal for LNAPL at this AOI is to address the potential exposure of construction workers to LNAPL.

4.14.1 Alternative 1: No Further Action

This alternative involves implementing no further action beyond the corrective measures proposed for soil at this AOI, as described in Section 4.13.1. Such controls would provide protection from direct contact to future Site users.

4.14.1.1 Estimated Costs

There is no cost associated with this alternative.

4.14.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.14.2 Alternative 2: LNAPL-Only Extraction

This alternative involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility, along with implementing the corrective measures proposed for soil at this AOI, as described in Section 4.13.1.

Two LNAPL recovery wells would be installed at this AOI, and submersible pumps designed to collect only LNAPL would be installed in the recovery wells. Because the Southend buildings have been demolished and active Site utilities are no longer present in this area, a solar-powered controller (or similar) would be used to operate the LNAPL-only extraction pumps. The collected LNAPL would be stored in a drum or other suitable container located near the wellheads until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 20 gallons per week.

4.14.2.1 Estimated Costs

The present net worth of this alternative is $484,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost are assumed to be $86,000, $54,000 and $30,000, respectively.

4.14.2.2 Evaluation Results

This alternative provides effective recovery of LNAPL, which may reduce the potential future impact to human health posed by the presence of LNAPL in the subsurface.

4.14.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: LNAPL-Only Extraction** due to the technical feasibility and implementation of this alternative. Collection and associated monitoring of LNAPL would continue until it was determined to be no longer practical. Deed restrictions and notices, however, would remain with the property deed in perpetuity, or until the area has been remediated to meet the risk level.

5. Groundwater Monitoring Plan

Manufacturing activities have taken place at the Site since the early to mid 1900's, and the likely time periods between the historical releases of contaminants and current conditions have allowed the subsurface to reach a stable condition. As documented in the RFI Phase I and II Reports, an extensive groundwater characterization program was implemented as part of the RFI. The analytical data from the RFI groundwater characterization further supports the stability of observed groundwater impacts, as discussed in the CA 750 Report. The RFI data were evaluated for risk from potential exposure as part of the human health risk assessment as documented in Section 6 of the RFI Phase II Report, and supplemented in Appendix A of this Revised CMP.

The human health risk assessment determined that the current groundwater conditions do not pose a significant risk under current and reasonably expected future land and groundwater use scenarios at and around the Site. However, as a prudent and conservative measure, GM proposes to continue monitoring groundwater elevations and/or concentrations and/or LNAPL absence, presence, and/or thickness at select monitoring wells for specific durations to confirm subsurface conditions at locations where limited sampling data are available, or where the stability of conditions at the downgradient edge of an impacted area may need further confirmation.

Additional monitoring data are not required within source areas that have been delineated by downgradient monitoring wells, or at downgradient locations where stable concentrations have been demonstrated and concentrations are expected to remain stable.

5.1 Groundwater Monitoring Plan Overview

The proposed groundwater monitoring program includes the collection of groundwater elevations and/or concentrations and/or LNAPL absence, presence, and/or thickness at 42 monitoring wells. The proposed monitoring program is summarized in Table 5-1. Figures 5-1 and 5-2 illustrate the locations of the monitoring wells included in the proposed monitoring program. All activities will be completed in accordance with the Field Sampling Plan (FSP) and Quality Assurance Project Plan (Appendix C of the RFI Work Plan, dated March 30, 2001, as amended [QAPP addendum on May 16, 2005]) and the Health and Safety Plan (HASP) updated June 2005.

Any future modification to Site activities (e.g., future demolition and/or redevelopment) may impact the position of some of the monitoring locations. To accommodate such

activities, alternate monitoring wells may be substituted to provide water level and LNAPL thickness measurements, and groundwater sampling locations. Monitoring wells proposed for monitoring as part of this program may also need to be properly abandoned and re-installed at nearby locations to accommodate future Site activities. Substantial modifications to the proposed monitoring program will be presented to USEPA for approval prior to implementation. Examples of such modifications involve the movement of monitoring points a distance of more than 30 feet, elimination or substitution of monitoring locations at greater distances than 30 feet, and the reduction of proposed analytes.

GM plans to properly abandon any existing monitoring wells associated with the Site (onsite or offsite) that are not proposed to be used as part of this proposed monitoring program, unless such wells have been previously identified to either be destroyed or not found.

5.2 Water Level and LNAPL Measurements

Groundwater elevation data have been contoured on a Site-wide basis for a series of monitoring dates, resulting in a comprehensive understanding of Site-related groundwater flow direction. Due to the consistency of the observed groundwater flow patterns, collection of additional Site-wide water level data is not included in the proposed monitoring program. However, in order to confirm that the subsurface distribution of LNAPL does not change in response to the implementation of the CMP, groundwater levels and LNAPL thickness measurements will be made annually at select monitoring wells listed in Table 5-1. Water levels and LNAPL thickness measurements will be compiled for inclusion in annual reports (see reporting information below).

5.3 Groundwater Sampling

To achieve the program objectives, groundwater samples will be collected on an annual basis, from the monitoring wells listed in Table 5-1 and shown on Figures 5-1 and 5-2. Table 5-1 lists 1) the monitoring wells included in the proposed monitoring program; 2) the proposed analytical parameters corresponding to each monitoring well; 3) the proposed duration of monitoring for each monitoring well; and 4) the purpose of each proposed monitoring location. Groundwater samples will be submitted to Merit Laboratories, Inc. of East Lansing, Michigan (or a similar laboratory) for analysis.

Since over 250,000 analytical data points were validated as part of the RFI, with nearly all being acceptable for use in the risk assessments, no further analytical data validation will be performed as part of this program.

5.4 Reporting

A report will be prepared annually to document the results of the proposed monitoring program. The text of each of the annual reports will describe the objectives and scope of each of the sampling events, and will include a summary of the procedures used to complete the sampling. The associated results will be presented using the following methods:

- Analytical data box figures to show the distribution of recent data in context with historical data;
- Summary tables; and
- Graphs to illustrate concentration changes over time (as appropriate).

The resulting data will be compared to historic concentrations, as well as risk-based criteria described in the RFI Phase II Report. Recommendations will also be provided regarding any changes to the number of monitoring wells being monitored, the frequency of measurements and analytical sampling, and/or the analytical parameters. Proposed monitoring well substitutions and replacements, necessitated by Site re-development activities, will also be presented. Again, substantial modifications to the proposed monitoring program will be presented to USEPA for approval prior to implementation. Examples of such modifications are noted above. In the event that a constituent's concentration approaches a risk-based criterion or increases significantly from historic concentrations, the results will be confirmed by re-sampling for that constituent. If the re-sampling confirms the trend, GM will notify the USEPA to discuss potential actions to address the condition.

Each of the annual reports prepared as part of this proposed monitoring program will be submitted to the USEPA within 90 days upon completion of each corresponding annual monitoring event.

TABLE 3-3

AREAS THAT REQUIRE FURTHER ACTION BASED ON THE RFI

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI:	Section Reference	Description:
02-C	4.5.13	Sump in Materials Laboratory
09-A Soil	4.5.36	Former USTs, Floor Trenches, and Former AST
09-B Soil	4.5.37	Hamilton Ave Tank Farm
09-B LNAPL	4.5.37	Hamilton Ave Tank Farm
12-A Soil	4.5.19	Press Pits, Sumps, Trenches, Traps, and Floor Staining
29-A	4.5.18	Elevator Pit and Observed Oil Staining
36-1 Gasoline Plume	4.4.2	Factory 36 Area; Engine Manufacturing and Metal Machining Processes
81-1	4.4.19	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
81-2 Soil	4.4.20	Factory 81 Area; Active Metal Welding and Machining and Torque Converter Assembly
83/84-2 Soil	4.4.27	Former and Existing Machining Operations
83/84-3	4.4.28	Former and Existing Machining Operations
Storm Sewer Outfall 002		
Storm Sewer Outfall 003		
Storm Sewer Outfall 004		
Storm Sewer Outfall 005		

TABLE 4-1
SUMMARY OF PROPOSED CORRECTIVE MEASURES

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

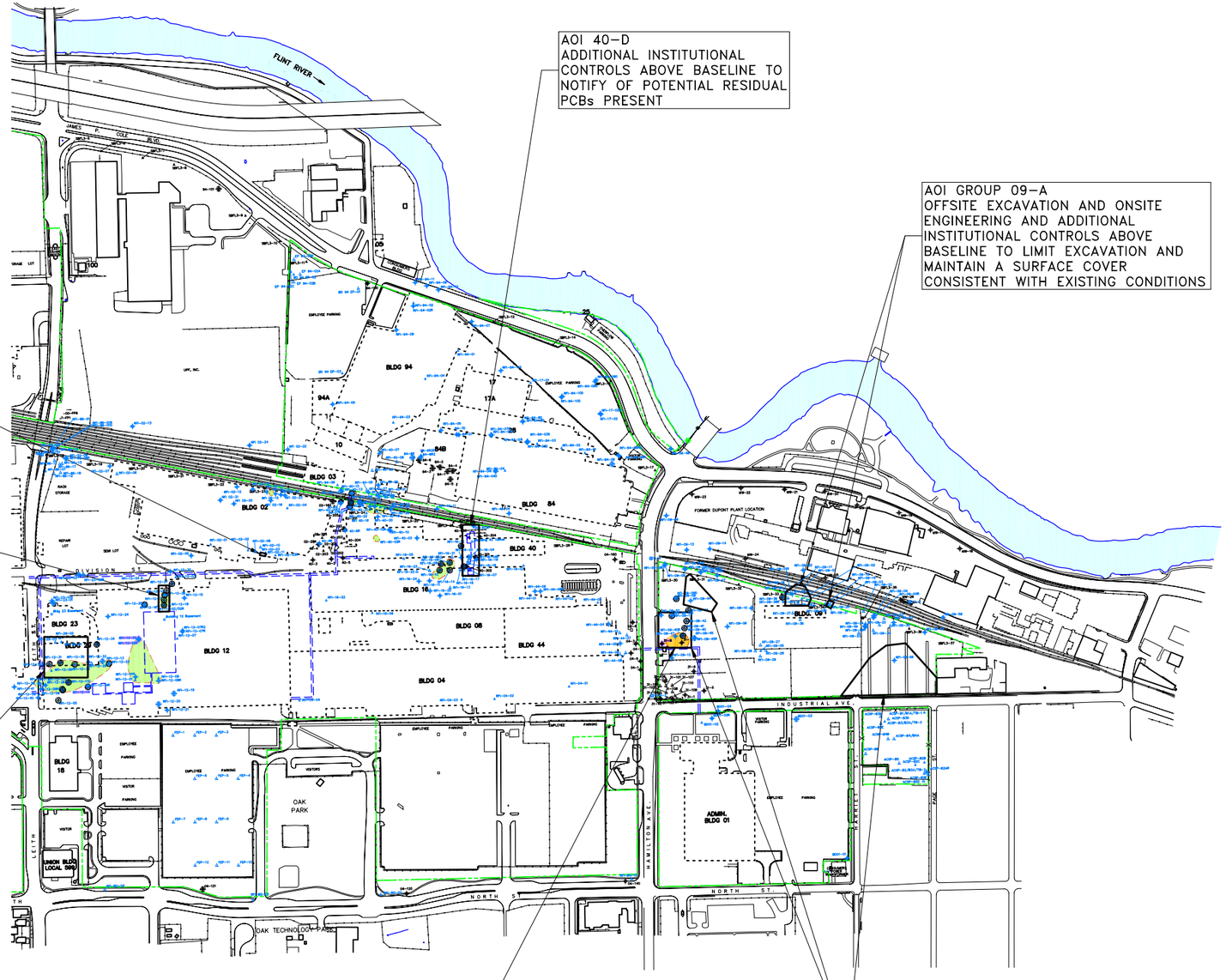
AOI	Description of AOI	Proposed Corrective Measure*
02-C	Sump in Materials Laboratory	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
05-1	Former Metal Machining Chip Processing	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
05-5	Active Process Machinery, Collection Trenches, and Sumps	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
09-A Soil	Former USTs, Floor Trenches, and Former AST	Offsite Excavation and Onsite Engineering and Additional Institiutional Controls above Baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
09-B Soil	Hamilton Avenue Tank Farm	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
09-B LNAPL	Hamilton Avenue Tank Farm	LNAPL-only extraction
12-A Soil	Press Pits, Sumps, Trenches, Traps, and Floor Staining	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
29-A	Elevator Pit and Observed Oil Staining	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
36-1 Gasoline Plume	Factory 36 Area; Engine Manufacturing and Metal Machining Processes	LNAPL-only extraction and additional institutional controls above baseline, including a deed restriction limiting excavation and prohibiting future non-OSHA use of current and future buildings
40-D	Flooded Basement/Tunnel Area	Additional institutional controls above baseline, including a deed restriction notification of potential presence of residual PCBs
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	Additional institutional controls above baseline, including a deed restriction limiting excavation

TABLE 5-1
GROUNDWATER MONITORING PLAN

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

Well I.D.	AOI	Onsite/ Offsite	CA 750 Monitoring Location (Groundwater Sampling)	Analytical Constituents to be Monitored	Previous Monitoring Purpose	Previously Detected in Groundwater at Concentrations Above Drinking Water Criteria	Monitoring Date of Constituent(s) of Concern							Rationale
							2001	2002	2003	2004	2005	2006	2007	
RFI-02-14	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-15	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-17	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-18	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-19	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	None					April (VOCs)			Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
43-166	05-1 and 05-06	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-05-1 and 05-6).	As	September	December						Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
43-167	05-1 and 05-06	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-05-1 and 05-6).	As	September							Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
43-168	05-1 and 05-06	onsite		NA	Monitor LNAPL downgradient of AOI-05-1 and 05-6 following LNAPL recovery system shutdown.	None	September	December						Upon USEPA's approval of the shutdown of the recovery system, LNAPL thickness/absence/thickness downgradient of AOI-05-1 and 5-6 will be monitored for two years, to document plume stability.
43-140	05-1 and 05-06	onsite		VOCs	Monitoring TCE concentrations in AOI-05-6.	TCE	September	June	April	October			November (VOCs)	TCE concentrations increased from 0.025 ppm in September 2001 to 0.25 ppm in October 2004. Monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for VOCs and the concentration of TCE was consistent with historical results. This well will be sampled in fall 2008 and if the results are consistent with the 2007 results, the monitoring well will be removed from the CMP groundwater monitoring program.
31-8	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	Benzene, ethylbenzene, Pb	September	June						Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.
RFI-09-09	09-B	onsite		VOCs	monitoring location at downgradient edge of LNAPL impacted area (AOI-09-B).	None	September	June	March					Upon USEPA's approval of the LNAPL recovery activities, monitoring well will be sampled annually for two years, to document plume stability.
RFI-09-44	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None			March	October				Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.
RFI-09-45R	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None		December						Upon USEPA's approval of the LNAPL recovery activities, monitoring well will be sampled annually for two years, to document plume stability.
RFI-09-46	09-B	offsite	X	VOCs	Monitoring benzene concentrations in AOI-09-B	Benzene (Xylenes were detected above GSI criteria)		December	April	October			June and October (VOCs)	Monitoring well will be sampled annual until concentrations of VOCs are below drinking water criteria or are stable and below GSI criteria for two consecutive monitoring events.
RFI-09-48	09-B	offsite	X	VOCs	Monitoring downgradient site conditions	None			April	October	December (VOCs)	November (VOCs)	April, June, November (VOCs)	Monitoring well will be sampled annually for VOCs until concentrations of VOCs are stable or below criteria for two consecutive monitoring events in monitoring well RFI-09-46.
RFI-09-52	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None			September					Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.

See Notes on Page 4



AOI 40–D
ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO NOTIFY OF POTENTIAL RESIDUAL PCBs PRESENT

AOI GROUP 09–A
OFFSITE EXCAVATION AND ONSITE ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 02–C
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 12–A
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION, MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 29–A
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 09–B
LNAPL
TWO LNAPL RECOVERY WELLS AND ABSORBENT SOCKS IN FOUR WELLS

AOI GROUP 09–B
SOIL
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

LEGEND:

- PROPERTY BOUNDARY
- DEMOLISHED BUILDING
- BUILDING CURRENTLY IDLED
- ESTIMATED CURRENT LIMITS OF MEASUREABLE LNAPL PLUMES THAT REQUIRE FURTHER ACTION ABOVE BASELINE RESTRICTIONS BASED ON THE RFI
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL PLUMES THAT DO NOT REQUIRE FURTHER ACTION ABOVE BASELINE RESTRICTIONS BASED ON THE RFI
- MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- PROPOSED AREA IDENTIFIED FOR ENGINEERING AND/OR ADDITIONAL INSTITUTIONAL CONTROLS SPECIFIED IN A DEED RESRTICTIONS, ABOVE BASELINE RESTRICTION, OR FOR REMEDIATION AS DESCRIBED.
- PROPOSED LNAPL RECOVERY WELL LOCATION

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. BASELINE INSTITUTIONAL CONTROL FOR ENTIRE SITE INCLUDES DEED RESTRICTION LIMITING GROUNDWATER AND PROPERTY USE.

0 300' 600'
GRAPHIC SCALE

MAY 1, 2008

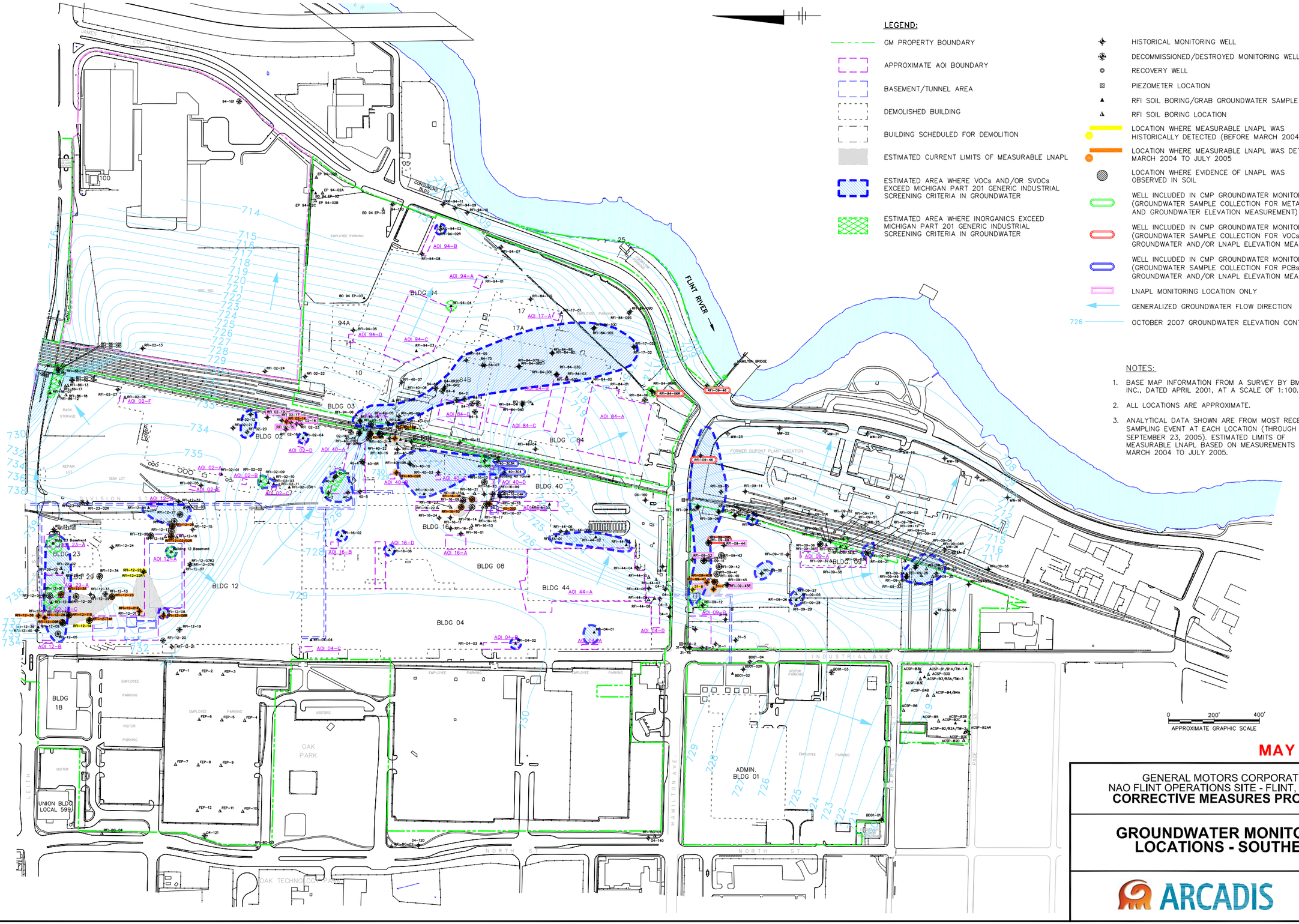
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

PROPOSED CORRECTIVE MEASURES - SOUTHEND

ARCADIS

FIGURE
4-2

CITY: SYRACUSE DIV/GROUP: 141 DB: GMS LD: GMS PM: M. LOVEJOY LYR: ON=*;OFF=*REF; |PROPERTY=PREV; |SHD=BUILDING; |NAPL_OBS
G:\CAD\ACTIB\06441\0\0000\18500\DWG\CMP\64410B22.DWG LAYOUT: 4-2 SAVED: 5/1/2008 11:33 AM ACADVER: 17.0S (LMS TECH) PAGESETUP: C-LD2B-PDF-TABLOID PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/1/2008 11:33 AM BY: STOWELL, GARY
XREFS: 64410X01
64410X3A
IMAGES: PROJECTNAME: ---



LEGEND:

- GM PROPERTY BOUNDARY
- APPROXIMATE AOI BOUNDARY
- BASEMENT/TUNNEL AREA
- DEMOLISHED BUILDING
- BUILDING SCHEDULED FOR DEMOLITION
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL
- ESTIMATED AREA WHERE VOCs AND/OR SVOCs EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- ESTIMATED AREA WHERE INORGANICS EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- HISTORICAL MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- RFI SOIL BORING/GRAB GROUNDWATER SAMPLE LOCATION
- RFI SOIL BORING LOCATION
- LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED (BEFORE MARCH 2004)
- LOCATION WHERE MEASURABLE LNAPL WAS DETECTED FROM MARCH 2004 TO JULY 2005
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR METALS ANALYSES AND GROUNDWATER ELEVATION MEASUREMENT)
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR VOCs ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR PCBs ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- LNAPL MONITORING LOCATION ONLY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- 726 OCTOBER 2007 GROUNDWATER ELEVATION CONTOUR (IN FEET)

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. ANALYTICAL DATA SHOWN ARE FROM MOST RECENT SAMPLING EVENT AT EACH LOCATION (THROUGH SEPTEMBER 23, 2005). ESTIMATED LIMITS OF MEASURABLE LNAPL BASED ON MEASUREMENTS FROM MARCH 2004 TO JULY 2005.

MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

GROUNDWATER MONITORING LOCATIONS - SOUTHEND

ARCADIS

FIGURE
5-2

ATTACHMENT 5

Excerpts from –

2010 Final Decision and Response to Comment for Soil and Groundwater Cleanup at the Southend of the Former General Motors Corporation North American Operations (Otherwise known as Buick City)

AOI Number and Description	Maximum Contaminant Concentrations Found	Screening Criteria	Cumulative Excess Cancer Risk	Hazard Index
09-A This area is related to releases from underground storage tanks, floor trenches, and above ground storage tanks in Building 09.	Soil: Benzo(a)pyrene-*57 mg/kg* Dibenzo(a,h)anthrace *11 mg/kg* Lead-*120,000 mg/kg* Manganese-*8,300 mg/kg* Groundwater: 1,1,1-Trichloroethane-*0.258 mg/L* Trichloroethene-*0.184 mg/L* Vinyl chloride-*0.0038 mg/L* Antimony-*0.016 mg/L* Lead-*0.026 mg/L* LNAPL (free product)	Soil: Benzo(a)pyrene-*8.0 mg/kg* Dibenzo(a,h)anthracene *8.0 mg/kg* Lead-*900 mg/kg* Manganese-*1,500 mg/kg* Groundwater 1,1,1-Trichloroethane-*0.2 mg/L* Trichloroethene-*0.005 mg/L* Vinyl chloride-*0.002 mg/L* Antimony-*0.006 mg/L* Lead-*0.004 mg/L*	**$3x10^{-4}$**	$8x10^{-1}$
09-B This area is related to releases from the Hamilton Avenue Underground Storage Tank Farm.	Soil: Benzo(a)pyrene-*13 mg/kg* Lead-*1,200 mg/kg* Manganese-*1,800 mg/kg* Groundwater: Benzene-*1.21 mg/L* Ethylbenzene *1.0 mg/L* Methylene chloride-*0.0074 mg/L* Total Xylenes-*0.053 mg/L* Total PCBs-*0.0017 mg/L* Antimony-*0.0068 mg/L* Arsenic-*0.061 mg/L* Barium-*1.5 mg/L* Lead-*0.0058 mg/L* Selenium-*0.052 mg/L* LNAPL (free product)	Soil: Benzo(a)pyrene-*8.0 mg/kg* Lead-*900 mg/kg* Manganese-*1,500 mg/kg* Groundwater: Benzene-*0.005 mg/L* Ethylbenzene-*0.70 mg/L* Methylene chloride- *0.005 mg/L* Total Xylenes-*0.035 mg/L (GSI)* Total PCBs-*0.005 mg/L* Antimony-*0.006 mg/L* Arsenic-*0.050 mg/L* Barium-*0.82 mg/L* Lead-*0.004 mg/L* Selenium-*0.050 mg/L*	**$8x10^{-5}$**	$6x10^{-2}$

CORRECTIVE MEASURES ALTERNATIVES CONSIDERED

The following remedies were considered for the various AOIs requiring remediation at the Southend.

Contaminated Soils On-site

Soil in the Southend of the property (on-site soil) is mainly contaminated with lead. The total amount of soil that is contaminated on-site is about 10,000 yd^3 and is located in six distinct areas of the Southend as shown in the attached Figure 4.

Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Facility users. The engineering control suggested is maintaining the existing surface cover as a cap. The institutional control identified under this alternative is establishing a deed restriction limiting excavations within areas where soil contains lead concentrations above the State of Michigan's criteria for industrial land use, 900 mg/kg. These restrictions would remain with the property in perpetuity, or until soil containing concentrations above 900 mg/kg has been remediated.

Alternative 2: Excavation

This alternative involves excavating soil with lead concentrations exceeding 900 mg/kg, and disposing of this soil offsite at an appropriate facility. The estimated volume of soil to be excavated is 10,470 cubic yards. Sampling of the soil prior to excavation would be performed to both better define the appropriate excavation limits and establish proper disposal requirements.

Contaminated Soil Off-site

This remedy relates to AOI 09-A (Building 09). The releases from this area came from underground storage tank (UST) floor trenches and concrete containment for an above-ground storage tank (AST) which migrated to an adjacent off-site area now owned by the CSX Railroad (see Figure 4).

Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to users of the affected area. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls would include establishing a deed restriction limiting excavations at the CSX's property deed. The deed restriction would remain with the property in perpetuity, or until the area has been remediated.

Alternative 2: Excavation

This alternative includes the excavation and offsite disposal of approximately 900 cubic yards of soil. The size of the excavation is based on the removal of soil that contains lead and benzo(a)pyrene at levels exceeding EPA and Michigan's risk limits for unrestricted use. The resulting excavation would be backfilled with appropriate fill imported from an off-site source.

Light Non-Aqueous Phase Liquid (LNAPL)

There are several areas where LNAPL or free product, has been found in the subsurface at the Facility (see Figure 2 and 3). The LNAPL, in some cases, acts as a source of contamination to the groundwater and has the potential to migrate to the Flint River.

Alternative 1: Institutional Controls Above Baseline

This alternative would restrict direct contact with LNAPL in the subsurface by requiring additional institutional controls on the property to prevent excavation in the areas where LNAPL is present in addition to the baseline deed restriction. The baseline deed restriction includes restricting the land use of the entire Southend to Industrial/Commercial II, III, and IV (as defined under Part 201 of the Michigan and Natural Resources Environmental Protection Act. This alternative would not require the removal of any LNAPL that is currently at the Facility.

Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls Above Baseline

This alternative involves collecting as much LNAPL from the subsurface as a standard pumping technology allows and disposing of the collected LNAPL at an appropriate off-site facility. This alternative would consist of installing one to six new LNAPL recovery wells in each area with LNAPL. Submersible pumps designed to collect only LNAPL would also be installed in existing monitoring wells. In addition, oil absorbing socks would be installed in existing monitoring wells in each of the areas. This system would be designed to enhance and maximize the effectiveness of the existing LNAPL extraction system. All collected LNAPL would be stored in drums or other suitable containers near the wellheads until sufficient LNAPL would be collected for off-site disposal. It is expected that there would be a minimum 30-year operation and maintenance period for this system.

Alternative 3: Steam Enhanced LNAPL Extraction

This alternative involves collecting as much LNAPL from the subsurface as is technically practicable and disposing of the collected LNAPL at an appropriate off-site facility. In this alternative, a subsurface network of steam injection and fluid extraction wells would be installed in each of the plumes. Steam would be injected through these wells into the contamination trapped in the geologic material (soil and rock) underground. The steam would "strip" or clean the contamination from the underground geologic material, mobilizing the contamination into the liquid phase. By mobilizing the contaminants in a controlled system, the LNAPL can be removed much more quickly and efficiently than using standard pumping technologies. A high vacuum fluid removal system would remove the liquid and the extracted material would go through oil/water separation, air stripping, and clay/carbon treatment to remove the newly mobilized contamination. All collected LNAPL would be stored in drums or other suitable containers near the wellheads until sufficient LNAPL are collected for offsite disposal. Other extracted and treated liquids (groundwater) would be discharged to the storm sewer as allowed by a state permit. It is anticipated that the operation and maintenance on this system would be approximately two years. If unacceptable levels of LNAPL remain after the system has achieved

its maximum amount of extraction (based on ongoing evaluation of the extraction rate and effectiveness of the system), institutional controls above baseline to limit excavation would be placed on the property to limit excavation and exposure to the remaining contaminants (as described in Alternative 1). This alternative also recognized that other technologies to enhance LNAPL recovery could be tested and evaluated to supplement or improve the effectiveness of the enhanced LNAPL extraction system.

SELECTED REMEDIES

The U. S. EPA selects the following corrective measures as the remedies to address contaminated soil and groundwater at the Southend. Most of comments received requested clarification of various issues. The selected remedy for LNAPL contamination addresses comments by refining the LNAPL remedy to include the testing of a few different technologies in order to select the best possible remedy for site-specific conditions and the different types of products found at the Facility.

Corrective Measures to Address General Contamination at the Southend

In addition to the individual remedies listed below, MLC will implement the following remedies for the Southend of the Facility: 1) creation of enforceable institutional controls to restrict the land use of the entire MLC property to Industrial/Commercial II, III and IV (as defined under Part 201 of the Michigan Natural Resources and Environmental Protection Act) only; 2) creation of enforceable institutional controls to prohibit the use of all Southend groundwater for any purpose beyond sampling and other related investigatory testing; 3) development and implementation of a groundwater monitoring program (explained in more detail below); and 4) providing adequate financial assurance to demonstrate that funding will be available to complete construction, monitoring and operation and maintenance of the selected remedies. The institutional controls in this case will be Restrictive Covenants that would be filed with the Genessee County Assessor's Office so that anyone wishing to purchase the property in the future would be notified of their obligation to comply with the restrictions placed on the property.

Corrective Measures to Address On-Site Soil Contamination

Alternative 1, Engineering Controls and Additional Institutional Controls above the Site-Wide institutional controls mentioned above, is the chosen remedy. All of the on-site soil contamination at levels of concern is located under building slabs or pavement. Given the fact that the property use is anticipated to remain industrial, and there is no current exposure pathway to the contamination, the added benefit from excavating and disturbing significant volumes of soil and shipping it off-site, is small. In addition, the main contaminant of concern in this area is lead, which adheres to soil particles thus making it stable in the environment. In the event the existing surface covers are removed, the use restrictions would require either replacement of the barrier or excavation and disposal of soil with contaminant concentrations above industrial cleanup standards. Therefore, for contaminated soils that remain on the Southend, the remedy will be the following:

1) Engineering controls will be implemented that will include maintenance of the existing slabs remaining from building demolition and former parking lots.
2) Additional institutional controls will be placed on the property that limit excavation in those areas where lead in soil exceeds the MDNRE Part 201 direct exposure criteria for industrial workers. EPA anticipates that the institutional controls will be implemented within 180 days after the Final Decision and Response to Comments is issued.

Corrective Measures to Address Off-site Soil Contamination

Alternative 2, excavating contaminated soil at the CSX Railroad property to unrestricted use standards, is the selected remedy. This approach is feasible and appropriate given the relatively small volume of contaminated soil. Once the excavation has occurred, no additional institutional controls will be required for the property since the lead and benzo(a)pyrene contamination from former General Motors operations will be removed. In addition, since no engineering control would be needed, no additional operation or maintenance will be required. This avoids the difficulty of imposing and maintaining long-term engineering controls and use restrictions on a third party's property.

EPA anticipates MLC will request access to the offsite area within thirty (30) days of the final decision and removal of soils will occur as soon as practical after access is obtained, depending on weather conditions at the time.

Corrective Measures to Address the LNAPL Contamination

The LNAPL (free product) remedy will be a modification of the extraction alternatives mentioned above. There are several different types of free product found at the site (gasoline, hydraulic oils, and diesel fuel) each having their own distinct properties affecting how they can best be extracted. In addition, the LNAPL is present in areas where the geology varies significantly from place to place, which also has an impact on extraction technologies.

As a result, EPA has decided that an LNAPL extraction system remedy is appropriate, but that a "one-size fits all" approach is not the most effective LNAPL extraction approach. In recognition of this situation, the remedy for LNAPL at the Southend will include several complementary extraction approaches rather than just the two described in the Statement of Basis. The extraction remedy will include LNAPL recovery trenches and multi-phase extraction (MPE). LNAPL recovery trenches are trenches excavated to the groundwater table in impacted areas and backfilled with rock. LNAPL present in the surrounding soils drains into the rock backfill. LNAPL that accumulates in the trenches will be periodically collected via sumps that will be installed in the recovery trenches. The collected LNAPL will be taken off site for disposal.

MPE is a process used to remove soil gas, groundwater, and free product from the subsurface. Vertical MPE extraction wells will be installed throughout the area to be treated. A centralized high-vacuum blower will be used to extract soil gas, groundwater, and free product

from the extraction wells via a subsurface piping network. The combined fluids will be separated by the MPE treatment equipment. The extracted soil gas that is rich in petroleum hydrocarbons will be treated on site by activated carbon polishing or thermal treatment. The recovered groundwater will then be treated and discharged to the sanitary sewer. The LNAPL will be taken offsite for disposal. This process is more effective than standard pumping because both product and vapor phase will be extracted and oxygen will also be introduced into the subsurface. (Moreover, as noted above, standard pumping approaches have limited effectiveness in areas where heavier or more viscous oils are present). Introduction of oxygen stimulates LNAPL degradation by native soil bacteria.

It is anticipated that MPE, although a standard and proven technology at removing LNAPL, will still leave significant amounts of LNAPL behind. Therefore, in addition to MPE, EPA is also requiring testing of different technologies to either further enhance the LNAPL extraction system or to use in lieu of MPE. As described below, A CMI Workplan detailing what technologies will be bench-scale tested will be submitted to EPA within ninety (90) days of the issuance of the Final Decision Response to Comments. The requirements of testing different technologies are as follows:

1) EPA requires that bench scale testing be performed with five different technologies.
2) From the five technologies, MLC will pilot test in the field the three technologies that EPA determines have performed best in the bench scale tests.
3) EPA will use the results of the pilot tests to determine which of these technologies will be used to enhance MPE, and/or as a treatment in lieu of MPE. The reason behind this is to maximize the effectiveness of the selected LNAPL extraction remedy for each of the specific types of contaminants found at the site.

Corrective Measures to Address Groundwater Contamination

The groundwater underlying the site is contaminated with volatile organic carbon compounds and metals. Since current data suggests that the contaminant plumes are not expanding, the chosen groundwater remedy is monitoring the groundwater and developing a contingent remedy in the event that the plume is found to be expanding. The specific purpose of groundwater monitoring will be to monitor the long-term stability of contaminants in the groundwater and to ensure continued compliance with Michigan Part 201 groundwater/surface water interface (GSI) criteria for the long-term protection of the Flint River. Details on the groundwater monitoring program and the contingent remedy will be developed in the Corrective Measures Implementation Workplan as described below.

ATTACHMENT 6

Excerpts from –

2014 Annual Groundwater Monitoring Report

2.3.8 Building 09 Area

Concentrations higher than MDEQ Part 201 GSI criteria were detected at RFI-09-11 and RFI-09-53. Monitoring RFI-09-11 exhibited concentrations of ethylbenzene and naphthalene higher than GSI criteria. These wells fall within the Outfall 011 drainage area (RFI-09-11) and Outfall 012 drainage area (RFI-09-53) which have not been fitted with bulkheads (**Figure 4**).

At monitoring well RFI-09-11, ethylbenzene and naphthalene were detected at concentrations of 26 µg/L and 12 µg/L, respectively, which exceed the GSI criteria for these COCs. Historical ethylbenzene concentrations ranged from 26 to 75 µg/L between 2001 and 2003 (**Appendix A**), with a concentration of the 26 µg/L in 2003; therefore, the concentration of ethylbenzene appears to be stable. RFI-09-11 was last sampled in 2001 for naphthalene, detected at a concentration of 3.4 µg/L. Monitoring well RFI-09-11 is adjacent to the Outfall 011 storm sewer, and historical groundwater contours indicate flow toward the sewer; therefore, there is a relatively high likelihood that the groundwater near this well is infiltrating into the storm sewer. However, previous National Pollutant Discharge Elimination System (NPDES) Permit Monitoring Program (NPMP) sampling at the river in the Outfall 011 sewer has demonstrated no impacts to the water discharging there. Therefore, while the GSI pathway at this location may be complete, there is no evidence of measurable impact to the surface water due to VOCs found in this monitoring well.

At monitoring well RFI-09-53, 1,1,1-TCA and vinyl chloride were detected at concentrations of 103 µg/L and 24 µg/L, respectively, which exceed the respective GSI criteria. Historical 1,1,1-TCA concentrations ranged from lower than detection limits to 258 µg/L (**Appendix A**), indicating that 1,1,1-TCA concentrations are stable. Historical vinyl chloride concentrations ranged from lower than detection limits to 32 µg/L (**Appendix A**), indicating that vinyl chloride concentrations are also stable at this well. Monitoring well RFI-09-53 is adjacent to the Outfall 011 storm sewer; therefore, there is a relatively high likelihood that the groundwater near this well is infiltrating into the storm sewer. Previous NPMP sampling at the river in the Outfall 011 sewer has demonstrated no impacts to the water discharging there. Therefore, while the GSI pathway here may be complete, there is no evidence of measurable impact to the surface water due to VOCs found in this monitoring well.

2.3.8.1 Building 09 Recommendations

Continued monitoring of RFI-09-08, RFI-09-11, RFI-09-44, RFI-09-53, and RFI-09-55S is recommended to document COC concentrations downgradient of the AOI 09-B LNAPL Area.

GSI exceedances of 1,1,1-TCA have been documented in this area. 1,4-Dioxane is known to have been used as a stabilizer and is often found in groundwater associated with 1,1,1-TCA impacts. In addition, 1,4-dioxane does not attenuate as quickly as other organic compounds. We recommend also monitoring 1,4-dioxane concentrations at monitoring point RFI-09-53 to track trends.

3. Vapor Intrusion Evaluation

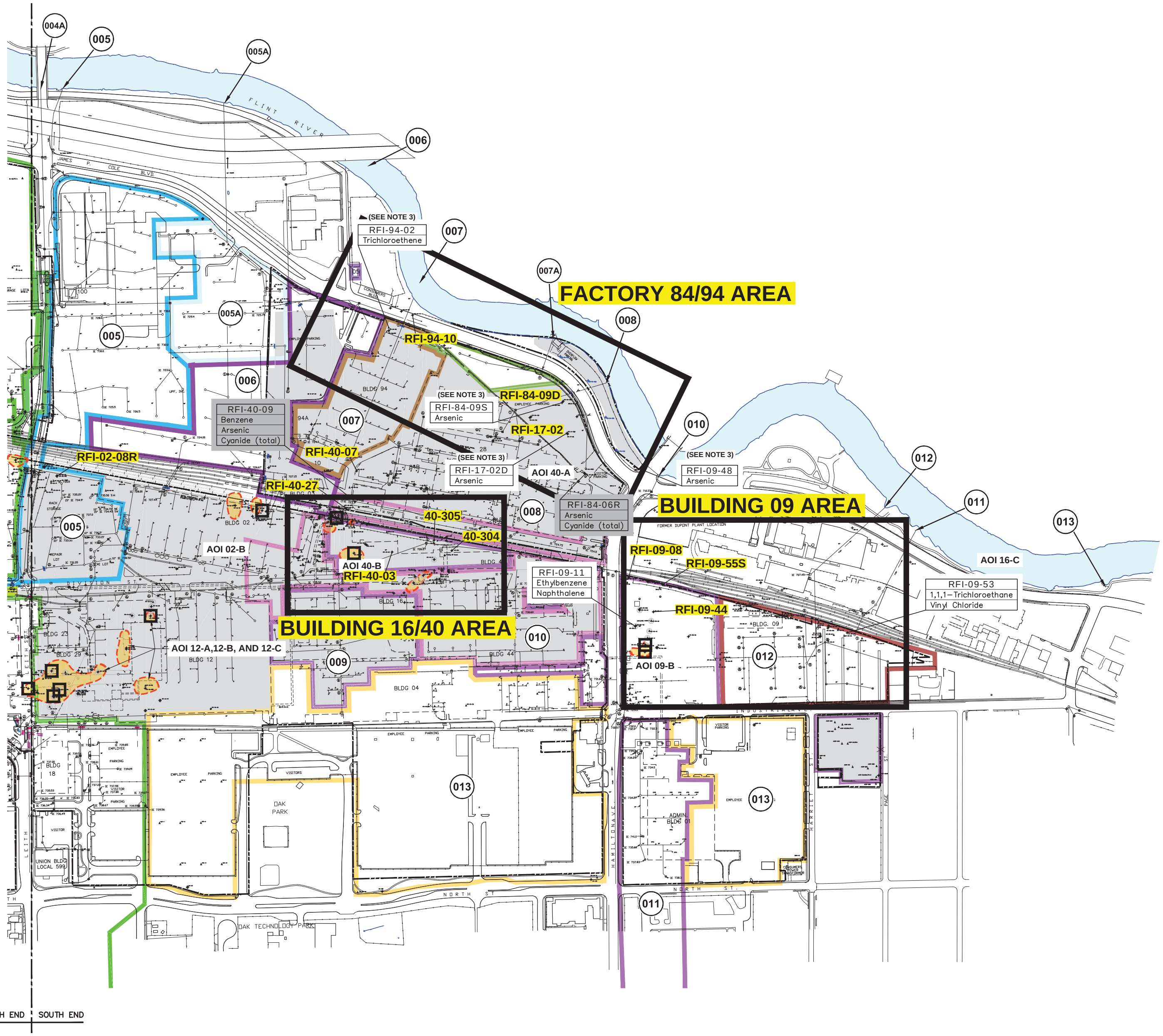
As part of the vapor intrusion (VI) evaluation for the Site, several monitoring wells along the property boundary were sampled and monitored to determine if there is a potential VI issue. These wells are part of the annual groundwater sampling event, and analytical results from these wells are being compared to MDEQ VI screening criteria as part of the VI evaluation.

Results from monitoring points on the north end of the Site are consistent with what has been seen in recent years. COCs were detected at monitoring points RFI-36-08, RFI-10-37, and 87-FP3 at concentrations exceeding MDEQ VI screening criteria, while the remaining five locations (20-102, 20-500R, RFI-10-26, 87-FP5, and RFI-86-06S) exhibited concentrations lower than criteria or were not detected when compared to MDEQ VI screening criteria.

In general, COC concentrations in the monitoring points on the south end of the Site are consistent with those detected in previous years. Of the six locations monitored,

COC concentrations in all but one were lower than criteria or were not detected when compared to MDEQ VI screening criteria (RFI-94-02, RFI-94-10, RFI-09-08, RFI-09-44, and RFI-09-55S). This is consistent with past concentrations at these locations. Monitoring point RFI-09-53 exhibited detectable levels of TCE (124 µg/L) higher than the MDEQ VI screening criteria, which represented an increase from recent years. However, historical TCE concentrations ranged from 1 µg/L to 184 µg/L between 2005 and 2013, indicating that TCE concentrations are stable.

Table 9 presents the proposed AGMP for 2015, including the rationale for continuing the VI evaluation at these select wells.



LEGEND:

PROPERTY BOUNDARY

APPROXIMATE KNOWN EXTENT OF MEASURABLE LNAPL (>0.1 FEET)

AREAS WHERE STORM SEWER HAS BEEN BULKHEADED

001 OUTFALL DRAINAGE AREA AND NUMBER

GROUNDWATER MONITORING IMPACT AREA

RFI-17-02 MONITORING WELL SAMPLED FOR ANNUAL GROUNDWATER MONITORING PROGRAM WHERE NO ANALYTES EXCEEDED CRITERIA

LOCATION WHERE LNAPL WAS MEASURED AT A THICKNESS OF >0.1 FEET DURING THE 2014 SAMPLING EVENT

WELL ID — RFI-09-53

ANALYTE WHICH EXCEED GROUNDWATER/SURFACE WATER INTERFACE CRITERIA — 1,1,1-Trichloroethane, Vinyl Chloride

RFI-84-06R Arsenic Cyanide (total) — DATABOXES SHOWN IN GRAY INDICATE MONITORING WELLS LOCATED IN AREAS WHERE THE STORM SEWER HAS BEEN BULKHEADED. THEREFORE, GROUNDWATER/SURFACE WATER INTERFACE CRITERIA ARE NOT APPLICABLE TO THESE AREAS.

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED APRIL 2001, AT A SCALE OF 1:100. AERIAL IMAGE FROM ARCGIS 10 ONLINE MAPPING, ACCESSED 6/12/2013.
2. BASED ON INFORMATION AVAILABLE AS OF MAY 2015.
3. WHILE MONITORING WELLS RFI-09-48, RFI-17-02D, RFI-84-09S AND RFI-94-02 ARE LOCATED WITHIN AN AREA WHERE THE STORM SEWER HAS BEEN BULKHEADED, THUS ELIMINATING THE GSI PATHWAY THROUGH THE SEWER SYSTEM, THEY ARE LOCATED WITHIN CLOSE PROXIMITY TO THE FLINT RIVER. THEREFORE, THERE IS A POTENTIAL GSI PATHWAY THROUGH DIRECT DISCHARGE.

0 250' 500'
APPROXIMATE SCALE IN FEET

RACER TRUST
BUICK CITY
FLINT, MICHIGAN

GROUNDWATER SAMPLES EXCEEDING GROUNDWATER/SURFACE WATER INTERFACE CRITERIA - SOUTHEND

ARCADIS

FIGURE 4

CITY: SYRACUSE DIV/GROUP: 141 DB: A.SANCHEZ LD: GMS PIC: C.S. PETERS PM: C. KIKER TM: C. KIKER LYR: ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0064410\2015\00701\B64410B01.dwg LAYOUT: 4 SAVED: 7/24/2015 2:43 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 7/24/2015 2:44 PM BY: SANCHEZ, ADRIAN
IMAGES: PROJECTNAME: ----

ATTACHMENT 7

Excerpts from –

2015 AOI 09-B MPE System Shutdown Memo

ARCADIS of Michigan, LLC
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MEMO

To:
Chris Black, USEPA Region 5

Copies:
Grant Trigger, RACER
Dave Favero, RACER
Brad Saunders, ARCADIS
Derek Kaiding, ARCADIS

From:
Micki M. Maki

Date:
March 11, 2015

ARCADIS Project No.:
B0064410.2015.01500

Subject:
AOI 09-B MPE System Shutdown Memo
RACER Buick City Site, Flint, Michigan

This AOI 09-B multiphase extraction (MPE) System (the System) Shutdown memo was prepared by ARCADIS on behalf of Revitalizing Auto Communities Environmental Response Trust (RACER) for the Buick City Site (Site) located in Flint, Michigan. As explained below further operation of this system is not warranted and will not provide any material environmental benefit because site conditions meet applicable cleanup criteria.

The AOI 09-B MPE System was installed to address offsite migration of dissolved phase concentrations of volatile organic compounds (VOCs) in groundwater and light non-aqueous phase liquid (LNAPL) impacts at AOI-09-B. As identified in the human health risk assessment (HHRA), which was presented in the RFI Phase II Report, the LNAPL impacts include potential exposure of routine workers in a non-OSHA commercial building to LNAPL via vapor intrusion and potential exposure of maintenance and redevelopment construction workers to LNAPL. Subsequent to the preparation of the RFI Phase II Report the remaining buildings on the Site were demolished; therefore, indoor inhalation is not presently an applicable pathway. The remaining applicable pathways include ambient air, soil and groundwater.

As further discussed below, the offsite groundwater impacts have been addressed by active removal with the MPE system and planned institutional controls will address the potential LNAPL impacts. Because applicable criteria have been met additional LNAPL recovery at AOI 09-B is no longer necessary.

1. AOI 09-B MPE System Objectives

As discussed above the original objectives of the AOI 09-B MPE System were to address offsite migration of dissolved phase concentrations of VOCs in groundwater and LNAPL direct contact and vapor intrusion to indoor air impacts at AOI-09-B. As noted above indoor air impacts are no longer applicable.

- The offsite migration of dissolved phase concentrations of VOCs in groundwater pertains to the detection of gasoline related constituents above residential and nonresidential drinking water (RDW and NDW) criteria at monitoring wells located along the property boundary (RFI-09-08 and RFI-09-55S) and at offsite monitoring well RFI-09-46 (**Figure 1**). Analytical data from annual groundwater samples collected in 2013 and 2014 from RFI-09-08, RFI-09-46, and RFI-09-55S show that there are no longer any exceedances of RDW or NDW criteria. Therefore, the risk to the offsite receptors has been addressed.

- The RFI Phase II HHRA indicated an unacceptable on-site risk for the potential exposure of routine workers in a non-OSHA commercial building to LNAPL via vapor intrusion and exposure of maintenance and redevelopment construction workers to LNAPL. There are currently no buildings at the Site; therefore, the indoor air pathway is not applicable. No exceedances of ambient are present and the potential future vapor intrusion and worker exposure concerns will be addressed by the Site-wide institutional controls planned for the Site.

2. Additional Considerations

This section presents additional information to consider when evaluating the shutdown of the AOI 09-B System.

2.1 Presence of LNAPL Observed in Existing Wells

Since the start of the System operation, LNAPL has been detected, as identified through gauging, in monitoring wells 31-7, 31-8, RFI-09-11, RFI-09-09, RFI-09-41, RFI-09-42, RFI-09-45, and RFI-09-47 (as shown on **Figure 1)**. The monitoring wells at AOI 09-B were gauged regularly during system operation.

During the most recent round of levels, collected in October 2014, LNAPL was only detected in wells 31-7, RFI-09-41, and RFI-09-47 with no detections at the perimeter wells as shown on **Figure 1**. As represented by this data the area of LNAPL impacts is substantially reduced and well within the facility boundaries.

2.2 ASTM Standard E2531

The 2006 ASTM Standard E2531 Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids (LNAPL) Released to the Subsurface provides in Table X5.1 under the heading LNAPL Site Objective – item 5, the three following criteria for determining when recovering LNAPL is no longer cost effective:

- When there is less than 0.1 percent additional recovery per day relative to cumulative recovery totals (asymptotic conditions)
- When pollution from energy use or system emissions or both is greater than the mass recovery
- When monetary costs exceed $50/gal equivalent and no further meaningful change in flux or longevity

Per the ASTM standard these metrics are provided as examples only; therefore, all three metrics do not have to be met for LNAPL recovery to be considered “no longer effective” nor are these the only standards by which this can be measured. Moreover, these suggested metrics are not intended to substitute for applicable cleanup criteria but rather are intended as guidance when meeting specific criteria may be a challenge.

2.2.1 Asymptotic Conditions

Asymptotic conditions were recommended as a reasonable endpoint in the *AOI 09-B Remedial Endpoints Memo (Endpoint Memo).* Per the Endpoint Memo asymptotic conditions are considered to be met when the daily total mass recovery (liquid and vapor) is less than 0.1 percent of the prior total mass recovery for two consecutive months. Please note that the focus of the ASTM guidance was on LNAPL removal in liquid form and applying this metric to a multi-phase system may be problematic – as was discovered in this case. Current Site conditions meet the applicable cleanup standard, demonstrating that compliance with the asymptotic condition combining liquid

and vapor removal was difficult to achieve. Because ASTM does not mandate compliance with the asymptotic condition we can appropriately rely on demonstrating compliance with applicable cleanup criteria.

As an example of the variability in meeting the asymptotic condition we note several conditions that impacted the results. During 2014 (April through September) 20 of the 28 recovery wells were operated. Eight of the recovery wells were not operated in 2014 due to low mass removal based on the 2013 data. The 20 recovery wells that were operated (shown on **Figure 1**) were selected to target the highest impacted areas within and around the LNAPL area. In 2014 the System achieved the 0.1 percent average daily mass recovery to total mass recovery ratio (ratio) in May. It was decided that weekly vapor samples would be collected in June and July to provide a definitive data set to determine the ratio. The average ratio was slightly above the targeted 0.1 percent in June with a ratio of 0.14 percent and fell below the target in July with a ratio of 0.06 percent (see **Table 1**).

Figures 2, 3, and 4 present graphs of the Monthly LNAPL Removal, Monthly Total Mass Removal, and Endpoint Comparison to evaluate asymptotic conditions.

2.2.2 Pollution for Energy Use Exceeds Mass Recovery

Operation of the System's Flame Oxidizer Model 1 requires natural gas to supplement the VOC mass loading during periods of lower mass removal which generates pollution emissions (NOx, SOx, & CO2) from burning natural gas. In 2014, the total mass recovered by the treatment system was approximately 1,587 pounds between April and November 2014. Based on the usage rates at the Site the System generated approximately 379 pounds of pollutants during the same time frame. During the 2014 operational period the mass of pollutants generated was approximately 24 percent of the mass removed by the System (See **Table 2**).

As asymptotic conditions are approached the mass of pollution generated will continue to increase and the mass recovery of the System will continue to decrease until the pollutants generated is greater than the mass recovered. For instance in July 2014, when the end point ratio was 0.06 percent, the System recovered approximately 46 pounds of VOCs but generated approximately 70 pounds of natural gas combustion pollution.

2.2.3 Monetary Cost

In 2014 approximately $245,000 has been spent on OMM of the System. A total of 1,587 pounds (253 gallons) of petroleum hydrocarbons was recovered in the vapor and liquid phases. The cost per gallon of removal was therefore calculated to be approximately $968.

3. Conclusions

The AOI 09-B MPE System was installed to address offsite migration of dissolved phase concentrations of VOCs in groundwater and LNAPL direct contact and potential vapor intrusion to indoor air impacts at AOI-09-B. The offsite impacts have been addressed and planned institutional controls will address the potential LNAPL impacts onsite.

In addition, the following summarizes the ASTM Standard E2531 performance metrics for the AOI 09-B LNAPL Area.

- The AOI 09-B MPE system is nearing asymptotic conditions for total mass recovery (liquid and vapor), but has not yet reached the goal of two consecutive months where the daily total mass recovery is less than 0.1% of the prior total mass recovery. The asymptotic condition was met one month (0.06%), was equal to the criteria one month (0.1%) and slightly above criteria (0.14%) one month in 2014, even though the monitoring well network was reduced to 20 recovery wells focused in the most impacted portion of the LNAPL area.

- The Pollution for Energy Use was approximately 24% of the total mass recovery in 2014. Therefore, there is currently more pollution being removed than generated.

- The cost per gallon for recovery during the 2014 operational period $968, which significantly exceeds the ASTM guideline of $50/gallon.

In summary, the system has reduced contaminant levels below the applicable cleanup criteria and no further operation is required to demonstrate compliance with applicable cleanup criteria.

Based on the results of this review and summary we intend to retrofit the system and relocate it to the Factory 36 area this summer. The reconfiguration of the system will depend on the results of the field pilot

tests and making necessary adjustments of the system components to establish the most effective means of remediating the contamination found at Factory 36.

WESTERN SECTION

CENTRAL SECTION

EASTERN SECTION

SOUTHERN SECTION

04-1 04-5 31-6 31-8 31-8 31-7

22 23 24 25 26 27 28

LIF-09-026 LIF-09-013 LIF-09-027 RFI-09-12 LIF-09-004 LIF-09-014

LIF-09-003 2 MW-09-1 MW-09-2 LIF-09-012 RFI-09-47 MPE-09-1 1 LIF-09-002 RFI-09-40R RFI-09-40R MW-09-5 RFI-09-41 3 LIF-09-001 RFI-09-42 MW-09-4 RFI-09-42 4 RFI-09-45 RFI-09-45R RFI-09-45R LIF-09-008 LIF-09-007

5 LIF-09-005 RFI-09-52 8 LIF-09-006 LIF-09-010 6 RFI-09-11 RFI-09-11D MW-09-3 9 10 LIF-09-009 7

16 LIF-09-015 17 18 19 RFI-09-06 LIF-09-029 20 21

LIF-09-016 11 13 LIF-09-011 RFI-09-09D RFI-09-09 LIF-09-025 15 LIF-09-028 12 14 RFI-09-44

LIF-09-031 RF-09-08D RFI-09-08 RFI-09-46 RFI-09-54S RFI-09-54D RFI-09-13 RFI-09-55D RFI-09-55S RFI-09-14 RFI-09-07 MW-24

LEGEND

- LASER-INDUCED FLUORESCENCE BORING
- MONITORING WELL
- RECOVERY WELL
- FULL TIME OPERATING WELL
- WELL NOT OPERATED
- LNAPL DETECTED DURING MOST RECENT GAUGING EVENT (OCT 2014)
- WELL HISTORICALLY DETECTED LNAPL
- APPROXIMATE LATERAL EXTENT OF LNAPL BASED ON LASER-INDUCED FLUORESCENCE (LIF) DATA
- RADIUS OF INFLUENCE

0 50 100

SCALE IN FEET

MOTORS LIQUIDATION COMPANY
BUICK CITY
FLINT, MICHIGAN

MULTI-PHASE EXTRACTION WELL LAYOUT - 2014 WELL OPERATION AREA OF INTEREST 09-B

ARCADIS

FIGURE 1

CITY: Novi DIV: ENV DB: TRY PIC: PM: TM: TR: PROJECT NUMBER: COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
D:\GIS\Project Files\MotorsLiquidationCompany\BuickCity\Documents\AOI_09B_Extraction Well Layout_2014 Operation.mxd PLOTTED: 2/20/2015 2:40:13 PM BY: TYarbrough

Figure 2
AOI-09B MPE System - Monthly LNAPL Removal
RACER Buick City
Flint, Michigan

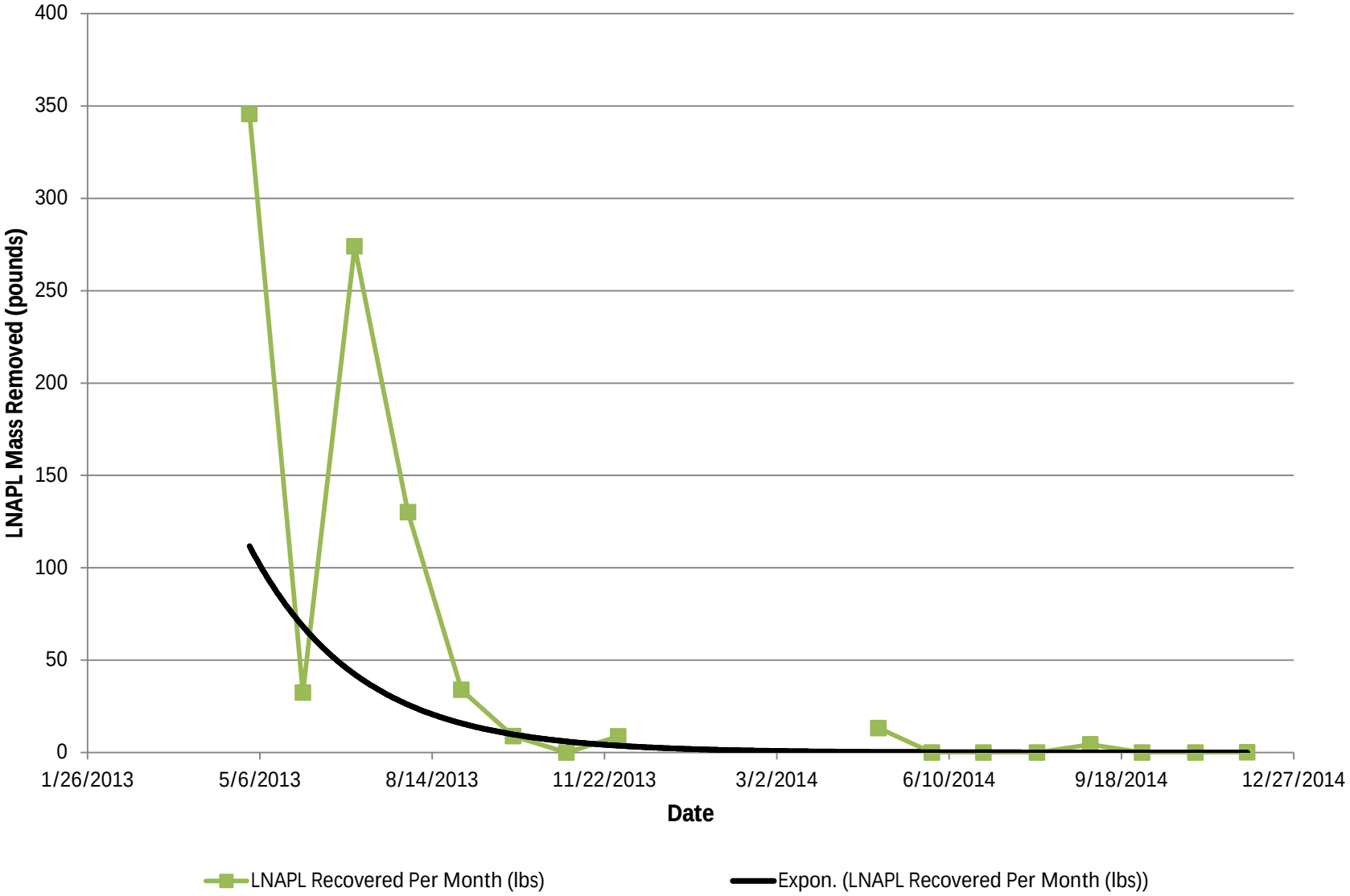
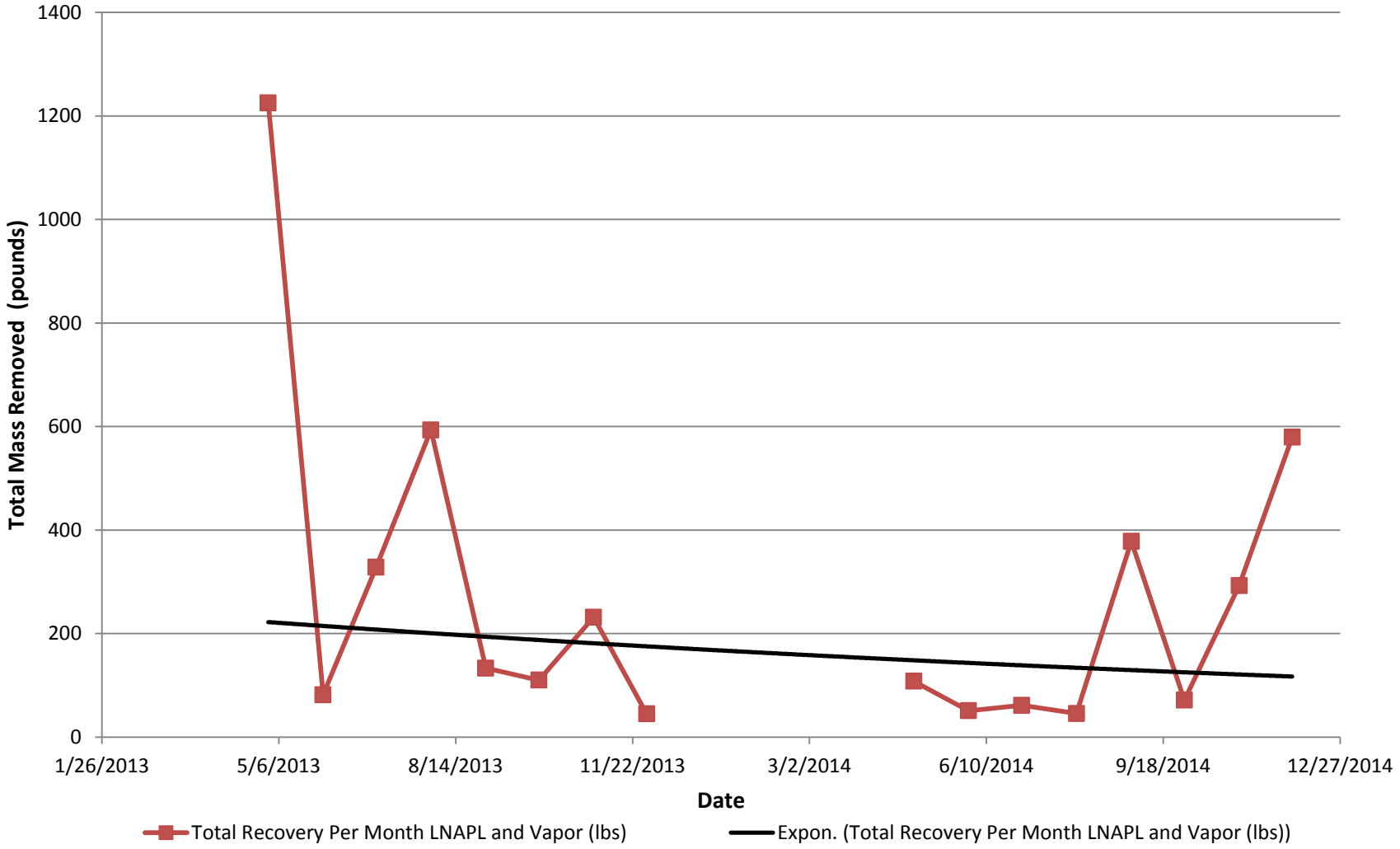
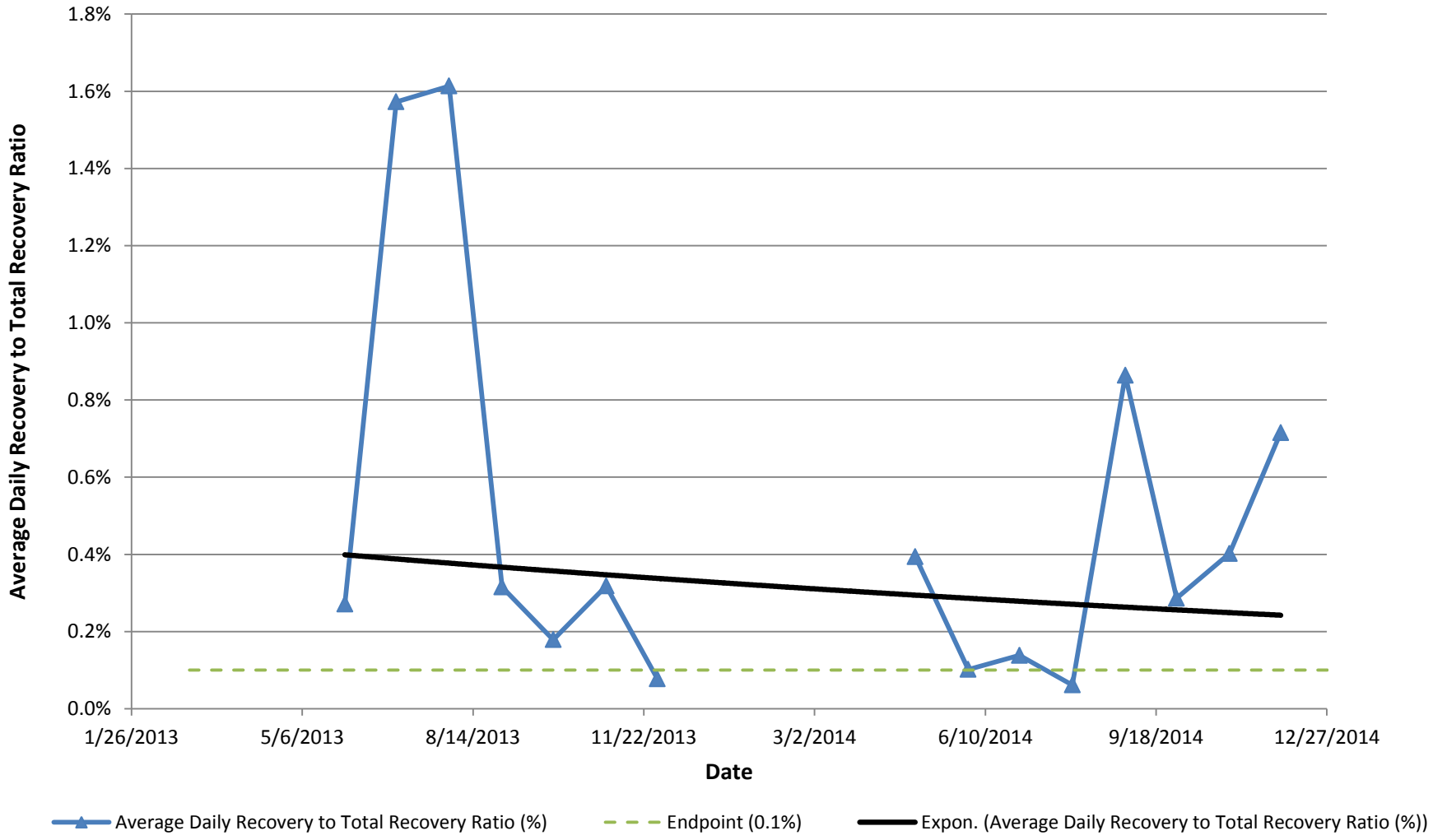


Figure 3
AOI-09B MPE System - Monthly Total Mass Removal
RACER Buick City
Flint, Michigan



Note: Vapor phase mass removal is determined by applying the instantaneous mass removal rate, based on SVE flow rate and weekly and/or monthly air sample concentrations, to the corresponding operating time

Figure 4
AOI-09B MPE System - Endpoint Compairson
RACER Buick City
Flint, Michigan



Note: Vapor phase mass removal is determined by applying the instantaneous mass removal rate, based on SVE flow rate and weekly and/or monthly air sample concentrations, to the corresponding operating time

Table 1. RACER Buick City Vapor Phase and LNAPL End Point Tracking
RACER Trust, Buick City Site, Flint, Michigan.

Year	Sample Date	Hours of System Operation Per weekly sample.	Hours of System Operation Per Month	Number of Operational Extraction Wells	Number of Extraction Wells Operating During Vapor Sample Collection	Volume of Water Discharged Per Month (gal)	Cumulative Annual Volume of Water Discharged (gal)	Cumulative Volume of Water Discharged 2013-2014 (gal)	SVE Vapor Phase Mass Recovered Per Weekly sample (lbs)	SVE Vapor Phase Mass Recovered Per Month (lbs)	Cumulative Annual SVE Vapor Phase Mass Recovered (lbs)	Cumulative SVE Vapor Phase Mass Recovered 2013-2014 (lbs)	LNAPL Recovered Per Month (lbs)	Cumulative Annual LNAPL Recovered (lbs)	Cumulative LNAPL Recovered 2013-2014 (lbs)	Total LNAPL and Vapor Mass Recovered Per weekly samples (lbs)	Total LNAPL and Vapor Mass Recovered Per Month (lbs)	Cumulative Annual LNAPL and Vapor Mass Recovered (lbs)	Cumulative LNAPL and Vapor Mass Recovered 2013-2014 (lbs)	Average Daily Mass Recovery to Total Mass Recovery Ratio (%)	Monthly Average Daily Mass Recovery to Total Mass Recovery Ratio (%)
2013	4/16/2013	--	125	28	28	54,686	54,686	54,686	--	879	879	879	346	346	346	--	1225	1225	1225	NA	NA
	5/10/2013	--	553	21	13	102,845	157,530	157,530	--	49	929	929	32	378	378	--	82	1307	1307	0.27%	0.27%
	6/11/2013	--	306	20	16	120,354	277,884	277,884	--	54	983	983	274	653	653	--	328	1635	1635	1.57%	1.57%
	7/17/2013	--	396	25	17	87,374	365,258	365,258	--	463	1446	1446	130	783	783	--	594	2229	2229	1.61%	1.61%
	8/14/2013	--	429	18	17	116,596	481,854	481,854	--	99	1545	1545	34	817	817	--	133	2362	2362	0.32%	0.32%
	9/24/2013	--	596	28	18	85,658	567,512	567,512	--	101	1646	1646	9	826	826	--	110	2472	2472	0.18%	0.18%
	10/9/2013	--	646	28	18	67,284	634,796	634,796	--	232	1878	1878	0	826	826	--	232	2704	2704	0.32%	0.32%
	11/20/2013	--	506	28	18	64,315	699,111	699,111	--	36	1914	1914	9	834	834	--	45	2748	2748	0.08%	0.08%
2014	4/25/2014	--	231	20	20	14,123	14,123	713,235	--	95	95	2009	13	13	848	--	108	108	2856	0.39%	0.39%
	5/14/2014	--	414	20	20	23,632	37,756	736,867	--	51	146	2060	0	13	848	--	51	159	2907	0.10%	0.10%
	6/13/2014	56		20	20				12							12				0.18%	
	6/23/2014	160		20	20				23							23				0.12%	
	6/27/2014	143		20	20				26							26				0.15%	
	6/30/2014	--	359	20	20	18,990	56,746	755,857	--	61	207	2121	0	13	848	--	61	220	2969	--	0.14%
	7/2/2014	24		20	20				12							12				0.42%	
	7/8/2014	120		20	20				2							2				0.01%	
	7/16/2014	149		20	20				14							14				0.07%	
	7/22/2014	140		20	20				15							15				0.08%	
	7/29/2014	157		20	20				3							3				0.02%	
	7/31/2014	--	589	20	20	20,607	77,353	776,464	--	46	253	2167	0	13	848	--	46	266	3014	--	0.06%
	8/4/2014	81		20	20				4							4				0.04%	
	8/15/2014	229		20	20				370							374				1.15%	
	8/31/2014	--	310	20	20	13,114	90,467	789,578	--	374	627	2541	4.4	17.6	852	--	378	644	3393	--	0.86%
	9/17/2014	--	172	20	20	6,309	96,776	795,888	--	71	698	2612	0	17.6	852	--	71	715	3464	--	0.29%
	10/15/2014	--	465	21	21	16,090	112,866	811,978	--	293	991	2905	0	17.6	852	--	293	1008	3757	--	0.40%
	11/6/2014	--	448	21	21	11,830	124,697	823,808	--	579	1570	3484	0	17.6	852	--	579	1587	4336	--	0.72%

Notes:

%	percent
gal	gallons
NA	Criterion or value is not available or, in the case of background and CAS numbers, not applicable.
SVE	Soil Vapor Extraction
lbs	pounds
LNAPL	Lighter-than-water, non-aqueous phase liquid

Table 2

RACER Buick City Vapor Phase and LNAPL End Point Tracking 2014
RACER Trust, Buick City Site, Flint, Michigan.

		Emissions								
Operational Period		**April 2014**	**May 2014**	**June 2014**	**July 2014**	**August 2014**	**September 2014**	**October 2014**	**November 2014**	**Annual Mass (2014)**
Criteria Pollutants & GHG Fuel Use per Month (10^6 SCF)		0.35200	0.24300	0.13430	0.38040	0.35330	0.11680	0.35630	0.11800	2.05410
Pollutant	**Emission Factor[a] NG (10^6 SCF)**									
NO_x (lb)	100	35	24	13	38	35	12	36	12	**205**
CO (lb)	84	30	20	11	32	30	10	30	10	**173**
SO_2 (lb)	0.6	0.21	0.15	0.08	0.23	0.21	0.07	0.21	0.07	**1.23**
Emissions Mass Generated from System Operations (lb)		65	45	25	70	65	22	66	22	**379**
Vapor Mass Removal from System Operations (lb)		108	51	61	46	378	71	293	579	**1587**
Difference in Mass Generated/ Removed		43	6	36	-24	313	49	227	557	**1208**

Notes: SCF = Standard Cubic Feet
NG = Natural Gas
GHG = Green House Gas
lb = Pounds
[a] = Obtained from USEPA's AP-42 Chapter 1, Section 4 (July 1998) for small, uncontrolled boilers.
[b] = Negative number indicates more pollutants were generated than mass recovered

ATTACHMENT 8

Excerpts from –

2015 Annual Groundwater Monitoring Report

3.4.3 Building 09 Area

In the Building 09 Area, five monitoring wells were sampled during the 2015 Event. The data collected from the Building 09 Area detected ethylbenzene, naphthalene and vinyl chloride at concentrations exceeding GSI criteria, as discussed below.

3.4.3.1 GSI Evaluation

Groundwater exceeding GSI criteria was detected at RFI-09-11 and RFI-09-53 in September 2015 (**Table 4** and **Figure 4**). These wells fall within the Outfall 011 drainage area (RFI-09-11) and Outfall 012 drainage area (RFI-09-53), which have not been fitted with bulkheads (**Figure 4**).

RFI-09-11

Ethylbenzene and naphthalene were detected at concentrations exceeding the GSI criteria in September 2015. Downgradient monitoring wells RFI-09-08 and RFI-09-55S were also sampled in 2015 and did not detect any VOCs at concentrations exceeding GSI criteria.

RFI-09-11 is adjacent to the Outfall 011 storm sewer and historical groundwater contours indicate flow toward the sewer; therefore, there is a relatively high likelihood that the groundwater near this well is infiltrating into the storm sewer. However, previous National Pollutant Discharge Elimination System (NPDES) Permit Monitoring Program (NPMP) sampling at the river in the Outfall 011 sewer has demonstrated no impacts to the water discharging there. Therefore, while the GSI pathway at this location may be complete, there is no evidence of measurable impact to the surface water due to VOCs found in this monitoring well.

RFI-09-53

At RFI-09-53 vinyl chloride was detected at a concentration exceeding the GSI criterion. 1,1,1-Trichlorethane, which exceeded GSI criteria in 2014, was below GSI criteria in 2015.

RFI-09-53 is adjacent to the Outfall 011 storm sewer; therefore, there is a relatively high likelihood that the groundwater near this well is infiltrating into the storm sewer. Previous sampling at the Outfall 011 discharge point to the river has demonstrated no impacts to the water discharging there. Therefore, while the GSI pathway here may be complete, there is no evidence of measurable impact to the surface water due to VOCs found in this monitoring well.

3.4.3.2 Groundwater Vapor Intrusion Evaluation

Based on the results of the 2014 Site vapor intrusion evaluation activities, monitoring wells RFI-09-44, RFI-09-53, and RFI-09-55S were selected for monitoring for potential VI impacts for benzene and TCE (**Figure 4**). Although the evaluation activities only identified these three wells for further monitoring in the Building 09 Area, all site data have been compared NGVIA and MDEQ VI Groundwater Screening Levels (**Table 5** and **Figure 4**). The depth to groundwater at RFI-09-44 and RFI-09-55S were less than 9.8 feet bgs (**Table 2**); therefore, concentrations were compared to the MDEQ VI Groundwater Screening Levels for shallow groundwater. While the depth to groundwater at RFI-09-53 was greater than 9.8 feet bgs during the 2015 Event, historical depths collected at RFI-09-53 have measured the depth to groundwater shallower than 9.8 feet bgs. Therefore, the appropriate criteria for comparison are MDEQ VI Groundwater Screening Levels at RFI-09-53.

There were no exceedances of screening values at monitoring wells RFI-09-44, RFI-09-53, and RFI-09-55S.

Please note that the laboratory detection limits for 1,1,2-trichloro-1,2,2-trifluoroethane exceeded the groundwater screening value in all four samples; however,1,1,2-trichlor-1,2,2-trifluoroethane is not a constituent of concern in the Building 09 Area.

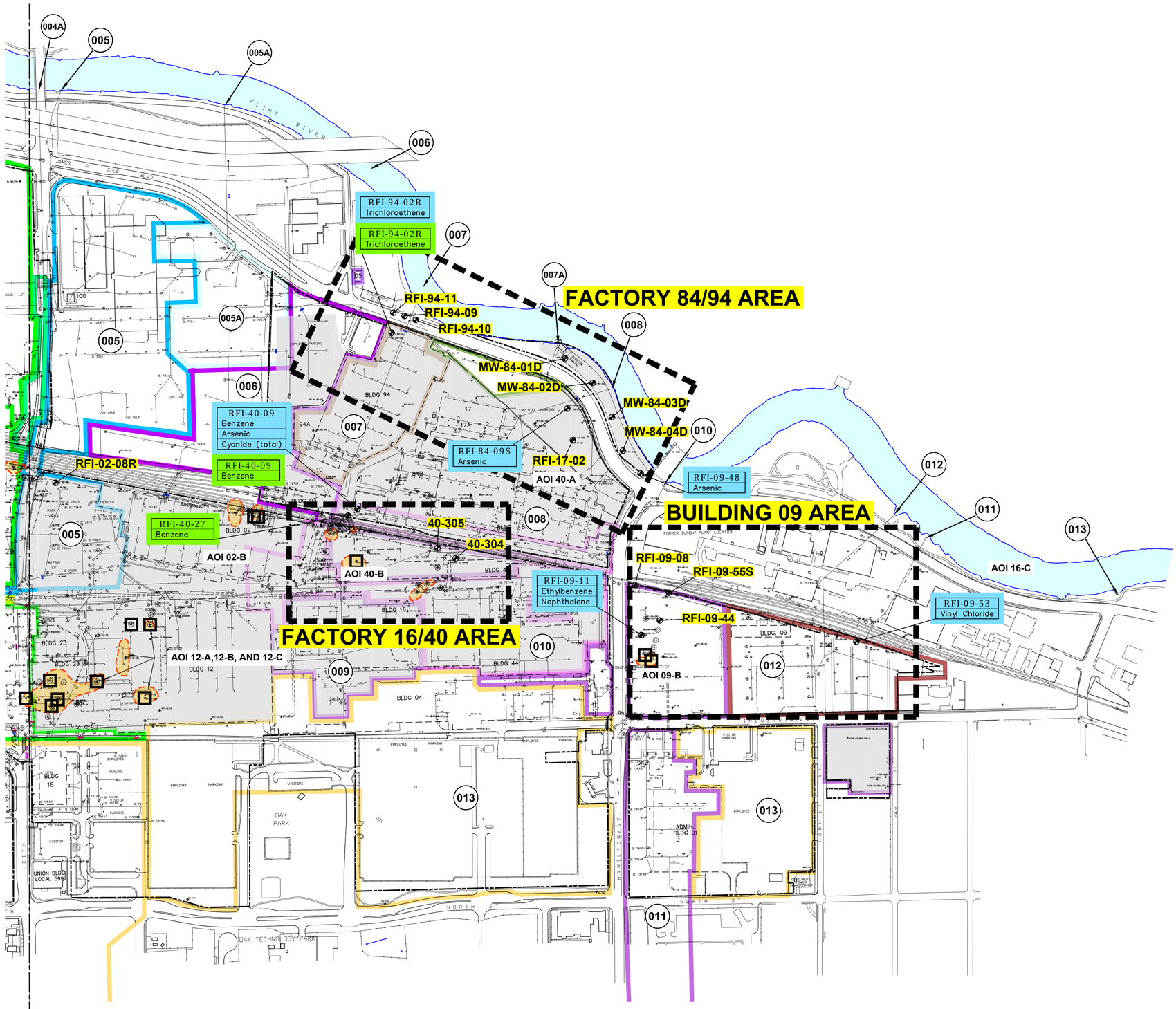
3.4.3.3 1,4-Dioxane Investigation

1,4-dioxane was not detected at monitoring well RFI-09-53 in 2015.

3.4.3.4 Building 09 Recommendations

Based on the 2015 AGMP sampling results, concentrations of COCs appear to be relatively stable in the AOI 09-B area. Recommended changes to the AGMP include removing 1,4-dioxane from the analyte list at RFI-09-53.

Table 6 and **Figure 6** summarize the 2016 monitoring program



LEGEND:

- PROPERTY BOUNDARY
- APPROXIMATE KNOWN EXTENT OF MEASURABLE LNAPL (>0.1 FEET) LNAPL AREAS BASED ON ALL AVAILABLE DATA AS OF MARCH 19, 2014
- AREAS WHERE STORM SEWER HAS BEEN BULKHEADED
- 001 — OUTFALL DRAINAGE AREA AND NUMBER
- GROUNDWATER MONITORING IMPACT AREA
- RFI-17-02 — MONITORING WELL SAMPLED FOR ANNUAL GROUNDWATER MONITORING PROGRAM WHERE NO ANALYTES EXCEEDED CRITERIA
- LOCATION WHERE LNAPL WAS MEASURED AT A THICKNESS OF >0.1 FEET DURING THE 2015 SAMPLING EVENT

ANALYTE WHICH EXCEED GROUNDWATER/SURFACE WATER INTERFACE CRITERIA → WELL ID: RFI-09-53 Vinyl Chloride

ANALYTE WHICH EXCEED MDEQ NONRESIDENTIAL VAPOR INTRUSION SCREENING LEVELS → WELL ID: 20-102R Trichloroethene, 1,1,1-Trichloroethane, Vinyl Chloride

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED APRIL 2001, AT A SCALE OF 1:100. AERIAL IMAGE FROM ARCGIS 10 ONLINE MAPPING, ACCESSED 6/12/2013.
2. BASED ON INFORMATION AVAILABLE AS OF JUNE 2016.

0 250' 500'
APPROXIMATE SCALE IN FEET

RACER TRUST
BUICK CITY
FLINT, MICHIGAN

2015 GROUNDWATER SAMPLES EXCEEDING GSI CRITERIA AND MDEQ VI SCREENING LEVELS - SOUTHEND

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4