

***General Motors Corporation***

***Saginaw Malleable Iron Plant  
Property and REALM, Inc.  
Green Point Landfill and  
Drum Remediation Area  
Saginaw, Michigan***

**Feasibility Study Report  
FINAL**

**July 29, 2003**

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# 1. Introduction

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## 1.1 Purpose and Objective

This *Feasibility Study Report* (FS Report) has been prepared on behalf of the General Motors Corporation (GM), its subsidiary, the Remediation and Liability Management Company, Inc. (REALM, Inc.), and Waste Management, Inc. (WMI). This FS Report describes site conditions and previous remedial actions implemented, assesses the need for further remedial actions, and where appropriate, presents potential remedies at the GM Saginaw Malleable Iron (SMI) Plant Property and the southern property owned by REALM, Inc. that includes the Green Point Landfill and Drum Remediation Area (DRA), all located in Saginaw, Michigan (the site) (Figure 1-1). The FS Report was developed pursuant to Part 201 of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended, to evaluate remedies (ongoing or proposed) to address constituents related to operations conducted at the site. This FS Report is being completed pursuant to a Consent Judgment executed between the Michigan Department of Environmental Quality (MDEQ), the Michigan Attorney General's (MAG's) Office, GM, and WMI, and entered by the State of Michigan Circuit Court for Saginaw County on March 16, 1998. Subsequent to FS Report approval by the MDEQ Environmental Response Division (ERD), a Remedial Action Plan (RAP) will be prepared that reflects the current and projected industrial use of the site.

The FS Report is based on information presented in the *Remedial Investigation Report* (RI Report) dated July 5, 2001, the *Human Health Evaluation Report* (HHE Report), attached, prepared by Blasland, Bouck & Lee, Inc. (BBL), and the *Ecological Risk Assessment Report* (ERA Report), also attached, prepared by Exponent. The HHE Report and the ERA Report are included as Appendices A and B, respectively. The FS Report has been prepared consistent with the following MDEQ regulations:

- Rule 513 of the MDEQ ERD R299.5513 regulations entitled *Feasibility Studies*; and
- Rules 601 through 607 of the MDEQ ERD R299.5601 through R299.5607 regulations entitled *Selection of Remedial Action*.

The following regulations and guidance documents were also referenced during preparation of this FS:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, 42 U.S.C. Sections 9601 et seq., as amended;
- Applicable provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations contained in Part 300 of Title 40 of the Code of Federal Regulations (40 CFR 300); and
- The U.S. Environmental Protection Agency (USEPA) guidance document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988).

The purpose of this FS Report is to identify remedies appropriate for site-specific conditions that still exceed acceptable risk for the projected land use, protective of human health and the environment, and consistent with relevant sections of the Michigan environmental regulations. The overall objective of the FS Report is to present remedies that satisfy the remedial action objectives (RAOs) for the site and are cost effective.

## 1.2 Report Organization

This FS Report is organized into the following sections:

| Section                                                                                                                | Purpose                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 – Introduction                                                                                                       | Presents the purpose and objective of the FS Report. Provides a description of the site background including the location and physical setting, the regional geology and hydrogeology, and the site history. |
| 2 – RI Summary                                                                                                         | Presents a summary of the RI activities and the results and conclusions of the activities.                                                                                                                   |
| 3 – Interim Response Actions                                                                                           | Presents a description of the interim response actions (IRAs), which have been completed, are currently being conducted, or are scheduled for implementation at the site.                                    |
| 4 – Evaluation of Groundwater Quality at Saginaw River Perimeter                                                       | Presents an evaluation of the groundwater associated with the Saginaw River perimeter.                                                                                                                       |
| 5 – Identification of Applicable or Relevant and Appropriate Requirements, Rules, Criteria, Limitations, and Standards | Identifies the Applicable or Relevant and Appropriate Requirements, rules, criteria, limitations, and standards that govern the development and selection of alternatives.                                   |
| 6 – Development and Identification of Remedial Action Objectives                                                       | Summarizes the results of the HHE and ERA conducted for the site, develops RAOs for the site that are protective of human health and the environment.                                                        |
| 7 – Areas Evaluated for Continued Monitoring, Ongoing Remediation, Deed Restrictions, or Remedial Action               | Presents a brief description of select site areas that were evaluated for continued monitoring, ongoing remediation, deed restrictions, or remedial action.                                                  |
| 8 – Detailed Evaluation of Alternative                                                                                 | Presents a detailed evaluation of the alternative proposed for the site against the MDEQ ERD R299.5513 evaluation criteria.                                                                                  |
| 9 – References                                                                                                         | Presents citations for reports, guidance documents, and other literature referenced throughout the FS Report.                                                                                                |

## 1.3 Site Background

The site background is described below with respect to location and physical setting, regional geology, regional hydrogeology, and site history (including summary of previous investigation and remedial activities).

### 1.3.1 Location and Physical Setting

The site encompasses approximately 276 acres. The northern portion of the site includes the SMI Plant, the Casting Technology Center (CTC) and surrounding ancillary areas, two closed Type III Landfills, and a former Water Recirculation System (WRS) that includes settling ponds and drainage channels (SMI Plant Property). The southern portion of the site (now owned by REALM, Inc.) includes the Green Point Landfill and the DRA, where drums were previously discovered, excavated, and removed. Site features are discussed below.

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The site is located approximately 2,000 feet north of the confluence of the Tittabawassee, Shiawassee, and Saginaw rivers, and is located on the western half of Section 35, T12N, R4E, in the city of Saginaw, Saginaw County, Michigan. The site is bounded to the west by the Delphi Automotive Systems Corporation (Delphi) Saginaw Steering Systems Plant 2 (Plant 2) and a junkyard; to the east by the Saginaw River and property previously used for agricultural purposes (previously owned by Ruben Schultz and the State of Michigan, now owned by REALM, Inc.); to the north by commercial, residential, and industrial properties; and to the south by agricultural property (Figure 1-1).

Figure 1-2 is a site plan illustrating the locations of the primary site features: the SMI Plant and CTC; the former WRS, which included the former Primary Settling Pond previously encompassing approximately 2 acres (the pond is dry and has been graded over to form a drainage swale), the recirculation channels (the north-south oriented channel has been filled and the east-west oriented channel is expected to be filled in 2002), the Secondary Settling Pond encompassing approximately 16 acres, the Stormwater Pond (also known as the Small Pond), encompassing approximately 1 acre, and stormwater drainage channels; the closed eastern 8-acre licensed Type III Landfill; the closed central 8-acre licensed Type III Landfill; the 30-acre Green Point Landfill; and the DRA encompassing approximately 13 acres. An area labeled "Previously Proposed Type III Landfill" is also shown on Figure 1-2. This area was the site of GM's proposed Type III Landfill; however, the landfill was never fully developed (a constructed base of inert foundry sand still remains).

The topography of the site is generally flat, with the exception of the closed Type III landfills and the Green Point Landfill, which are mounded above the surrounding land. The components of the former WRS, including the ponds and the associated east-west trending channel, also result in minor topographic variability in the northern part of the site. In the southwest portion of the site, wetlands are present, and a series of ditches provide for drainage throughout the southern portion of the site.

The 100-year floodplain elevation is 594 feet above mean sea level (amsl) (RMT, 1980). Many areas of the site, including the former Primary Settling Pond, the Secondary Settling Pond, the lower portions of the licensed Type III landfills, and the DRA, are below this elevation.

### **1.3.2 Regional Geology**

The site is located within the Central Lowland geomorphic province and overlies bedrock units of the Michigan basin, which is a roughly circular synclinal structure in which the youngest formations subcrop at the center of the basin, and progressively older formations subcrop outward in concentric rings. The site lies over bedrock units in the central part of the basin, the shallowest of which consist of Pennsylvanian age bedrock of the Grand River and Saginaw formations. The Grand River Formation consists primarily of sandstones, which are unconformably overlain by the Saginaw Formation, which consists of interbedded sandstone, shale, and limestone, with frequent coal seams.

Overburden deposits consist of layers of clay to sand-size sediments that were deposited by fluvial and glaciofluvial processes. The overburden varies on a regional scale across the Saginaw area as a result of variations in the depth to bedrock and the proximity to former and existing depositional controls, including rivers and glacial outwash channels. At the site, the overburden is generally composed of (in descending order) fill materials, a discontinuous sand unit possibly of fluvial origin, glaciolacustrine silt and clay, glaciofluvial sand, discontinuous glaciolacustrine clay, a discontinuous sand unit, glaciolacustrine silty clay, and glacial till.

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### 1.3.3 Regional Hydrogeology

The Saginaw Formation bedrock is confined by an overlying continuous lower silty clay unit in the vicinity of the site. This lower silty clay unit has been observed in all borings completed across the site and has considerable thickness, as evidenced by the deep geotechnical boring (MW-139) and the historic construction-related geotechnical boring data in the SMI Plant area (construction boring logs for the SMI Plant area were transmitted to the MDEQ on March 10, 1994) (BBL, 1994). Bedrock groundwater quality is poor due to the presence of heavy mineralization; it would generally be unfit for use as a drinking water aquifer due to high concentrations of chlorides, iron, total and dissolved solids, and other minerals (U.S. Geological Survey [USGS], 1980). Saginaw and the surrounding communities use water obtained from Lake Huron for their drinking water supply (USEPA, 1981; Saginaw County Health Department, 1997).

Shallow groundwater at the site exists in an unconfined or “water table” condition. The depth to groundwater varies from 2 to 10 feet below ground surface (bgs) and depends on the proximity of recharge areas and seasonal influences. Saturated conditions first occur in either the fill materials or the silty clay stratigraphic unit, which typically underlies these materials. The sand units at the site, which pinch out toward the west, act as the primary pathways for groundwater flow at the site. The underlying silty clay unit acts as a local flow boundary or lower confining unit.

Median groundwater concentrations for inorganics in the area were provided for outwash glacial deposits by Cummings (1989). Elevated magnesium, iron, and sodium were typical. An evaluation of regional groundwater quality compared with site conditions was completed as presented in the *Background Groundwater Quality Assessment Report* (BBL, 1998).

Despite localized influences on the groundwater flow direction, flow is controlled on a regional scale by the Saginaw River, which generally acts as a discharge point for overburden groundwater. The Saginaw River is formed by the confluence of the Tittabawassee and Shiawassee rivers, approximately 2,000 feet upstream of the southern site boundary, and regional groundwater and surface water discharge from adjacent land. Further upstream, the Cass and Flint rivers discharge to the Shiawassee River. The Saginaw River flows northward 22 miles to Saginaw Bay of Lake Huron. The drainage area of the Saginaw River basin is approximately 6,100 square miles (USGS, 1993).

The mean discharge of the Saginaw River at the closest gauging station located approximately 1 mile downstream of the site (Rust Avenue) for the water year 1991 - 92 is 7,171 cubic feet per second (cfs), which is equivalent to 16.08 inches of runoff per year (USGS, 1993) from the watershed. For water years 1991 - 92, the harmonic mean of the discharges was 4,173 cfs, and the 95% exceedance was 2,240 cfs. A summary of the Saginaw River gauging information is presented in the *Remedial Investigation/Feasibility Study Work Plan* (RI/FS Work Plan) (BBL, 1997a).

### 1.3.4 Site History and Summary of Previous Investigation and Remedial Activities

This section describes the history of the general site areas associated with the SMI Plant and surrounding areas. In addition, this section presents a summary of previous investigation activities, with the exception of the RI activities discussed separately in Section 2, conducted at the site.

For discussion purposes, the site can be divided into the following general areas of investigation: the SMI Plant and production areas (including the CTC), an area along Center Street associated with the former Queen Street Dump, the two Type III landfills, the former WRS, the DRA, and the Green Point Landfill. Several pre-RI

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environmental investigations were conducted at the SMI Plant Property, dating back to 1979. A summary of these previous investigations is provided in the RI/FS Work Plan, and key points of these investigations are presented below.

#### SMI Plant, CTC, and Production Areas

The SMI Plant occupies an area of approximately 1 million square feet. Manufacturing operations at the plant consist of activities associated with casting and heat-treating iron. Scrap metal is melted and transferred through a series of furnaces before it is placed, as molten metal, into the molds to form the castings. Molds, which form the outer shape of the casting, are formed by putting mold sand (a mixture of lake sand, sea coal, bentonite, and water) under pressure around a die. Cores, which form the internal cavities of a casting, are made by mixing lake sand with a two-part resin and then injecting a catalyst into the core box to set up the resin. Once the mold and core are completed, molten metal is placed into the mold to form the casting. After cooling, the mold is broken to remove the casting. The resulting castings are then heat-treated and quenched with oil to develop malleability.

The plant has expanded several times during its history. GM purchased the northern margin of the SMI Plant Property in the early 1970s, when the Center Street Bridge was completed over the Saginaw River, and Queen Street was truncated at its intersection with Center Street. Prior to GM's purchase of the property, local residents dumped municipal waste in this area along the former location of Queen Street (BBL, 1997a). The two-story CTC building is located just east of the SMI Plant, and contains labs, offices, and meeting rooms.

#### Underground Storage Tanks (USTs)

Eleven USTs have previously been identified and removed from the SMI Plant Property. Tank removal activities, which occurred between 1982 and 1991, were completed in accordance with applicable regulatory guidance at the various times of removal. Historical information regarding the pre-RI investigations of the USTs is described in the RI/FS Work Plan, and a summary is provided in the following paragraphs for reference.

No further action was determined to be necessary to address six of the former UST areas (UST #s 1, 2, 6, 9, 10, and 11). There was no evidence of petroleum releases at UST #s 2, 6, and 10 at the time of removal, as documented by the State Fire Marshal Division of the Department of State Police (Schaefer, 1991; Schaefer, 1992). Therefore, no further actions were required. Additional investigation was completed at the former locations of UST #s 1 and 9. Soil samples were found to meet the then-current Michigan Environmental Response Act (MERA) Type B criteria, and UST #s 1 and 9 were formally documented by the MDEQ as requiring no further action (Brouillet, 1993). Limited information is available regarding former UST #11; however, records indicate that it was in service for a short time in the 1960s and was used to store oil removed from the Stormwater Pond.

Confirmed releases of petroleum products were reported by GM to the Michigan State Fire Marshal Division for five of the USTs (UST #s 3, 4, 5, 7, and 8). GM requested that any additional response activities at these former tank areas be completed pursuant to Part 201 of NREPA, as part of the RI/FS activities (Tomaszewski, 1995). The MDEQ UST Division agreed to that request, as described in a letter dated September 19, 1995 (Alexander, 1995). Additional discussion regarding the UST #7 removal is presented in Section 3.

Because of their proximity, UST #s 3, 4, and 5 are collectively referred to as the "Former Tank #4 Area." Subsurface investigations were performed in the Former Tank #4 Area and the Former Tank #8 Area by Earth Tech from April through July 1994 (Earth Tech, 1994; Earth Tech, 1995), and the reports for these

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investigations were transmitted to the MDEQ. Based on the laboratory analytical results, and visual findings for these investigations, further investigation of the Former Tank #4 and Former Tank #8 areas was not necessary as part of the RI.

#### Aboveground Storage Tanks (ASTs)

Five aboveground storage tanks (ASTs) were previously located adjacent to the northern side of the SMI Plant building. In November 1988, a soil investigation was implemented by Soil and Materials Engineers, Inc. (SME) adjacent to the tanks in response to an overflow or spill of “fatty oil” from one of the tanks. A trench system of unknown construction was reported to be present around the tanks (SME, 1988).

Investigation activities included the completion of seven borings to depths of 12 to 15 feet, and seven composite soil samples were analyzed for oil and grease, total petroleum hydrocarbons (TPH), DNR Scan 2 (gasoline constituents), and DNR Scan 3 (pesticides, polychlorinated biphenyls [PCBs], and chlorinated organic compounds). A temporary monitoring well was also installed at one of the boring locations to allow collection of a groundwater sample that was analyzed for oil and grease, TPH, and DNR Scan 3 constituents. In summary, oil and grease and TPH were reported for the soil and groundwater samples. Xylene was detected above the laboratory detection limit in only one soil sample, at a concentration of 0.5 parts per million (ppm). No pesticides, PCBs, or chlorinated organic compounds were detected in any of the samples.

A supplemental investigation in the area was conducted in September 1989 by SME (SME, 1989). Four groundwater samples were collected from four temporary monitoring wells, and 20 soil samples were collected from nine soil borings for laboratory analysis. The samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX), TPH, and oil and grease. Concentrations of BTEX and TPH did not exceed the laboratory detection limits in any of the samples. Oil and grease were detected in most of the samples collected.

#### Plant Interior Investigations

Several supplemental investigations and remedial activities have been completed within the SMI Plant building. These supplemental investigations were outside of the scope of the RI, as described in the RI/FS Work Plan, and were initiated in response to observed site conditions. The results of these investigations were summarized in the RI Report.

##### ***Former Harden, Quench, and Draw Area***

The former Harden, Quench, and Draw Area (HQD) is located within the southwestern portion of the SMI Plant building (Figure 1-2). Each of the former HQD units included a quench oil bath used to uniformly cool metal castings. A total of 10 HQD units were installed in 1968. Units No. 1 through No. 9 were taken out of service between 1973 and 1991. The remaining unit (No. 10) was removed in 1996. Light nonaqueous phase liquid (LNAPL) was observed during 1996 in storm sewer catch basin Q16.5, located within the HQD area, prompting an investigation of the area. The investigation did not encounter any groundwater in the area of the HQD.

##### ***Quench Pit Area***

The Quench Pit Area is located in the Annealing Department inside the central portion of the SMI Plant building (Figure 1-2). The area contains three quench pits, commonly referred to as direct quench pits #1, #2, and #3. Quench pit #1 was installed in 1966. Quench pits #2 and #3 were installed in 1970. The pits are constructed of stainless steel panels welded together to form a double box or shell. Each



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quench pit typically holds approximately 25,000 gallons of quench oils. The quench pits are used during a heat treatment process. The quench pit area investigation was conducted to assess groundwater quality in the area surrounding the three quench pits. The scope of the investigation was modified after LNAPL was detected. The results of these investigations were transmitted to the MDEQ in April 1998 in the *Quench Pit Investigation Report* (BBL, 1998a).

### ***I27.7 Area***

The I27.7 Area is located in the Foundry Department inside the northern portion of the SMI Plant building (Figure 1-2). During sewer sampling activities within the plant, PCBs were detected sporadically in various sewers in the I27.7 Area. Further investigation indicated that a transformer leaked PCB-containing oil in the I27.7 Area in 1971, when the transformer was dropped during installation. The oil collected in a small area of exposed soil around a column where no concrete was present. The exposed soil was covered with concrete in 1972. A supplemental soil investigation was conducted by Conestoga-Rovers Associates (CRA) in 1998 to identify the horizontal and vertical extent of PCB-impacted soil. The results of this investigation were transmitted to the MDEQ as part of the alternative evaluation in the *Feasibility Analysis* (CRA, 1998a).

### ***Melting Department Area***

The Melting Department is located in the northeastern portion of the SMI Plant building (Figure 1-2). The current Melting Department started operation in approximately 1970 to 1975, supplying molten iron for the production of castings. Iron is melted by electric induction melting furnaces powered by five separate, numbered power supplies (Power Supply 1, 2, 3, 4, and 5). Although the features associated with each power supply vary, typical features include a control room, transformer room, generator room, hydraulic room, pit, and BUSS tunnel. All the areas in the Melting Department are restricted access locations as defined in 40 CFR 761.123. A supplemental investigation was conducted by CRA in 1996 to evaluate the presence of PCB contamination in rooms associated with the five power supplies.

### **LNAPL Assessment and Remediation Area**

An oil sheen and floating oil (i.e., LNAPL) were observed on the water table during RI field activities within the Unpaved Area located southwest of the SMI Plant building between SMI and the adjacent Plant 2 Property (Figure 1-2). During the course of additional investigations at the LNAPL Assessment and Remediation Area, a series of soil borings and monitoring wells was installed to assess the extent of LNAPL in the area. More thorough discussions of the field investigations and the IRA are presented in the separately prepared and previously submitted *LNAPL Assessment and Recovery Remedial Investigation Interim Report* (BBL, 1995) and *LNAPL Assessment and Recovery Report* (BBL, 1998b).

### **Previous Metal Feedstock Area**

The Previous Metal Feedstock Area is located east of the SMI Plant, and is partially covered by pavement and partially by lawn (Figure 1-2). This area was previously used for the storage of metal feedstock. Investigation activities conducted within this area as part of the RI and the results of the investigation are presented in Section 2.

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### Former Railyard Area

The Former Railyard Area is located north of the SMI Plant at the location shown on Figure 1-2. The area is unpaved, and is used for the temporary storage of metal feedstock and miscellaneous other process materials and equipment. The Former Railyard Area previously contained railroad tracks to provide direct rail access to this operational area. Investigation activities conducted within this area as part of the RI and the results of the investigation are presented in Section 2.

### Unpaved Area

The Unpaved Area is located south of the SMI Plant building (Figure 1-2). Three 20,000-gallon ASTs of quench oil are located along the fenced western edge of the area within a concrete secondary containment structure. The area is also used to store roll-off boxes of municipal waste, steel scrap, and miscellaneous other plant materials. Investigation activities conducted within this area as part of the RI and the results of the investigation are presented in Section 2.

### Type III Landfills

The site contains two closed, licensed, Type III industrial solid-waste landfills (referred to as the eastern and central Type III landfills, as identified by the relative location within the property). These two landfills received spent foundry sands, scrubber residues, slag, and other materials approved for Type III disposal (e.g., refractory brick and core butts). The eastern Type III landfill started receiving waste in 1979 and was closed in 1984. The central Type III landfill received wastes from 1984 (after the closure of the eastern landfill) until approximately 1990, when it was closed. Waste characterization was conducted as part of landfill permit operating requirements, and closure certifications for these two landfills have been filed with the MDEQ. The SMI Plant currently disposes of its solid wastes offsite, as appropriate for the waste.

### Former WRS

The SMI Plant Property contains remnants of the former WRS, which received and recirculated noncontact process water, stormwater drainage, and air-scrubber effluents as part of the plant processes. The former system, which was taken off line in January 1997 (when the new WRS went on line), consisted of three settling ponds (primary, secondary, and stormwater) and associated drainage channels, which connected the ponds and returned flow to the plant. The former Primary Settling Pond occupied approximately 2 acres, but has dried up since the plant ceased to use the system, and has been regraded. Highly turbid water had been discharged into the former Primary Settling Pond, where most of the solids settled out. The former Primary Settling Pond then gravity-drained to the Secondary Settling Pond, which previously occupied approximately 16 acres, and has been reduced in size due to reduced inflows. The Secondary Settling Pond then drained via a weir located on its northeastern side. This water traveled north along the north-south oriented drainage channel to the east-west channel. This water was then directed back into the SMI Plant (Figure 1-2). During summer 2001, GM filled the north-south oriented channel of the former WRS, leaving a surface-water drainage swale along the former channel route. The Stormwater Pond, located north of the Secondary Settling Pond, received, and continues to receive, stormwater from roof drains and parking lots. The stormwater is discharged via a pump system to the Secondary Settling Pond. In the past, the Stormwater Pond had received incidental quantities of quench oils due to leaks from the cooling towers and associated lines located on the roof of the SMI Plant, in addition to noncontact process water and air scrubber effluents. In 2000, GM stabilized the banks of the Stormwater Pond with lime and lined the pond with a flexible membrane liner.

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Water losses for the WRS were compensated for by the addition of stormwater runoff and the addition of water purchased from the City of Saginaw. Prior to 1992, water was occasionally drawn from the Saginaw River. Storm drainage from the southern part of the property was also periodically pumped to the Secondary Settling Pond through an aboveground pipe system to provide makeup water to the plant (the piping system was disassembled during construction of the subgrade of the Green Point Landfill).

Dredged materials from the former Primary Settling Pond were previously stockpiled adjacent to the former Primary Settling Pond, and dredged materials from the Stormwater Pond were stockpiled adjacent to the Stormwater Pond. These materials consisted of sand and silt-/clay-size solids, which were continuously removed from the pond to maintain the pond's capacity. In the past, these dredged materials were used for daily cover at the Green Point Landfill during its operation, as fill materials throughout the plant property, and in GM's Saginaw Metals Casting Operations Landfill (SMCO) as fill materials throughout the plant property, also located in Saginaw, Michigan. Sediments from both the former Primary Settling Pond and the Stormwater Pond were frequently tested. The sediments from the former Primary Settling Pond, which was dredged regularly, were tested to maintain the SMI Plant's Inert Status with MDEQ (MDEQ Designation for Inertness 92-I-012). As reported in correspondence from the MDNR (MDNR, 1992), former Primary Settling Pond sediments met the inert criteria as defined in Part 115 of Michigan Act 451 (formerly Act 641). The sediments dredged from the Stormwater Pond were disposed of at an offsite GM landfill at SMCO. Summaries of the analytical data for these sediments collected since 1992 and a copy of the *MDNR Designation for Inert Status* were forwarded to MDEQ's ERD Saginaw Bay office on August 9, 1993 (Brown, 1995). Dredging of both ponds was discontinued following the start-up of the new WRS in January 1997.

#### Green Point Landfill

The Green Point Landfill was owned by Ruben Schultz and was operated by various commercial enterprises between the 1950s and 1978. The landfill was reportedly used for the disposal of municipal waste, foundry sand, and unspecified quantities and types of waste from a variety of industrial facilities (RMT, 1979). Prior to operation of the eastern Type III landfill, which began in 1979, foundry materials from the SMI Plant were disposed of at the Green Point Landfill. In 1978, the Green Point Landfill stopped receiving waste and was closed. GM purchased the Green Point Landfill, along with the remainder of the property south of the landfill, in December 1982. Several previous environmental investigations have been conducted at the Green Point Landfill, dating back to 1976. A summary of these previous investigations is provided in the RI/FS Work Plan. Additional discussion regarding the Green Point Landfill is provided in Sections 2 and 3.

#### DRA

The DRA is located in the southwest portion of the SMI Plant Property, as shown on Figure 1-2. GM purchased this property in December 1982. It first became evident that the area had been used for disposal purposes prior to GM's purchase of the property in 1987 when several drums were observed at the ground surface following a flood. There is no evidence to suggest that the drums found in the DRA, or in the vicinity of the DRA, came from any GM facility.

From 1987 through 1995, various investigation and response actions have been undertaken to address the DRA. The historical pre-RI efforts are described in detail in the RI Report. Descriptions of response actions conducted in the DRA are presented in Sections 2 and 3, as well as the RI/FS Work Plan.

Pursuant to the March 16, 1998 Consent Judgment entered into between MDEQ, the MAG, GM, WMI, an RI was conducted at the site. The RI activities were initiated in December 1994 were completed with the submission of the final RI Report to MDEQ in July 2001. In general, as specified in the MDEQ-approved RI/FS

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Work Plan, the RI activities were conducted in order to characterize the nature and extent of environmental contamination at the site.

## ***2. RI Summary***

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This section provides a summary of the RI activities, followed by results and conclusions.

### **2.1 RI Activities**

RI activities were conducted to characterize the nature and extent of environmental impacts at the site. As such, the RI activities consisted of both site-wide investigation activities focusing on the site perimeter to assess potential offsite impacts, and area-specific investigation activities conducted to evaluate known or suspected potential sources of contamination. The data presented in the RI Report were approved by the MDEQ on July 5, 2001 (Brouillet, 2001).

#### **2.1.1 Site-Wide RI Activities**

The site-wide RI activities consisted of the following:

- Perimeter surface geophysical investigation;
- Hydrogeologic investigation;
- Sewer study and publicly owned treatment works (POTW) discharge monitoring program;
- Surface water and sediment sampling program;
- Surface water/groundwater interaction study;
- Preliminary ecological assessment; and
- Air quality assessment.

A brief description of the above-listed RI activities is presented below. The results of the above-listed RI activities are described in Section 2.2 and the RI Report.

##### Perimeter Surface Geophysical Investigation

A perimeter surface geophysical investigation was conducted along the northern, eastern, and southern property of the site. The purpose of the investigation was to provide data to supplement the existing knowledge of the overburden stratigraphy and to evaluate the potential existence of buried channels and unknown buried utilities that could provide preferential pathways for groundwater migration.

Twenty-three magnetic anomalies were identified during the investigation. Of the 23 anomaly locations, a total of 12 anomaly locations were interpreted as potential linear features. The 11 remaining anomalies were determined to be caused by overhead power lines or known underground structures (e.g., sewer pipes). Twelve test pits were completed to investigate vegetative anomalies, and metallic debris were identified at each location, accounting for the observed anomalies. No unmapped underground utilities or discrete buried channels were identified.

##### Hydrogeologic Investigation

A hydrogeologic investigation was conducted to provide additional sampling points along the hydraulically downgradient site perimeter and around the perimeter of the SMI Plant building. Thirty-nine temporary

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monitoring well clusters were installed for the investigation. Groundwater samples were collected as each boring was advanced by either pushing a well point ahead of the augers to the desired depth or by placing a well screen at the desired depth within the augers, placing a temporary sand pack, and then pulling the augers back to allow groundwater to flow to the well. Based on a review of the analytical data collected from the temporary wells, permanent monitoring wells were installed at three of the temporary well locations: one along the Saginaw River, one south of the Secondary Settling Pond, and one between the SMI Plant and Plant 2 buildings.

In addition, due to the age and unknown condition of the existing wells onsite, BBL conducted an inspection of each existing well. Recommendations for repair of 22 wells, redevelopment of 24 wells, replacement of 16 wells, and abandonment of 19 wells were presented in the *Inventory and Evaluation of Existing Monitoring Wells Report* (BBL, 1995a).

The recommendations were implemented, and as a result of modifications due to site conditions, monitoring wells at a total of 27 locations were replaced. In addition, 30 augmentation monitoring wells were installed at existing well cluster locations, 10 monitoring wells were abandoned due to construction activities at the site, four monitoring wells were abandoned and not replaced due to construction activities associated with the new WRS, and 10 monitoring wells adjacent to the Green Point Landfill were abandoned to allow landfill cap subgrade construction.

As a result of the RI activities, a total of 145 monitoring wells were installed, including 90 wells at 29 new cluster locations and 55 new individual water table wells. During and after the monitoring well installation activities, additional field activities were conducted at select well locations, including geotechnical analyses of soil samples; geophysical borehole logging; hydraulic conductivity testing; elevation and horizontal surveying of monitoring wells, borings, and staff gauges; collection of potentiometric data; and collection of groundwater samples.

#### Sewer Study and POTW Discharge Monitoring Program

A program involving weekly PCB sampling and analysis of the sewer discharge to the POTW was implemented at the request of the MDEQ. Samples were collected and analyzed weekly from GM's POTW discharge point of compliance and the City of Saginaw's water intake line. In addition, at GM's request, grab samples were collected weekly from a manhole located along the 42-inch-diameter sanitary sewer line south of the visitor's parking area.

#### Surface Water and Sediment Sampling Program

As part of the RI activities, 19 surface-water and 131 sediment samples were collected to characterize the nature and extent of contamination, if any, associated with the surface water ponds and drainage channels at the site. Additional surface water and sediment samples were collected from the southern portion of the site.

#### Surface Water/Groundwater Interaction Study

To further understand the potential hydraulic interaction of the former WRS, the onsite groundwater system, and the Saginaw River, an evaluation of the data collected as part of the RI was conducted. To complete the surface water/groundwater interaction study, groundwater and surface water elevation measurements were collected at monitoring wells adjacent to the former WRS and at staff gauges in the former Primary Settling Pond, Secondary Settling Pond, and north-south channel. In addition, meteorological data were obtained, including precipitation and temperature measurements, and were used to correlate with changes in the groundwater and

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surface water elevations. BBL determined vertical hydraulic gradients at each monitoring well cluster, estimated the hydraulic conductivity of sediments at the base of the ponds, and measured sediment thicknesses.

#### Preliminary Ecological Assessment

A preliminary ecological assessment was conducted during the RI to describe existing habitat, to identify potential receptors, and to identify potentially complete pathways of exposure. Sampling activities were conducted to collect data from areas of the site most likely to be used by wildlife as habitat. A risk-based screening of relevant soil, sediment, and surface water data was performed to determine the need for further evaluation of complete pathways and was used to complete the baseline ecological assessment prepared as part of this FS Report. The results of the preliminary ecological assessment are presented in Section 2.5.

#### Air Quality Assessment

A qualitative assessment of the potential impacts to air quality from potential impacted site material was conducted at the request of the MDEQ. Soil sample headspace data and air monitoring data were collected for health and safety and soil characterization purposes. In addition, ambient air quality data and personal air monitoring data were collected during intrusive site activities.

### **2.1.2 Area-Specific RI Activities**

The area-specific RI activities consisted of the following:

- DRA investigation;
- Green Point Landfill investigation;
- Supplemental investigation of Former UST #7 Area;
- Type III landfill leachate characteristics investigation;
- Buried utility investigation;
- Potential preferential groundwater contamination migration pathways investigation;
- Previous Metal Feedstock Area investigation;
- Potential worker exposure soil sampling activities;
- Supplemental soil sampling activities;
- B-3 augmentation well oil sheen investigation;
- Center Street oil sheen investigation;
- LNAPL Assessment and Remediation Area investigations;
- Driveway expansion soil investigation;
- Supplemental Stormwater Pond investigation;
- Former HQD Area investigation;
- Quench Pit Area investigation;
- I27.7 Area investigation; and
- Melting Department investigation.

A brief description of the investigation activities completed for each of the above-listed areas is presented below. The results of the above-listed RI activities are described in Section 2.2 and the RI Report.

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### DRA Investigation

Two specific investigative tasks were conducted in the DRA to characterize the presence of “target materials” identified as drums, drum fragments, wastes associated with drums, stained soils, materials with an organic vapor content of greater than 600 ppm, and soils containing NAPL. The tasks included the completion of a geophysical investigation followed by a test pit investigation to further examine identified anomalies. Geophysical data were presented in the *Geophysical Investigation Report for the Drum Remediation Area* (BBL, 1994), which included a specific list of proposed test pit locations to be completed based on the relative intensity of the electromagnetic (EM) and magnetometer anomalies. Originally, 21 test pits were identified for the test pit investigation activities. Nineteen test pits were excavated in 2-foot depth intervals to permit collection of samples of soil and/or waste materials from the sidewall or base of the test pit. Two test pits were not completed due to the presence of standing water at the ground surface. The results of the test pit investigation (including soil sample analytical results) were described in the *Test Pit Investigation Report* (BBL, 1995). Additional activities associated with the DRA conducted during the RI activities consisted of soil sampling for Appendix IX constituents, a wetland mitigation area evaluation, supplemental groundwater investigations, and a supplemental test pit program.

### Green Point Landfill Investigation

In accordance with the Consent Judgment, GM and WMI proposed the design and installation of a cap at the Green Point Landfill (previously closed in accordance with landfill regulations in effect in 1978) that was consistent with current closure requirements for solid waste municipal landfills and consistent with the final RAP for the site. To develop the landfill cap design, a boring program was completed to define the limits of waste within the Green Point Landfill. Groundwater and leachate analytical data for samples collected from monitoring wells located within or near the landfill were evaluated. In addition, groundwater quality data were collected from monitoring wells located around the perimeter of the landfill to assess potential impacts from the landfill to the surrounding groundwater.

Construction of the landfill cap has since been completed as described in the *Final Engineering Design Report, Green Point Landfill* (BBL, 1998a).

### Supplemental Investigation of Former UST #7 Area

As part of the Former UST #7 Area investigation activities, five water table monitoring wells and five soil borings were installed to augment the existing monitoring well network to characterize groundwater flow in the area and the distribution of organic and inorganic constituents in the soil and groundwater. The investigation activities included the collection of soil geotechnical and analytical samples, hydraulic conductivity testing, collection of potentiometric data, and the collection and analysis of groundwater samples. Thirteen groundwater sampling events were completed through spring 2001, and monitoring is ongoing on a semiannual basis.

### Type III Landfill Leachate Characteristics Investigation

As part of the RI activities, leachate samples were collected from select monitoring wells located at the closed Type III landfills.



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### Buried Utility Investigation

The buried utility investigation was conducted as part of the RI activities to determine whether the buried utilities that exit the property or the bedding material of the utilities may be acting as a preferential pathway for groundwater migration. The following activities were conducted:

- A sewer map was superimposed on the site base map to evaluate newly collected data;
- Invert elevations of the buried utilities were compared with seasonally high water table elevations to determine if the buried utilities and associated bedding materials were below or above the water table;
- A monitoring well was installed in the bedding material of the utility near the site perimeter downgradient of the LNAPL Assessment and Remediation Area; and
- Surface site-perimeter geophysical data were evaluated to verify known utility locations and to identify anomalies that could indicate the presence of unmapped utilities.

### Potential Preferential Groundwater Contamination Migration Pathways Investigation

To evaluate whether select site areas exhibiting the presence of coarse-grained material could be acting as preferential pathways for groundwater migration, additional investigation activities were conducted in the vicinity of the Green Point Landfill. As part of the activities, two soil borings and subsequent temporary monitoring wells were installed. In addition, a deep boring was advanced to the top of bedrock upgradient of the SMI Plant to lithologically characterize soil within the lower silty clay layer in the vicinity of the plant building.

### Previous Metal Feedstock Area Investigation

The investigation activities associated with the Previous Metal Feedstock Area included the installation of two soil borings to evaluate whether the area contains impacted soils that may be acting as a source of contamination to groundwater.

### Potential Worker Exposure Soil Sampling Activities

Based on facility usage patterns, three areas where workers may come in contact with potentially impacted soils were identified. To evaluate the risks, eight surface soil samples were collected from each of the suspected areas: the Previous Metal Feedstock Area, the Railyard Area, and the Unpaved Area.

### Supplemental Soil Sampling Activities

Supplemental soil sampling activities were conducted during the RI to provide additional soil quality data in select site locations. The activities consisted of the following:

- Collection of 24 surface soil and four subsurface soil samples from the Saginaw River Berm Area;
- Collection of six soil samples from the Secondary Settling Pond sidewalls;

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- Collection of 13 soil samples from seven test pits excavated in the previously proposed Type III landfill south of Green Point Landfill; and
  - Collection of 15 surface soil samples from areas south and west of the Green Point Landfill.

#### B-3 Augmentation Well Oil Sheen Investigation

An oil sheen was observed on soil samples collected during installation of the augmentation monitoring well installed at the western edge of the central Type III landfill. Investigation activities included the installation of three soil borings and one monitoring well and the collection of two soil samples.

#### Center Street Oil Sheen Investigation

During the course of monitoring well installation as part of the RI activities, oil sheens were observed on soil samples collected from wells located along Center Street. To assist in evaluating the extent and potential source of the oil sheens along Center Street, 10 soil borings and two water table monitoring wells were installed.

#### LNAPL Assessment and Remediation Area Investigations

An oil sheen was detected on the water table at a temporary monitoring well adjacent to the Unpaved Area south of the SMI Plant building. Numerous monitoring wells and soil borings were installed to delineate the oil sheens and LNAPL observed.

#### Driveway Expansion Soil Investigation

As a result of the expansion of the driveway entering the SMI Plant from Center Street, excavated soil was staged onsite for future sampling and analysis. Results of sampling and analysis activities indicated the presence of PCBs above MDEQ criteria. As such, in-situ soil sampling activities (for PCB analysis) were conducted in the area where the soil was excavated. A total of six surface soil samples were collected adjacent to the driveway/parking expansion area.

#### Supplemental Stormwater Pond Investigation

Supplemental sampling activities were implemented in response to the occurrence of oily material containing low concentrations of PCBs on the surface of the Stormwater Pond, located north of the Secondary Settling Pond. The investigation included collecting groundwater samples from select monitoring wells, LNAPL samples from the Stormwater Pond, and a surface water sample from the pond. In addition, sediment samples from the edge of the pond, an LNAPL sample from a monitoring well, and a round of groundwater and LNAPL measurements was collected.

#### Former HQD Area Investigation

As part of the RI activities, investigation activities associated with the former HQD Area were conducted. Four soil borings were installed in the area to determine whether LNAPL was present in the subsurface materials in the vicinity of sewer catch basin Q16.5.

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### Quench Pit Investigation

The Quench Pit investigation was performed to assess groundwater quality in the vicinity of the three quench pits located under the plant floor. The investigation was later expanded to characterize the nature and extent of LNAPL and potential source(s) in the area. The investigation activities included the installation of 22 soil borings, 13 of which were completed as temporary water table monitoring wells, the collection and analysis of LNAPL samples from seven temporary wells, the collection and analysis of groundwater samples from seven temporary wells, and implementation of surveying activities associated with the temporary wells recently installed.

### I27.7 Area Investigation

Investigation of the soil located beneath the concrete floor of the building in the I27.7 Area was conducted as part of the RI activities. A total of 11 soil borings were installed, and soil samples were collected to investigate the vertical and horizontal extent of PCBs in soil in the area.

### Melting Department Investigation

Investigation and remediation activities were completed in the Melting Department Area of the SMI Plant to define the extent of PCBs in the concrete floor of the rooms associated with the five power supplies for the four furnaces in the Melting Department and to complete remediation as needed based on the potential for worker exposure and protection of the environment. As a result, wipe and bulk concrete samples were collected in each room, followed by cleaning and verification sampling. Soil samples were also collected below areas where floor core samples exceeded 21 milligrams per kilogram (mg/kg) PCBs prior to the cleaning activities.

## **2.2 Results and Conclusions**

Results and conclusions of the investigations described in Section 2.1 are presented below and are described in terms of physical site characteristics and analytical results with respect to MDEQ cleanup criteria.

### **2.2.1 Physical Site Characteristics**

#### Description of Geologic Units

The overburden deposits at the site are composed of the following primary units (in descending order): fill materials consisting primarily of foundry sand, glaciolacustrine silts and clays, a sand unit that grades coarser with depth, glaciolacustrine silty clay, and glacial till. The subsurface distribution of the overburden units varies across the site. The sand unit pinches out beneath the SMI Plant building and also toward the western and northern site boundaries. In addition, the sand unit is separated into upper and lower units by the glaciolacustrine silt and clay layer in the vicinity of the Saginaw River. Bedrock, consisting of dark gray weathered shale, was encountered at a depth of 86 feet at an upgradient boring location that was advanced through the overlying silty clay and till.

The sequence of overburden units observed at the site is characteristic of glacial compaction of generally fine grained materials to form the till unit that overlies bedrock, followed by deposition within varied outwash, fluvial, and lacustrine environments associated with glacial activity. More recently, the Saginaw River has created broad channel deposits and deposited fine-grained materials.

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### Characteristics of the Lower Silty Clay Confining Unit

Based on the data collected during the RI, the lower silty clay unit is a lower confining boundary to groundwater flow in the overburden. Geotechnical evaluations of the lower silty clay unit indicate that the potential for preferential groundwater flow to occur along foundation piles at the SMI Plant does not exist (evaluated at the request of the MDEQ). Based on the geotechnical data, remolding of the clay around the driven piles would have occurred, thus sealing the piles and preventing the downward flow of groundwater between the piles and the soil.

### Hydraulic Conductivity Testing

In-situ hydraulic conductivity ("slug") testing of 182 monitoring wells indicates that the geometric mean of the hydraulic conductivities measured in the fill and sand units at the site are on the order of  $10^{-3}$  centimeters per second (cm/sec). In contrast, the geometric mean of the hydraulic conductivities measured in the upper and lower silty clay units is on the order of  $10^{-6}$  cm/sec. These data suggest that the silty clay units are confining relative to the fill and sand units, and that the primary pathways of groundwater flow are within the fill and sand.

### Interpretation of Potentiometric Surface Elevation Data

The general direction of groundwater flow at the water table is toward the southeast in the northern portion of the site and to the south-southeast in the southern part of the site, with localized variations as a result of mounding from the site landfills and the former WRS surface water bodies. Groundwater flow within the lower sand unit is generally to the east with some north-south divergence of flow in the center of the site and a component of flow to the south to southwest in the vicinity of the eastern end of the DRA. Generally, groundwater flow is toward the Saginaw River. During the study period, minor temporal hydraulic gradient reversals from the Saginaw River to groundwater occurred in response to high water levels in the river. Due to the temporal nature of the gradient reversals, flow from the river is expected to be minimal both in duration and travel distance (inches to no more than a few feet). In addition, significant flow reversals would not be expected to occur due to the relatively strong hydraulic gradient near the river.

Downward vertical hydraulic gradients were observed throughout the overburden, with the exception of upward vertical gradients noted between the upper and lower sand units in the vicinity of the Saginaw River.

Groundwater flow rates vary over several orders of magnitude across the site, from less than 0.1 foot per year in the silt and clay at the northern portion of the site to 14.8 feet per year within the sand adjacent to the Green Point Landfill. Higher flow rates exist in the sand units along the Saginaw River (26 to 3,000 feet per year), driven by the relatively higher hydraulic gradient between the surface water of the former WRS and the Saginaw River.

### Results of the Surface Water/Groundwater Interaction Study

Based on the net downward vertical hydraulic gradients observed between the remaining surface water features of the former WRS and groundwater, groundwater is recharged by these surface water features. An estimate of potential flow rates of water from the surface water bodies to groundwater was calculated to be approximately 14,700 gallons per day (gpd). The current flow rates are expected to be significantly lower, since the water bodies of the former WRS no longer receive plant process water, and the Primary Settling Pond and the north-south drainage channel have been backfilled.

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## Assessment of Potential Preferential Pathways for Groundwater Migration

An assessment of potential preferential pathways for groundwater migration examined results from associated area-specific RI activities. The buried utility investigation included a comparison of utility inverts to water level measurement data to identify potential preferential migration pathways. Also, the preferential flow of LNAPL and impacted groundwater was identified within the LNAPL Assessment and Remediation Area investigations. The LNAPL was found in an elongated area that had been influenced by the presence of utility lines. Monitoring wells were installed along several sewer lines to define the extent of migration. No other preferential pathways for migration of contaminated groundwater were identified at the site.

### **2.2.2 Nature and Extent of Constituents**

The RI activities focused on the site perimeter and on areas within the site known or suspected to be sources of constituents. This approach was implemented in order to monitor and evaluate potential offsite impacts and to target interior site investigation to appropriate areas. Some areas required additional supplemental field activities to further delineate the nature and extent of constituents.

Various applicable MDEQ cleanup criteria, key areas identified as a result of this approach, and the analytical data for each area, are described below.

#### MDEQ Cleanup Criteria

As presented in the RI Report, each generic MDEQ criterion corresponds to a specific exposure pathway based on land use. The criteria and screening levels used for the comparison of site data are summarized in MDEQ Interim ERD Operation Memorandum #18 (MDEQ, 2000). Descriptions for the applicability and usage of the MDEQ cleanup criteria are discussed on the RI Report. The MDEQ criteria acronyms are presented below:

- **Groundwater/Surface Water Interface** – GSI Criteria;
- **Drinking Water Usage** – Generic Residential Drinking Water (RDW) Cleanup Criteria and Generic Industrial Drinking Water (IDW) Cleanup Criteria;
- **Groundwater - Dermal Exposure** – Generic Groundwater Contact Criteria (GCC);
- **Groundwater - Indoor Air Hazards** – Generic Acute Inhalation Screening Level (AISL) and Generic Groundwater Volatilization to Indoor Air Criteria (GVIIC);
- **Other Groundwater Hazards** – Generic Flammability and Explosivity Screening Level (FESL) and Water Solubility Screening Level (WSSL) values;
- **Soil – Hazards to Drinking Water** – Generic Soil Criteria Protective of Residential and Commercial I Drinking Water (RDWP) and Generic Soil Criteria Protective of Industrial and Commercial II, III, and IV Drinking Water (IDWP);

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- **Soil - Dermal Contact** – Generic Soil Criteria Protective for Groundwater Contact (GCCP), Generic Residential and Commercial I Direct Contact (RDC) and Generic Industrial and Commercial II Direct Contact (IDC);
  - **Soil Indoor Hazards** – Generic Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC), Generic Residential and Commercial I Soil Volatilization to Indoor Air Inhalation Criteria (RSVIIC), and Generic Industrial and Commercial II, III, and IV Soil Volatilization to Indoor Air Inhalation Criteria (ISVIIC);
  - **Soil Ambient Air Hazards** – Generic 5-Meter Source Thickness Volatile Soil Inhalation Criteria (VSIC) for Ambient Air and Generic Particulate Soil Inhalation Criteria (PSIC) for Ambient Air, Generic Residential and Commercial I 5-Meter Source Thickness Volatile Soil Inhalation Criteria (RVSIIC) for Ambient Air, Generic Residential and Commercial I Particulate Soil Inhalation Criteria (RPSIC), Generic Industrial and Commercial II, III, and IV 5-Meter Source Thickness Volatile Soil Inhalation Criteria (IVSIIC) and Generic Industrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (IPSIC); and
  - **Surface Water** – GCC. Although the generic GCC are intended to be used to evaluate groundwater data, they are relevant to the site surface water data since exposure to surface water is likely to be limited to dermal exposure.

#### Site Perimeter

The results of the RI activities conducted at the site perimeter are discussed below.

#### ***Center Street Oil Sheen***

The extent of oil sheens in the vicinity of Center Street was investigated through the completion of soil borings and monitoring wells. The oil sheen area was found to correlate with the waste associated with the former Queen Street Dump, and not with any known GM source (the area is not connected to any groundwater impacts related to the plant). The area of the sheens extends northeast past the SMI Plant perimeter. Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were detected in soil and groundwater within the area of oil sheen investigation; PCBs were not detected. The results of the investigation are presented in the *Center Street Supplemental Investigation Report* (BBL, 1997).

#### ***Saginaw River Boundary***

Xylene was detected at an estimated concentration of 56 micrograms per liter ( $\mu\text{g/L}$ ), above the generic GSI criteria of 35  $\mu\text{g/L}$  at one Saginaw River perimeter well (monitoring well MW-6CAUG) on one of three sampling dates. Phenol was detected at a concentration of 6,200  $\mu\text{g/L}$  (above the generic GSI criteria of 210  $\mu\text{g/L}$ ), during one of two sampling events at monitoring well MW-111S3, screened within the lower sand unit, and located east of the Secondary Settling Pond. Bis(2-ethylhexyl)phthalate was detected at a concentration of 54  $\mu\text{g/L}$  (above the generic GSI criteria of 32  $\mu\text{g/L}$ ) at monitoring well MW-111WT in June 1995. During the second and third site-wide groundwater sampling events in June 1996 and in May 2000, bis(2-ethylhexyl)phthalate was not detected above GSI criteria at any river perimeter monitoring well. The dioxin/furan toxicity equivalency factor (TEF) obtained for an unfiltered groundwater sample collected at river perimeter monitoring well B-7R (0.000001008  $\mu\text{g/L}$ ) was below the generic GSI criteria of 0.00001  $\mu\text{g/L}$ . Dioxins/furans were not detected in a second sample obtained from monitoring well B-7R.

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The generic GSI criteria for PCBs is 0.2 µg/L, equal to MDEQ's default target detection limits (TDLs), which range from 0.2 to 0.4 µg/L for various PCBs. Therefore, any PCB detection above the TDL along the Saginaw River is above GSI criteria. The generic GSI criteria for PCBs was exceeded for groundwater at six water table monitoring wells and at one deeper monitoring well on one or more dates. Groundwater samples collected along the river were analyzed for both total (unfiltered) and dissolved (filtered) PCBs. At the seven permanent monitoring well locations along the river, PCBs were detected in the unfiltered samples only, suggesting that PCBs were adsorbed to particulates that are larger than the filter size of 0.45 microns.

The impact of particulates on unfiltered groundwater samples is further demonstrated by the analytical data collected from the temporary monitoring wells compared to that represented by the permanent wells. At these temporary well locations, PCB concentrations were significantly higher than those detected in samples collected from nearby permanent monitoring wells (generally by orders of magnitude). These data demonstrate that the higher particulate content of groundwater collected from the temporary wells (e.g., the temporary wells were installed for screening purposes, and as such they were not developed as thoroughly as the permanent wells, nor were optimal sampling methods employed to limit turbidity) resulted in higher detections of the particulate-sorbed PCBs.

Similarly, PCBs were initially detected in unfiltered groundwater samples from permanent monitoring wells, which were installed through soils containing low concentrations of PCBs. However, the PCB concentrations consistently declined through time. The groundwater samples collected from the monitoring wells along the Saginaw River in May 2000 were nondetect for PCBs (filtered and unfiltered samples). These samples were collected using a modified sampling procedure incorporating the use of a peristaltic pump to allow lower purging and sampling rates, which are closer to the natural groundwater flow rates in the soil. This method minimizes sample turbidity and the introduction of particulates and associated adsorbed compounds that are not mobile under in-situ conditions. The absence of detectable levels of PCBs in these samples strongly suggests that the PCBs previously detected in monitoring wells located along the Saginaw River are the result of particulates being introduced into the samples as a result of the drilling and sampling methods used to collect the samples. Additional groundwater investigation activities were conducted in 2001. These investigation activities, and the corresponding results, are discussed in Section 4.

Detections of inorganic constituents at concentrations above the corresponding generic GSI criteria were noted at one or more locations for arsenic (monitoring well MW-149WT, one sampling event), copper (monitoring well MW-108S4, one sampling event), manganese (monitoring well MW-111WT, two sampling events; monitoring well MW-149WT, one sampling event), and thallium (monitoring well MW-149WT, one sampling event; monitoring well MW-108WT, one sampling event; monitoring well MW-112WT, one sampling event; monitoring well X-4AR, one sampling event).

Supplemental surface and subsurface soil samples were collected from the berm of the Saginaw River in July 2000 and analyzed for PCBs and Target Analyte List (TAL) inorganics. PCBs were detected in all the surface soil samples, but did not exceed the generic IDC value. However, inorganics consisting of aluminum, cobalt, iron, manganese, and thallium were detected above applicable MDEQ criteria.

A detailed discussion of the GSI criteria and proposed continued monitoring of the groundwater in this area is presented in Section 4.

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## Site Interior

The results of the investigation activities associated with specific areas within the site perimeter are discussed below.

### ***DRA***

Soil samples were collected from test pits that were located in the DRA Hillock. Analyses indicated VOCs, SVOCs, and PCBs in one or more samples at concentrations exceeding the MDEQ generic IDC criteria. However, soil and fill that make up the DRA Hillock were excavated to the water table and placed within the fill materials of the Green Point Landfill prior to capping the landfill. Additional soil materials were placed in the excavated areas to bring the area up to grade.

One monitoring well (MW-126WT) was installed within the DRA Hillock Area, and additional monitoring wells were installed along the southern perimeter of the site, just south of the DRA. Groundwater collected from monitoring well MW-126WT was found to contain VOCs (vinyl chloride, cis-1,2-dichloroethene, and TCE), and one SVOC (bis[2-ethylhexyl]phthalate) at concentrations above the generic RDW criteria. This well was screened within the fill materials that have since been excavated and moved to the Green Point Landfill. The former well location is also hydraulically downgradient of a junkyard on the adjacent property. Groundwater samples collected from the monitoring wells along the downgradient southern perimeter of the area were found to contain only iron at concentrations above criteria. A shallow temporary monitoring well was installed north of the former DRA Hillock to establish a wetland mitigation area. Due to the detection of VOCs, a series of groundwater samples was collected from locations surrounding the temporary well. A test pit program was subsequently implemented to determine the source of the VOCs detected at the temporary well and surrounding groundwater sample locations. During the test pit program, a concrete drain tile was found that extends from the neighboring junkyard property, passing approximately 10 feet south of the temporary monitoring well. Flow within the pipe is from west to east, onto the REALM, Inc. property. The drain tile was sampled at the property boundary and at a location south and east of the temporary well. The same VOC constituents previously detected at the temporary well were detected in water samples obtained from the pipe (both upstream and downstream samples). These results indicate migration of VOCs to the site from an offsite source. The impacted area is limited in size (approximately 100 feet by 100 feet) and the groundwater gradient is nearly level.

### ***Green Point Landfill***

Samples of the leachate were collected within the Green Point Landfill, and groundwater samples were collected from locations immediately below and surrounding the landfill. The following constituents were detected at concentrations above generic IDW criteria: benzene, 1,4-dioxane, vinyl chloride, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, PCBs, manganese, sodium, iron, lead, aluminum, antimony, barium, magnesium, and nickel. The distribution of these constituents in the subsurface in the areas surrounding the landfill appears to be limited, with concentrations above criteria observed at wells screened within the landfill or at locations at the landfill perimeter. The landfill cap has been completed, limiting the infiltration of precipitation, with the anticipated result of reducing the hydraulic mound previously interpreted at the landfill. A post closure groundwater monitoring program is being implemented.



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### ***Former UST # 7***

Lead and BTEX constituents were detected in subsurface soil and groundwater in the immediate vicinity of the former UST #7. The subsurface impacts appear to be limited to a small area, and the natural attenuation processes of soil sorption and intrinsic biodegradation via methanogenesis and sulfate reduction are ongoing in the area, as discussed in the *Former UST #7 Area, Supplemental Investigation Report* (BBL, 1997). An MDEQ-approved IRA consisting of monitored natural attenuation is being implemented in this area of the site.

### ***Terminated Type III Landfills***

Monitoring well B-3BAUG, located at the western end of the central Type III landfill and screened within the sand unit, contained vinyl chloride at concentrations above the generic IDW criteria on sampling dates in 1995 and 1996. Neither the water table monitoring well at that location nor a second water table well located just west of the landfill contained detectable concentrations of vinyl chloride. Manganese was detected at a concentration above the generic IDW criteria in July 1995; however, the detected concentration was below background levels.

The following constituents were found to exceed the generic IDW criteria at one or more of the monitoring wells installed within the fill material or beneath the eastern Type III landfill at the B-4 cluster location: 4-methylphenol, PCBs, and sodium. The vertical distribution of these constituents varies. The concentrations of 4-methylphenol and aluminum were highest at monitoring well B-4CAUG, within the lower sand unit. The monitoring wells screened above (in the fill unit) and below (in the lower sand unit) monitoring well B-4CAUG had significantly lower concentrations. PCBs have been detected in unfiltered and filtered samples from all of the wells in the B-4 cluster. Initial samples collected from the cluster in July 1995 show decreasing PCB concentrations with depth. The concentrations of PCBs in these wells have generally decreased with time. The concentrations of antimony were approximately the same in the fill and lower sand units. The concentration of chloride was highest at monitoring well B-4DAUG (2,000,000 µg/L). Concentrations of chloride within the overlying fill varied from 210,000 µg/L to 1,100,000 µg/L. Nickel has only been detected at monitoring well B-4CAUG, screened within the lower sand unit. Nickel has not been detected in samples collected from wells screened within the fill materials of the landfill. The highest concentration of lead was detected at monitoring well B-4AR (9.3 µg/L). Lead has also been detected at monitoring well B-4CAUG at concentrations ranging from 1.5 µg/L to 3.9 µg/L. Lead has not been detected in the deepest well in the cluster (monitoring well B-4DAUG). Sodium concentrations are generally higher in the lower sand unit (69,000 to 170,000 µg/L) than in the fill unit (56,500 µg/L to 775,000 µg/L).

Total PCBs have also been detected in groundwater at several monitoring wells adjacent to the Saginaw River, hydraulically downgradient of the eastern Type III landfill; however, total PCBs were not detected at other downgradient monitoring locations. During the May 2000 groundwater monitoring event, PCBs were not detected in any wells downgradient of the landfill.

### ***Previous Metal Feedstock Area***

Soil samples were collected at the ground surface to evaluate potential worker exposure, and additional soil samples were collected at depth to evaluate potential impacts to groundwater. The results of sampling indicated that the generic IDC, IDWP, and GCCP values were not exceeded in any of the surface soil samples for organic compounds. Chromium, cobalt, copper, iron, lead, and manganese were detected at concentrations above the generic IDWP criteria; however, concentrations did not exceed the generic IDC values.

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### ***Former Railyard Area***

PCBs were detected in surface soil samples at concentrations above the generic IDC values in the Former Railyard Area, and a soil excavation (interim action) program was completed during July 1998 to address the impacted area. The generic IPSIC value for manganese was exceeded at four locations in the Former Railyard Area. The generic IDW criteria for PCBs and manganese were not exceeded in groundwater in the vicinity of the Former Railyard Area.

### ***Unpaved Area***

PCBs were detected in individual surface soil samples at concentrations above the generic IDC values in the Unpaved Area. A soil excavation (interim action) program was completed in that area of the site during July 1998 to remove the impacted soil.

### ***B-3 Oil Sheen Area***

In response to the observation of an oil sheen at the western end of the central Type III landfill, five borings and two monitoring wells were installed to define the extent and possible source of the sheen. The area associated with the oil sheen was found to extend to the south, toward the monitoring well cluster at the northwest corner of the Green Point Landfill. Soil samples indicated the presence of VOCs (benzene, toluene, xylenes, methylene chloride, and acetone), various SVOCs, and PCBs. Groundwater samples were analyzed for organic constituents. VOCs (benzene, vinyl chloride) and PCBs (Aroclors 1248 and 1254) were detected at concentrations above the generic IDW criteria at one or more of the monitoring well locations within the sheen area. The area of detected constituents appeared to be limited. The source of these constituents was unknown, but no ongoing source was identified. However, there does not appear to be a connection between the B-3 Oil Sheen Area and any impacts related to plant activities.

### ***LNAPL Assessment and Remediation Area***

The subsurface LNAPL identified in the area between the SMI Plant and Plant 2 buildings contained BTEX constituents and a number of other VOCs, including TCE, PCE, DCE, vinyl chloride, methylene chloride, styrene, chloromethane, 1,2-dichlorobenzene, 2-butanone, and acetone. SVOCs detected in the LNAPL included a series of PAH compounds: 2-methylnaphthalene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. PCBs (Aroclors 1248, 1254, and 1260) were also detected. Manganese was detected in groundwater at several locations in the LNAPL Assessment and Remediation Area at concentrations above the generic IDW criteria and the observed background concentrations.

These constituents were detected in a relatively small area south of the plant building, and do not appear to have migrated a significant distance in the dissolved phase. The PCBs observed within the LNAPL Assessment and Remediation Area were not found at downgradient well locations, beyond the focused area of investigation along the sewer lines. The primary migration route of the LNAPL appeared to be limited to preferential migration along the sewer lines, which resulted in an elongated area of observed impacts. Following the investigation activities, an automated LNAPL recovery system was constructed as part of an IRA and is in operation in order to remove LNAPL in the observed area. As of November 1, 2001, more than 11,200 gallons of LNAPL had been removed, and more than 1,500,000 gallons of groundwater had been removed from the subsurface and treated.

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No generic IDC or IDWP values were exceeded for VOCs, SVOCs, or PCBs in soil samples collected in this area. One subsurface soil sample (SB-363), collected at a depth of 4 to 6 feet below surrounding grade, exceeded the generic IDC for lead; however, soil samples collected at a shallow depth at that location did not indicate exceedances of this generic IDC.

### ***Driveway Expansion Soil Investigation***

A sample of removed soils from the expansion of the plant driveway was found to contain 190 mg/kg PCBs. Additional testing of the driveway was conducted. As a result, PCBs were not detected in the surface soil samples collected from the excavation associated with the SMI Plant driveway expansion. Based on the collected data, no additional investigation or response activity is needed.

### ***Supplemental Stormwater Pond Investigation***

Supplemental Stormwater Pond investigation activities included the collection of samples of oily material (oil-water mix), surface water, and sediment following the observation of oily material on the surface of the pond in mid-1998. PCBs were detected in the oily material at the pond surface and in some of the collected sediment samples. In response, the oil-stained sediments from the sidewalls of the pond were excavated, the pond bottom sediments were stabilized using lime and fly ash, and the Stormwater Pond was lined.

### ***POTW Sewer Discharges***

Weekly samples were collected for PCB analyses between September 25, 1995 and May 24, 1996 from three locations within the SMI Plant water supply and sewer discharge lines. Samples were collected from the point of compliance for sewer discharges to the City of Saginaw POTW (CFD-02), the water supply to the SMI Plant (CFD-03), and from a manhole (EE10.1) upstream of sample location CFD-02. During this period, PCBs were not detected in any of the samples.

A detailed program of sewer line mapping sampling at the SMI Plant was implemented by GM due to subsequent PCB detections at the compliance point, and the results of that investigation following the above activities are presented in the *Feasibility Analysis* (CRA, 1998) for the sewers, and in monthly reports submitted to the MDEQ.

### ***Surface Water Sampling Program***

Surface water samples were collected from onsite surface water bodies, including the former Primary Settling Pond, Secondary Settling Pond, Stormwater Pond, former WRS channels, southern drainage channels, and other areas of standing water in the southern part of the site. The data were screened against the generic GCC criteria, and no surface water concentrations were detected above the GCC. Additional sampling was later completed at the Stormwater Pond following the observation of oily material on the pond surface, which led to construction of a pond liner during July and August 2000.

### ***Sediment Quality Evaluation***

Sediment samples were collected from onsite surface water bodies, including the former Primary Settling Pond, Secondary Settling Pond, Stormwater Pond, former WRS channels, southern drainage channels, and other areas of standing water in the southern part of the site. The generic IDC criteria were not exceeded for any of the sediment or native soil samples collected at the site.

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A detailed evaluation was completed to identify apparent impacts to downgradient groundwater from site sediments. No impacts to downgradient groundwater were observed, and no additional evaluation of site sediments is anticipated.

### ***Former HQD Area Investigation***

Monitoring well installation activities did not encounter groundwater in the HQD Area. Soil encountered during soil boring activities did not appear to be stained, and odors were not observed.

### ***Quench Pit Investigation***

The extent of LNAPL has been defined beneath the plant floor in the Quench Pit Area. LNAPL analytical data indicated detections of VOCs, PCBs, and metals. Groundwater analytical data from perimeter monitoring wells indicated no detections of VOCs, SVOCs, or PCBs. Arsenic and manganese were detected in groundwater at concentrations above the MDEQ generic IDW criteria. The groundwater data suggested that dissolution of the monitored constituents from the LNAPL to groundwater is limited. LNAPL is manually bailed daily (during the work week) from the Quench Pit monitoring wells, and an automated system is being installed in one well to observe the effectiveness of the system.

### ***I27.7 Area Investigation***

Previous sampling activities indicated the presence of PCBs soil samples collected beneath the plant floor in the area of Manhole I27.7. The PCB concentrations detected in seven of the 23 soil samples collected during the I27.7 Area investigation exceeded IDC criteria. The impacted soils are not accessible to plant workers since the soils are located beneath the plant floor. Groundwater was not encountered during the investigation.

### ***Melting Department Investigation***

PCBs were detected in soil samples collected beneath the plant floor in the Melting Department. Soils containing PCBs at concentrations above the generic IDC concentration were excavated to the extent practicable, given the access limitations within the plant. Groundwater was not encountered during the removal activities.

## **2.3 2001 Additional Groundwater Investigation Activities**

On April 6, 2001, an additional groundwater sampling event was conducted along the Saginaw River. As part of the activities, four groundwater monitoring wells (B-7R, MW-111WT, MW-112WT, and MW-114WT) were sampled using "ultra" low-flow sampling methods. A total of eight groundwater samples were collected from the monitoring wells for PCB analysis. An additional monitoring well located along the Saginaw River, MW-110WT, could not be sampled due to well damage. However, this well was abandoned, replaced, and sampled. Analytical results indicate that PCBs were detected at concentrations at or slightly above the associated laboratory detection limit in three samples obtained from monitoring well MW-112WT (MW-112WT [0.20J µg/L], MW-112WT RE [0.24J µg/L], and MW-112WT-dissolved [0.22 µg/L]).

Monitoring well MW-112WT is the only location along the Saginaw River that has continued to sporadically show PCB detections. Therefore, monitoring well MW-185WT was installed in November 2001 immediately downgradient from MW-112WT to further investigate the PCB detections noted in this area, and to potentially establish a new GSI monitoring point. To minimize the impact of drilling activities on turbidity in the well and

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disturbance of surrounding soils and the detection of PCBs in collected samples, the well was installed by driving casing instead of using hollow-stem augers. The well was sampled using “ultra” low-flow sampling methods. Sample results did not indicate the presence of PCBs above the laboratory detection limit.

## **2.4 Proposed Fall 2003 Groundwater Monitoring Activities**

Groundwater monitoring activities are proposed in the fall of 2003 for select groundwater monitoring wells, specifically B-7R, MW-110WTR (replacing MW-110WT), MW-111WT, MW-112WT, MW-114WT, and MW-185WT. Consistent with the April 2001 sampling method, samples would be collected using “ultra” low-flow sampling methods for laboratory analysis for PCBs. In addition, samples will be collected from select monitoring wells for analysis of inorganic constituents that were detected on one or more date(s) at concentrations above the GSI criteria. Specifically, samples will be collected from monitoring wells MW-149WT (manganese, arsenic, and thallium analysis), MW-111WT (manganese analysis), MW-108WT (thallium analysis), MW-112WT (thallium analysis), and X-4AR (thallium analysis). A groundwater sampling plan will be submitted to MDEQ prior to the sampling event.

## **2.5 Preliminary Ecological Assessment**

The preliminary ecological assessment included the completion of various site visits during June 1996 and June and September 1997 to observe and describe site habitat, and to collect fish population data. Supplemental sampling of soil, sediment, and surface water was conducted in August 2000 to address MDEQ concerns about data gaps in parts of the study area that could be used by wildlife as habitat.

A pathway analysis was completed for each environmental medium to determine if a complete exposure pathway is present (e.g., a source, a potential point of exposure, and a viable route of exposure and receptor at the exposure point). As a result of the pathway analysis, complete groundwater exposure pathways for ecological receptors were determined not to be present. The surface soil, surface water, and sediment exposure pathways could not be ruled out, based on this analysis.

### ***3. Interim Response Actions***

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Since 1979, multiple environmental investigations have been performed at the site as described in Sections 1 and 2. As a result of these investigations, GM, REALM, Inc., and WMI (as appropriate) have implemented numerous IRAs to address potential environmental concerns associated with the plant property. This section presents a summary of IRAs conducted to date, identifies IRAs to be implemented in the near future, and describes how the potential environmental concerns previously identified have been addressed by IRA implementation. In addition, the approximate cost associated with the IRAs conducted during the RI/FS program is presented below. Costs associated with IRAs conducted prior to initiation of the RI/FS program are not presented. The IRAs are presented by site geographic area.

#### **DRA/Hillock Area**

Although GM was not responsible for placement of the drums in this area, from 1987 through 1995 various IRAs have been undertaken to address the DRA/Hillock Area. IRAs have included the removal of drums and other “target materials” (e.g., drum fragments, wastes associated with drums, stained soil, soil associated with an organic vapor content of greater than 600 ppm [as measured with an organic vapor analyzer], soil containing NAPL) encountered within the DRA.

In 1987, GM excavated, overpacked, and staged 339 drums/drum fragments (none of which contained hazardous wastes) from the western portion of the area. In July 1989, GM collected and disposed of surface metal debris, collected drums at the ground surface and overpacked the drums as needed, restaged the 339 drums identified above, excavated 23 test pits (removing drums and drum fragments encountered) and characterized the staged materials. In February 1990, GM disposed of 408 tons of staged material (characterized as a hazardous waste due to the presence of copper and lead at concentrations above regulatory criteria). In June 1990, GM disposed of 1,538 tons of non-hazardous waste and eight drums offsite as non-hazardous waste. In June 1994, an intact drum was discovered during removal of additional surface debris. The drum was characterized and appropriately disposed offsite. In March and April 1995, two intact drums and drum fragments were removed, overpacked, sampled, and disposed offsite as non-hazardous waste. The approximate cost of these removal activities is on the order of \$500,000.

In addition, the soil and fill that constituted the remaining unexcavated part of the Hillock Area was excavated to the water table and placed within the fill materials of the Green Point Landfill prior to capping (GM had previously excavated and removed fill from a majority of the DRA). Clean fill was then used to bring the area up to grade. During additional test pitting activities completed north of the Hillock Area during the RI (described in Section 2), a pipe containing VOC-impacted water was encountered emanating from an offsite location (not operated or owned by GM, REALM, Inc., or WMI).

The approximate total cost of the DRA/Hillock Area IRA activities conducted during the RI/FS program (to date) is \$520,000.

To mitigate future potential VOC impacts to soil and groundwater within the DRA/Hillock Area from the offsite source, an IRA will be implemented as further described in Section 8 of this FS.

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### **LNAPL Assessment and Remediation Area**

As identified in the RI, LNAPL identified in the area between the SMI Plant and Delphi Plant 2 buildings contained a number of VOCs (identified in Section 2), select SVOCs (including a series of PAH compounds identified in Section 2), PCBs, and manganese (detected in groundwater).

During the investigation activities, GM replaced/repaired approximately 35 feet of 42-inch-diameter sewer line located within the LNAPL Assessment and Remediation Area to mitigate the potential for infiltration for LNAPL and impacted groundwater to the sewer system at a cost of approximately \$230,000. During the repair activities, approximately 4,300 gallons of LNAPL were removed from the pipe excavation area. Following the investigation activities in the area, an automated LNAPL recovery system was constructed as part of an IRA and is currently in operation. As of November 1, 2001, more than 11,200 gallons of LNAPL had been removed, and more than 1,500,000 gallons of groundwater has been removed from the subsurface and treated. Investigation, design, and capital construction costs associated with this system were approximately \$750,000. Operation and maintenance (O&M) costs for the LNAPL recovery system are approximately \$50,000 per year.

The approximate total cost of the LNAPL Assessment and Remediation Area IRA activities conducted during the RI/FS program, to date, is \$1,130,000.

### **Former UST #7 Area**

As described in Section 2, the Former UST #7 Area investigation indicated the presence of lead and BTEX constituents in subsurface soil and groundwater in the immediate vicinity of the former UST #7. UST #7 (an approximately 15,000-gallon tank) was removed on January 3, 1990 along with its associated piping.

A groundwater monitoring program has been implemented as an IRA in the Former UST #7 Area since 1997, in accordance with an MDEQ-approved Interim Response Action Work Plan (BBL, 1997). The subsurface impacts are limited to a small area, and the natural attenuation processes of soil sorption and intrinsic biodegradation via methanogenesis and sulfate reduction are ongoing in the area, mitigating further migration of the plume. No exposure pathway was identified in the HHE Report or the ERA Report for the impacted media associated with this area. As such, no additional IRAs are required for this area.

The approximate total cost of the Former UST #7 Area IRA activities conducted during the RI/FS program, to date, is \$230,000.

### **Former Railyard Area**

Following the detection of PCBs in surface soil samples at concentrations above the generic IDC criteria in the Former Railyard Area, GM implemented a soil excavation IRA to address the impacted material. This IRA was completed in July 1998. PCBs were not detected at concentrations in confirmatory samples; however, select inorganics were detected above MDEQ GCC criteria. As indicated in the HHE Report, inorganics were either detected at concentrations above industrial drinking water criteria (which is not an exposure pathway for this site) or the constituents were not detected above the calculated site-specific cleanup criteria (SSCC) and therefore not considered to present an exposure risk. However, to confirm that manganese present in surface soil does not pose a human health risk offsite, an air monitoring program will be implemented along the site perimeter in the vicinity of the railyard.

The approximate total cost of the Former Railyard Area soil removal activities is \$25,000.

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### **Unpaved Area**

Following the detection of PCBs in surface soil samples at concentrations above the generic IDC criteria in the Unpaved Area, GM implemented a soil excavation IRA to address the impacted material. This IRA was completed in July 1998. PCBs were not detected at concentrations in confirmatory samples; however, select inorganics were detected at concentrations above MDEQ GCC criteria. As indicated in the HHE Report, the inorganics were detected at concentrations above industrial drinking water criteria, which is not an exposure pathway for this site, and therefore not considered to present an exposure risk. As such, no further IRAs are required for this area.

The approximate total cost of the Unpaved Area soil removal activities is \$25,000.

### **Quench Pit Area**

As part of GM's quench pit construction assessment activities (presented in the Quench Pit Investigation Report), each quench pit was drained and cleaned (BBL, 1998a). As a result of the assessment, GM replaced the west sidewall panel, rewelded all of the seams of quench pit #1, and repaired the shells of quench pits #2 and #3. In January 1998, GM completed construction activities that modified the quench pits to include secondary containment at a cost of approximately \$1,000,000. The abandoned 50-inch storm sewer line that bisects the quench pit area was investigated during a site-wide sewer assessment. During the assessment, GM identified and removed approximately 4,000 gallons of LNAPL from the 50-inch storm sewer as an IRA at a cost of approximately \$230,000. LNAPL analytical data indicated the presence of VOCs, PCBs, and metals. However, groundwater analytical data from perimeter monitoring wells indicated no detections of VOCs, SVOCs, or PCBs at concentrations above laboratory detection limits. As a result of the quench pit investigation, GM initiated interim product recovery (IPR) activities as an IRA, consisting of daily (during the work week) manual removal of LNAPL from impacted wells at a cost of approximately \$50,000 per year. GM is currently working to install an automatic recovery system (pilot test of ferret oil scavenger pump) in this area.

The approximate total cost of the Quench Pit Area IRA activities conducted during the RI/FS program, to date, is \$1,500,000.

### **Melting Department Area**

As presented in the Feasibility Analysis (CRA, 1998), the Melting Department Area was cleaned, capacitors in this area were replaced, and rooms containing PCBs at concentrations above action levels were remediated in 1996 and 1997 as an IRA. The flooring material in the five capacitor rooms and in one hydraulic room was completely removed. In addition, PCBs were detected in soil samples collected beneath the plant floor in the Melting Department Area. Soil was excavated to the extent practicable within this area. Soil excavation and capacitor removal/replacement activities were conducted in this area at a cost of approximately \$3,000,000. As part of the IRAs conducted in this area, a 30-inch-diameter sewer line was cleaned and sediment removed at a cost of approximately \$100,000. PCB-impacted soil remains beneath the concrete floor; however, provided the concrete floor remains and intrusive activities are not conducted in this area, no exposure pathway exists for GM personnel conducting day-to-day operations within the Melting Department Area.

The approximate total cost of the Melting Department and Area IRA activities conducted during the RI/FS program, to date, is \$3,100,000.



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### **I27.7 Area**

As described in the Feasibility Analysis (CRA, 1998), numerous IRAs were conducted in connection with this area. The sewer lines in the I27.7 Area were cleaned in December 1997 and a sewer sleeve was installed between two manholes in the vicinity of the area (I23.6 and J25.8) to prevent infiltration of impacted materials into the sewer from the I27.7 Area at a cost of approximately \$35,000. In addition, sediment in the 60-inch-diameter storm sewer downstream of the I27.7 Area (identified as a potential source of PCBs) was removed and a sewer sleeve was inserted at a cost of approximately \$250,000. Also as part of the IRA activities, a 48-inch-diameter storm sewer was cleaned and sediment was removed from the sewer at a cost of approximately \$130,000. PCB-impacted soil was encountered beneath the concrete floor within this area. Following sewer cleaning and sleeve placement activities, the concrete floor was repaired/replaced. Because the concrete floor serves as a physical barrier, no complete soil exposure pathway exists for facility personnel conducting day-to-day operations within the I27.7 Area provided the corridor floor remains intact and intrusive activities are not conducted in this area.

The approximate total cost of the I27.7 Area activities conducted during the RI/FS program, to date, is \$415,000.

### **Former WRS**

During historic site operations, the facility contained a former process unit that recycled water used in select plant operations (referred to as the former WRS). Prior to January 1997, this system received noncontact process water, stormwater drainage, and air scrubber effluents. GM has since constructed a new Water Recycle System in the central area of the site, north of the Primary Settling Pond. This system includes a lined buffer basin and a wastewater treatment facility. As of January 1997, the system began full operation and the noncontact process water and air scrubber effluents were diverted from the former WRS. Portions of the former WRS are now used for the management of stormwater while other components have been filled. As an IRA, GM substantially filled the former Primary Settling Pond and the north-south oriented channel of the former WRS at a cost of approximately \$200,000, leaving a drainage swale along the former channel route. Oil-stained sediments from the sidewalls of the Stormwater Pond were excavated, the bottom sediments were stabilized using lime and fly ash, and the pond was lined at a cost of approximately \$200,000. In addition, GM installed oil removal booms as a contingency to contain and remove floating oil (if any) introduced into the Stormwater Pond. GM also removed chillers from the SMI plant roof to mitigate sporadic oil sheens previously introduced to the Stormwater Pond. With the conversion of the former WRS from an engineered industrial process unit to a stormwater management system, and with the lining of the Stormwater Pond and removal of the roof chillers, the oil sheens have abated. Total estimated cost for construction of the new Water Recycle System (including the wastewater treatment facility) is \$14,000,000.

The approximate total cost of the former WRS IRA activities conducted during the RI/FS program, to date, is \$14,400,000.

### **Green Point Landfill**

As described in Section 1, the Green Point Landfill stopped receiving waste and was closed in 1978. GM purchased the Green Point Landfill in December 1982. In accordance with the Consent Judgment, GM and WMI proposed the design and installation of a cap for the landfill consistent with current closure requirements for solid waste municipal landfills. Construction on the landfill cap (consistent with Part 115 of Michigan Act 451) was completed and the Green Point Landfill Final Cover System Certification Report was submitted to the

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MDEQ on January 26, 2000. As indicated in the Final Cap Design Report, Green Point Landfill (BBL, 1998a), the cap consists of the following components, top to bottom:

- A 12-inch thick gas venting layer;
- A non-woven geotextile;
- A 12-inch thick low-permeability barrier layer;
- A 40-mil thick high-density polyethylene (HDPE) layer;
- A 24-inch thick protective soil layer; and
- A 6-inch thick topsoil layer with vegetation.

Also as part of this IRA, the following post-closure Operation, Maintenance and Monitoring (OM&M) activities are being implemented:

- Maintaining the integrity and effectiveness of the cap system, including erosion control;
- Conducting groundwater monitoring activities and maintaining the groundwater monitoring system;
- Maintaining the passive gas venting system;
- Maintaining the environmental monitoring system; and
- Maintaining the wetlands constructed as part of the IRA activities.

The approximate costs associated with preconstruction activities and construction of the Green Point Landfill cap system is approximately \$6,200,000. The approximate annual OM&M costs associated with the Green Point Landfill is \$20,000.

The approximate total cost of the Green Point Landfill IRA activities conducted during the RI/FS program, to date, is \$6,240,000.

### **Sewers**

At the request of the MDEQ, a program involving weekly PCB sampling and analysis of the sewer discharge to the POTW was implemented during the RI. Samples were collected and analyzed weekly from GM's POTW discharge point of compliance and the City of Saginaw's water intake line. In addition, at GM's request, grab samples were collected weekly from a manhole located along the 42-inch-diameter sanitary sewer line south of the visitor parking area. As an IRA, GM has since conducted extensive testing, cleanup, and remediation associated with the site sewer system in coordination with the City of Saginaw.

The approximate total cost of the Storm Sewer IRA activities conducted (to date) is \$2,600,000. This cost includes investigation and sampling activities, installing a 42-inch-diameter pipe from the diversion chamber through an inverted siphon, and installing a 36-inch-diameter slip liner in the 42-inch-diameter storm sewer line. In addition, GM executed a consent order with the City of Saginaw (signed December 4, 2001) regarding continuing sample collection and attainment of treatment standards.

In summary, nearly \$30,000,000 has been expended during the RI/FS program, to date, by GM/REALM, Inc., and WMI in the completion of IRAs at the site.

## 4. Evaluation of Groundwater Quality at Saginaw River Perimeter

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### 4.1 Data Summary - Temporary Monitoring Wells

Groundwater samples were collected from 19 temporary monitoring wells installed at seven monitoring well cluster locations along the Saginaw River perimeter. Each groundwater sample was analyzed for USEPA SW-846 TCL VOCs, SVOCs, total and dissolved PCBs, and dissolved TAL inorganics. Installation and sampling of the temporary wells was completed to further characterize the groundwater at the site perimeter and to assist in locating permanent wells. Temporary well data are not considered as reliable for sorptive analytes (e.g., PCBs, inorganics, and certain SVOCs) because they tend to produce turbid samples that are not representative of groundwater chemistry. Thus, while the detection in a groundwater sample of a sorptive analyte may not represent actual groundwater quality, the absence of this type of constituent should be indicative of groundwater quality. Therefore, these temporary well samples can provide a preliminary screening level characterization of groundwater quality. In response to the detection of analyte concentrations above the generic MDEQ criteria, permanent monitoring wells were installed (MW-149WT, MW-109WT, MW-110WT, MW-112WT, and MW-113WT).

The exposure point concentration for each constituent was compared with relevant MDEQ generic cleanup criteria. The results of this analysis revealed:

VOCs: No generic GSI, GCC, FESL, or WSSL values for VOCs were exceeded in the samples collected from the temporary monitoring wells.

SVOCs: No generic GCC, FESL or WSSL values for SVOCs were exceeded in samples collected from temporary monitoring wells. The generic GSI value for bis(2-ethylhexyl)phthalate (32 µg/L) was exceeded at two temporary monitoring well locations: TW-209WT (49 µg/L) and TW-210S1 (34 µg/L).

PCBs: No generic GCC or WSSL values for PCBs (unfiltered or filtered) were exceeded in samples collected from the temporary monitoring wells. No PCBs from filtered samples exceeded the generic GSI value for PCBs. The generic GSI value for PCBs was exceeded in unfiltered samples from four temporary monitoring wells.

Inorganics: Samples from the temporary monitoring wells were analyzed for unfiltered and filtered (dissolved) inorganics and total cyanide. As provided by MDEQ Operational Memorandum #18 (MDEQ, 2000), site-specific background values for copper, manganese, and zinc were substituted for the GSI values. Dissolved inorganics detected above the higher of the generic GSI or site-specific background values were arsenic and manganese. No generic GCC values were exceeded in the samples collected from temporary monitoring wells along the Saginaw River perimeter.

### 4.2 Data Summary - Permanent Monitoring Wells

Groundwater samples were collected from 40 permanent monitoring wells along the Saginaw River perimeter. The concentration of each constituent was compared with relevant MDEQ generic cleanup criteria. Table 4-1 provides a summary of analytical data for the sampling locations where constituents were detected above the

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generic GSI criteria on at least one occasion. The constituent concentrations detected at permanent monitoring wells located along the Saginaw River and the generic MDEQ criteria are compared below.

VOCs: No generic GCC, FESL, or WSSL values for VOCs were exceeded in the samples collected from the permanent wells. The generic GSI value for total xylenes was exceeded at one permanent well (MW-6CAUG) during the first sampling event in 1995. Two subsequent sampling events, however, indicated no VOC detections above the GSI criteria at this well. Therefore, additional response activity is not warranted at the MW-6CAUG location.

SVOCs: No generic GCC, FESL or WSSL values for SVOCs were exceeded in samples collected from permanent monitoring wells. Phenol and bis(2-ethylhexyl)phthalate were each detected at concentrations above the generic GSI values during the initial sampling event at one monitoring well (Table 4-1). Subsequent sampling results, however, including recent data collected in May 2000, showed no GSI exceedances for these compounds. Therefore, additional response activity at these well locations is not warranted.

PCBs: No generic GCC or WSSL values for PCBs (unfiltered or filtered) were exceeded in samples collected from the permanent monitoring wells. Filtered samples did not exceed the generic GSI value for PCBs, however, unfiltered samples from a few wells initially did exceed the GSI value. While unfiltered samples from the wells located closest to the Saginaw River currently do not exceed GSI, the PCB monitoring results require a more in-depth analysis than the other constituents. The interpretation of PCB results is somewhat more complicated than other constituents at the Site because there has been no identified background concentration, the GSI criteria has been established at the target detection limit (TDL), and PCBs are highly adsorbed onto fine soil particles that may become entrained into the water sample collected for analysis. The inadvertent introduction into the sample of a few soil particles with PCBs (PCBs have been detected at low concentrations in the berm soil) can result in the detection of PCBs in an unfiltered groundwater sample when in fact PCBs are not present in groundwater. Furthermore, in an effort to minimize the potential for this type of false positive result, several corrective measures such as additional well purging and the use of different sample collection procedures (lower flow rates) have been implemented since initial completion of the Work Plan.

There have been very few detections of PCBs in unfiltered samples from the 40 permanent monitoring wells installed along the river boundary. The generic GSI value for PCBs was initially exceeded in unfiltered samples from five permanent monitoring wells in 1995. However, these samples generally exhibited the highest levels of turbidity because of inadequate well development (due to fine grained soils with low groundwater yields) and sample collection methods which did not minimize the artificial turbidity in the well. Following the initial groundwater sampling events completed in July 1995 and June 1996, in accordance with the RI Work Plan, additional sampling has been completed at the monitoring wells along the river that were found to contain detectable levels of PCBs during the initial sampling events. Several wells (MW-111S4 and MW-108S1) were found to contain PCBs during the initial sampling round only. At other locations, PCBs were detected during subsequent sampling events. Figure 4-1 illustrates the location of the permanent monitoring wells associated with the detections of PCBs on one or more sampling dates. As described below, analysis of samples collected during the latest sampling events indicate no current exceedance of GSI criteria.

During preparation of the Work Plan, it was known that artificially produced turbidity during sample collection could create false positive detections of PCBs (i.e., detections of PCB when none actually exist) in groundwater samples where PCB soil contamination was present. Therefore, a field filtered PCB sample was added to the unfiltered sample requirement to further assess whether detections in the unfiltered sample were actually dissolved in groundwater. There have been no exceedances of GSI criteria for PCBs in any of the filtered samples analyzed.

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At the time of the Work Plan preparation, other strategies designed to exclude the inadvertent introduction of particulates into the well were just being developed in the scientific community and thus were not included. These techniques include alternative well installation methods, enhanced well development and purging processes, and low flow sampling methodologies that mimic the natural rate of groundwater flow. Subsequent to implementation of the Work Plan, these techniques have become widely accepted and, when implemented, have been found to minimize the occurrence of false positive detections of highly adsorptive constituents like PCBs. Thus, these techniques have been utilized in the latter sampling rounds with generally positive results, supporting the use of filtered PCB sampling data to assess the presence absence of PCBs that are mobile in the groundwater system under material conditions. As shown in Table 4-1, the detected total PCB concentrations and the number of river perimeter wells with detections have decreased over time.

The most significant of these techniques has been the change from sampling using moderate-flow procedures (purge rates of up to 9.5 L/min; sampling rates of 100 ml/min), which disturb the water column and introduces high levels of artificial turbidity during sampling, to low (purge rate of up to 500 ml/min; sampling rate of 100 ml/min) and “ultra” low-flow (purge and sampling rate of 1 L/hr, which minimizes sample turbidity by mimicking the rate of natural groundwater flow) sample collection methods. In addition, the accumulative amount of water purged prior to sample collection has increased significantly more completely removing fine soil particles from the sand pack prior to sample collection. Unless removed, these fine soil particles can be slowly released during the sample collection process, thus increasing the level of artificial turbidity in the sample. Figure 4-2 illustrates the overall relationship between the PCB analytical data, the various sampling rounds, and the method of sample collection. Following implementation of an ultra low-flow sampling method (which minimizes sample turbidity) in May 2000, PCBs have been detected at only one monitoring well (MW-112WT), during one of two sampling events.

The available data collected from the various sampling rounds clearly indicates that the PCB detections are related to sample collection methods. When PCBs have been detected in unfiltered samples from wells along the river boundary, the paired filtered sample results have been below the GSI criteria. This suggests that the PCBs were adsorbed to particulates that are larger than the filter size of 0.45 microns. The impact of particulates on unfiltered groundwater samples is further demonstrated by the analytical data from samples previously collected from the temporary monitoring wells. The temporary wells were installed for screening purposes, and as such they were not developed as thoroughly as the permanent wells nor were low flow sampling techniques used, therefore samples had much higher levels of turbidity. At these locations, PCB concentrations were significantly higher than those detected in samples collected from nearby permanent monitoring wells (generally by orders of magnitude). These data demonstrate that the higher particulate content of groundwater collected from the temporary wells resulted in higher detections of the particulate-sorbed PCBs.

Similarly, PCBs were initially detected in unfiltered groundwater samples from permanent monitoring wells, which were installed in fine grain soils containing low concentrations of PCBs. However, the PCB concentrations have declined through time due to continued well development and improvements in sampling methodology that have minimized unrepresentative sample turbidity. Figures 4-3 through 4-9 illustrates the relationship between measured sample turbidity and detected PCB concentration. As shown by these figures, there is, in almost every instance, a direct correlation between sample turbidity and the detected concentration of PCBs. Ideally, trends of detected PCB concentration would mimic the trend in the turbidity level at a particular well. However, several factors may confound such an ideal relationship. First, variations from this correlation are found in some instances where measured turbidity is very low (less than 0.5 nephelometric turbidity units [NTUs]) due to the sensitivity range of the turbidity meter. Second, heterogeneous levels of PCB concentrations on entrained particulates can result in an uneven relationship between turbidity and PCB detections. Nevertheless, a distinct trend is observable in the body of the data.

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These new techniques to minimize artificial sample turbidity have been successful. The groundwater samples collected from the monitoring wells along the Saginaw River in May 2000 were non-detect for PCBs (filtered and unfiltered samples). In April 2001, samples were collected for PCB analysis from four monitoring wells located along the river that had contained detectable concentrations of PCBs during any of the previous three sampling events. The data were non-detect for PCBs, with the exception of the sample collected from MW-112WT, which contained PCBs at a concentration of 0.20 µg/L (0.24 µg/L upon reanalysis). These samples were collected using a modified sampling procedure as described in the Quality Assurance Project Plan (QAPP) Addendum (Attachment L-A to the RI/FS Work Plan), which incorporates a peristaltic pump to allow lower purging and sampling rates to minimize disturbance of the natural groundwater flow rates in the soil.

Due to the sporadic detection of PCBs at MW-112WT since 1997, a new monitoring well (MW-185WT) was installed downgradient of MW-112WT in November 2001 to establish an alternate GSI monitoring point, and to potentially demonstrate that the PCB detections at MW-112-WT represent non-mobile PCBs present in soil. The well was installed using driven casing to advance the boring (instead of hollow-stem-augers) to minimize disturbance of the subsurface soil structure. Replacement well MW-110WTR (replacement for MW-110WT; damaged by tree roots) was also installed in November 2001. Unfiltered groundwater samples collected from the two new wells in November 2001 were non-detect for PCBs. The absence of detectable levels of PCBs in these samples is consistent with the premise that the PCBs previously detected in monitoring wells located along the Saginaw River are the result of particulates being introduced into the samples due to the more disruptive methods previously used to install wells and collect groundwater samples.

In summary, the available data indicate that PCBs are not present in groundwater adjacent to the Saginaw River at concentrations above the laboratory detection limit. Previous detections of PCBs in groundwater appear to be the result of the inadvertent introduction of fine soil particles into the monitoring wells during sample collection. This conclusion is supported by the absence of PCB exceedances in all of the filtered samples (with the exception of one collected at monitoring well MW-112WT) and unfiltered samples that were collected utilizing techniques to reduce artificial turbidity. As well, the berm area along the Saginaw River is constructed of fine grain soils containing of low concentrations of PCBs. These conditions are inconsistent with the PCB detections resulting from a source area contributing dissolved PCBs but are consistent with the inadvertent introduction of fine soil particles into the monitoring wells. Additional groundwater sampling will be conducted as described in Section 4.3 to confirm these findings.

*Pesticides and Herbicides:* Groundwater samples from two monitoring wells along the Saginaw River were analyzed for pesticide and herbicide compounds. Concentrations of pesticides and herbicides were not reported above the laboratory detection limits in the samples.

*Dioxins and Furans:* Groundwater samples were collected from two permanent monitoring wells along the Saginaw River perimeter for analysis of dioxins/furans. No generic GSI, GCC, or WSSL values for dioxins/furans were exceeded in these samples.

*Inorganics:* Samples from the permanent monitoring wells were analyzed for unfiltered and filtered (dissolved) inorganics and total cyanide. As provided by MDEQ Operational Memorandum #18 (MDEQ, 2000), site-specific background values for copper, manganese, and zinc were substituted for the GSI values when the background values were higher. Dissolved inorganics detected above the higher of the generic GSI or site-specific background values during at least one sampling event were arsenic, copper, manganese, and thallium. The generic GSI criteria for barium, beryllium, cadmium, chromium, lead, nickel, and selenium were not exceeded in the monitoring wells. Only one unfiltered sample exceeded the generic GSI value for cyanide; however, during subsequent sampling, cyanide was not detected in the filtered or unfiltered samples. No generic GCC values were exceeded in the samples collected along the Saginaw River perimeter.

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Copper was detected slightly above GSI criteria at MW-108S4 in a groundwater sample collected in 1995 during the initial sampling event. Two samples collected in 1996 and 2000 were non-detect for copper. Thallium was detected above the GSI criteria at four river perimeter wells during the fifth sampling event in May 2000. The data were qualified, indicating that the reported concentrations were between the instrument detection limit and the required reporting limit. In addition, all of the detected concentrations were approximately the same value. Thallium had not been detected in wells along the river boundary, nor had it been detected above criteria during any previous sampling events at any location on the site. Thus, it is unlikely that these detections are significant.

Manganese was detected above GSI criteria at two monitoring well locations, and arsenic was detected above GSI criteria at one monitoring well location (Table 4-1). Manganese was detected at a concentration exceeding the GSI criteria at MW-149WT during the sampling event of June 1996. However, during a subsequent sampling event in May 2000, manganese was detected at a concentration significantly below the GSI criteria. Manganese was detected at MW-111WT at concentrations above GSI criteria during two of four sampling events. Arsenic was also detected at MW-149WT above the GSI criteria during the June 1996 event, but below the criteria in the subsequent event. To address the detection of thallium, arsenic, and manganese in groundwater monitoring wells adjacent to the Saginaw River, additional groundwater sampling will be conducted as described in Section 4.3.

### **4.3 Groundwater Monitoring Plan**

Despite the extensive amount of groundwater monitoring data available for the river perimeter wells as well as the planned Fall 2003 sampling event discussed in Subsection 2.4, a groundwater monitoring program will be developed and implemented as part of the RAP, to provide additional data for PCBs, arsenic, manganese, and thallium.

## ***5. Identification of Applicable or Relevant and Appropriate Requirements, Rules, Criteria, Limitations, and Standards***

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### **5.1 Overview**

This FS Report was prepared in general conformance with the applicable guidelines set forth in MDEQ regulations presented in R299.5513. Under the R299.5513 requirements, the detailed evaluation of alternatives includes an analysis of the extent to which the alternative complies with legally applicable or relevant and appropriate requirements, rules, criteria, limitations, and standards of state and federal environmental law (hereby referred to as ARARs). This section presents a summary of ARARs identified for the site.

#### **5.1.1 Definition of ARARs**

“Applicable requirements, rules, criteria, limitations and standards” are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a constituents, remedial action, location, or other circumstance.

“Relevant and appropriate requirements, rules, criteria, limitations and standards” are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that address situations similar to conditions encountered at the site; however, the requirements are not strictly “applicable” to the site.

#### **5.1.2 Types of ARARs**

The USEPA has provided guidance on the application of the ARARs concept to the RI/FS process. ARARs are to be progressively identified and applied on a site-specific basis as the RI/FS proceeds. The ARARs considered for the potential remedial components identified in this FS Report were categorized into the following USEPA-recommended classifications:

- ***Chemical-Specific ARARs*** – These ARARs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for each constituent of concern. These values establish the acceptable amount or concentration of constituents that may be found in, or discharged to, the ambient environment;
- ***Action-Specific ARARs*** – These ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste management and site cleanup; and
- ***Location-Specific ARARs*** – These ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in specific locations.



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## **5.2 Identified ARARs**

The identification of federal and state ARARs for the evaluation of remedial alternatives at the site was based on a review of the RI Report, the HHE Report, and the ERA Report. The ARARs identified for the site are presented below.

### **5.2.1 Chemical-Specific ARARs**

As identified in Table 5-1, potential chemical-specific ARARs are:

- Resource Conservation and Recovery Act (RCRA) hazardous waste management regulations;
- Toxic Substances Control Act (TSCA);
- Clean Water Act (CWA);
- Water Pollution Control Act (WPCA);
- Federal surface-water quality criteria;
- MDEQ Interim ERD Operational Memorandum #18, dated June 2000;
- Michigan Water Resources Protection Rules -Water Quality Standards;
- Michigan Environmental Remediation Rules;
- Michigan Groundwater Quality Rules;
- Michigan Solid Waste Management Rules; and
- Michigan Hazardous Waste Management Rules.

### **5.2.2 Action-Specific ARARs**

As identified in Table 5-2, potential action-specific ARARs are:

- Occupational Safety and Health Administration (OSHA) regulations pertaining to recordkeeping and reporting occupational injuries/illnesses, general standards, and safety and health regulations for construction;
- Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, preparedness and prevention regulations, and contingency plan and emergency procedures specified under RCRA;
- CWA;
- Federal transportation regulations;
- Michigan Soil Erosion and Sedimentation Control Rules;
- Michigan Water Resource Protection Rules;
- Michigan Occupational Safety and Health Rules; and
- Michigan Wetland Protection Rules.

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### 5.2.3 Location-Specific ARARs

As identified in Table 5-3, potential location-specific ARARs are:

- Rivers and Harbors Act;
- USEPA Executive Orders pertaining to the protection of wetlands and floodplain management;
- Federal regulations specified under RCRA pertaining to a hazardous waste facility located in a floodplain;
- CWA;
- U.S. Fish and Wildlife Coordination Act;
- National Historic Preservation Act;
- Michigan Floodplains and Floodways Rules; and
- Michigan Wetland Protection Rules.

## **6. Development and Identification of Remedial Action Objectives**

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### **6.1 Rationale**

RAOs are defined by the USEPA as medium-specific objectives for protecting human health and the environment. RAOs for the site were developed by considering the results and conclusions of the RI (see Subsection 2.2), the HHE, evaluation of groundwater quality at the Saginaw River perimeter (see Section 4), and the ERA. In addition, RAOs for the site were developed by considering the ARARs presented in Section 5 as well as by accommodating the preliminary objectives cited in the RI/FS Work Plan. This section briefly summarizes the results and conclusions of the HHE and ERA, the Saginaw River perimeter groundwater quality evaluation, discusses the preliminary objectives directed by MDEQ in 1993, and identifies the RAOs established for the site.

### **6.2 HHE Results and Conclusions**

The HHE was conducted to assess potential risks to human receptors that may result from exposure to constituents of interest detected in environmental media. The HHE Report is presented as Appendix A. As indicated in the HHE Report, the evaluation methodology utilizes a tiered approach. The initial step is to compare site chemical constituent concentrations to relevant MDEQ generic cleanup criteria. Site data were organized and the 95% upper confidence limit (UCL) was calculated as a conservative estimate to evaluate chemical exposure. The results of the initial step identified constituents exceeding the applicable MDEQ generic cleanup criteria for both groundwater and soil. Based on the initial-step results, both surface water and sediment were excluded from further consideration because they do not contain constituents above applicable MDEQ criteria or present an exposure risk.

The second step calculated facility-specific generic cleanup criteria (FSGCC) based upon the characteristics of the property that are not expected to change. As explained in the HHE, it was determined highly unlikely that groundwater at the GM SMI Plant facility and in the City of Saginaw would be used as drinking water. Based on the recording of restrictions on the property deed preventing groundwater use for drinking water purposes, ingestion of groundwater as residential or industrial drinking water was not considered a complete exposure pathway and therefore not considered in the risk evaluation.

The third step calculated SSCC developed for the constituents identified in the previous steps by using site-specific parameters. The purpose of the third step was to provide risk-based concentrations that are more reflective of current and reasonably anticipated future conditions at the site. During the third step, the preliminary site exposure model was revised to specifically address site conditions (chemicals and affected media, potentially exposed populations, and potential exposure pathways). Once the SSCC were developed for these constituents exceeding applicable criteria, the site data were compared with the SSCC. Any constituent concentrations exceeding the SSCC required further evaluation (to be addressed in this FS). The HHE separated areas of the site into two categories: production areas and non-production areas. The HHE identified four areas within the production area and two in the non-production area to be addressed in the FS. The four areas in the production area were identified as the soil beneath the LNAPL Assessment and Remediation Area (exceeding the SSCC for lead), the former UST #7 area (exceeding the SSCC for benzene), and the Melting Department and I27.7 areas (both exceeding the SCC for total PCBs). The two areas requiring further evaluation in the non-

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production area were identified as the groundwater within the DRA (exceeding the SSCC for vinyl chloride), and the surface soil associated with the Saginaw River Berm Area (exceeding the SSCC for manganese). Please note that the LNAPL Assessment and Remediation, Melting Department, and the I27.7 areas were retained only in the unforeseen event that excavation activities associated with these areas are required in the future. The impacted soil associated with these areas is currently inaccessible due to the presence of soil or concrete over the area of exceedance. The former UST #7 does not currently pose a risk to on-site workers, but does need to be assessed for potential risk in the unlikely event of construction in the area. It is important to also note that exposure to vinyl chloride (exceeding the indoor air criteria) associated with the groundwater within the DRA/Hillock Area was considered unlikely based on current land use as indicated in the HHE Report, as this is a remote area of the property that has no structures or SMI plant activity. However, future land use in the DRA/Hillock Area (e.g., building construction), if any, could potentially present an exposure risk (and would be addressed accordingly). In addition, the SSCC derived for the manganese at select surface soil locations within the Saginaw River Berm Area (presented in the summary table in Section 6 of the HHE Report), considered vehicle traffic consistent with the MDEQ default value of 50 vehicular trips per day in the area of the exceedances. Although unlikely, the MDEQ indicated the areas of exceedances located within the berm area are accessible to vehicles and present a potential particulate inhalation exposure pathway.

Based on the results of the HHE, there are no foreseen complete exposure pathways following implementation of deed restrictions and the IRA proposed for the Saginaw River Berm Area (further described in Section 8). As such, evaluation of remedial alternatives, other than deed restrictions, and the proposed Saginaw River Berm Area IRA are not required.

### **6.3 Groundwater Quality at the Saginaw River Perimeter**

As described in Section 4, the following conclusions have been drawn from the evaluation of groundwater quality at the Saginaw River perimeter:

- No additional response activity is required to address select VOCs (specifically xylene) or SVOCs [specifically phenol and bis(2-ethylhexyl)phthalate] detected during the initial sampling event (in 1995) because subsequent sampling events did not indicate VOC or SVOC detections above the GSI criteria.
- The current PCB analytical data indicates that PCBs are not present in groundwater adjacent to the Saginaw River at concentrations above the laboratory detection limit.
- Select inorganics (namely thallium, arsenic, manganese, and copper) have been sporadically detected at concentrations above the GSI criteria during the various sampling events. Since the initial sampling event, copper was not detected in the permanent monitoring wells along the Saginaw River at concentrations above the laboratory detection limit.

To address the sporadic historic detections of PCBs and the select inorganics, a groundwater monitoring plan will be implemented to demonstrate that further action is not required.

### **6.4 ERA Results and Conclusions**

The ERA was conducted to assess potential risks to ecological receptors that may result from exposure to constituents detected in environmental media. The ERA Report is presented as Appendix B.

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An evaluation of complete ecological exposure pathways identified in the preliminary ecological assessment (submitted in the Final RI Report) was performed. Food-web exposure to constituents in soil, sediment, and water was estimated for representative mammalian and avian wildlife receptors using standard modeling approaches. These exposure estimates were compared to published adverse effect thresholds to generate a hazard quotient. The ERA risk characterization indicated that the potential for any ecological impacts associated with constituents at the site is minimal. As there are no significant ecological risk issues, no remedial evaluations are required.

## 6.5 Preliminary Objectives

The preliminary objectives were originally presented in the RI/FS Work Plan. As discussed in the RI/FS Work Plan, MDEQ specified that the response action must achieve objectives as documented in the RI/FS Work Plan but recognized that the preliminary objectives presented in the RI/FS Work Plan could be modified to accommodate existing site conditions (and recognize IRAs conducted to date) and the investigation results. The MDEQ-specified preliminary objectives are listed below in italics, followed by the applicability of each preliminary objective in light of results and conclusions of the RI, HHE, ERA, and IRA activities.

- *Prevent hazardous substance releases to adjacent surface and groundwater resources that violate state water quality standards. Special attention must be focused on preferential groundwater migration pathways such as storm sewers, utility conduits, or other preferential pathways that might underlie the site.* The RI indicated that no preferential pathways for migration of contaminated groundwater exist at the site with the exception of the LNAPL and impacted groundwater within the LNAPL Assessment and Remediation Area, which was found in an area influenced by the presence of utility lines. GM is currently removing and treating LNAPL and impacted groundwater in this area. In addition, as discussed in Section 4, PCBs have been sporadically, though not recently, detected in groundwater associated with the Saginaw River Boundary Area (specifically monitoring well MW-112WT) at concentrations above MDEQ's GSI criteria. As detailed in Sections 2 and 4, the PCBs periodically detected in samples collected from monitoring wells within the Saginaw River Boundary Area are likely a result of particulates being introduced into the samples as a result of the drilling and sampling methods used to collect the samples and not a hazardous substance release to the groundwater.
- *Prevent hazardous substance releases to city sanitary sewers that violate city pretreatment standards.* As discussed in Section 3, GM has conducted extensive testing, cleanup, and remediation associated with the site sewer system. GM has installed a new water treatment and water recirculation system. In addition, a consent order regarding attainment of treatment standards was executed December 4, 2001 between GM and the City of Saginaw.
- *Investigate and remediate, as necessary, hazardous substances that have migrated onto adjacent residential/commercial properties from the GM Saginaw Plant property.* The results of the RI indicate that constituent migration onto adjacent residential/commercial properties from the site has not occurred.
- *Address direct contact risks and air exposure risks.* The HHE and ERA reports do not indicate human and/or ecological direct contact risks or air exposure risks with the exception of the potential inhalation exposure to manganese present at select surface soil locations within the Saginaw River Berm.
- *Adequately protect wildlife resources and the environment with specific emphasis on exposure pathways, such as ponds and open ditches.* The results of the ERA do not indicate exposure levels that would result in significant risk to ecological receptors from impacted media at the site.

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*Monitor general response actions (GRAs) to ensure continued effectiveness.* Long-term monitoring of ongoing IRAs (described in Section 3) will provide continued effectiveness of the IRAs. Continued monitoring of the groundwater in the vicinity of the Saginaw River Boundary Area (discussed in Section 4) will document that groundwater in the vicinity of the Saginaw River Boundary Area is not impacted by PCBs. In addition, site-specific deed restrictions will be implemented to limit and control future intrusive activities at the site that may negatively impact the effectiveness of the ongoing IRAs as well as to provide future worker safety at the site.

## **6.6 RAOs**

The RAOs identified below were developed based on the results and conclusions of the RI, the HHE, the ERA and a review of MDEQ-specified preliminary objectives (in light of current conditions). As indicated in the RI/FS Work Plan, the RAOs should also take into account site-specific ARARs, as identified in Section 5. Furthermore, the MDEQ-specified preliminary objectives were modified to account for additional data collected and IRAs conducted since the preliminary objectives were developed (as documented in the RI, HHE, and ERA reports) and to achieve site-specific ARARs. Given all these considerations, the RAOs established for the site are:

- Mitigate LNAPL migration and, to the extent practicable, remove and treat LNAPL located in select site areas;
- Mitigate, to the extent practicable, potential inhalation exposure to manganese located in select surface soil locations within the Saginaw River Berm Area;
- Minimize, to the extent practicable, intrusive activities onsite property through the establishment of deed restrictions; and
- Restrict potential future land use and use of site groundwater through establishment of deed restrictions.

## ***7. Areas Evaluated for Continued Monitoring, Ongoing Remediation, Deed Restrictions, or Remedial Action***

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### **7.1 Overview**

Nine areas were identified as areas retained for continued monitoring, identified for ongoing remediation (via existing IRAs), to be maintained through deed restrictions, or to be addressed through remedial action (via proposed IRAs). These nine areas were selected based on the RAOs, the results of the HHE, the ERA, or because of regulatory considerations. A tenth area, the Former Railyard Area, is included due to the planned completion of an air monitoring program to provide analytical data in support of a particulate migration model presented in the HHE (Appendix A). The following subsection describes the areas evaluated as well as the rationale for their selection followed by a summary of the areas retained for the identified actions.

### **7.2 Areas Evaluated**

#### **Saginaw River Boundary**

The Saginaw River Boundary in the vicinity of monitoring well MW-112WT was selected as an area for continued groundwater monitoring due to the sporadic historic detection of PCBs at concentrations above MDEQ criteria in groundwater samples collected during previous sampling events. This area was not cited as presenting an unacceptable exposure risk in the HHE or ERA. As detailed in Section 4, this area will be monitored via a groundwater monitoring plan. Therefore, screening of potential remedial technologies for this area is not required and a remedial alternative evaluation is not warranted for this area.

#### **Saginaw River Berm Area**

The Saginaw River Berm Area in the vicinity of the Secondary Settling Pond was identified as an area requiring further evaluation due to the potential inhalation exposure pathway in connection with manganese above the SSCC. This FS proposes an IRA to excavate select manganese-impacted surface soil. Following soil excavation and backfilling activities, erosion control measures would be implemented along the Saginaw River Berm Area to address potential berm erosion from surface water runoff. While erosion of the berm was not identified in the HHE or ERA as an unacceptable risk or an area requiring action to achieve an RAO, erosion of the berm will be addressed. A description of the proposed IRA for the Saginaw River Berm Area is included in Section 8.

#### **DRA/Hillock Area**

Although the DRA/Hillock Area was not cited as an exposure risk in the HHE Report under existing conditions, this area was selected because a pipe (draining onto GM property) was encountered within the DRA/Hillock Area during test pitting activities. This pipe appears to convey VOC-impacted groundwater into the DRA/Hillock Area from an adjacent offsite property. Because this area is the result of an offsite source (not from a GM/REALM, Inc. or WMI operation), screening of potential remedial technologies for this area is not required. Instead, this FS report proposes an IRA to address this potential offsite source. While construction in

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this area is unlikely, a deed restriction will be placed on this area of the site to restrict the construction of buildings without investigation of potential volatilization risks. A description of the proposed IRA for the DRA/Hillock Area is included in Section 8.

### **LNAPL Assessment and Remediation Area**

The LNAPL Assessment and Remediation Area was selected due to the presence of LNAPL and the presence of lead at one subsurface soil location above the SSCC. Currently, GM is successfully removing the LNAPL and associated groundwater in this area as part of an IRA via an automated removal system. In addition, the lead-impacted soil above the SSCC was observed at one subsurface soil location (4 to 6 feet below grade) and soil located above the location did not contain lead above the SSCC thereby mitigating a direct contact exposure pathway. Through continued IRA activities and implementation of deed restrictions to restrict intrusive activities, screening of potential remedial technologies for the area is not required and a remedial alternative evaluation is not warranted for this area. A description of this ongoing IRA is presented in Section 3.

### **Green Point Landfill**

The Green Point Landfill was selected due to the ongoing operation, maintenance, and monitoring of this area. A description of the continued operation and maintenance associated with the cap system and the groundwater monitoring program is described in Section 3. As such, screening of remedial technologies and a remedial alternative evaluation are not required for this area.

### **Former UST #7 Area**

Although the HHE Report and ERA Report did not identify any exposure pathways for the impacted media of the Former UST # 7 Area, this area was selected as a potential area for remediation because of concentrations of benzene, toluene, and ethylbenzene (BTEX) constituents present in soil and/or groundwater above MDEQ regulatory criteria. GM has been monitoring this area as part of an ongoing IRA. The MDEQ-approved ongoing IRA consists of a semi-annual monitoring program (monitored natural attenuation [MNA] program) to monitor the natural attenuation processes of soil sorption and intrinsic biodegradation via methanogenesis and sulfate reduction ongoing in this area. The semi-annual monitoring program will be continued until two consecutive semi-annual sampling rounds do not indicate the presence of BTEX constituents at concentrations above applicable MDEQ criteria; then the monitoring program will be conducted on an annual basis. Once two consecutive annual sampling rounds do not indicate the presence of benzene at concentrations above applicable MDEQ criteria, GM will discontinue monitoring activities within this area. As such, screening of remedial technologies and a remedial alternative evaluation are not required for this area. While construction in this area is unlikely, a deed restriction will be placed on this area of the site to restrict the construction of buildings without investigation of potential volatilization risks. A description of this ongoing IRA is presented in Section 3.

### **Quench Pit Area**

The Quench Pit Area was selected because of the presence of LNAPL in the groundwater underlying this area. Although the HHE Report and ERA Report do not identify exposure pathways for the LNAPL, GM is addressing the LNAPL through ongoing monitoring and removal activities. Therefore, screening of remedial technologies and a remedial alternative evaluation are not warranted for this area. A description of the ongoing monitoring and removal activities is included in Section 3.



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### **Melting Department Area**

The Melting Department Area was selected as a potential remediation area due to the presence of PCBs in the soil; however, the HHE Report does not identify complete exposure pathways following institution of intrusive activity deed restrictions for the Melting Department Area. The ERA Report does not identify complete exposure pathways under existing conditions. As discussed previously, the impacted soil in this area was excavated to the extent practicable without undermining the plant's structure and stability, and the remaining impacted soil is located beneath an existing concrete floor. Deed restrictions will be implemented to restrict intrusive activities within this area, therefore, screening of remedial technologies is not required for the Melting Department Area and a remedial alternative evaluation is not warranted for this area.

### **I27.7 Area**

The I27.7 Area was selected as a potential remediation area due to the presence of PCBs in the soil; however, the HHE Report does not identify complete exposure pathways following institution of intrusive activity deed restrictions for the I27.7 Area. The ERA Report does not identify complete exposure pathways under current conditions. As discussed previously, the impacted soil is located beneath the concrete floor of the plant and is not accessible to plant workers. Deed restrictions will be implemented to restrict intrusive activities within this area. Therefore, screening of remedial technologies is not required for the I27.7 Area and remedial alternatives will not be identified for this area.

### **Former Railyard Area**

The HHE Report evaluated the presence of manganese in surface soil samples at the Former Railyard Area. None of the soil samples collected in the Former Railyard Area exceeded the SSCC for manganese. However, in order to demonstrate that the migration of particulates does not present an unacceptable risk to offsite receptors, a USEPA model was used. This model indicated no unacceptable risk to offsite receptors. To confirm the model results, an air monitoring program will be conducted along the site perimeter in the vicinity of the railyard.

## **7.3 Areas Retained for Continued Monitoring**

Based on the evaluation presented in Subsection 7.2, the following areas were retained for continued monitoring:

- The LNAPL Assessment and Remediation Area;
- The Green Point Landfill;
- The Saginaw River Boundary;
- The Former UST #7 Area.; and
- The Former Railyard Area (confirmatory air monitoring).

The monitoring associated with these areas was previously discussed in Sections 3 and 4. Further evaluation of these areas is not required.

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## **7.4 Areas Identified for Ongoing Remediation**

Based on the evaluation presented in Subsection 7.2, the following areas were identified as requiring ongoing remediation:

- The LNAPL Assessment and Remediation Area; and
- The Quench Pit Area.

The ongoing remediation of these areas will achieve the LNAPL RAO presented in Section 6. Therefore, as previously indicated, additional remedial action and a remedial alternative evaluation of these areas are not required.

## **7.5 Areas to be Addressed Through Remedial Action**

Based on the evaluation presented in Subsection 7.2, the following areas were identified as requiring remedial action:

- The DRA/Hillock Area; and
- The Saginaw River Berm Area.

The DRA/Hillock Area will be addressed via an IRA. As previously indicated, screening of potential remedial alternatives is not required because this area is being voluntarily addressed due to an offsite source (and not as a result of GM/REALM, Inc., or WMI operations).

The Saginaw River Berm Area in the vicinity of the Secondary Settling Pond will be addressed via an IRA and will incorporate excavation of limited areas of manganese-impacted surface soil near soil borings SB-378, SB-380, and SB-381 and implementation of soil erosion control measures along the berm area to mitigate erosion due to surface-water runoff. The manganese-impacted soil will be addressed as an IRA that will achieve the inhalation RAO presented in Section 6. In addition, erosion of the berm was not identified in the HHE or ERA as an unacceptable risk and is not an area requiring action to achieve an RAO. Therefore, screening of potential remedial alternatives for the Saginaw River Berm Area is not required.

Section 8 presents a detailed description of the proposed IRAs.

## **7.6 Areas to be Maintained Through Deed Restrictions**

Based on the evaluation present in Subsection 7.2, deed restrictions will be placed on a number of site areas to control intrusive activities and/or future building construction.

In addition, a site-wide deed restriction will be placed on the property limiting future land use to industrial activities. A description of the deed restrictions to be established is presented in Section 8. Also presented in Section 8 is a comparative analysis of the proposed deed restrictions to the MDEQ criteria. This comparative analysis will be used to determine if the proposed deed restrictions will meet the RAOs for the site.

## 8. Detailed Evaluation of Alternative

### 8.1 General

This section presents information relevant to the evaluation of the deed restriction alternative selected for the site, followed by a brief description of the proposed IRAs for the Saginaw River Berm Area and the DRA/Hillock Area. The deed restriction alternative is described in detail and is evaluated with respect to criteria specified in MDEQ ERD regulation R299.5513. In addition, the NCP and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, (USEPA, 1988) were also referenced in preparation of this section. The evaluation criteria set forth in MDEQ ERD R299.5513 and the NCP, while categorized differently, are very similar, as identified in the following table.

| MDEQ ERD R299.5513 Criteria                                                                                                                                                                                                                                                       | NCP Criteria                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Refinement and specification of alternatives in detail                                                                                                                                                                                                                            | No specific NCP criteria; however, a technical description is typically provided to present the remedial alternative |
| Analysis of the extent to which the alternative attains a degree of cleanup or control of hazardous substances that complies with legally applicable or relevant and appropriate requirements, rules, criteria, limitations, and standards of state and federal environmental law | Compliance with ARARs                                                                                                |
| Assessment of the effectiveness of the alternative in protecting the public health, safety, welfare, and the environment                                                                                                                                                          | Overall protection of human health and the environment                                                               |
| Analysis of the risks and impacts remaining after implementation of the remedy                                                                                                                                                                                                    | Long-term effectiveness and permanence                                                                               |
| Analysis of whether recycling, reuse, waste minimization, waste biodegradation, waste destruction, or other advanced, innovative, or alternative technologies are appropriate                                                                                                     | Reduction of toxicity, mobility, and volume through treatment                                                        |
| An analysis of any adverse environmental impacts, methods of mitigation, and costs of mitigation, including those adverse impacts which may result from planned demolition activities                                                                                             | Short-term effectiveness                                                                                             |
| Evaluation in terms of engineering implementation, reliability, and constructability.<br>Evaluation of technical feasibility                                                                                                                                                      | Implementability                                                                                                     |
| Detailed cost estimation, including operation and maintenance costs, distributed over time, of implementing the final remedy                                                                                                                                                      | Cost                                                                                                                 |

A detailed evaluation of the deed restriction alternative compared to the above-listed MDEQ criteria is presented below. As previously discussed in Section 7, the proposed IRAs are not evaluated with respect to the MDEQ criteria.

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## 8.2 Detailed Analysis of Alternative

This section presents the detailed analysis of the deed restrictions. The deed restrictions are evaluated against the criteria described above as applicable. Following the detailed evaluation of the alternative, descriptions of the proposed IRAs for the Saginaw River Berm Area and the DRA/Hillock Area are presented.

### 8.2.1 Deed Restriction

#### Refinement and Specification of Alternative in Detail

This alternative has been developed to minimize future impacts to human health and the environment site wide by limiting future land use activities. GM will institute a deed restriction throughout the site to restrict future land use to industrial use, and restrict potential future use of groundwater either under GM ownership or future ownership by another entity. In addition to the site property as a whole being subject to the deed restriction, site-specific areas will also be deed restricted as shown on Figure 8-1, to limit and control future intrusive activities in select areas of the site. Specific areas to be identified in the intrusive activity deed restriction consist of the following:

- The SMI Plant (including the former HQD Area, the I27.7 Area, the former UST #7 Area, the Quench Pit Area, the Melting Department Area, and the LNAPL Assessment and Remediation Area);
- The DRA/Hillock Area;
- The Queens Street Dump Area;
- The Former Railyard Area;
- The Previous Metal Feedstock Area;
- The Type III Landfills; and
- The Green Point Landfill.

In addition, the following two areas of the site will be subject to deed restrictions to ensure that, prior to future building construction, potential volatilization of VOCs from the subsurface is evaluated and addressed:

- The DRA/Hillock Area; and
- The Former UST #7 Area.

The deed restriction will specify that the site remain in industrial type use in the future unless otherwise approved by MDEQ and the land owner. In addition, groundwater associated with the site would be restricted from use as a potable water supply. Intrusive activities (e.g., soil excavation, utility location/relocation, groundwater extraction, etc.) would only be allowed following an assessment by the facility operator of any health and safety requirements to ensure the excavation and placement of potentially impacted soil can be safely performed. The deed restriction will require that activities be conducted in accordance with a site-specific HASP and due care plan. The site-specific HASP would include a description of the site-specific areas and the health and safety concerns associated with each area. The HASP would also describe measures to prevent exposure to impacted media and mitigate occupational hazards. Intrusive activities would require monitoring only as necessary to verify work activities are conducted in compliance with the HASP.

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**Analysis of the Extent to Which the Alternative Attains a Degree of Cleanup or Control of Hazardous Substances that Complies with Legally Applicable or Relevant and Appropriate Requirements, Rules, Criteria, Limitations, and Standards of State and Federal Environmental Law**

The implementation of deed restrictions does not involve the implementation of any remedial activities. However, in the event that intrusive activities are required, those activities would be conducted in accordance with the applicable chemical-, action-, and location-specific ARARs identified in this FS and the HASP.

**Assessment of the Effectiveness of the Alternative in Protecting the Public Health, Safety, Welfare, and the Environment**

Implementation of this alternative would achieve the deed restriction RAOs (minimizing intrusive activities and restricting groundwater use) established for the site and would provide a long-term alternative to protect the public health, safety, welfare, and the environment ensuring intrusive activities at the site were conducted in strict accordance with the HASP.

**Analysis of the Risks and Impacts Remaining After Implementation of the Remedy**

As indicated in the HHE Reports (Appendix A), following institution of the deed restrictions there will be no complete exposure pathways presenting an unacceptable risk at this site. The ERA Report (Appendix B) did not identify significant risks to the environment under the current site conditions.

**Analysis of Whether Recycling, Reuse, Waste Minimization, Waste Biodegradation, Waste Destruction, or Other Advanced, Innovative, or Alternative Technologies are Appropriate**

This alternative does not involve the implementation of any additional remedial measures (beyond the IRAs and deed restrictions), therefore this evaluation criterion is not applicable.

**An Analysis of any Adverse Environmental Impacts, Methods of Mitigation, and Costs of Mitigation, Including Those Adverse Impacts Which may Result From Planned Demolition Activities**

This alternative does not involve the implementation of any additional remedial measures (beyond the IRAs and deed restrictions). As such, no environmental impacts or risks would result from this alternative.

**Evaluation of Technical Feasibility/Evaluation in Terms of Engineering Implementation, Reliability, and Constructability**

The implementation of deed restrictions to limit intrusive activities (in select areas) and groundwater use at the site is technically feasible and can be implemented. Implementation of a site-specific HASP establishes a program to monitor necessary intrusive activities and would prove a reliable means of mitigating potential impacts associated with the intrusive activities at the site.

**Detailed Cost Estimation**

The costs associated with this alternative include preparation of deed restriction documentation and a site-specific HASP. In addition, this alternative includes the preparation of a monitoring program associated with potential future intrusive activities as deemed necessary by GM (or future land owners). The estimated cost of this alternative is approximately \$50,000.

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### 8.3 Soil Excavation and Erosion Control IRA

This IRA would address the select manganese-impacted surface soils within the Saginaw River Berm Area through excavation followed by implementation of erosion control measures to mitigate berm erosion by surface-water runoff. The general site location of the soil excavation and erosion control IRA is shown on Figure 8-2. Based on information presented in the RI Report and the HHE Report, soil associated with soil borings SB-378, SB-380, and SB-381 would be excavated to a depth of 0.5 to 1 foot below surrounding grade. The areas identified for soil removal contain manganese-impacted soil that exceed the SSCC established for manganese (as part of the HHE) indicating a potential inhalation risk. The approximate horizontal extent of the surface soil excavation areas is presented on Figure 8-3. Following implementation of the soil removal IRA, GM will evaluate the need for future vehicular traffic deed restrictions or excavation verification sampling.

Excavation of the impacted surface soil would generally be conducted using conventional construction equipment (e.g., a backhoe). Under this IRA, approximately 65 cubic yards of soil would be excavated. Excavated areas would be backfilled and compacted with clean soil fill materials.

The erosion control portion of the IRA would consist of activities to stabilize select areas and limit the potential for future erosion of the berm adjacent to the access road in the vicinity of the Secondary Settling Pond as shown on Figure 8-2. This upper portion of the berm has evidence of erosion, likely attributable to surface-water runoff from the access road during rain events. The surface area of the berm is approximately 1,800 feet long and up to 25 feet wide and exhibits a slope of approximately 1:1 (horizontal to vertical). There currently exists a vegetative (grass, brush, trees) cover in this area. Based on a visual review of the Saginaw River berm, up to 40% (or 18,000 square feet) of the berm is estimated to require stabilization to address the erosion from surface-water runoff.

Areas requiring stabilization would undergo clearing and grubbing as needed to remove existing vegetation (except for major trees). The areas would then be graded to fill existing rills and provide a smooth and level surface. A permanent erosion control mat consisting of polypropylene netting and a coconut fiber blanket would be installed and secured over the graded area to mitigate future erosion. Finally, a 6-inch layer of topsoil would be placed over the erosion control mat, followed by seed and mulch to reestablish a vegetative cover.

Concurrent with the berm stabilization activities, a drainage swale would be excavated along the top of the berm parallel to the access road (1,800 feet in length). Following excavation of the drainage swale, a 6-inch layer of topsoil, followed by seed and mulch, would be installed within the swale. At the south end of the drainage swale, a drainage inlet (with lawn grate) would be installed in the swale to collect the surface water runoff entering the swale. A pipe connected to the inlet would be installed beneath the access road and would convey collected surface-water runoff to the Stormwater Pond.

### 8.4 DRA/Hillock Area

In order to mitigate future VOC impacts to soil and groundwater within the DRA/Hillock Area from the offsite source, GM will address the DRA/Hillock Area using phytoremediation techniques. Initially, the pipe would be capped at the site boundary to prevent future discharge to the area from the offsite source. Next, poplar trees will be planted within the area to promote attenuation and/or removal of VOCs in the groundwater by removing the shallow perched groundwater in the area (associated with the offsite source). Groundwater monitoring would be conducted to evaluate the effectiveness of the IRA.

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## ***Tables***

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Table 4-1

**General Motors Corporation**  
**Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area**  
**Saginaw, Michigan**

**Constituent Concentrations Detected Above Generic MDEQ**  
**Groundwater Surface Water Interface Values**  
**Saginaw River Perimeter Permanent Monitoring Well Data**

| Chemical Constituent       | Well ID  | Sampling Date | Concentration in ug/L | Turbidity (NTU) | Generic MDEQ GSI Value (ug/L) |
|----------------------------|----------|---------------|-----------------------|-----------------|-------------------------------|
| VOCs                       |          |               |                       |                 |                               |
| xylene                     | MW-6CAUG | 7/13/1995     | 56 J                  |                 | 35                            |
|                            |          | 6/9/1996      | 15                    |                 |                               |
|                            |          | 5/22/2000     | 13                    |                 |                               |
| SVOCs                      |          |               |                       |                 |                               |
| bis(2-ethylhexyl)phthalate | MW-111WT | 7/14/1995     | 54                    |                 | 32                            |
|                            |          | 6/12/1996     | ND (5.0)              |                 |                               |
|                            |          | 5/19/2000     | ND (5.0)              |                 |                               |
| phenol                     | MW-111S3 | 6/10/1996     | 6,200 D               |                 | 210                           |
|                            |          | 5/19/2000     | 33                    |                 |                               |
| PCBs (total)               |          |               |                       |                 |                               |
|                            | MW-108S1 | 7/13/1995     | 0.22                  | 14              | 0.2 {J,M}                     |
|                            |          | 6/8/1996      | ND (0.20)             | 2               |                               |
|                            |          | 3/10/1997     | ND (0.20)             | 0               |                               |
|                            |          | 6/29/1999     | ND (0.10)             | 0.2             |                               |
|                            |          | 5/23/2000     | ND (0.20)             | 6.1             |                               |
|                            | MW-111WT | 7/14/1995     | 0.41                  | 421             |                               |
|                            |          | 6/12/1996     | ND (0.20)             | 17              |                               |
|                            |          | 3/7/1997      | 0.28                  | 150             |                               |
|                            |          | 6/30/1999     | 0.11                  | 9               |                               |
|                            |          | 5/19/2000     | ND (0.20)             | 2.0             |                               |
|                            |          | 4/5/2001      | ND (0.20)             | 1.6             |                               |
|                            | MW-112WT | 7/17/1995     | 5.3                   | 642             |                               |
|                            |          | 6/12/1996     | 0.29                  | 12              |                               |
|                            |          | 9/27/1996     | 0.28                  | 17              |                               |
|                            |          | 3/5/1997      | ND (0.20)             | NA              |                               |
|                            |          | 6/30/1999     | 0.58                  | 1.1             |                               |
|                            |          | 5/20/2000     | ND(0.20)[ND(0.20)]    | 9               |                               |
|                            |          | 4/5/2001      | 0.20 [0.24]           | 1.04            |                               |
|                            | B-7R     | 7/17/1995     | 0.34                  | 106             |                               |
|                            |          | 6/13/1996     | ND(0.20)[ND(0.20)]    | 6               |                               |
|                            |          | 3/5/1997      | 0.25 [0.27]           | NA              |                               |
|                            |          | 6/29/1999     | ND (0.10)             | 0.2             |                               |
|                            |          | 5/20/2000     | ND (0.20)             | 2               |                               |
|                            |          | 4/5/2001      | ND (0.20)             | 1.6             |                               |
|                            | MW-114WT | 6/8/1996      | ND (0.20)             | NA              |                               |
|                            |          | 3/6/1997      | 0.41                  | NA              |                               |
|                            |          | 5/22/2000     | ND (0.20)             | 0               |                               |
|                            |          | 4/5/2001      | ND (0.20)             | 0.32            |                               |

See Notes on Page 3.

Table 4-1

**General Motors Corporation**  
**Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area**  
**Saginaw, Michigan**

**Constituent Concentrations Detected Above Generic MDEQ**  
**Groundwater Surface Water Interface Values**  
**Saginaw River Perimeter Permanent Monitoring Well Data**

| Chemical Constituent               | Well ID    | Sampling Date | Concentration in ug/L | Turbidity (NTU) | Generic MDEQ GSI Value (ug/L) |
|------------------------------------|------------|---------------|-----------------------|-----------------|-------------------------------|
| PCBs (total) - cont'd.             |            |               |                       |                 |                               |
|                                    | MW-110WT   | 6/12/1996     | ND (0.20)             | 13              |                               |
|                                    |            | 3/6/1997      | 0.23                  | 7               |                               |
|                                    |            | 5/22/2000     | ND (0.20)             | 0               |                               |
|                                    | MW-110WTR  | 11/27/2001    | ND (0.20)             | 0               |                               |
|                                    |            |               |                       |                 |                               |
|                                    | MW-111S4   | 7/14/1995     | 0.21                  | 7               |                               |
|                                    |            | 6/10/1996     | ND (0.20)             | 30              |                               |
|                                    |            | 3/7/1997      | ND (0.20)             | 100             |                               |
|                                    |            | 7/2/1999      | ND (0.20)             | 0.1             |                               |
|                                    |            | 5/23/2000     | ND (0.20)             | 0               |                               |
| MW-185WT                           | 11/27/2001 | ND (0.20)     | 0                     |                 |                               |
| Inorganic Constituents (dissolved) |            |               |                       |                 |                               |
| manganese                          | MW-149WT   | 6/12/1996     | 3,180                 |                 | 2,100 {B,G,X}*                |
|                                    |            | 5/21/2000     | 915                   |                 |                               |
|                                    | MW-111WT   | 7/14/1995     | 1,800                 |                 |                               |
|                                    |            | 6/12/1996     | 3,910                 |                 |                               |
|                                    |            | 6/30/1999     | 2,000 J               |                 |                               |
|                                    |            | 9/2/1999      | 2,200                 |                 |                               |
| copper                             | MW-108S4   | 7/13/1995     | 31                    |                 | 26 {G}*                       |
|                                    |            | 6/8/1996      | ND (25)               |                 |                               |
|                                    |            | 5/21/2000     | ND (25)               |                 |                               |
| arsenic                            | MW-149WT   | 6/12/1996     | 230                   |                 | 150 {B,X}                     |
|                                    |            | 5/21/2000     | 6.0 B                 |                 |                               |
| thallium                           | MW-149WT   | 6/12/1996     | 2.0 UJ                |                 | 3.7 {B,X}                     |
|                                    |            | 5/21/2000     | 6.4 B                 |                 |                               |
|                                    | MW-108WT   | 7/13/1995     | ND (2.0)              |                 |                               |
|                                    |            | 6/8/1996      | 4.0 UJ                |                 |                               |
|                                    |            | 5/21/2000     | 5.3 B                 |                 |                               |
|                                    | MW-112WT   | 7/17/1995     | ND (2.0)              |                 |                               |
|                                    |            | 6/12/1996     | 2.0 UJ                |                 |                               |
|                                    |            | 6/30/1999     | ND (1.0)              |                 |                               |
|                                    |            | 9/2/1999      | ND (1.0)              |                 |                               |
|                                    | X-4AR      | 5/20/2000     | 5.9 B                 |                 |                               |
|                                    |            | 7/24/1995     | ND (2.0)              |                 |                               |
|                                    |            | 6/9/1996      | 2.0 UJ                |                 |                               |
|                                    |            | 5/21/2000     | 4.6 B                 |                 |                               |
|                                    |            |               |                       |                 |                               |

See Notes on Page 3.

Table 4-1

**General Motors Corporation  
Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area  
Saginaw, Michigan**

**Constituent Concentrations Detected Above Generic MDEQ  
Groundwater Surface Water Interface Values  
Saginaw River Perimeter Permanent Monitoring Well Data**

**Notes:**

1. Duplicate sample lab data are shown in brackets.
2. ND (0.20) indicates that the sample was not detected; the quantitation limit is shown in parentheses. Note that where a total PCB quantitation limit of 0.2 ug/L is shown, the quantitation limit of one Aroclor (1232) is 0.4 ug/L.
3. During the sampling event completed in May 2000, at some locations duplicate samples were collected using low-flow and ultra low-flow procedures. All of the samples were ND for PCBs. The turbidity value shown is for the sample collected using ultra low-flow procedures.
4. MDEQ Criteria Qualifiers:
  - {B} = Background, as defined in Rule 299.5701(c), may be substituted if higher than the calculated cleanup criteria. Background levels may not exceed criteria for all inorganic compounds.
  - {G} = GSI value is pH or water hardness dependent.
  - {J} = Hazardous substance may be present in several isomer forms. Isomer-specific concentrations must be added together for comparison to criteria.
  - {M} = Calculated criterion is below the analytical Target Detection Limit (TDL), therefore, the criterion defaults to the TDL.
  - {X} = The GSI criterion shown is not protective for surface water that is used as a drinking water source. For groundwater discharges to the Great Lakes and their connecting waters or discharges in close proximity to water supply intake(s) in inland surface waters, the generic GSI criterion is the Surface Water Human Drinking Water Value (HDV) listed in the table below except for those HDV indicated with an asterisk. For HDV with an asterisk, the generic GSI criterion is the lesser of the HDV, the WV and the calculated FCV (see formulas in footnote {G}). Soil protection criteria based on the HDV are listed below except for those values with an asterisk. Soil GSI protection criteria for compounds with an asterisk are the greater of the 20 X GSI and GSI soil-water partition values using the GSI criteria developed with the procedure described in this footnote.
  - { }\* = Site-specific background value has been used as the constituent criteria value.
5. Laboratory Data Qualifiers:
  - B = (Organic) The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect.  
(Inorganic) The analyte has been positively identified. The concentration is between the instrument detection limit and the required reporting limit.
  - J = The compound/constituent was positively identified; however, the associated numerical value is an estimated concentration only.
  - UJ = The compound/constituent was not detected above the reported sample quantitation limit. However, the reported limit is approximate and may or may not represent the actual limit of quantitation.
  - D = Concentration is based on a diluted sample analysis.

**Table 5-1**

**General Motors Corporation  
Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area  
Saginaw, Michigan**

**Potential Chemical-Specific ARARs**

| <b>Regulation/Description</b>                                                           | <b>Citation</b>                                           | <b>Potential Status</b>  | <b>Summary of Requirements</b>                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Resource Conservation and Recovery Act (RCRA)<br>Hazardous Waste Management Regulations | 40 CFR Parts 260-268                                      | Applicable               | Outlines criteria for determining if a solid waste is a hazardous waste and provides requirements for subsequent management of the waste.                                                                                                                                 |
| Toxic Substances Control Act (TSCA)                                                     | 40 CFR Part 761                                           | Applicable               | Establishes requirements for handling, storage, and disposal of PCB-impacted material.                                                                                                                                                                                    |
| Clean Water Act (CWA) – Discharge to Water of the U.S.                                  | 40 CFR Parts 122, 125, 230, 402, and 403, CWA Section 404 | Relevant and Appropriate | Establishes site-specific constituent limitations designed to protect surface water quality. Types of discharges regulated under CWA include discharge to surface water or ocean, indirect discharge to POTW, and discharge of dredged or fill material into U.S. waters. |
| Water Pollution Control Act (WPCA)                                                      | 40 CFR Part 129                                           | Relevant and Appropriate | Establishes effluent standards for toxic compounds discharged to navigable waters.                                                                                                                                                                                        |
| Federal Surface-Water Quality Criteria                                                  | 40 CFR Part 131                                           | Relevant and Appropriate | Establishes concentrations for discharge of treated water to a surface-water body.                                                                                                                                                                                        |
| MDEQ Interim Environmental Response Division Operational Memorandum #18, June 2000      |                                                           | Applicable               | Establishes cleanup criteria (enforceable under Part 201, Environmental Remediation of the Natural Resource and Environmental Protection Act) for site media based on method of exposure.                                                                                 |
| Michigan Water Resources Protection Rules – Water Quality Standards                     | R323.1041–R323.1117                                       | Relevant and Appropriate | Establishes surface-water quality standards.                                                                                                                                                                                                                              |

**Table 5-1**  
**(Cont'd)**  
**General Motors Corporation**  
**Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area**  
**Saginaw, Michigan**

**Potential Chemical-Specific ARARs**

| <b>Regulation/Description</b>             | <b>Citation</b>           | <b>Potential Status</b>     | <b>Summary of Requirements</b>                                                                                                  |
|-------------------------------------------|---------------------------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Michigan Environmental Remediation Rules  | R324.20101-<br>R324.20140 | Relevant and<br>Applicable  | Establishes rules specifying environmental response, risk assessment, remedial action, and site cleanup criteria.               |
| Michigan Groundwater Quality Rules        | R323.2201-R323.2240       | Relevant and<br>Applicable  | Establishes groundwater quality standards.                                                                                      |
| Michigan Solid Waste Management Rules     | R324.11501-<br>R324.11550 | Relevant and<br>Appropriate | Establishes requirements for solid waste management including waste disposal.                                                   |
| Michigan Hazardous Waste Management Rules | R324.11101-<br>R324.11152 | Relevant and<br>Appropriate | Establishes requirements for hazardous waste generators, transporters, and treatment, storage, and disposal facilities (TSDFs). |

**Table 5-2**

**General Motors Corporation  
Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area  
Saginaw, Michigan**

**Potential Action-Specific ARARs**

| <b>Regulation/Description</b>                                                                                      | <b>Citation</b>              | <b>Potential Status</b>  | <b>Summary of Requirements</b>                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Occupational Safety and Health Administration (OSHA) – Recording and Reporting Occupational Injuries and Illnesses | 29 CFR Part 1904             | Applicable               | These regulations outline recordkeeping and reporting requirements for an employer under OSHA.                                                                                                                  |
| OSHA – General Industry Standards                                                                                  | 29 CFR Part 1910             | Applicable               | These regulations specify the 8-hour time-weighted average concentrations for worker exposure to various organic compounds. Training requirements for workers at hazardous waste operations are also specified. |
| OSHA – Safety and Health Regulations for Construction                                                              | 29 CFR Part 1926             | Applicable               | These regulations specify the type of safety equipment and procedures to be followed during site remediation.                                                                                                   |
| Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities                  | 40 CFR Part 264              | Relevant and Appropriate | These regulations establish minimum national standards that define the acceptable management of hazardous waste.                                                                                                |
| RCRA – Preparedness and Prevention                                                                                 | 40 CFR Parts 264.30 – 264.31 | Relevant and Appropriate | These regulations outline requirements for safety equipment and spill control.                                                                                                                                  |
| RCRA – Contingency Plan and Emergency Procedures                                                                   | 40 CFR Parts 264.50 – 264.56 | Relevant and Appropriate | Provides requirements for outlining emergency procedures to be used following explosions, fires, etc.                                                                                                           |



**Table 5-2**  
**(Cont'd)**  
**General Motors Corporation**  
**Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area**  
**Saginaw, Michigan**

**Potential Action-Specific ARARs**

| <b>Regulation/Description</b>                         | <b>Citation</b>                                             | <b>Potential Status</b>  | <b>Summary of Requirements</b>                                                                                                                                                                                                                              |
|-------------------------------------------------------|-------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CWA – Discharge to Waters of the U.S.                 | 40 CFR Parts 122, 125, 403, 230, and 402<br>CWA Section 404 | Applicable               | Establishes performance standards designed to protect surface water quality. Types of discharges regulated under CWA include discharge to surface water or ocean, indirect discharge to a POTW, and discharge of dredged or fill material into U.S. waters. |
| Transportation Regulations                            | 49 CFR Parts 100, 107, 171-178                              | Relevant and Appropriate | Establishes regulations applicable to transportation of waste material.                                                                                                                                                                                     |
| Michigan Soil Erosion and Sedimentation Control Rules | R323.1701-<br>R323.1714                                     | Relevant and Appropriate | Establishes rules prescribing soil erosion and sedimentation control plans, procedures, and measures.                                                                                                                                                       |
| Michigan Water Resource Protection Rules              | R323.1001-<br>R323.2192<br>R324.3101-<br>R324.3133          | Relevant and Appropriate | Rules established regarding permit requirements for discharges.                                                                                                                                                                                             |
| Michigan Occupational Safety and Health Rules         | Act 154 of 1974 as amended (Parts 1-49)                     | Applicable               | Establishes the rules for safety standards in the workplace.                                                                                                                                                                                                |
| Michigan Wetland Protection Rules                     | R281.921-R281.925                                           | Relevant and Appropriate | Establishes the rules regarding wetland uses and the permit application process for protection of state wetland areas.                                                                                                                                      |

Table 5-3

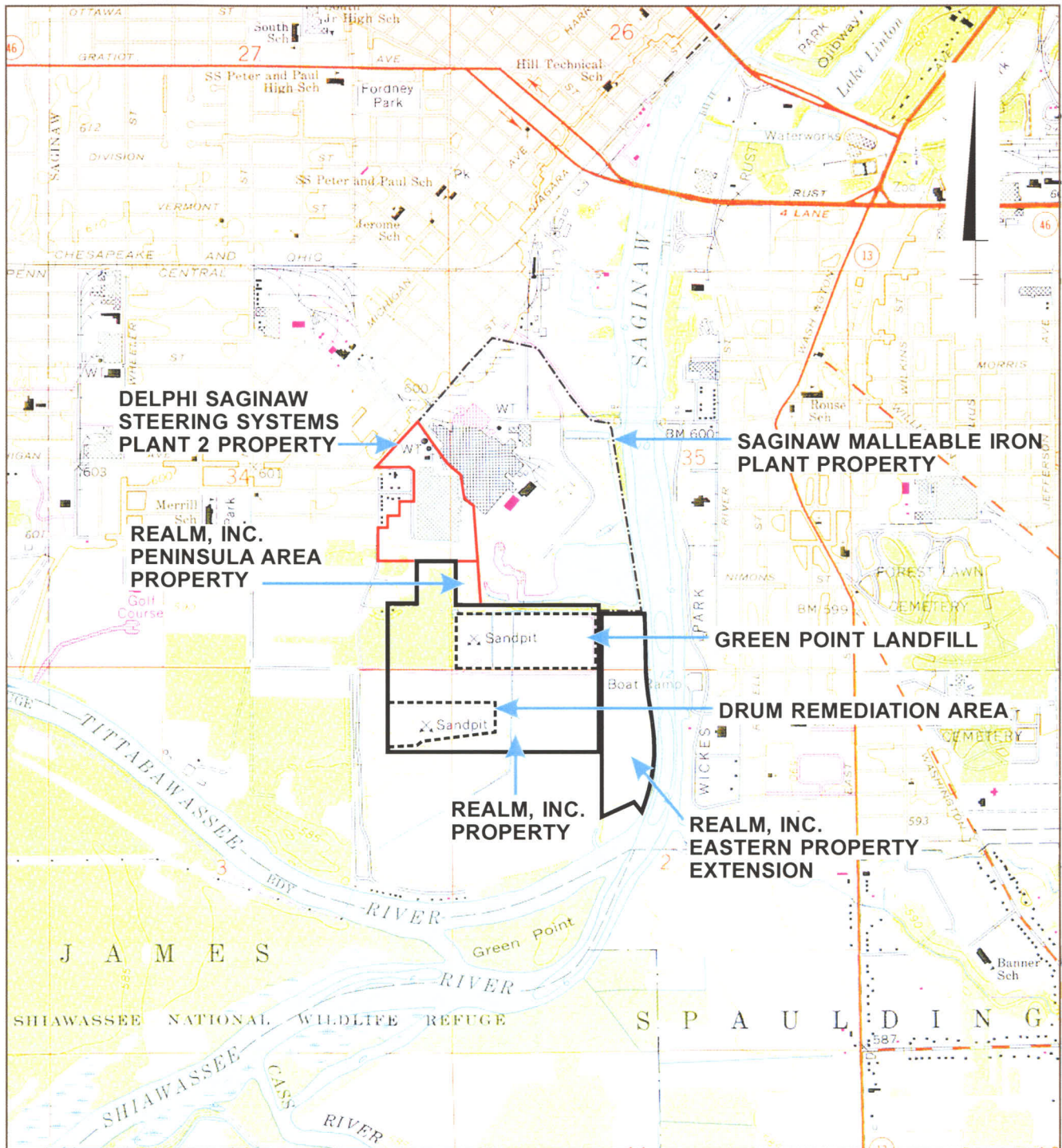
**General Motors Corporation  
Saginaw Malleable Iron Plant Property and REALM, Inc. Green Point Landfill and Drum Remediation Area  
Saginaw, Michigan**

**Potential Location-Specific ARARs**

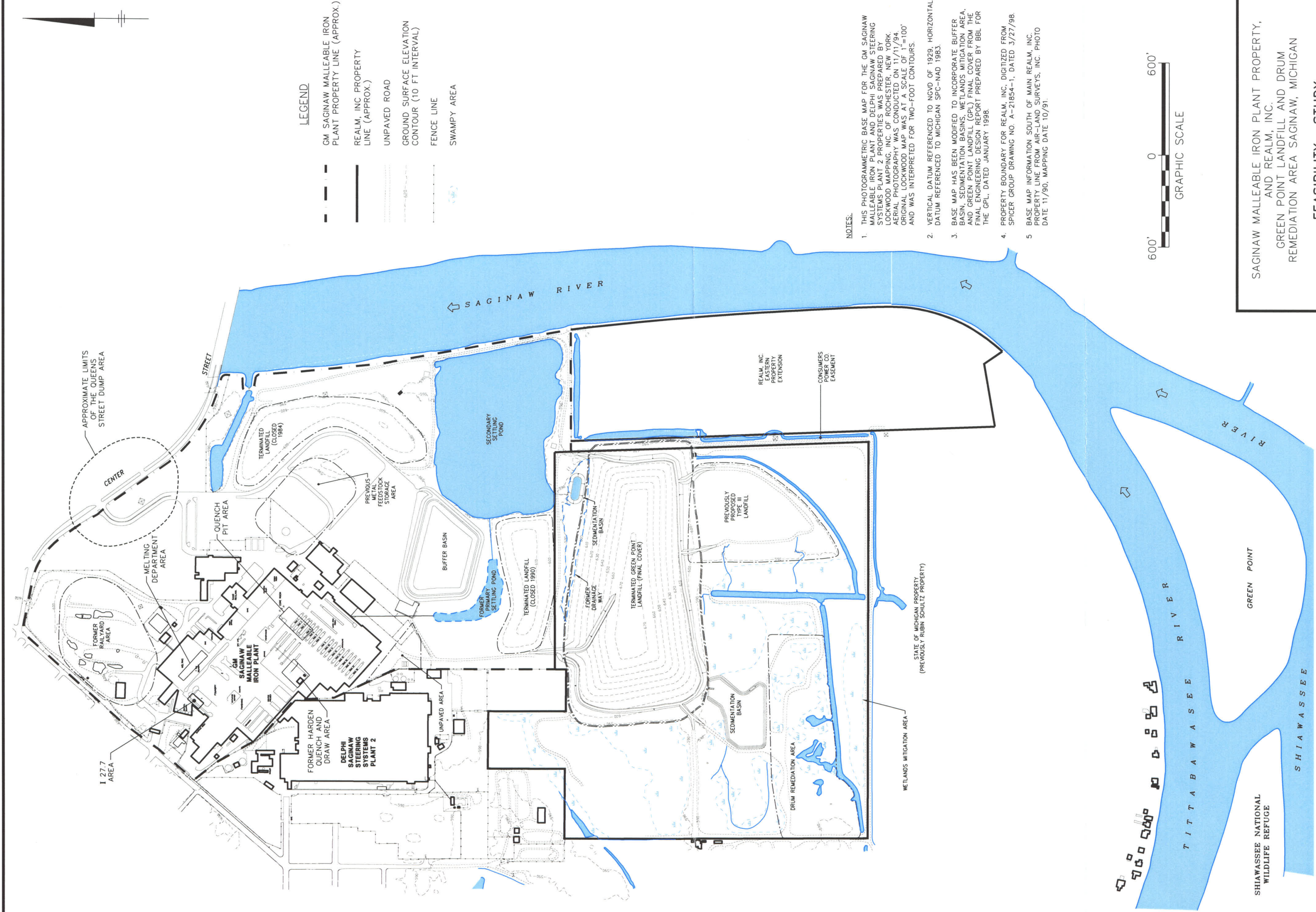
| Regulation/Description                                                                       | Citation                                   | Potential Status         | Summary of Requirements                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------|--------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rivers and Harbor Act                                                                        | 33 CFR Parts 320-330                       | Relevant and Appropriate | Prohibits unauthorized obstruction or alteration of any navigable water in the U.S.                                                                                                                                            |
| USEPA – executive orders:<br>11990 – Protection of Wetlands<br>11988 – Floodplain Management | 40 CFR Part 6.302<br>40 CFR Part 6, App. A | Relevant and Appropriate | Requires federal agencies, where possible, to avoid or minimize adverse impacts of federal actions upon wetlands/floodplains and enhance natural values of such.                                                               |
| Hazardous Waste Facility Located in a Floodplain                                             | 40 CFR Part 264.18(b)                      | Relevant and Appropriate | Describes requirements for treatment, storage, and disposal (TSD) facility built within a 100-year floodplain.                                                                                                                 |
| Clean Water Act                                                                              | Section 404                                | Relevant and Appropriate | Indicates the types of discharge regulated under the CWA, including discharge to surface water or ocean, indirect discharge to a POTW, and discharge or dredged or fill material into waters of the U.S. (including wetlands). |
| U.S. Fish and Wildlife Coordination Act                                                      | 16 USC 661                                 | Relevant and Appropriate | Establishes procedures for conservation of fish and wildlife habitats.                                                                                                                                                         |
| National Historic Preservation Act                                                           | 36 CFR Part 800                            | Relevant and Appropriate | Describes requirements for preservation of historic properties.                                                                                                                                                                |
| Michigan Floodplains and Floodways Rules                                                     | R323.1311-<br>R323.1399                    | Relevant and Appropriate | Establishes regulations pertaining to remedial activities conducted within a floodplain.                                                                                                                                       |
| Michigan Wetland Protection Rules                                                            | R281.921-R281.925                          | Relevant and Appropriate | Establishes the rules regarding wetland uses and the permit application process for protection of state wetland areas.                                                                                                         |

## ***Figures***

---







SHIAWASSEE NATIONAL  
WILDLIFE REFUGE

GREEN POINT

RIVER

RIVER

SHIAWASSEE  
RIVER

SAGINAW MALLEABLE IRON PLANT PROPERTY,  
AND REALM, INC.  
GREEN POINT LANDFILL AND DRUM  
REMEDIATION AREA SAGINAW, MICHIGAN

FEASIBILITY STUDY

SITE PLAN







**Figure 4-2**  
**Summary of PCB Detections over time**  
**Saginaw River Perimeter Wells**

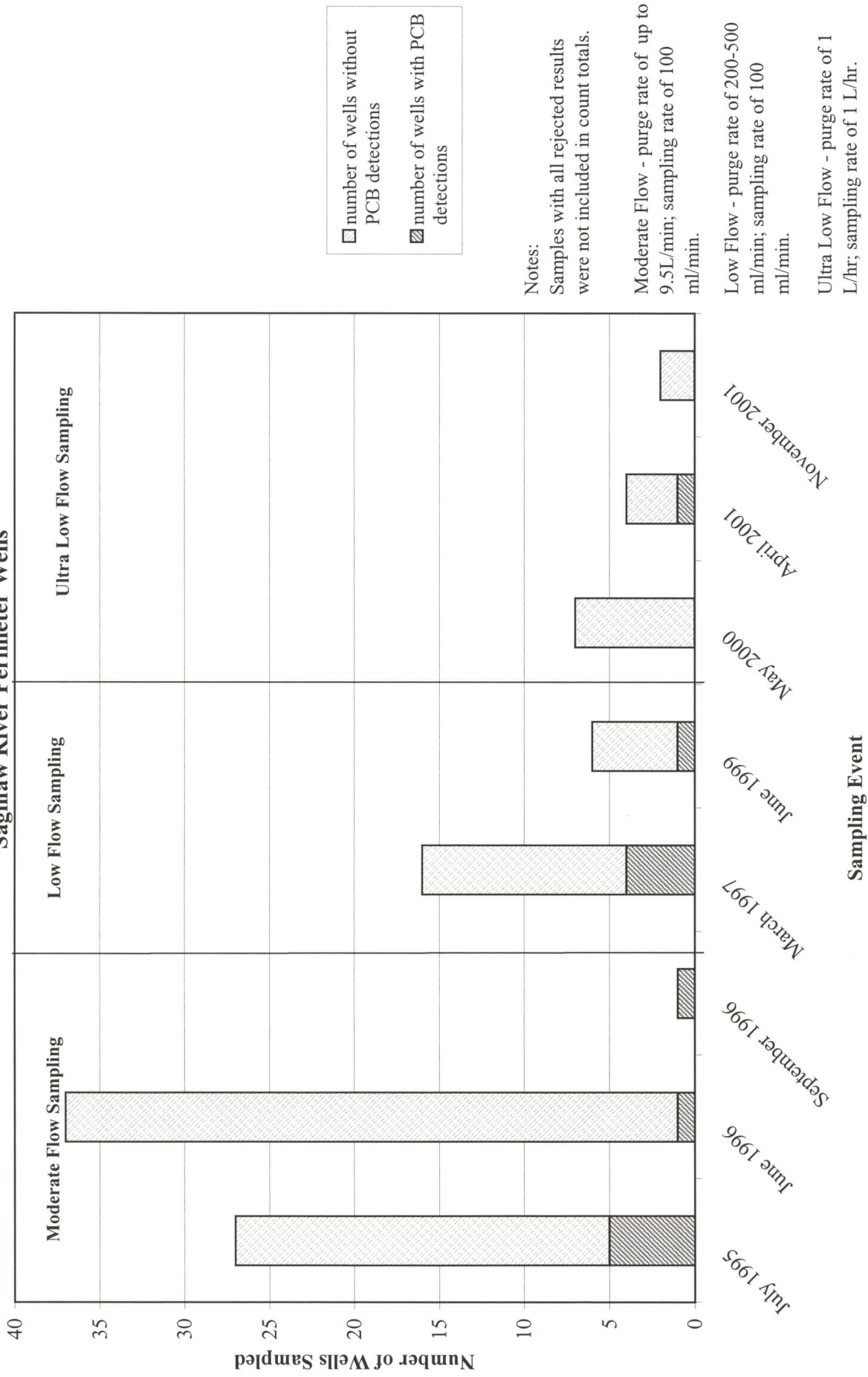
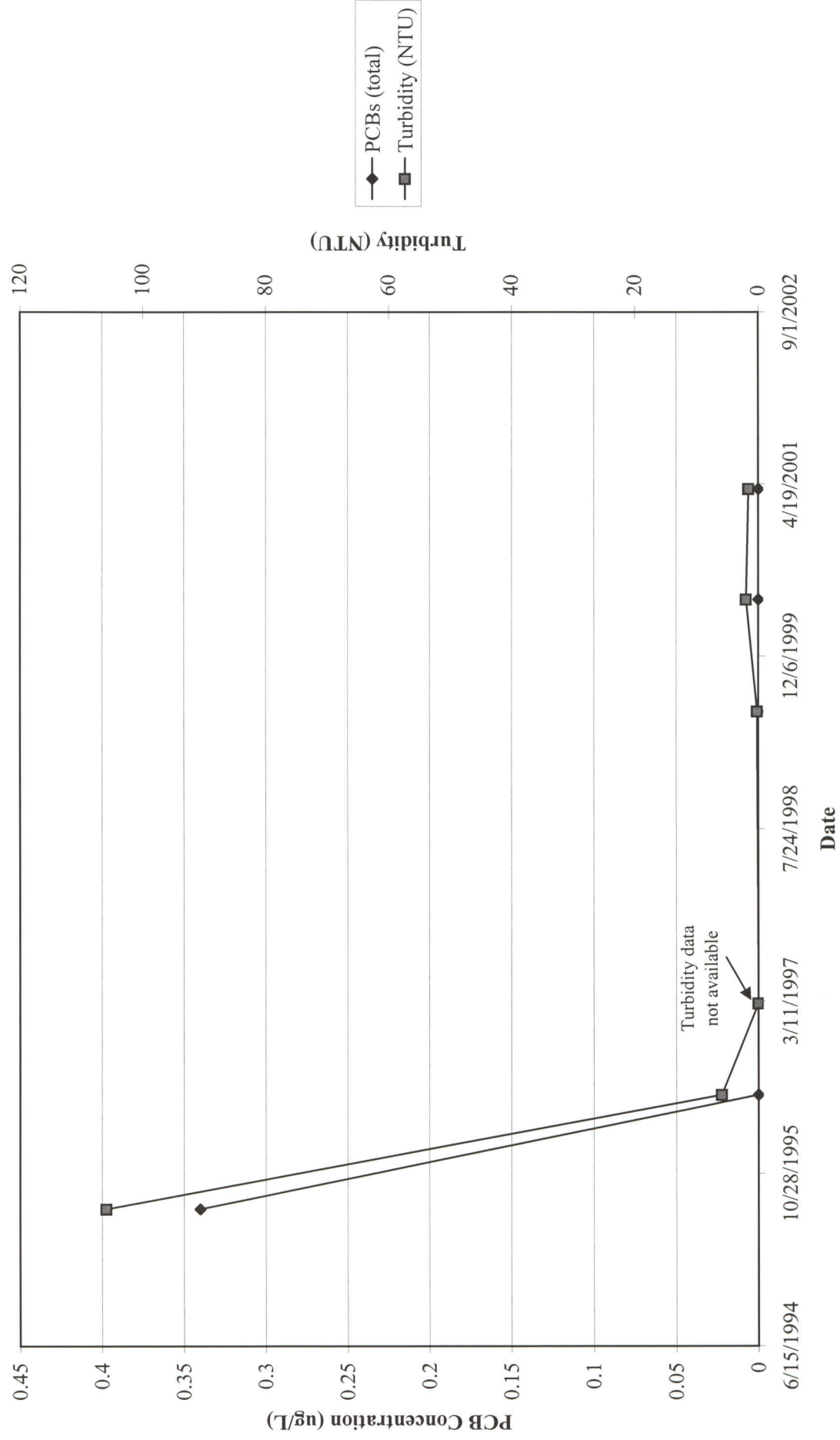
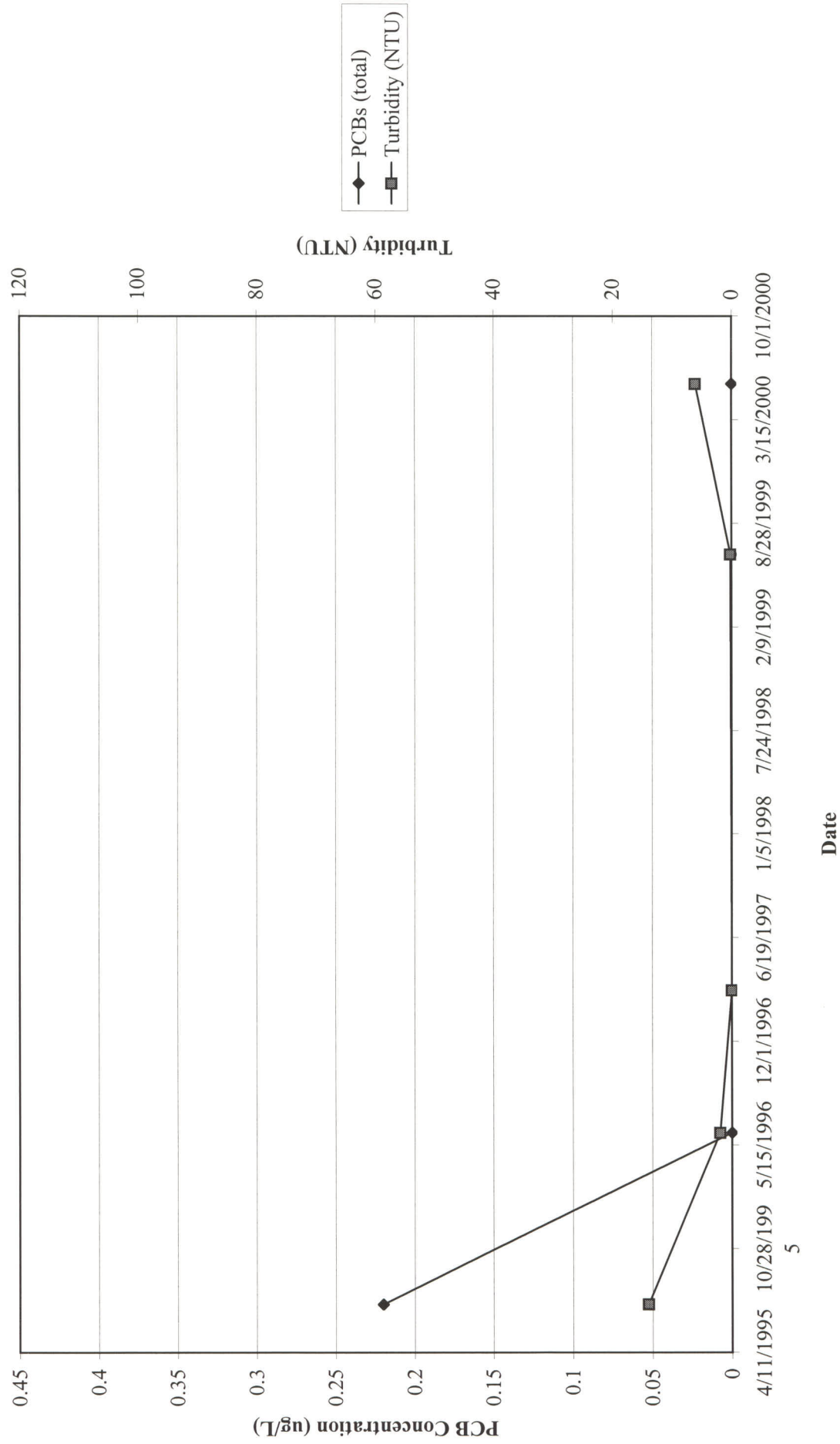


Figure 4-3  
PCB Concentration and Turbidity Over Time  
Monitoring Well B-7R





**Figure 4-4**  
**PCB Concentration and Turbidity Over Time**  
**Monitoring Well MW-108S1**



**Figure 4-5**  
**PCB Concentration and Turbidity Over Time**  
**Monitoring Well MW-110WT / MW-110WTR**

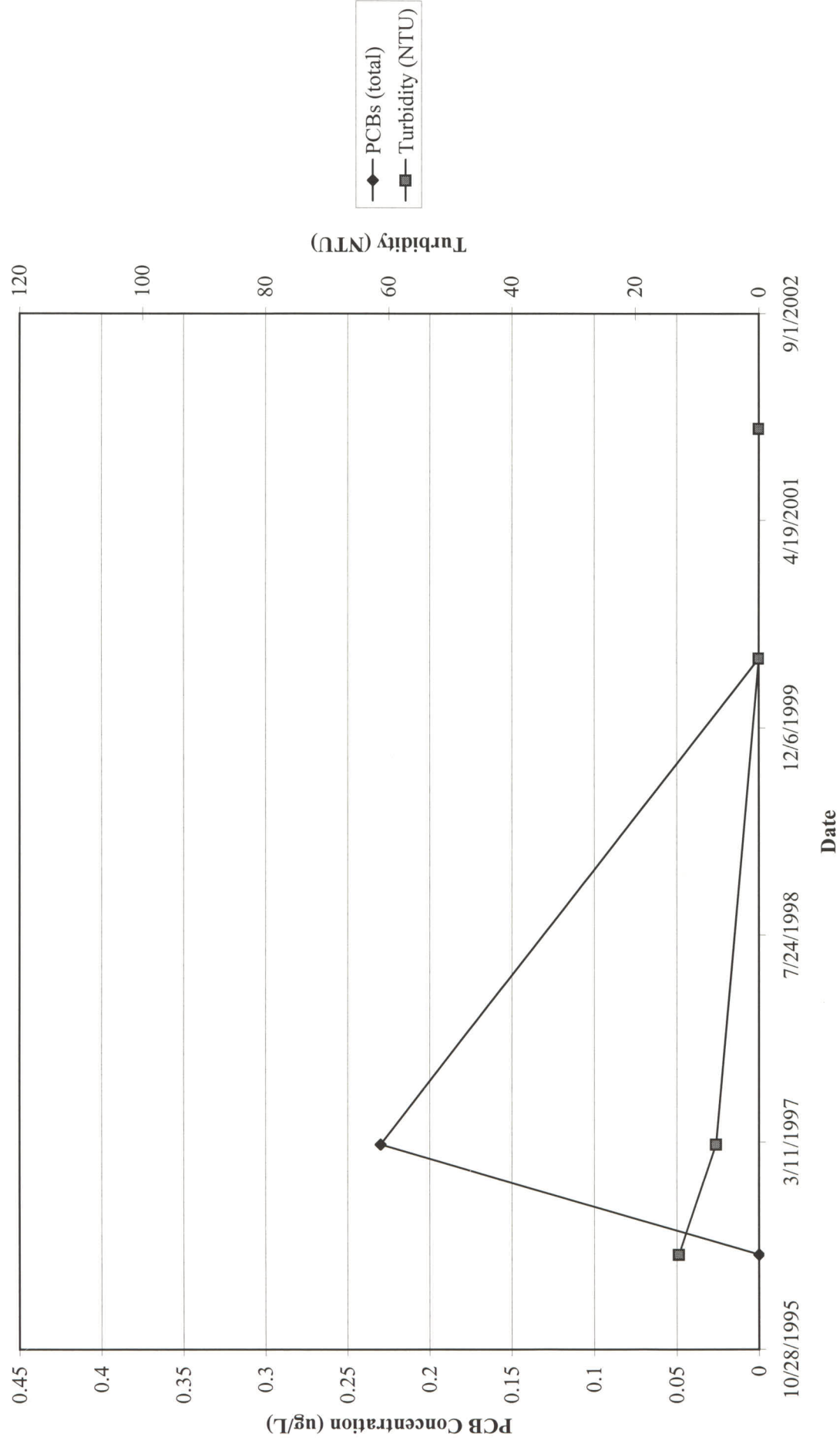


Figure 4-6  
PCB Concentration and Turbidity Over Time  
Monitoring Well MW-111S4

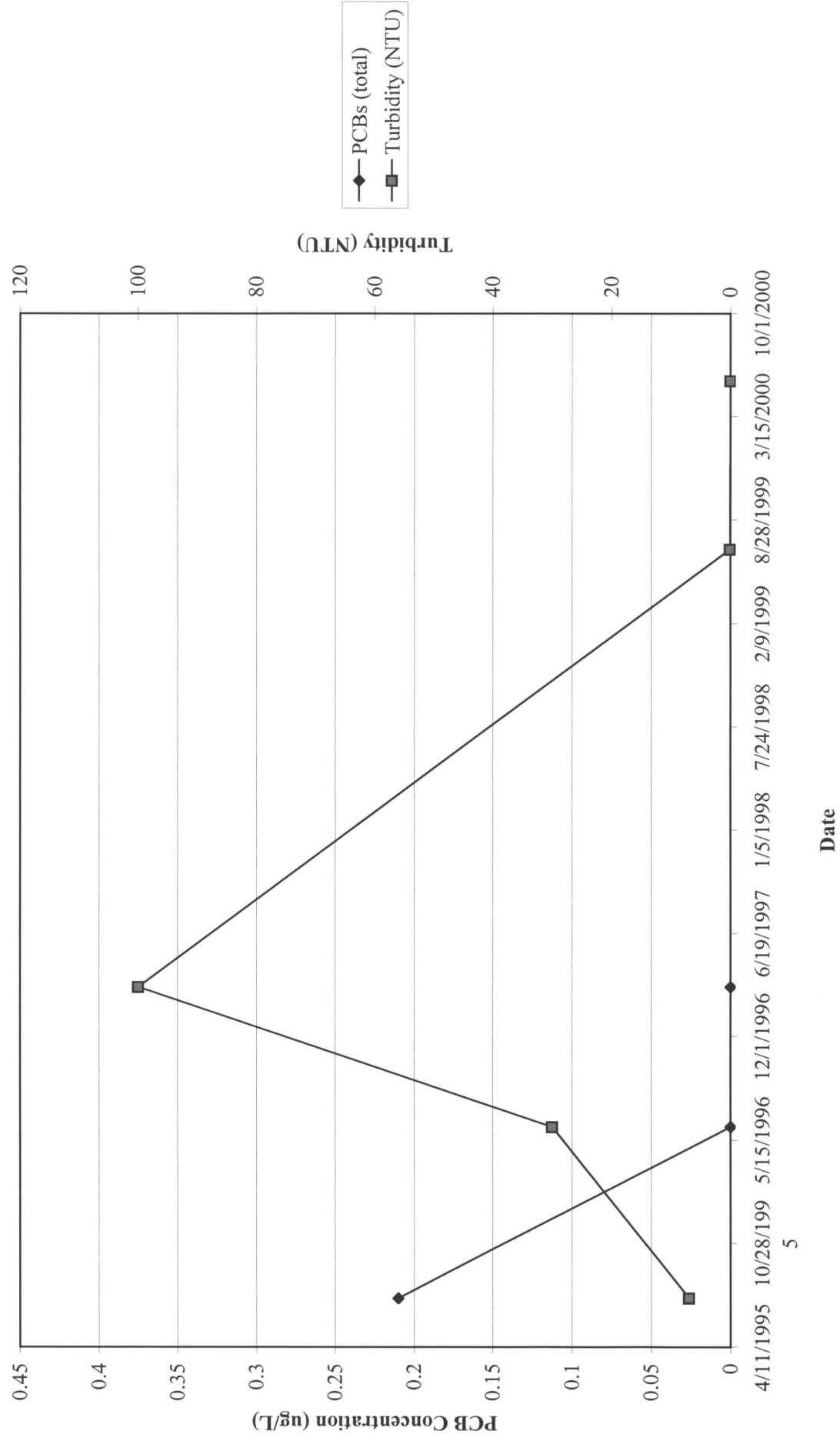


Figure 4-7  
PCB Concentration and Turbidity Over Time  
Monitoring Well MW-111WT

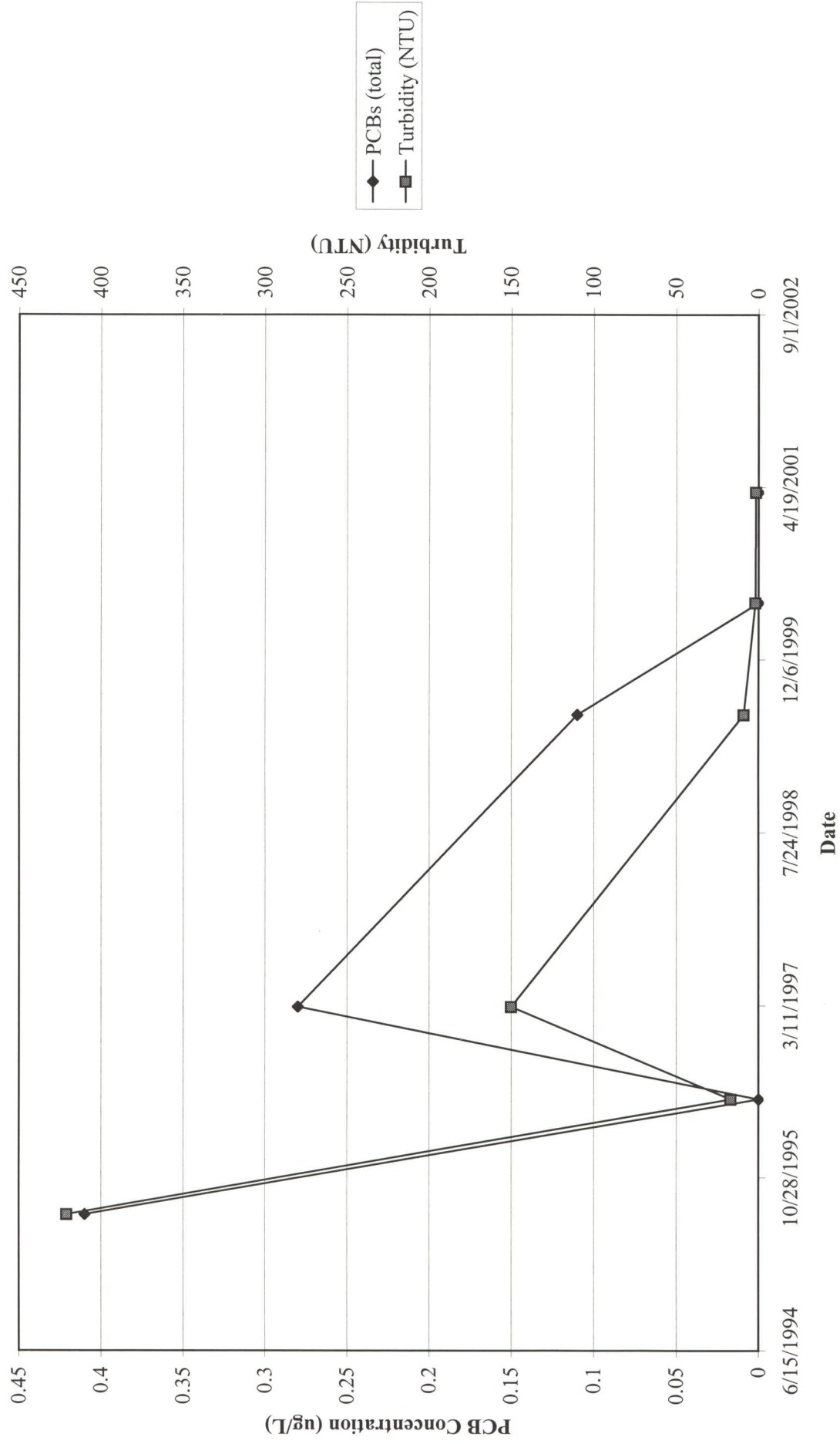


Figure 4-8  
 PCB Concentration and Turbidity Over Time  
 Monitoring Wells MW-112WT and MW-185WT

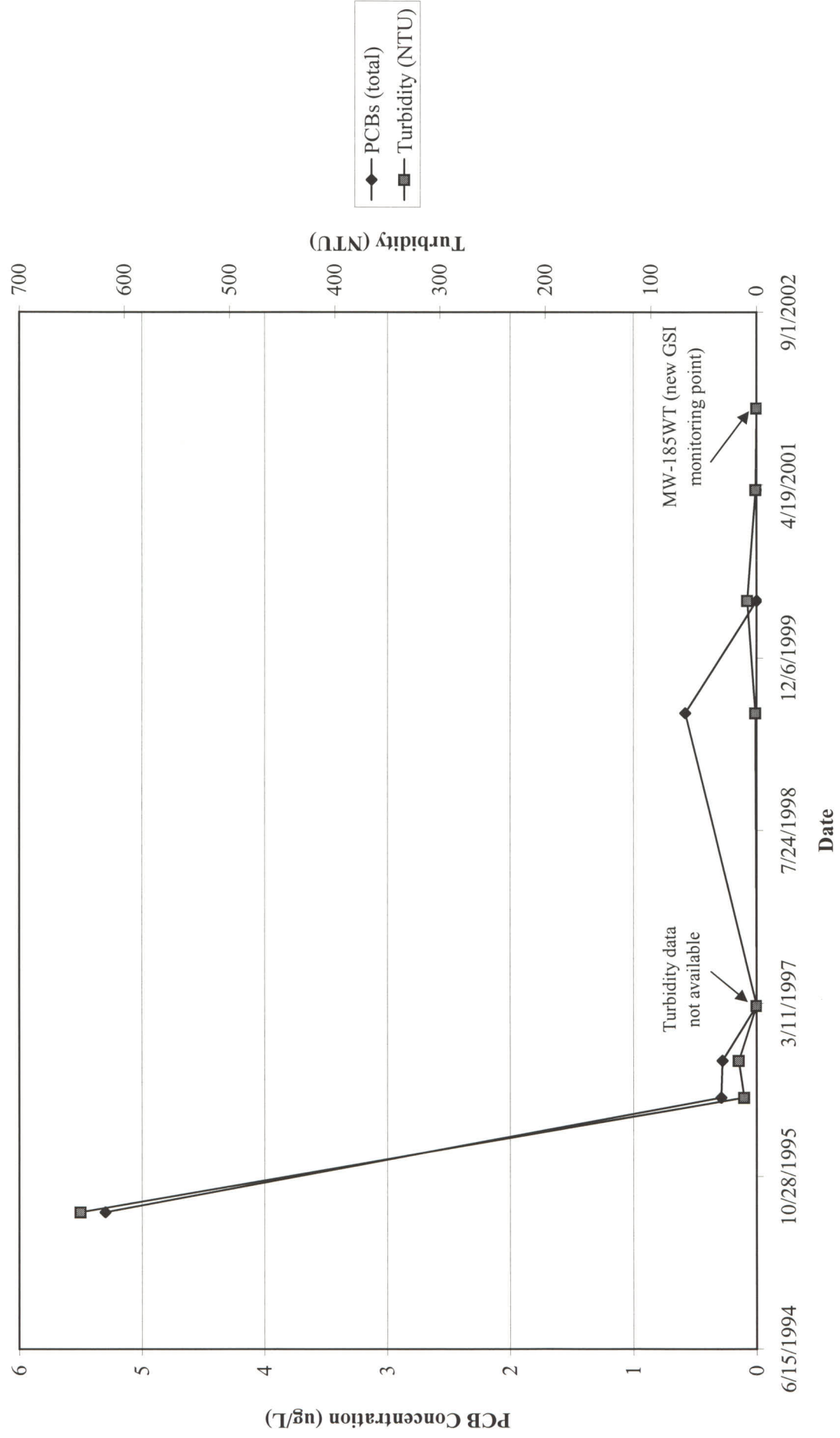
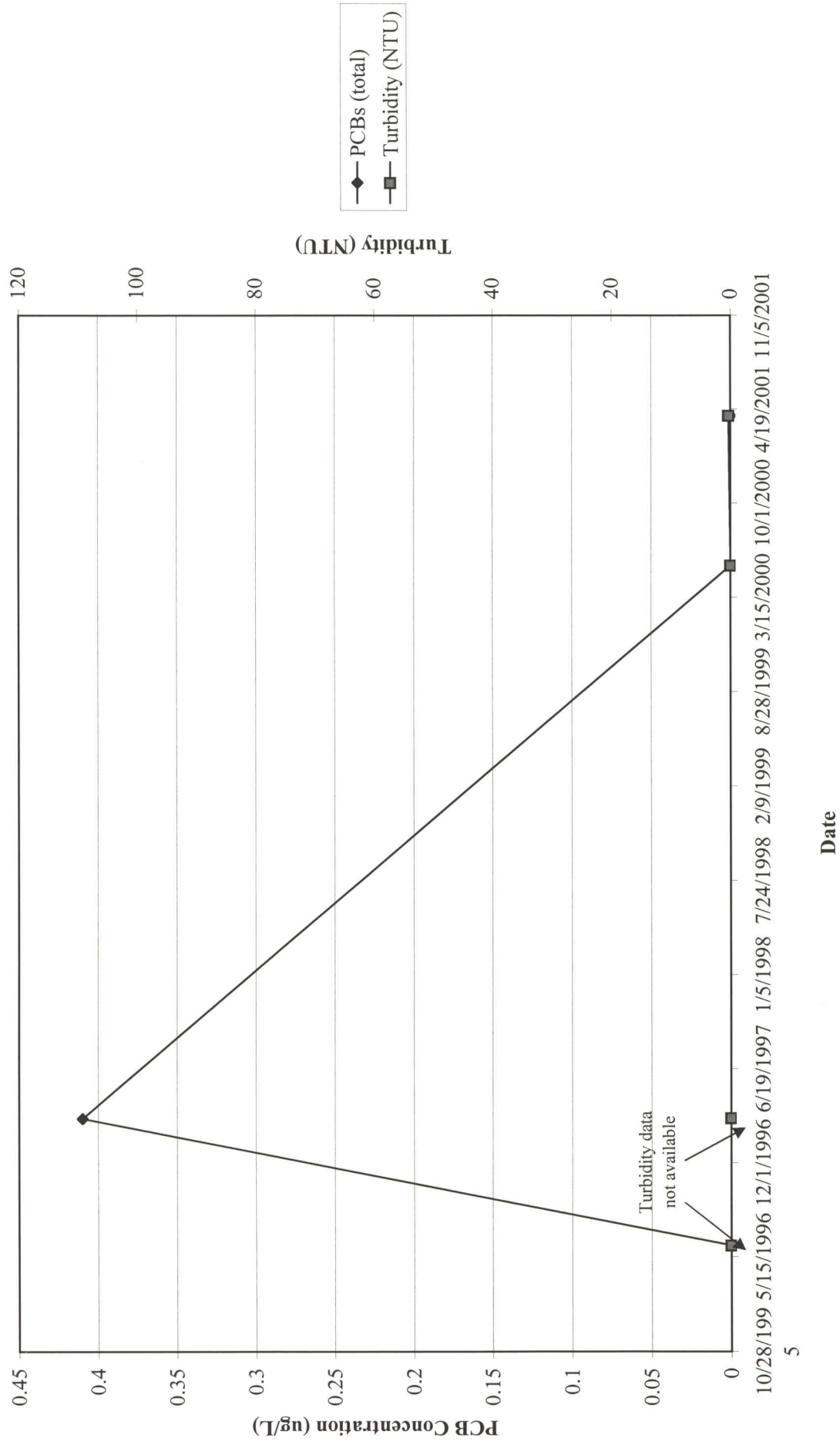
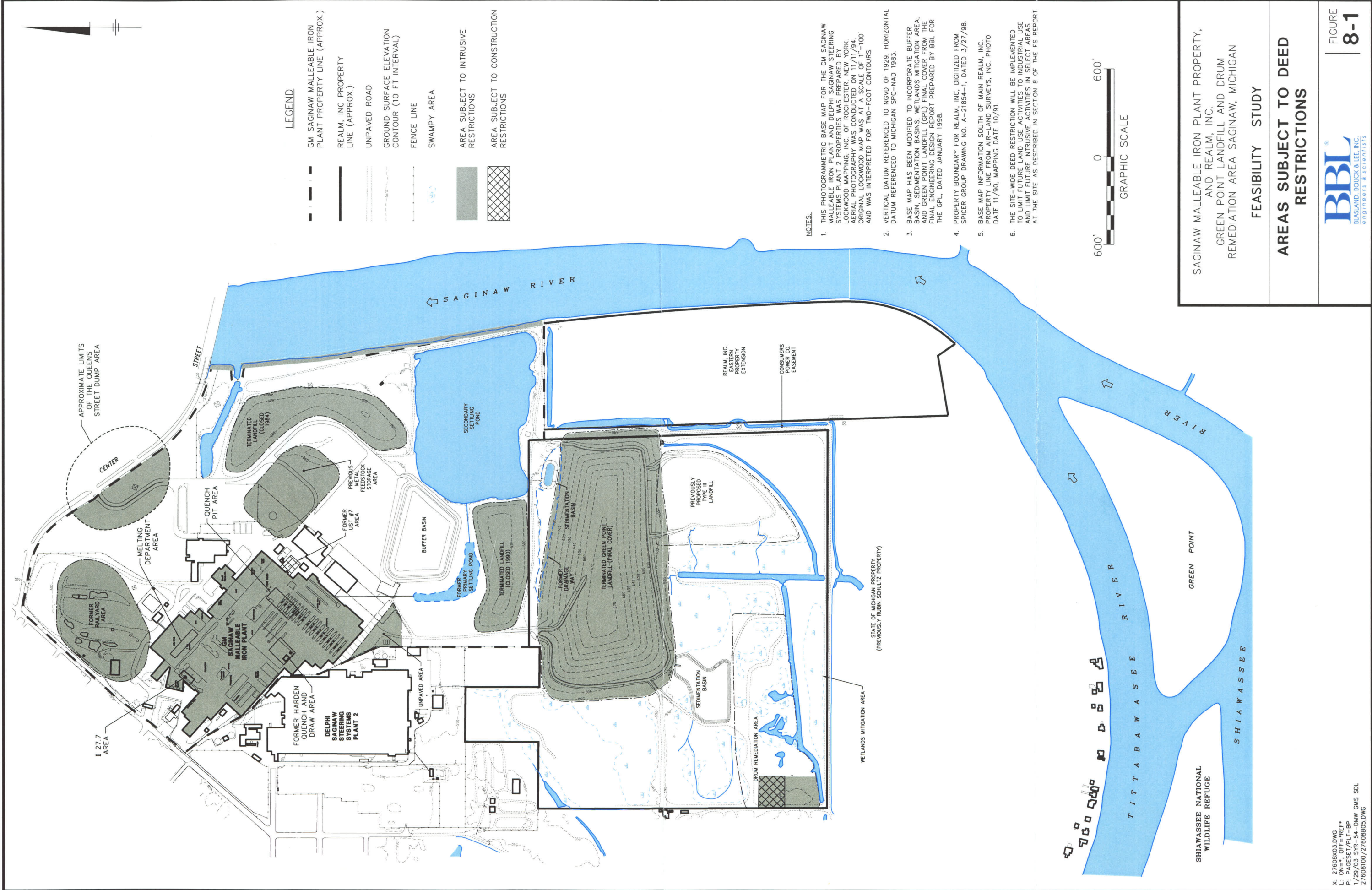


Figure 4-9  
PCB Concentration and Turbidity Over Time  
Monitoring Well MW-114WT







SHIAWASSEE NATIONAL  
WILDLIFE REFUGE

GREEN POINT

RIVER

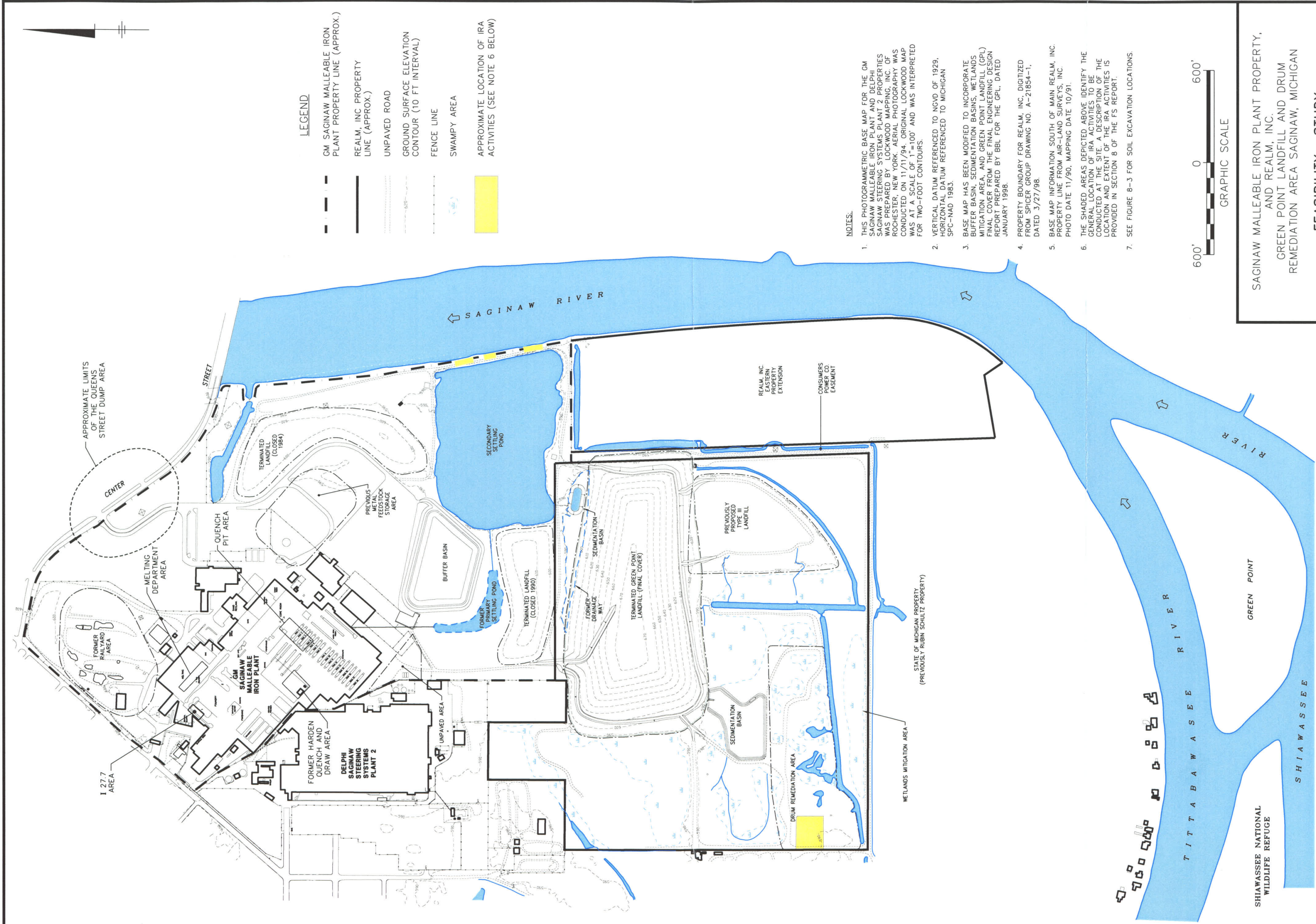
SAGINAW RIVER

SAGINAW MALLEABLE IRON PLANT PROPERTY,  
AND REALM, INC.,  
GREEN POINT LANDFILL AND DRUM  
REMEDIATION AREA SAGINAW, MICHIGAN

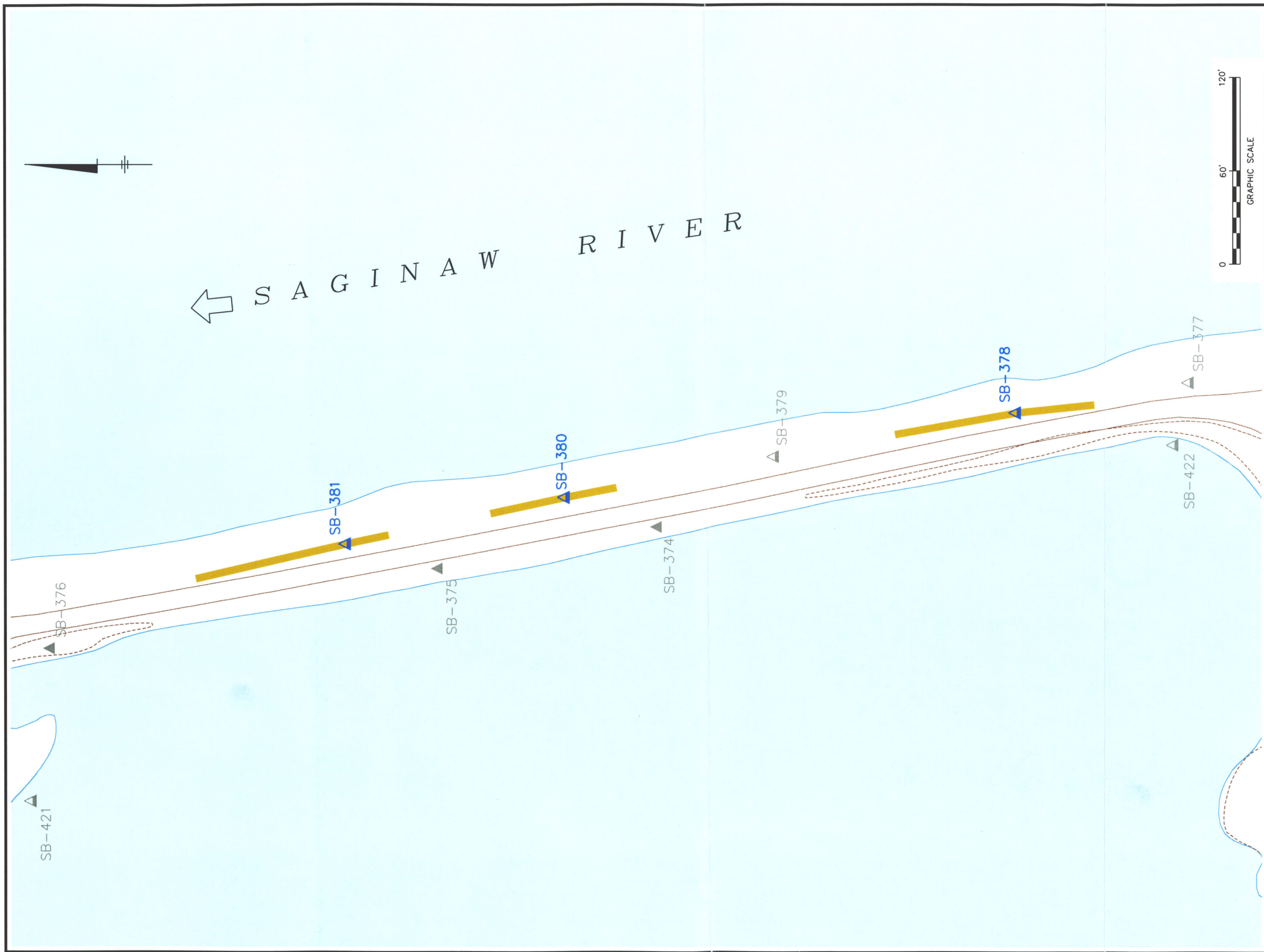
FEASIBILITY STUDY

AREAS SUBJECT TO DEED  
RESTRICTIONS









**NOTES:**

1. ALL LOCATIONS ARE APPROXIMATE.
2. SEE FIGURE 1-2 FOR BASE MAP INFORMATION.

**LEGEND:**

-  SOIL EXCAVATION AREA
-  SB-378 SOIL BORING

SAGINAW MALLEABLE IRON PLANT PROPERTY,  
AND REALM, INC.  
GREEN POINT LANDFILL AND DRUM  
REMEDIATION AREA SAGINAW, MICHIGAN

**FEASIBILITY STUDY**

**SOIL EXCAVATION AND EROSION  
CONTROL IRA - SOIL EXCAVATION  
LOCATIONS**

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

FIGURE  
**8-3**

## ***Appendices***

---

## ***Appendix A***

---

# **Human Health Evaluation Report**

***General Motors Corporation***

***Saginaw Malleable Iron Plant  
Property and REALM, Inc.  
Green Point Landfill and  
Drum Remediation Area  
Saginaw, Michigan***

**Human Health Evaluation Report  
FINAL**

**July 29, 2003**

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# 1. Introduction

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This *Human Health Evaluation Report* (HHE) has been prepared on behalf of General Motors Corporation (GM), its subsidiary, the *Remediation and Liability Management Company, Inc.* (REALM, Inc.), and Waste Management, Inc. (WMI). This HHE addresses the potential for human health risks associated with the GM Saginaw Malleable Iron (SMI) Plant Property, and the southern property owned by REALM, Inc. that includes the Green Point Landfill and Drum Remediation Area (DRA), all located in Saginaw, Michigan. A site map is shown on Figure 1.

The purpose of this HHE is to provide necessary information and determine site-specific, risk-based cleanup objectives to support the development of a land-use based *Feasibility Study* (FS) and, subsequently, a *Remedial Action Plan* (RAP) for this industrial site. The HHE was conducted using information provided in the *Remedial Investigation Report for General Motors Corporation Saginaw Malleable Iron Plant Property, and REALM, Inc. Green Point Landfill and Drum Remediation Area, Saginaw, Michigan* (BBL, 2001) and the following state and federal guidance:

- Michigan Department of Environmental Quality (MDEQ) Part 201 of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended;
- MDEQ Environmental Response Division (ERD) Operational Memorandum #18 (Op Memo 18): Part 201 Generic Cleanup Criteria Tables, Revision 1;
- Risk Assessment Guidance for Superfund (RAGS), Volume I Human Health Evaluation Manual, Part A (USEPA, 1989); and
- Exposure Factors Handbook (USEPA, 1997).

The methodology adopted for this HHE is consistent with the procedures outlined in Op Memo 18. In practice, the methodology is a tiered approach, which starts with a relatively simple analysis and moves to more sophisticated analyses as dictated by initial results.

The chemical constituent concentrations detected at the site were compared to relevant MDEQ cleanup criteria. MDEQ cleanup criteria are based upon types of remedial actions. The MDEQ remedial action types appropriate for this HHE are: *Generic Remedial Actions*, *Facility-Specific Generic Remedial Actions*, and *Site-Specific Remedial Actions*. The first category of cleanup criteria utilized in the MDEQ process is the *Generic Cleanup Criteria*. These criteria are based on generic exposure assumptions that are representative of or exceed the expected exposures for potential receptors. The second category of MDEQ cleanup criteria is the *Facility-Specific Generic Cleanup Criteria* where the generic criteria have been modified based upon facility specific characteristics of the property. This second category is actually a refined subset of the *Generic Cleanup Criteria*. The third category of MDEQ cleanup criteria is the *Site-Specific Cleanup Criteria*. *Site-Specific Cleanup Criteria* are based on alternative exposure assumptions unique to the facility that is the focus of the evaluation. MDEQ cleanup criteria are based on a cancer risk value of  $1 \times 10^{-5}$  (1 in 100,000) or a hazard quotient (HQ) of 1. *MDEQ Generic Cleanup Criteria* were developed by rearranging a typical forward risk assessment equation to determine the chemical concentration that would result in this risk value. This method is presented in the following equations.

$$\text{Risk} = \text{Chemical Concentration} \times \text{Exposure} \times \text{Toxicity}$$

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By rearranging the above risk equation, the following equation is used to determine the chemical concentration that would result from applying the desired MDEQ risk value of  $1 \times 10^{-5}$  or HQ of 1.

$$\text{Chemical Concentration} = \frac{\text{Risk}}{\text{Exposure} \times \text{Toxicity}}$$

Development of *Facility-Specific Generic Cleanup Criteria* and *Site-Specific Cleanup Criteria* follow this same procedure. The only difference is that *Facility-Specific Generic Cleanup Criteria* (FSGCC) are modified based upon site-specific physical characteristics that are not expected to change, and *Site-Specific Cleanup Criteria* are modified based on site-specific exposure assumptions (MDEQ, 2000). The FSGCC evaluation is presented in Section 5.

The procedure used for this HHE is presented as a flow diagram in Figure 2. As a first step in this HHE, site data were organized and the 95% upper confidence limit (UCL) of the arithmetic mean was calculated where appropriate (detailed discussion of the 95% UCL calculation is included in Appendix 9.5). The 95% UCL is considered a conservative estimate of the true arithmetic mean and an acceptable value to use to evaluate chemical exposures (MDEQ, 2001a). Concurrent with this step, a preliminary site exposure conceptual model was developed for the site. All the chemical constituents detected at the GM SMI Plant were then compared to MDEQ *Generic Cleanup Criteria*. This comparison is meant to eliminate from further consideration all chemicals which, because of either low concentrations, low frequency of detection, or low exposure potential are not expected to represent significant human health risks. Comparison of the chemical constituents to MDEQ *Generic Cleanup Criteria* is presented in Section 4.0. Following this step, any chemical constituents found to have concentrations in excess of the MDEQ *Generic Cleanup Criteria* were carried through for a more thorough analysis. Merely exceeding these generic cleanup values did not imply that the concentrations found at the GM SMI Plant represent a significant health risk, only that additional analysis is required.

Complying with MDEQ guidance (Op Memo 18), chemical constituents remaining after comparison to *Generic Cleanup Criteria* were compared to *Facility-Specific Generic Cleanup Criteria* (FSGCC). FSGCC are based on site-specific physical characteristics that are not expected to change, such as groundwater characteristics (MDEQ, 2000).

In accordance with MDEQ guidance (Op Memo 18), *Site-Specific Cleanup Criteria* (SSCC) were developed for those chemical constituents remaining after comparison to the FSGCC during this HHE. The purpose of this subsequent analysis is to provide risk-based concentrations that are more reflective of current and reasonably anticipated future conditions at this facility. The development of the SSCC requires certain modifications to the exposure assumptions and default variables used to derive the MDEQ *Generic Cleanup Criteria*. The specific modifications and the scientific justification for these alternated values are described in Section 6.

The product of the revised algorithms provides the basis of the SSCC comparison. During the SSCC evaluation, the preliminary site exposure conceptual model was revised to specifically address site conditions. The revised site exposure conceptual exposure model was developed to identify potential or suspected sources of chemicals and affected media, potentially exposed populations, and potential exposure pathways. The SSCC are only developed for those constituents that have concentrations exceeding MDEQ *Generic Cleanup Criteria* or *Facility-Specific Generic Cleanup Criteria*. The development of the SSCC is presented in Section 6.5. Once the SSCC are developed for those constituents exceeding the MDEQ *Generic Cleanup Criteria* or *Facility-Specific Generic Cleanup Criteria*, the site data are compared to these site-specific criteria. Any constituent with a concentration exceeding the SSCC requires further evaluation, and will be addressed as part of the Feasibility Study. The results of the SSCC evaluation are presented described in Section 6.6.



## 2. Site Description

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This section provides a general description of the General Motors Corporation (GM) Saginaw Malleable Iron (SMI) Plant and the southern property owned by the Remediation and Liability Management Company, Inc. (REALM, Inc.) that includes the Green Point Landfill, and Drum Remediation Area. REALM is a wholly owned subsidiary of GM. A summary of the site history and physical characteristics is provided in this section. Much of the information presented in this section is presented in more detail in the *Final Remedial Investigation Report* (BBL, 2001) and can be referred to for additional information.

The site is approximately 276 acres in size. On the north side of the property, the site includes the SMI Plant, the Casting Technology Center (CTC) and surrounding ancillary areas, the two closed Type III Landfills, and a former Water Recirculation System (WRS) that includes settling ponds and drainage channels ("SMI Plant Property"). The southern portion of the property (now owned by REALM, Inc.) includes the Green Point Landfill and the former Drum Remediation Area (DRA), where drums were previously discovered, excavated, and removed. Each of these site features is more fully discussed below.

### 2.1 Physical Setting

The site is located approximately 2,000 feet north of the confluence of the Tittabawassee, Shiawassee, and Saginaw Rivers, and is located on the western half of Section 35, T12N, R4E, in the city of Saginaw, Saginaw County, Michigan. The site is bounded to the west by the Delphi Automotive Systems Corporation (Delphi) Saginaw Steering Systems Plant 2 (Plant 2) and a junkyard; to the east by the Saginaw River and property previously used for agricultural purposes (previously owned by Ruben Schultz and the State of Michigan, now owned by REALM, Inc.); to the north by commercial, residential, and industrial properties; and to the south by agricultural property (Figure 1).

The primary site features include: the SMI Plant and CTC; the former WRS, which included the former Primary Settling Pond previously encompassing approximately 2 acres (now that the WRS is no longer operational, the pond is dry and has been graded to form a drainage swale), the Secondary Settling Pond encompassing approximately 16 acres, the Stormwater Pond (also known as the Small Pond), encompassing approximately one acre, and surface drainage channels (the north-south drainage channel was filled in during September 2001); the closed eastern 8-acre licensed Type III Landfill; the closed central 8-acre licensed Type III Landfill; the 30-acre Green Point Landfill; and the DRA with an approximate area of 13 acres. An area in the southeast portion of the site referred to as the Previously Proposed Type III Landfill was never fully developed as a landfill area (a constructed base of inert foundry sand still remains).

The topography of the site is generally flat, with the exception of the closed Type III Landfills and the Green Point Landfill, which are mounded above the surrounding land. The components of the former WRS, including the settling ponds and associated channels, also result in minor topographic variability in the northern part of the site. In the southwest portion of the property, wetlands are present, and a series of ditches provide for drainage throughout the southern portion of the site.

The 100-year floodplain elevation is 594 feet above mean sea level (RMT, November 1980). Many areas of the site, including the former Primary Settling Pond, the Secondary Settling Pond, the lower portions of the licensed Type III Landfills, and the DRA, are below this elevation.

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## **2.2 Site Geology**

The 276-acre GM SMI Plant is located approximately 2,000 feet north of the confluence of the Tittabawassee, Shiawassee, and Saginaw Rivers, within the Central Lowland geomorphic province. The topography of the site is generally flat, with the exception of the mounded landfill areas. The site is underlain by fill material consisting primarily of foundry sand and a sequence of glacial and lacustrine deposits of silty clay and sand. A lower confining unit of silty clay and a discontinuous unit of glacial till overlie bedrock, which lies at a depth of approximately 86 feet below land surface. A full description of the geologic units present at the site is presented in the *Final Remedial Investigation Report* (BBL, 2001).

## **2.3 Site Hydrogeology**

Shallow groundwater at the site exists in an unconfined or "water table" condition. Depth to groundwater varies from 2 to 10 feet below land surface. The sand units present at the site act as the primary pathway for groundwater flow, and pinch out to the west of the site. The Saginaw River primarily controls the regional groundwater flow. The Saginaw River is formed by the confluence of the Tittabawassee and Shiawassee Rivers, approximately 2,000 feet upstream from the southern site boundary, and from regional groundwater and surface water discharge. The Saginaw River flows northward 22 miles to Saginaw Bay of Lake Huron. Bedrock groundwater quality is poor due to the presence of heavy mineralization and would generally be unfit for use as an aquifer due to high concentrations of chlorides, iron, total and dissolved solids, and other minerals (United States Geological Survey [USGS], 1980). A full description of the site hydrogeology is presented in the *Final Remedial Investigation Report* (BBL, 2001).

## **2.4 Site Background/History**

For discussion purposes, the site can be divided into the following general areas of investigation: the SMI Plant and Production Areas, the two Type III Landfills, the former WRS, the Green Point Landfill and the DRA.

### **2.4.1 SMI Plant and Production Areas**

The SMI Plant footprint occupies an area of approximately one million square feet. Manufacturing operations at the plant consist of activities associated with casting and heat-treating iron. Scrap metal is melted and transferred through a series of furnaces before it is placed, as molten metal, into the molds to form the castings. Molds, which form the outer shape of the casting, are formed by putting mold sand (a mixture of lake sand, sea coal, bentonite, and water) under pressure around a die. Cores, which form the internal cavities of a casting, are made by mixing lake sand with a two part resin and then injecting a catalyst into the core box to set up the resin. Once the mold and core are completed, molten metal is placed into the mold to form the casting. After cooling, the mold is broken to remove the casting. The resulting castings are then heat treated and quenched to develop malleability.

The plant has expanded several times during its history. The northern portion of the SMI Plant property was purchased by GM in the early 1970s when the Center Street Bridge was completed over the Saginaw River, and Queen Street was truncated at its intersection with Center Street. Prior to GM's purchase of the property, dumping of municipal waste occurred along the former location of Queen Street (BBL, April 1997).

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## **Underground Storage Tanks (USTs)**

Eleven USTs have previously been identified and removed from the SMI Plant Property. Tank removal activities, which occurred between 1982 and 1991, were completed in accordance with applicable regulatory guidance at the various times of removal. No further action was determined to be necessary to address six of the former UST areas (UST #s 1, 2, 6, 9, 10, and 11). Confirmed releases of petroleum products were reported by GM to the Michigan State Fire Marshall Division for five of the USTs (UST #s 3, 4, 5, 7, and 8), and have been investigated.

## **Former Harden, Quench, and Draw Area**

The former Harden, Quench, and Draw Area (HQD) is located within the southwestern portion of the SMI Plant building. Each of the former HQD units included a quench oil bath used to uniformly cool metal castings. A total of ten HQD units were installed in 1968. Units No. 1 through No. 9 were taken out of service between 1973 and 1991. The remaining unit (No. 10) has been used to test alternative quench oil formulas. Light non-aqueous phase liquid (LNAPL) was observed during 1996 in storm sewer catch basin Q16.5, located within the HQD area, prompting an investigation of the area.

## **Quench Pit Area**

The Quench Pit Area is located in the Annealing Department inside the central portion of the SMI Plant building. The area contains three quench pits, commonly referred to as direct quench pits #1, #2, and #3. Quench pit #1 was installed in 1966. Quench pits #2 and #3 were installed in 1970. The pits are constructed of steel panels that are welded together to form a box or shell. In 1999, a second interior shell was added to each quench pit to provide secondary containment. Each quench pit typically holds approximately 25,000 gallons of quench oil.

## **Former I27.7 Area**

The I27.7 Area is located in the Foundry Department inside the northern portion of the SMI Plant building. During sewer sampling activities within the plant, PCBs were detected sporadically in various sewers in the I27.7 Area, prompting additional investigation of the area.

## **Melting Department Area**

The Melting Department is located in the northeastern portion of the SMI Plant building. The current Melting Department started operation in approximately 1970 to 1975, supplying molten iron for the production of castings. Iron is melted by electric induction melting furnaces that are powered by five separate, numbered power supplies (Power Supply 1, 2, 3, 4, and 5). Although the features associated with each power supply vary, typical features include a control room, transformer room, generator room, hydraulic room, pit, and BUSS tunnel. All the areas in the melting department are restricted access locations as defined in Chapter 40 Section 761.123 of the U.S. Code of Federal Regulations (CFR) (40 CFR § 761.123).

## **LNAPL Assessment and Remediation Area**

An area of light non-aqueous phase liquid (LNAPL) is present at the water table within the Unpaved Area located southwest of the SMI building between SMI and the adjacent Plant 2 Property. This area is in the process of being remediated as an interim response action (IRA) under Part 201.

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### **Previous Metal Feedstock Area**

The Previous Metal Feedstock Area is located east of the SMI Plant, and is partially covered by pavement and partially by lawn. This area was previously used for the storage of metal feedstock.

### **Railyard Area**

The Railyard Area is located north of the SMI Plant. The area is unpaved, and currently is used for the temporary storage of metal feedstock and miscellaneous other process materials and equipment.

### **Unpaved Area**

The Unpaved Area is located south of the SMI Plant building. Three 20,000 gallon aboveground tanks of quench oil are located along the fenced western edge of the area within a concrete secondary containment structure. The area is also used to store roll-off boxes of municipal waste, steel scrap, and miscellaneous other plant materials.

## **2.4.2 Type III Landfills**

The site contains two closed, licensed, Type III industrial solid-waste landfills (referred to as the eastern and central Type III landfills). These two landfills received spent foundry sands, scrubber residues, slag, and other materials approved for Type III disposal (e.g., refractory brick and core butts). The eastern landfill started receiving waste in 1979 and was closed in 1984. The central Type III Landfill received wastes from 1984 (after the closure of the eastern landfill) until approximately 1990, when it was closed. Waste characterization was conducted as part of landfill permit operating requirements. Closure certifications for these two landfills have been filed with the MDEQ. The SMI Plant currently disposes of its solid wastes offsite, as appropriate for the waste.

## **2.4.3 Former Water Recirculation System**

The SMI property contains a former WRS, which received and recirculated non-contact process water, stormwater drainage, and air-scrubber effluents as part of the plant processes. The former system, which was taken off line in January 1997 (when the new Water Recycle System went on line), consisted of three settling ponds (primary, secondary, and stormwater) and associated drainage channels, which connected the ponds and returned flow to the plant. The former Primary Settling Pond was approximately two acres in size, but has dried up since the plant ceased to use the system, and has been regraded. Highly turbid water had been discharged into the former Primary Settling Pond, where most of the solids settled out. The former Primary Settling Pond then gravity drained to the Secondary Settling Pond, which previously occupied approximately 16 acres, and has reduced in size due to reduced inflows. The Secondary Settling Pond then drained via a weir located on its northeastern side. This water traveled north along the north-south oriented drainage channel to the east-west channel. This water was then directed back into the SMI Plant. The north-south channel was filled in during September 2001, and GM intends to fill the east-west channel of the former WRS in the same manner. The Stormwater Pond, located north of the Secondary Settling Pond, received, and continues to receive, stormwater from roof drains and parking lots, and is discharged via a pump system to the Secondary Settling Pond. In the past, the Stormwater Pond has received incidental quantities of quench oils due to leaks from the cooling towers

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and associated lines located on the roof of the SMI Plant, in addition to non-contact process water and scrubber effluents.

#### **2.4.4 Green Point Landfill**

The Green Point Landfill was owned by Ruben Schultz and was operated by various commercial enterprises between the 1950s and 1978. The landfill was reportedly used for the disposal of municipal waste, foundry sand, and unspecified quantities and types of waste from industrial facilities (RMT, 1979). Prior to operation of the eastern Type III Landfill, which began in 1979, foundry materials from the SMI Plant were disposed of at the Green Point Landfill. In 1978, the Green Point Landfill stopped receiving waste and was closed. GM purchased the Green Point Landfill, along with the remainder of the property south of the landfill, in December 1982. The landfill has been capped, consistent with closure requirements for solid waste municipal landfills (Part 115 of Michigan Act 451) and the *Green Point Landfill Final Cover System Certification Report* was submitted to the MDEQ in January 2000.

#### **2.4.5 Drum Remediation Area**

The Drum Remediation Area (DRA) is located in the southwest portion of the SMI property. GM purchased this property in December 1982. In 1987, it first became evident that the area had been used for disposal purposes prior to GM's purchase of the property when several drums were observed at the ground surface following a flood event. There is no evidence to suggest that the drums found in the DRA, or in the vicinity of the DRA came from any GM facility.

Various investigation and response actions have been undertaken to address the DRA. In February 1997, the fill material that made up the portion of the DRA referred to as the DRA hillock were excavated and placed within the Green Point Landfill.

### ***3. Summary of the Remedial Investigation***

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The RI activities, reported in the *Final Remedial Investigation Report* (BBL, 2001), were focused on the site perimeter, and on areas within the site that were known or suspected to be sources of chemical constituents. Based on the data collected during the RI, each primary site feature, or potential area of concern (AOC), and the chemical constituents identified at these areas have been characterized in accordance with MDEQ requirements. The remedial investigation included the following methods to define the general characteristics and horizontal and vertical extent of chemical occurrence in the AOCs:

- Perimeter surface geophysical investigation;
- Inventory and evaluation of existing groundwater monitoring wells;
- Temporary and permanent groundwater monitoring well installation;
- Geotechnical analyses of soil samples;
- Geophysical borehole logging;
- Hydraulic conductivity testing;
- Elevation and horizontal survey of monitoring wells, borings, and staff gauges;
- Potentiometric data;
- Vertical hydraulic gradient evaluation;
- Surface water/groundwater interaction study;
- Sewer discharge monitoring;
- Groundwater sampling and analysis; and
- Surface water and sediment sampling and analysis.

The majority of environmental samples were analyzed for USEPA Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total and dissolved polychlorinated biphenyls (PCBs), and dissolved Target Analyte List (TAL) inorganic constituents.

The nature and extent of chemical occurrence for each AOC, as identified during the RI, is discussed in detail in the *Final Remedial Investigation Report* (BBL, 2001).

## **4. Generic Remedial Action Evaluation**

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### **4.1 Introduction**

The MDEQ Op Memo 18 provides the general process for determining final cleanup criterion for a given hazardous substance in soil and groundwater. The first step in this process is selecting the appropriate land use criteria. The GM SMI Plant facility has been used for industrial purposes for decades. Since GM/REALM intends to restrict use of the property for industrial use in the future, the “generic and limited commercial” category was deemed appropriate for this HHE. The initial evaluation used the *Generic Remedial Action Evaluation*.

### **4.2 Summary of Analytical Data**

The analytical data used for this HHE were collected during sampling events conducted throughout the remedial investigation (RI) and interim measurement activities from 1995 to present.. The analytical methods and target detection limits for the RI are presented in the *RI/FS Quality Assurance Project Plan (QAPP)* (BBL, May 1996), as approved by the MDEQ (Kaebler-Matlock, February 1996). A QAPP addendum was prepared and submitted to MDEQ in 2000 (Saroff, January 2000).

Data from the site-wide sampling events and supplemental sampling events were used in this HHE. For this HHE, each chemical constituent that originally exceeded MDEQ *Generic Cleanup Criteria* during the remedial investigation was individually evaluated to determine its appropriateness for use as an exposure point concentration in this HHE. Due to remedial activities conducted in various areas of the facility, subsequent confirmation sampling may have been conducted after these remedial activities. Subsequent data results were generally lower than the original results. These subsequent data were used for comparison to the generic criteria, given the fact that they are more reflective of current site conditions.

The 95% upper confidence limit (UCL) of the arithmetic mean was calculated and used where appropriate. In accordance with MDEQ guidance, the 95% UCL of the arithmetic mean can be used to determine compliance with the generic criteria for select pathways provided the 95% UCL reasonably represents the areas over which exposures are expected to occur. The 95% UCL was calculated for each chemical detected within each area of concern (AOC) provided the data sets were sufficiently robust to adopt this statistical approach. Data sets with 10 to 20 samples per exposure area provide somewhat better estimates of the mean, and data sets with 20 to 30 samples provide fairly consistent estimates of the mean (USEPA, 1992). The 95% UCL were compared to the MDEQ criteria except in data sets where the 95% UCL exceeded the maximum concentration. Where this occurred, the maximum detected concentration was used as the exposure point concentration (USEPA, 1992). A detailed explanation of the derivation of the 95% UCL values is provided in Appendix 9.5.

### **4.3 Site Exposure Conceptual Model**

The primary activity at the GM SMI Plant facility is and will continue to be industrial; and the current zoning of the property is industrial and is anticipated to remain industrial. Currently, the site is a malleable iron plant whose operations consist of activities associated with casting and heat-treating iron. The GM SMI Plant facility is located in an industrial area of Saginaw that is zoned for industrial usage. The primary activity at the property is industrial in nature. The possibility of residential development at the site is highly unlikely. While the

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northern portion of this property has been used for manufacturing and waste management purposes, most of the southern portion of the property has been used for industrial purposes (waste management). REALM also owns a farm field east of the site which has not been used for industrial activity. In accordance with MDEQ guidelines, this site is identified as an Industrial Land Use Category. The MDEQ Industrial Land Use Category is defined in the following way (MDEQ, 2000):

*The primary activity at the property is and will continue to be industrial in nature (e.g. manufacturing, utilities, industrial research and development, petroleum bulk storage) and access is and will continue to be readily restricted consistent with its use (e.g. fences, security personnel, or both). Inactive or abandoned properties can be included in this category if the use was and/or will be industrial, as described above and access is controlled as necessary to assure unacceptable exposures do not occur).*

GM/REALM have agreed to place restrictions on the land use at the property to ensure, as a result, the site will remain an industrial area for the foreseeable future. Therefore, current and future land-use is considered as one and the same. Due to the industrial nature of the site and surrounding area, the only potential human populations considered relevant to this HHE are industrial workers and occasional site visitors. However, COPCs detected in groundwater in the Non-River Residential Perimeter areas were compared to MDEQ residential criteria since data from these areas could be considered a conservative estimate of the concentration contacted by local residents. Figure 3 presents a site exposure conceptual model for the GM SMI Plant facility.

The exposure pathways assessed in this HHE are:

- Incidental ingestion of, dermal contact with, and inhalation of chemical constituents associated with surface and subsurface soil;
- Ingestion of groundwater;
- Dermal contact with and inhalation of chemical constituents found in groundwater;
- Inhalation of indoor air resulting from volatilization of subsurface sources (subsurface soil and groundwater);
- Incidental ingestion of, dermal contact with, and inhalation of chemical constituents associated with sediment; and
- Dermal contact with chemical constituents found in surface water.

Exposure pathway analysis includes a list of the potential exposure sources and an assessment of the completeness of the potential exposure pathways. Since direct exposure measurements to potentially exposed populations are rarely conducted for a particular site, a number of exposure assumptions are required to estimate the degree of human contact with chemicals in site media. The exposure pathway analysis identifies human exposure scenarios for chemicals present at the site and describes the course a chemical takes from the source to a potentially exposed individual. An exposure pathway analysis consists of four elements:

- a source and mechanism of chemical release to the environment (e.g., residual PCBs);
- a relevant environmental transport medium (e.g., surface soil);



- a relevant point of human exposure to the chemicals present in that medium (e.g., dermal contact with chemicals in surface soil); and
- a route of uptake at the exposure point (e.g., dermal absorption of chemicals from surface soil).

A pathway is considered complete if all four elements are present and incomplete if one or more of these elements are not present. It is also assumed that a pathway is complete only if there exists a segment of the human population, which potentially may contact site chemicals.

The potential exposure pathways for each potential receptor are given in Table 4-1 and represent the most important pathways for which the receptor may be exposed to site-related chemicals. Certain of these potential exposure pathways may appear unlikely or insignificant, but they are nonetheless routinely considered in the HHE process. Table 4-1 lists the exposure pathways, exposure media and potentially exposed site population, whether or not a particular exposure pathway is complete for a particular population, as well as the rationale for the selection or exclusion of the exposure pathway. Pathways considered for the potentially exposed population include ingestion, dermal, and inhalation exposure to chemicals in surface soil, subsurface soil, groundwater, sediment, and surface water.

**Table 4-1**  
**Potential Receptor and Exposure Pathways**

| Potentially Exposed Population                                                                 | Exposure Pathway and Medium                                                                      | Pathway Selected for Evaluation | Potential for Occurrence (High/Low) | Reason for Selection or Exclusion                                                     |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|---------------------------------------------------------------------------------------|
| <b>Residential Populations</b>                                                                 | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | No                              | Low                                 | Residential populations are not expected to be onsite.                                |
|                                                                                                | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | No                              | Low                                 | Residential populations are not expected to be onsite.                                |
|                                                                                                | Ingestion exposure to chemicals in groundwater                                                   | Yes                             | Low                                 | Residential populations may ingest groundwater that migrated from the site.           |
|                                                                                                | Dermal exposure to chemicals in onsite groundwater.                                              | Yes                             | Low                                 | Residential populations are not expected to be onsite.                                |
|                                                                                                | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | No                              | Low                                 | Residential populations are not expected to be onsite.                                |
|                                                                                                | Dermal and inhalation (volatiles) exposure to chemicals in onsite surface water/sediment.        | No                              | Low                                 | Residential populations are not expected to be onsite.                                |
| <b>Onsite Workers (includes production, groundskeeper, maintenance, and intrusive workers)</b> | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                             | High                                | Onsite workers may come in contact with onsite surface soil.                          |
|                                                                                                | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | Yes                             | High                                | Onsite workers may come in contact with subsurface soil during excavation activities. |

| Potentially Exposed Population  | Exposure Pathway and Medium                                                                      | Pathway Selected for Evaluation | Potential for Occurrence (High/Low) | Reason for Selection or Exclusion                                                                                                          |
|---------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | Ingestion exposure to chemicals in groundwater.                                                  | Yes                             | Low                                 | Onsite workers may ingest groundwater from the site.                                                                                       |
|                                 | Dermal exposure to chemicals in groundwater.                                                     | Yes                             | High                                | Onsite worker may come into contact with groundwater during intrusive activities.                                                          |
|                                 | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | Yes                             | Low                                 | Onsite worker may come into contact with volatiles in enclosed spaces.                                                                     |
|                                 | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | Yes                             | Low                                 | Onsite worker may come into contact with surface water/sediment.                                                                           |
| <b>Offsite Intrusive Worker</b> | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                             | Low                                 | Offsite intrusive workers may come in contact with offsite surface soil.                                                                   |
|                                 | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | Yes                             | Low                                 | Offsite intrusive workers may come in contact with subsurface soil during excavation activities.                                           |
|                                 | Dermal exposure to chemicals in groundwater.                                                     | Yes                             | Low                                 | Offsite intrusive worker may come into contact with groundwater during intrusive activities.                                               |
|                                 | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | No                              | Low                                 | Offsite intrusive worker is not expected to come into contact with volatiles in enclosed spaces associated with the site.                  |
|                                 | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | No                              | Low                                 | Offsite intrusive worker is not expected to come into contact with surface water/sediment associated with the site.                        |
| <b>Site Visitor</b>             | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                             | Low                                 | Site visitor may contact surface soil during site visit.                                                                                   |
|                                 | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | No                              | Low                                 | Site visitor is not expected to come in contact with subsurface soil during site visit.                                                    |
|                                 | Dermal exposure to chemicals in groundwater.                                                     | No                              | Low                                 | Site visitor is not expected to come in contact with groundwater during site visit.                                                        |
|                                 | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | No                              | Low                                 | Site visitor is not expected to come into contact with volatiles in enclosed spaces since there are no buildings in the low contact areas. |
|                                 | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | Yes                             | Low                                 | Site visitor may come into contact with surface water/sediment.                                                                            |

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#### 4.4 Comparison of COPCs to MDEQ *Generic Cleanup Criteria*

The laboratory analytical results for the GM SMI Plant facility were compared to MDEQ *Generic Cleanup Criteria*, which are summarized in the ERD Op Memo 18, dated June 7, 2000 (MDEQ, June 2000). The GM SMI Plant facility is placed in the Industrial Land Use Category and therefore, chemical constituents detected at the site were compared to MDEQ *Industrial Generic Cleanup Criteria*, with the exception of groundwater. Given that groundwater may migrate offsite, groundwater was compared to MDEQ residential generic criteria. The purpose of this comparison is to identify chemicals of potential concern (COPCs) that do not pose a significant health risk and can be eliminated from further evaluation; and identify which COPCs need to be evaluated further.

##### 4.4.1 MDEQ *Generic Cleanup Criteria*

###### Groundwater

Although there is no actual routine exposure to groundwater at the site, groundwater samples collected from temporary and permanent monitoring wells were compared to the following applicable MDEQ *Generic Cleanup Criteria*:

- Groundwater Surface Water Interface (GSI);
- Residential and Commercial I Drinking Water (RDW);
- Industrial and Commercial II, III & IV Drinking Water (IDW);
- Groundwater Contact Criteria (GCC), to assess dermal exposure;
- Acute Inhalation Screening Level (AISL); to assess inhalation exposure;
- Residential and Industrial Groundwater Volatilization to Indoor Air Criteria (RGVIIC and IGVIIC; respectively), to assess indoor air hazards;
- Flammability and Explosivity Screening Level (FESL) values; and
- Water Solubility Screening Level (WSSL) values.

###### Soil

Currently at the site, there is potential for exposure to soils; therefore, soil data were compared to the following MDEQ *Generic Cleanup Criteria*:

- Soil Criteria Protective of Residential and Commercial Drinking Water (RWDP);
- Soil Criteria Protective of Industrial and Commercial II, III, & IV Drinking Water (IDWP);
- Soil Criteria Protective of Groundwater Contact (GCCP);
- Industrial and Commercial Direct Contact (IDC), to assess ingestion and dermal exposure;
- Industrial and Commercial II, III, and IV Soil Volatilization to Indoor Air Inhalation Criteria (ISVIIC), to assess indoor air hazards;
- Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (IVSIC), to assess ambient air inhalation hazards; and
- Industrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (IPSIC), to assess ambient air inhalation hazards.

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### **Sediment**

Although there is no routine exposure to sediment at the site, sediment samples were compared to generic IDC criteria. It is recognized that sediments are not simply "wet soils," however, given the industrial nature of the property it is unlikely that workers may come into contact with the sediments on a frequent basis. This, in combination with the conservative adherence factor used in the derivation of the IDC, ensure that the IDC generic criteria are adequately protective if workers infrequently come into contact with sediment. All sediment/native soil sample analytical data associated with onsite water bodies were then evaluated to assess whether they were negatively impacting downgradient groundwater. If groundwater may have been impacted, the sediment data were compared to GCCP criteria established for soil.

### **Surface Water**

There is no routine (wading or swimming) exposure to surface water at this industrial site; however in an effort to be conservative, incidental contact with surface water were assessed using the generic GCC. Although these criteria are intended to be used to evaluate groundwater data, the use of the generic GCC are relevant for the surface water data at this site because exposure to surface water, if any, is likely to be limited to dermal exposure.

A summary of the chemical constituents detected at the site during the remedial investigation that exceed MDEQ criteria is provided in the following paragraphs and are presented in Tables 4-2 through 4-26. The exposure point concentrations used in this HHE are provided in the tables. A description of the MDEQ *Generic Cleanup Criteria* applicable to this HHE is provided in Appendix A. Consistent with the format of the *Final Remedial Investigation Report* (BBL, 2001), the chemical constituents are summarized for each primary feature or AOC at the site.

## **4.4.2 Site Perimeter**

The site perimeter groundwater was divided into three main areas: Saginaw River Perimeter, Non-River Residential Perimeter, Non-River Industrial Perimeter and Site Interior. Saginaw River Boundary groundwater samples were collected from temporary and permanent monitoring wells. The temporary wells were analyzed for VOCs, SVOCs, total and dissolved PCBs, and dissolved TAL inorganics. The permanent monitoring wells were analyzed for VOCs, SVOCs, total and dissolved PCBs, pesticides and herbicides, dioxins and furans, and dissolved TAL inorganics.

A total of 78 groundwater samples and four duplicates were collected from 30 temporary monitoring well cluster locations in 1995. Samples were collected from a total of 207 permanent monitoring wells during three separate sampling events. The groundwater samples collected in these wells were also compared to the MDEQ *Generic Cleanup Criteria* previously mentioned. Groundwater issues concerned with MDEQ groundwater/surface water interface (GSI) criteria are addressed separately in the GSI evaluation report.

### **4.4.2.1 Saginaw River Perimeter**

Groundwater samples were collected from 30 temporary and 37 permanent monitoring wells along the Saginaw River Perimeter. The exposure point concentration for each constituent was compared to relevant MDEQ *Generic Cleanup Criteria* listed in Section 4.4.1. The results of this analysis reveal:

VOCs: No generic GCC, IGVIIC, FESL, or WSSL values for VOCs were exceeded in the samples collected from the temporary wells.

SVOCs: No generic GCC, FESL or WSSL values for SVOCs were exceeded in samples collected from temporary or permanent monitoring wells.

PCBs: No generic GCC or WSSL values for PCBs (unfiltered or filtered) were exceeded in samples collected from the temporary and permanent monitoring wells. FESL criteria do not apply to PCBs. The generic IGVIIC criteria for PCBs was exceeded in temporary monitoring well TW-212WT (62 ug/L). This well, located adjacent to the Secondary Settling Pond was subsequently removed and a permanent monitoring well cluster (MW-112) was installed in the same area. No PCB concentrations exceeding the generic IGVIIC have been detected in MW-112, as a result PCBs are not considered further in this assessment.

Pesticides and Herbicides: Concentrations of pesticides and herbicides were not reported above the laboratory detect limits in any of the groundwater samples collected from permanent monitoring wells. Groundwater samples collected from the temporary monitoring wells were not analyzed for pesticides and herbicides.

Dioxins and Furans: Groundwater samples were collected from two permanent monitoring wells along the Saginaw River Perimeter for analysis of dioxins/furans. No generic GCC, or WSSL values for dioxins/furans were exceeded in these samples. No dioxin/furan samples were collected from temporary monitoring wells.

Inorganics: Samples from the temporary and permanent monitoring wells were analyzed for unfiltered and filtered (dissolved) inorganics and total cyanide. No generic GCC values were exceeded in the samples collected along the Saginaw River Perimeter.

#### 4.4.2.2 Saginaw River Berm Area

Supplemental surface and subsurface soil samples were collected from the berm of the Saginaw River in July 2000 and analyzed for TCL PCBs and TAL inorganics. PCBs were detected in all the surface soil samples, but did not exceed the generic IDC value for PCBs. No PCBs exceeded the CSAT values and PCBs are not expected to leach to groundwater under normal conditions (BBL, 2001). The maximum detected concentration was used as the exposure point concentration because the calculated 95% UCL was greater than the maximum detected concentration. Manganese was the only inorganic detected in the berm area above the IPSIC value. Several inorganics were detected above IDWP values. Similar inorganics (aluminum, iron, and manganese) were detected in groundwater above IDW values in the area along the berm during 1995 and 1996 groundwater sampling events. GSIP concentrations were exceeded for cobalt, mercury, selenium and silver. The chemical constituents exceeding MDEQ generic criteria in soil are listed below in Table 4-2.

**Table 4-2**  
**Saginaw River Berm Area**  
**Exceeded in Soil**

| Chemical Constituent<br>Criteria Exceeded | Exposure Point<br>Concentration <sup>1</sup><br>(mg/kg) | MDEQ<br>IPSIC Value<br>(mg/kg) | MDEQ<br>IDWP Value<br>(mg/kg) | MDEQ GSIP<br>Value (mg/kg) |
|-------------------------------------------|---------------------------------------------------------|--------------------------------|-------------------------------|----------------------------|
| <b><i>Inorganics</i></b>                  |                                                         |                                |                               |                            |
| Aluminum                                  | 27,900                                                  | --                             | 1                             |                            |
| Cobalt                                    | 7.1                                                     | --                             | 2                             | 2                          |

| Chemical Constituent<br>Criteria Exceeded | Exposure Point<br>Concentration <sup>1</sup><br>(mg/kg) | MDEQ<br>IPSIC Value<br>(mg/kg) | MDEQ<br>IDWP Value<br>(mg/kg) | MDEQ GSIP<br>Value (mg/kg) |
|-------------------------------------------|---------------------------------------------------------|--------------------------------|-------------------------------|----------------------------|
| Iron                                      | 40,200                                                  | --                             | 6                             |                            |
| Manganese                                 | 32,600                                                  | 1,500                          | 1                             |                            |
| Mercury                                   | 0.230                                                   | --                             | --                            | 0.1                        |
| Selenium                                  | 2.9                                                     | --                             | --                            | 0.4                        |
| Silver                                    | 1.3                                                     | --                             | --                            | 0.5                        |
| Thallium                                  | 3.3                                                     | --                             | 2.3                           |                            |

Notes: <sup>1</sup> = maximum detected concentration. -- = criteria not exceeded.

### ***Technical Assessment of Exceedances***

The GSIP is a concentration of a chemical in soil that is protective of the GSI in groundwater. This soil concentration is protective of groundwater and is modeled by simplifying assumptions related to the fate and transport of chemicals to account for their effect on chemical migration from subsurface soil to groundwater. Select soil samples collected from the Saginaw River berm area contained cobalt, mercury, selenium, and silver at concentrations above the GSIP value. However, these inorganics were not detected in groundwater samples collected from permanent groundwater monitoring wells installed within the Saginaw River berm area at concentrations above the GSI criteria. Due to the uncertainties associated with modeling, as well as the historical nature of the fill, high water table, and the significant amount of groundwater data available for this area (which does not indicate exceedances of GSI criteria), the presence of inorganics in the Saginaw River berm area soils at concentrations above the GSIP does not likely pose a threat to groundwater. Therefore, the generic GSIP exceedances are not further addressed in this assessment.

### **4.4.2.3 Non-River Residential Perimeter**

#### **Groundwater Sampling**

Groundwater samples were collected from 27 temporary and 38 permanent monitoring wells along the Non-River Residential Perimeter. Several of the Non-River Residential Perimeter monitoring well locations are associated with a specific AOC of the facility; therefore, some overlapping of data results and comparison of these results to relevant criteria will occur in this HHE. As a result, the detailed evaluation of the data results and comparison to the generic criteria will be addressed during the discussion of the specific AOC. The exposure point concentration for each constituent was compared to the relevant MDEQ *Generic Cleanup Criteria* listed in Section 4.4.1. The results of the analysis indicated:

VOCs: No generic GCC, FESL, or WSSL values for VOCs were exceeded in the samples collected from temporary or permanent monitoring wells. The generic RDW values for cis-1,2-dichloroethene, trichloroethene, and vinyl chloride were exceeded at one permanent monitoring well location during the first and second rounds of groundwater sampling. Subsequent groundwater sampling in this area, along the western property boundary, indicated these VOCs were detected below RDW values and were significantly lower than previous analytical results.

The generic RGVIC for vinyl chloride was exceeded at one location (MW-126WT). The well was located in the southwest corner of REALM property adjacent to the former Ruben Schultz property, the west side of the DRA, within the fill materials of the Former Hillock Area. This well was abandoned in February 1997 during the removal of fill materials from the Former Hillock Area. Groundwater in this area flows toward the east-

southeast from the former Ruben Schultz property to the site, and the vinyl chloride in the groundwater is likely from an offsite source. A drain tile, running from the former Ruben Schultz property to the REALM property just north of the former MW-126WT location, was located during a test pit program in August of 2000. Water was observed flowing in the tile onto REALM property from the offsite area west of the property and a sample obtained at the upstream property boundary contained 37 ug/L of vinyl chloride indicating migration of VOCs from the offsite source.

SVOCs: No generic FESL values for SVOCs were exceeded in samples collected from temporary or permanent monitoring wells. Bis(2-ethylhexyl)phthalate, benzo(a)anthracene, benzo(b)fluoranthene, and chrysene were detected above generic RDW values.

The generic GCC values for bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, and chrysene were exceeded. The WSSL values for benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were also exceeded.

PCBs: No generic RDW, GCC, RGVIIIC or WSSL values were exceeded in the unfiltered and filtered samples collected from temporary and permanent monitoring wells. FESL criteria do not apply to PCBs.

Pesticides and Herbicides: Concentrations of pesticides and herbicides were not reported above the laboratory detect limits in any of the groundwater samples collected from the permanent monitoring wells. Groundwater samples collected from the temporary monitoring wells were not analyzed for pesticides and herbicides.

Dioxins and Furans: One groundwater sample was collected along the Non-River Residential Perimeter for analysis of dioxins/furans. No dioxins/furans were detected in this sample.

Inorganics: Samples from the temporary and permanent monitoring wells were analyzed for filtered (dissolved) inorganics and unfiltered and filtered (dissolved) total cyanide. As provided by MDEQ Operational Memorandum #18 (MDEQ, June 2000), site-specific background values for aluminum, barium, iron, lead, manganese, and zinc were substituted for the generic drinking water values when the background values were higher. Dissolved inorganics detected above the higher of the generic RDW criteria or site-specific background values were aluminum, antimony, arsenic, barium, iron, , sodium, and vanadium. No generic GCC values were exceeded.

Per MDEQ guidance (MDEQ, 2001b), the maximum concentration was used as the exposure point concentration for groundwater because the 95% UCL is not applicable for comparison to RDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents exceeding MDEQ generic criteria in the Non-River Residential Perimeter area are summarized below in Table 4-3 and Table 4-4.

**Table 4-3**  
**Non-River Residential Perimeter**  
**Generic Criteria Exceeded in Groundwater**

| Chemical Class        | RDW | GCC | FESL | WSSL | RGVIIIC |
|-----------------------|-----|-----|------|------|---------|
| Volatiles             | X   |     |      |      | X       |
| Semivolatiles         | X   | X   |      | X    |         |
| PCBs                  |     |     |      |      |         |
| Pesticides/Herbicides |     |     |      |      |         |
| Dioxins/Furans        |     |     |      |      |         |
| Inorganics            | X   |     |      |      |         |

Note: X = At least one exceedance occurred for the generic criteria.

**Table 4-4**  
**Non-River Residential Perimeter**  
**Generic RDW and GCC Exceeded in Groundwater**

| Chemical Constituent       | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ RDW Value<br>(µg/L)  | MDEQ GCC Value<br>(µg/L) | MDEQ RGVIIIC Value<br>(µg/L) |
|----------------------------|-----------------------------------------------------|---------------------------|--------------------------|------------------------------|
| <b>VOCs</b>                |                                                     |                           |                          |                              |
| 1,2-dichloroethene, Total  | 220                                                 | 70                        | --                       | --                           |
| Cis-1,2-dichloroethene     | 220                                                 | 70                        | --                       | --                           |
| Trichloroethene            | 17                                                  | 5                         | --                       | --                           |
| Vinyl chloride             | 270                                                 | 2                         | --                       | 110                          |
| <b>SVOCs</b>               |                                                     |                           |                          |                              |
| Bis(2-ethylhexyl)phthalate | 14 *                                                | 6                         | 320                      | --                           |
| Benzo(a)anthracene **      | 5.3 J                                               | 2.1                       | --                       | --                           |
| Benzo(b)fluoranthene **    | 5.9 J                                               | 2                         | 2                        | --                           |
| Chrysene **                | 7                                                   | 5                         | 5                        | --                           |
| <b>Inorganics</b>          |                                                     |                           |                          |                              |
| Aluminum                   | 320                                                 | 50 (240) <sup>2</sup>     | --                       | --                           |
| Antimony                   | 6.9                                                 | 6                         | --                       | --                           |
| Arsenic                    | 53.9                                                | 50                        | --                       | --                           |
| Barium                     | 2,290                                               | 2,000                     | --                       | --                           |
| Iron                       | 31,000                                              | 300 (13,000) <sup>2</sup> | --                       | --                           |
| Sodium                     | 4,660,000                                           | 120,000                   | --                       | --                           |
| Vanadium                   | 56                                                  | 4.5                       | --                       | --                           |

Notes: J = Concentration is an estimated value. -- = criteria not exceeded. <sup>1</sup> = maximum concentration. <sup>2</sup> = the higher of site-specific background or generic cleanup criteria.; italicized value is site-specific background value. \* = May 2000 sample results. \*\* = not likely representative of groundwater conditions; only detected in one temporary well (TW-203WT).

### **Technical Assessment of Exceedances**

Bis(2-ethylhexyl)phthalate was detected above the GCC value of 320 µg/L in only one monitoring well (X-15BR) during the first sampling event (1995). This concentration, however, appears to be anomalous, as subsequent sampling events in June 1996 and May 2000 showed much lower concentrations, 6.7 µg/L and 14 µg/L; respectively. Therefore, the May 2000 concentration of 14 µg/L, which does not exceed the GCC, was used in this HHE. The May 2000 value is also more reflective of current conditions.

Benzo(a)anthracene, benzo(b)fluoranthene and chrysene were detected in only one temporary well (TW-203WT) above GCC values. These chemical constituents were not detected at nearby permanent monitoring wells. Temporary monitoring well TW-203WT is located in the Center Street Oil Sheen Area in the northeast portion of the GM property. Temporary wells cannot be effectively developed to remove soil particulates from them prior to sampling. Therefore, groundwater samples commonly result in the detection of absorbed constituents if the well is installed in affected fill materials. Discussion of these exceedances is presented in the Center Street Oil Sheen section of this report.



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#### 4.4.2.4 Non-River Industrial Perimeter & Site Interior

Groundwater samples were collected from 32 temporary and 142 permanent monitoring wells along the Non-River Industrial Perimeter and Site Interior. Most of the Non-River Industrial Perimeter and Site Interior monitoring well locations are associated with a specific AOC of the facility; therefore, some overlapping of data results and comparison of these results to relevant criteria will occur in this HHE. As a result, the detailed evaluation of the data results and comparison to the generic criteria will be addressed during the discussion of the specific AOC. The exposure point concentrations were compared to relevant MDEQ *Generic Cleanup Criteria* listed in Section 4.4.1. The results of the analysis revealed:

VOCs: No generic FESL or WSSL values for VOCs were exceeded in samples collected from temporary or permanent monitoring wells. The generic IDW values for benzene, toluene, ethylbenzene, xylene, 1,4-dioxane, 1,1-dichloroethene, cis-1,2-dichloroethene, trichloroethene, and vinyl chloride were exceeded in the Non-River Industrial Perimeter & Site Interior samples. Exceedances of 1,1-dichloroethene, cis-1,2-dichloroethene, and trichloroethene were from MW-156WT (located in the LNAPL Assessment and Remediation Area) or TWW-1 (located in the Drum Remediation Area [DRA]). The generic GCC for vinyl chloride was also exceeded in the DRA. The generic IGVIIC for vinyl chloride was exceeded at one location, TWW-1, in the DRA. Exceedances of benzene, ethylbenzene, toluene, and xylenes were found predominately within the Former UST #7 area. A detailed discussion of these exceedances is provided in the following sections pertaining to these specific AOCs.

SVOCs: No generic FESL values for SVOCs were exceeded in samples collected from the temporary or permanent monitoring wells. The generic IDW values for bis(2-ethylhexyl)phthalate, chrysene, pentachlorophenol, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene, were exceeded in the samples collected in the Non-River Industrial Perimeter & Site Interior area. The generic GCC values for benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate and chrysene were also exceeded. And the WSSL values for benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, and indeno(1,2,3-cd)pyrene were exceeded in samples from this area. These exceedances were generally found in the monitoring well cluster, X-6, located in the Green Point Landfill area; and are discussed in detail in the following section pertaining to this AOC.

PCBs: Unfiltered and filtered samples were collected from the temporary and permanent monitoring wells along the Non-River Industrial Perimeter and within the Site Interior. No FESL, or WSSL values for PCBs were exceeded in these samples. The generic IDW and IGVIIC values for PCBs were exceeded in samples collected from the monitoring wells located in the LNAPL Assessment and Remediation Area and landfill areas. A detailed discussion of these exceedances and the specific AOCs are provided in the following sections.

Pesticides and Herbicides: Concentrations of pesticides and herbicides were not reported above the laboratory detection limits in any of the groundwater samples collected from permanent monitoring wells. Groundwater samples collected from the temporary monitoring wells were not analyzed for pesticides and herbicides.

Dioxins and Furans: Groundwater samples were collected from twelve permanent monitoring wells along the Non-River Industrial Perimeter and the Site Interior for analysis of dioxins/furans. The WSSL values for dioxins/furans were not exceeded in these samples. The generic IDW and GCC values for 2,3,7,8-TCDD TEQ were exceeded at one location, MW-148WT, in the LNAPL Assessment and Remediation Area. A detailed discussion is provided in the LNAPL Assessment and Remediation Area section of this report. No dioxin/furan samples were collected from temporary monitoring wells.

**Inorganics:** Samples from the temporary and permanent monitoring wells were analyzed for filtered (dissolved) inorganics and unfiltered and filtered (dissolved) total cyanide. As provided by MDEQ OP Memo #18 (MDEQ, June 2000), site-specific background values for aluminum, barium, iron, lead, manganese, and zinc were substituted for the generic drinking water values when the background values were higher. Dissolved inorganics detected above the higher of the generic IDW criteria or site-specific background values were aluminum, antimony, arsenic, barium, cadmium, chloride, iron, lead, magnesium, manganese, nickel, sodium, and thallium. No generic GCC values were exceeded.

Per MDEQ guidance, the maximum concentration was used as the exposure point concentration in groundwater because the 95% UCL is not applicable for comparison to IDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents exceeding MDEQ generic criteria in the Non-River Industrial Perimeter and Site Interior areas are summarized in Table 4-5 and 4-6.

**Table 4-5**  
**Non-River Industrial Perimeter and Site Interior**  
**Generic Criteria Exceeded in Groundwater**

| Chemical Class        | IDW | GCC | FESL | WSSL | IVGHC |
|-----------------------|-----|-----|------|------|-------|
| Volatiles             | X   | X   |      |      | X     |
| Semivolatiles         | X   | X   |      | X    |       |
| PCBs                  | X   |     |      |      | X     |
| Pesticides/Herbicides |     |     |      |      |       |
| Dioxins/Furans        | X   | X   |      |      |       |
| Inorganics            | X   |     |      |      |       |

Note: X = At least one exceedance occurred for the generic criteria.

**Table 4-6**  
**Non-River Industrial Perimeter and Site Interior**  
**Generic IDW , GCC and IVGHC Criteria Exceeded in Groundwater**

| Chemical Constituent       | Exposure Point<br>Concentration <sup>1</sup><br>(µg/L) | MDEQ<br>IDW Value<br>(µg/L) | MDEQ<br>GCC Value<br>(µg/L) | MDEQ<br>IVGHC Value<br>(µg/L) |
|----------------------------|--------------------------------------------------------|-----------------------------|-----------------------------|-------------------------------|
| <b>VOCs</b>                |                                                        |                             |                             |                               |
| 1,4-dioxane                | 670                                                    | 320                         | --                          | --                            |
| 1,1-dichloroethene         | 52                                                     | 7                           | --                          | --                            |
| Cis-1,2-dichloroethene     | 9,600                                                  | 70                          | --                          | --                            |
| Trichloroethene            | 630                                                    | 5                           | --                          | --                            |
| Vinyl chloride             | 2,300                                                  | 2                           | 570                         | 690                           |
| Benzene                    | 1,600                                                  | 5                           | --                          | --                            |
| Toluene                    | 1,400                                                  | 790                         | --                          | --                            |
| Ethylbenzene               | 1,800                                                  | 74                          | --                          | --                            |
| Xylene                     | 6,900                                                  | 280                         | --                          | --                            |
| <b>SVOCs</b>               |                                                        |                             |                             |                               |
| Bis(2-ethylhexyl)phthalate | 450                                                    | 6                           | 320                         | --                            |
| Benzo(a)pyrene             | 7.6 J                                                  | 5                           | 5                           | --                            |
| Benzo(b)fluoranthene       | 12 J                                                   | 2                           | 2                           | --                            |
| Chrysene                   | 9.4                                                    | 5                           | 5                           | --                            |
| Pentachlorophenol          | 3.2 J                                                  | 1                           | --                          | --                            |
| 4-methylphenol             | 5,000                                                  | 1,000                       | --                          | --                            |
| <b>PCBs (unfiltered) *</b> |                                                        |                             |                             |                               |
| Aroclor-1016               | 0.67                                                   | 0.5                         | *                           | --                            |
| Aroclor-1242               | 460                                                    | 0.5                         | *                           | --                            |

| Chemical Constituent         | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ IDW Value<br>(µg/L) | MDEQ GCC Value<br>(µg/L) | MDEQ IVGHC Value<br>(µg/L) |
|------------------------------|-----------------------------------------------------|--------------------------|--------------------------|----------------------------|
| Aroclor-1248                 | 610                                                 | 0.5                      | *                        | --                         |
| Aroclor-1254                 | 2.3 J                                               | 0.5                      | *                        | --                         |
| Aroclor-1260                 | 910                                                 | 0.5                      | *                        | 45                         |
| Total Aroclors               | 1,520                                               | 0.5                      | *                        | 45                         |
| <b>PCBs (filtered)</b>       |                                                     |                          |                          |                            |
| Aroclor-1248                 | 1.5                                                 | 0.5                      | --                       | --                         |
| Aroclor-1254                 | 1.1                                                 | 0.5                      | --                       | --                         |
| Total Aroclors               | 2.6                                                 | 0.5                      | --                       | --                         |
| <b>Dioxins/Furans</b>        |                                                     |                          |                          |                            |
| 2,3,7,8-TCDD TEQ             | 0.0000558                                           | 0.00003                  | 0.00001                  | --                         |
| <b>Inorganics (filtered)</b> |                                                     |                          |                          |                            |
| Aluminum                     | 1,890 J                                             | 240                      | --                       | --                         |
| Antimony                     | 19                                                  | 6                        | --                       | --                         |
| Arsenic                      | 50.9                                                | 50                       | --                       | --                         |
| Barium                       | 11,800                                              | 2,000                    | --                       | --                         |
| Cadmium                      | 15.3 J                                              | 5                        | --                       | --                         |
| Chloride                     | 16,100,000                                          | 250,000                  | --                       | --                         |
| Iron                         | 372,000                                             | 13,000                   | --                       | --                         |
| Lead                         | 9.3                                                 | 6                        | --                       | --                         |
| Magnesium                    | 1,720,000                                           | 1,200,000                | --                       | --                         |
| Manganese                    | 8,930                                               | 2,100                    | --                       | --                         |
| Nickel                       | 173                                                 | 100                      | --                       | --                         |
| Sodium                       | 3,350,000                                           | 160,000                  | --                       | --                         |
| Thallium                     | 26.8                                                | 2                        | --                       | --                         |

Notes: <sup>1</sup> = maximum detected concentration. J = Concentration is an estimated value. -- = criteria not exceeded. \* = consistent with MDEQ guidance, unfiltered data are not appropriate for comparison to GCC.

### Technical Assessment of Exceedances

Filtered PCB groundwater samples did not exceed the generic GCC value. MDEQ (2000) advises,

*When comparing onsite groundwater data to Groundwater Contact Criteria (GCC), samples contaminated with substances identified with footnote {AA} should be filtered. (The GCC equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that highly adsorb to soil particulates, the particulates should be removed via filtering so that only contaminants in the dissolved phase will be reported.).*

This guidance is applicable to the generic GCC value for PCBs, which considers chemical constituents that adsorb to soil particulates. Therefore, only filtered samples were considered for comparison to the GCC value. The filtered groundwater samples did not exceed the generic GCC value; therefore, this exposure pathway has been eliminated from further consideration in this HHE.

The SVOCs that exceeded generic GCC values may be related to sample turbidity. As with PCBs, some SVOCs (particularly polyaromatic hydrocarbons [PAHs]) tend to preferentially absorb to particulate matter. The generic GCC values for the PAHs exceeded should also be compared to filtered data; however filtered samples were not available for comparison to GCC values. This is further discussed in the Green Point Landfill section.

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## 4.5 Site Interior

### 4.5.1 Drum Remediation Area and Former Hillock Area (DRA/Hillock)

Several investigations and response actions have been undertaken from 1987 through 2000 to address the Drum Remediation Area and Former Hillock Area (DRA/Hillock). A summary of these activities is provided in the *Final Remedial Investigation Report (BBL, 2001)*. During the investigations, soil and groundwater samples were collected from test pits within the DRA/Hillock area where target materials (i.e. drums/drum fragments, stained soil) were observed. The samples were analyzed for VOCs, SVOCs, PCBs, pesticides and herbicides, and inorganics; and compared to relevant MDEQ *Generic Cleanup Criteria* listed in Section 4.4.1.

#### Soil Sampling

Concentrations of VOCs (ethylbenzene and xylenes) exceeded generic IDWP and GCCP criteria in one test pit sample. Several SVOCs exceeded generic criteria. Generic IDWP values for anthracene, carbazole, fluoranthene, phenanthrene, and pyrene were exceeded. The generic GCCP values for anthracene, fluoranthene, and pyrene were exceeded. Concentrations of PCBs exceeded generic IDC criteria. The generic ISVIIC for ethylbenzene and xylenes and the generic IPSIC for manganese were exceeded. The generic IVSIC for phenanthrene was also exceeded. No chemical constituents were detected at concentrations exceeding MDEQ generic criteria in soil collected in the Former Hillock Area of the DRA in 1995.

Although these earlier soil data exceeded generic criteria, these soils and fill that comprised the DRA/Hillock were excavated in February 1997. A total of 27,125 cubic yards of soil were removed and placed within the Green Point Landfill prior to landfill capping. A report was transmitted to the state on March 18, 1997 (Saroff, March 1997). During the soil removal, five drums were located and sampled. As reported in the *Test Pit Investigation Report* (BBL, August 1995), no constituents in the drums were detected above laboratory detection limits. Therefore, the drums were considered non-hazardous and were properly disposed of by GM.

During the capping of the Green Point Landfill in 1997, soil samples were collected from six soil borings in the vicinity of the DRA/Hillock area in the Wetland Mitigation Area. No VOCs or SVOCs were detected above industrial generic criteria. No PCBs were detected in these soil samples. Aluminum, cobalt, iron, and manganese were detected above the higher of the generic IDWP values or the state default background levels (SDBL).

A summary of the exposure point concentrations used in this HHE and the MDEQ generic criteria exceeded for these constituents is presented in Table 4-7. As a result of 1997 soil removal in the DRA/Hillock Area, the exposure point concentrations used in this HHE are from samples collected in the Wetland Mitigation Area after soil removal activities were conducted. No GCCP or IDC values for inorganics were exceeded in the soil samples collected in the Wetland Mitigation Area. The maximum detected concentrations were used because the 95% UCL exceeded the maximum concentration. Table 4-7 presents the inorganics exceeding generic criteria in the samples collected in this area.

**Table 4-7**  
**Drum Remediation Area**  
**Generic IDWP Criteria Exceeded in Soil**

| Chemical Constituent     | Exposure Point Concentration <sup>1</sup><br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) |
|--------------------------|------------------------------------------------------|----------------------------|
| <b>SOIL</b>              |                                                      |                            |
| <i><b>Inorganics</b></i> |                                                      |                            |
| Aluminum                 | 14,700                                               | 4.3                        |
| Cobalt                   | 7.8                                                  | 6.8                        |
| Iron                     | 44,600                                               | 12,000                     |
| Manganese                | 1,170                                                | 440                        |

Notes: <sup>1</sup> = maximum detected concentration used because the 95% UCL exceeded the maximum concentration.

### **Groundwater Sampling**

A series of groundwater samples were collected from within the DRA/Hillock Area and along the downgradient southern perimeter. Iron was the only constituent detected above MDEQ criteria in the downgradient southern perimeter wells. A monitoring well installed north of the DRA/Hillock Area was found to have elevated concentrations of VOCs. These VOCs were detected above generic IDW/RDW values. Additional samples were collected at monitoring wells near this location and supplemental test pitting was conducted to determine the source of the VOCs. A concrete drain pipe was found to extend from the neighboring junkyard property to approximately 10 feet south of the monitoring well. This drain pipe is conveying water containing VOC constituents from the adjacent property onto SMI property, where it discharges into the groundwater. Subsequent groundwater sampling indicated that the generic IDW and RDW values were exceeded for 1,1-dichloroethene, cis-1,2-dichloroethene, total 1,2-dichloroethene, methylene chloride, and vinyl chloride. Vinyl chloride was also detected above the generic GCC, IGVIIC and RGVIIIC values. IDW and RDW values were exceeded for manganese during the first round of sampling, but not during subsequent sampling. Thallium concentrations exceeded the IDW and RDW values in the latest sampling event.

Per MDEQ guidance, the maximum concentration was used as the exposure point concentration for groundwater because the 95% UCL is not applicable for comparison to IDW/RDW criteria and is generally not practical for assessing the GCC and IGVIIC/RGVIIC exposure pathways. A summary of the exposure point concentrations of chemical constituents detected in groundwater samples that exceed MDEQ generic criteria are presented in Table 4-8.

**Table 4-8**  
**Drum Remediation Area and Former Hillock Area**  
**Generic IDW, RDW, IGVIIC and RGVIIIC Criteria Exceeded in Groundwater**

| Chemical Constituent       | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ IDW Value<br>(µg/L) | MDEQ RDW Value<br>(µg/L) | MDEQ GCC Value<br>(µg/L) | MDEQ IGVIIC Value<br>(µg/L) | MDEQ RGVIIIC Value<br>(µg/L) |
|----------------------------|-----------------------------------------------------|--------------------------|--------------------------|--------------------------|-----------------------------|------------------------------|
| <i><b>VOCs</b></i>         |                                                     |                          |                          |                          |                             |                              |
| 1,1-Dichloroethene         | 51 J                                                | 7                        | 7                        | --                       | --                          | --                           |
| Cis-1,2-Dichloroethene     | 8,800                                               | 70                       | 70                       | --                       | --                          | --                           |
| 1,2- Dichloroethene, Total | 8,800                                               | 70                       | 70                       | --                       | --                          | --                           |
| Methylene chloride         | 54 JD                                               | 5                        | 5                        | --                       | --                          | --                           |
| Vinyl chloride             | 2,300                                               | 2                        | 2                        | 570                      | 690                         | 110                          |
| <i><b>Inorganics</b></i>   |                                                     |                          |                          |                          |                             |                              |
| Thallium                   | 8.6 B (avg)                                         | 2                        | 2                        | --                       | --                          | --                           |

Notes: <sup>1</sup> = maximum detected concentration. -- = criteria not exceeded. J = concentration is an estimated value. D = concentration is based on diluted sample analysis. B = concentration is between instrument detection limit and required reporting limit. avg = average of original sample and duplicate sample.

### Technical Assessment of Exceedances

Post remedial sampling results indicate that chemical constituents originally detected in the soil samples were remediated during the soil removal activities conducted in 1997.

Concerning groundwater, vinyl chloride was detected at a concentration of 2,300 µg/L in 2000, which is above the IGVIIC value of 690 µg/L and the RGVIIIC value of 110 µg/L. The IGVIIC and RGVIIIC identify the groundwater concentration that is protective of workers or occupants from the inhalation of chemical constituents in indoor air via the migration of chemical constituent vapors from groundwater through soil into the indoor air of a workplace or building. Given the current property use and the terrain of the area (i.e. wetland), it is highly unlikely that buildings will be constructed in the Drum Remediation/Hillock Area. However, in the unforeseeable future there is a remote chance a building could be constructed in this area; therefore, the vinyl chloride exceedance of the IGVIIC will be addressed in the Feasibility Study. Residential buildings will not be constructed in the Drum Remediation/Hillock Area, as indicated in the Feasibility Study [p 8-2], the deed restrictions will be implemented throughout the site to restrict future land use to industrial use. Therefore, the vinyl chloride exceedance of the RGVIIIC is eliminated from further consideration in this HHE.

### 4.5.2 Green Point Landfill

Several environmental investigations have been conducted at the Green Point Landfill, dating back to 1976. Results of the Leachate Assessment are found in the *Combined CEDR and 35 Percent Design Report* (BBL, February 1996). Samples of the leachate were collected within the Green Point Landfill. Groundwater samples were collected immediately below and surrounding the landfill. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration because the 95% UCL is not applicable for comparison to IDW criteria. A summary of the chemical constituents detected in groundwater samples surrounding the landfill and in the leachate assessment wells exceeding MDEQ criteria is presented in Table 4-9.

**Table 4-9**  
**Green Point Landfill**  
**Generic IDW Criteria Exceeded in Groundwater**

| Chemical Constituent       | Exposure Point Concentration <sup>1</sup> (µg/L) | MDEQ IDW Value (µg/L) |
|----------------------------|--------------------------------------------------|-----------------------|
| <b>VOCs</b>                |                                                  |                       |
| 1,4-dioxane                | 670                                              | 350                   |
| Benzene                    | 820                                              | 5                     |
| Vinyl chloride             | 9.8                                              | 2                     |
| <b>SVOCs</b>               |                                                  |                       |
| Benzo(a)pyrene             | 7.6 J                                            | 5                     |
| Benzo(b)fluoranthene       | 12 J                                             | 2                     |
| Bis(2-ethylhexyl)phthalate | 450                                              | 6                     |
| Chrysene                   | 9.4 J                                            | 5                     |
| <b>PCBs (unfiltered) *</b> |                                                  |                       |
| Total Aroclors             | 8.2 J                                            | 0.5                   |
| <b>Inorganics</b>          |                                                  |                       |
| Aluminum                   | 1,890 J                                          | 240                   |
| Antimony                   | 19                                               | 6                     |
| Barium                     | 10,900                                           | 2,000                 |

| Chemical Constituent | Exposure Point Concentration <sup>1</sup> (µg/L) | MDEQ IDW Value (µg/L) |
|----------------------|--------------------------------------------------|-----------------------|
| Chloride             | 7,200,000                                        | 250,000               |
| Iron                 | 372,000                                          | 13,000                |
| Lead                 | 8.9                                              | 6                     |
| Magnesium            | 1,720,000                                        | 1,100,000             |
| Manganese            | 4,660                                            | 2,100                 |
| Nickel               | 173                                              | 100                   |
| Sodium               | 1,490,000                                        | 350,000               |

Notes: <sup>1</sup> = maximum detected concentration. \* = PCBs were not detected in filtered samples. J = concentration is an estimated value.

### Technical Assessment of Exceedances

Benzo(a)pyrene, benzo(b)fluoranthene, and chrysene were only detected in one monitoring well (X-6B), out of 17 wells associated with Green Point Landfill, at concentrations above generic GCC values. The monitoring well cluster, X-6, was a temporary well point installed within the fill of Green Point Landfill at a depth of 70- to 75-feet below the surface of the landfill to allow collection of a leachate sample. After sample collection, the well was abandoned. Given the depth of this sample and the completion of the landfill cap subsequent to the sample collection, it is highly unlikely that anyone will come into direct contact with the leachate, thus eliminating the groundwater contact (GCC) pathway from consideration. The Green Point Landfill Final Cover System Certification Report was submitted to the MDEQ on January 26, 2000 (BBL, 2000); MDEQ has approved the Green Point Landfill remedial activities as an Interim Response (Brouillet, B., July 2).

Only unfiltered PCB groundwater samples were reported at concentrations that exceeded the generic GCC criteria. Filtered PCB groundwater samples did not exceed the generic GCC value. These chemical constituents tend to absorb to particulate matter, and may be related to sample turbidity. MDEQ advises:

*When comparing onsite groundwater data to Groundwater Contact Criteria (GCC), samples contaminated with substances identified with footnote {AA} should be filtered. (The GCC equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that highly adsorb to soil particulates, the particulates should be removed via filtering so that only contaminants in the dissolved phase will be reported.) (MDEQ, 2000).*

As a result, only filtered samples were considered for comparison to the GCC value. The filtered groundwater samples did not exceed the generic GCC value; therefore, PCBs detected in the Greenpoint Landfill have been eliminated from further consideration in this HHE.

### 4.5.3 Southern Property - South and West of Green Point Landfill

Soil samples were collected from an area south and west of the Green Point Landfill during the supplemental soil sampling program conducted in July/August 2000. The generic IDWP value for methylene chloride was exceeded at one location, SB-396, but was not detected in the groundwater from this location (monitoring well cluster MW-3A,B). The validated analytical results for the soil sample collected from SB-396 indicated that methylene chloride was detected at an estimated concentration (i.e., the analytical result was "J" qualified). Additionally, the IDWP models methylene chloride migration to groundwater; however, methylene chloride has never been detected in the monitoring wells in that area. Based on the groundwater data from monitoring well cluster MW-3A,B, the estimated concentration of methylene chloride present in the soil sample is not impacting groundwater.

No generic IDC values were exceeded for VOCs, SVOCs, PCBs, or inorganics. No generic GCCP values for VOCs, SVOCs, or inorganics were exceeded; PCBs are not expected to leach to groundwater under normal conditions. The 95% UCL was calculated for manganese in this area. This value did not exceed the generic IPSIC value for manganese. The chemical constituents that exceeded the MDEQ generic criteria are presented below in Table 4-10.

**Table 4-10**  
**Area South of Green Point Landfill**  
**Generic IDWP Exceeded in Soil**

| Chemical Constituent | Exposure Point Concentration <sup>1, 2</sup><br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) |
|----------------------|---------------------------------------------------------|----------------------------|
| <b>Organics</b>      |                                                         |                            |
| Methylene Chloride   | 300 J <sup>1</sup>                                      | 100                        |
| <b>Inorganics</b>    |                                                         |                            |
| Aluminum             | 13,400 <sup>1</sup>                                     | 6,900                      |
| Cobalt               | 7.8 <sup>1</sup>                                        | 6.8                        |
| Iron                 | 29,100 <sup>1</sup>                                     | 12,000                     |
| Manganese            | 956 <sup>2</sup>                                        | 440                        |
| Thallium             | 5.9 <sup>1</sup>                                        | 2.3                        |

Notes: <sup>1</sup> = maximum detected concentration. <sup>2</sup> = 95% UCL concentration.

#### 4.5.4 Terminated Type III Landfills

##### 4.5.4.1 Central Terminated Type III Landfill

VOCs, SVOCs, and inorganics were detected in groundwater samples collected at monitoring wells at the Central Terminated Type III Landfill. PCBs were not detected in any of these groundwater samples. No generic GCC, FESL, IGVIIC or WSSL values were exceeded at the Central Terminated Type III Landfill. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration because the 95% UCL is not applicable for comparison to IDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents exceeding MDEQ generic criteria are summarized in Table 4-11.

**Table 4-11**  
**Central Terminated Type III Landfill**  
**Generic IDW Exceeded in Groundwater**

| Chemical Constituent | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ IDW Value<br>(µg/L) |
|----------------------|-----------------------------------------------------|--------------------------|
| <b>VOCs</b>          |                                                     |                          |
| Vinyl chloride       | 31                                                  | 2                        |
| <b>Inorganics</b>    |                                                     |                          |
| Iron                 | 13,700                                              | 13,000                   |

Notes: <sup>1</sup> = maximum detected concentration.



#### 4.5.4.2 Eastern Terminated Type III Landfill

VOCs, SVOCs, PCBs, and inorganics were detected in groundwater samples collected at monitoring wells at the Eastern Terminated Type III Landfill. No generic FESL, IGVIIC or WSSL values were exceeded at the Eastern Terminated Type III Landfill. The only generic GCC value exceeded was for PCBs. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration because the 95% UCL is not applicable for comparison to IDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents exceeding other MDEQ generic criteria are summarized in Table 4-12.

**Table 4-12**  
**Eastern Terminated Type III Landfill**  
**Generic GCC and IDW Exceeded in Groundwater**

| Chemical Constituent      | Maximum Concentration (µg/L) | MDEQ GCC Value (µg/L) | MDEQ IDW Value (µg/L) |
|---------------------------|------------------------------|-----------------------|-----------------------|
| <b>SVOCs</b>              |                              |                       |                       |
| 4-methylphenol            | 5,000                        | --                    | 1,000                 |
| <b>PCBs (unfiltered)*</b> |                              |                       |                       |
| Aroclor-1016              | 0.67                         | *                     | 0.5                   |
| Aroclor-1248              | 2.1                          | *                     | 0.5                   |
| Aroclor-1254              | 2.3                          | *                     | 0.5                   |
| Total Aroclors            | 4.4                          | *                     | 0.5                   |
| <b>PCBs (filtered)</b>    |                              |                       |                       |
| Aroclor-1248              | 1.5                          | --                    | 0.5                   |
| Aroclor-1254              | 1.1                          | --                    | 0.5                   |
| Total Aroclors            | 2.6                          | --                    | 0.5                   |
| <b>Inorganics</b>         |                              |                       |                       |
| Aluminum                  | 1,050                        | --                    | 240                   |
| Antimony                  | 9.4                          | --                    | 6                     |
| Chloride                  | 2,000,000                    | --                    | 250,000               |
| Lead                      | 9.3                          | --                    | 6                     |
| Nickel                    | 110                          | --                    | 100                   |
| Sodium                    | 1,170,000                    | --                    | 250,000               |

Notes: -- = criteria not exceeded. \* = consistent with MDEQ guidance, unfiltered data are not appropriate for comparison to GCC.

#### *Technical Assessment of Exceedances*

Filtered PCB groundwater samples did not exceed the generic GCC value. MDEQ advises,

*When comparing onsite groundwater data to Groundwater Contact Criteria (GCC), samples contaminated with substances identified with footnote {AA} should be filtered. (The GCC equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that highly adsorb to soil particulates, the particulates should be removed via filtering so that only contaminants in the dissolved phase will be reported.) (MDEQ, 2000).*

This MDEQ guidance is applicable to the generic GCC value for PCBs, which considers chemical constituents that adsorb to soil particulates. Therefore, only filtered samples were considered for comparison to the GCC value. The filtered groundwater samples did not exceed the generic GCC value; therefore, this exposure pathway has been eliminated from further consideration in this HHE.

#### 4.5.5 Previous Metal Feedstock Area

The Previous Metal Feedstock Area is located east of the SMI Plant. This area was previously used for the storage of metal feedstock. Chemical constituent levels in soil samples collected in the Previous Metal Feedstock Area did not exceed generic IDC, IDWP, GCCP, ISVIIC or Soil Saturation Screening Levels (CSAT) values for any of the organic compounds. No generic IDW values were exceeded for inorganics. The generic IPSIC for manganese was exceeded at one surface soil sample location and three subsurface soil samples locations. The maximum concentration of inorganics detected in subsurface soil was used as the exposure point concentration because the calculated 95% UCL exceeded the maximum concentration. For surface soil, the 95% UCL was used as the exposure point concentrations for manganese; however, the maximum concentration was used for iron because the calculated 95% UCL exceeded the maximum concentration. The chemical constituents exceeding MDEQ generic criteria in soils are presented in Table 4-13

**Table 4-13**  
**Previous Metal Feedstock Area**  
**Generic IDWP and IPSIC Criteria Exceeded in Surface and Subsurface Soil**

| Chemical Constituent | Exposure Point Concentration <sup>1, 2</sup><br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) | MDEQ IPSIC Value<br>(mg/kg) |
|----------------------|---------------------------------------------------------|----------------------------|-----------------------------|
| <b>SOIL BORING</b>   |                                                         |                            |                             |
| <i>Inorganics</i>    |                                                         |                            |                             |
| Aluminum             | 11,700 <sup>1</sup>                                     | 6,900                      | --                          |
| Cobalt               | 7.9 <sup>1</sup>                                        | 6.8                        | --                          |
| Iron                 | 87,400 <sup>1</sup>                                     | 12,000                     | --                          |
| Manganese            | 9,190 <sup>1</sup>                                      | 440                        | 1,500                       |
| <b>SURFACE SOIL</b>  |                                                         |                            |                             |
| <i>Inorganics</i>    |                                                         |                            |                             |
| Iron                 | 34,900 <sup>1</sup>                                     | 12,000                     | --                          |
| Manganese            | 859 <sup>2</sup>                                        | 440                        | --                          |

Notes: <sup>1</sup> = maximum detected concentration. <sup>2</sup> = 95% UCL concentration. -- = criteria not exceeded.

#### 4.5.6 Railyard Area

The Railyard Area is an unpaved area located north of the SMI Plant and is used for the temporary storage of metal feedstock and other process materials and equipment. Surface soil samples were collected from in the Railyard Area. The original 8 samples were analyzed for VOCs, SVOCs, PCBs, and inorganics. No VOCs or SVOCs were detected at concentrations exceeding MDEQ generic criteria. PCBs were detected above the generic IDC value (20 mg/kg) at one location, RS-5. The surface soils containing PCBs were removed during the soil excavation program completed in July 1998. Subsequent samples were collected in for lead and PCBs. PCB results from subsequent soil sampling were below MDEQ generic criteria. Two confirmatory samples were collected from the base of the excavation and analyzed for PCBs. PCBs were not detected in the confirmatory samples, indicating that the soils containing PCBs above generic values have been removed from the Railyard Area. The generic IDW criteria for PCBs and inorganics were not exceeded in groundwater in the vicinity of the Railyard Area. Manganese exceeded the generic IPSIC at four locations in the Railyard Area. The maximum concentration was used as the exposure point concentration because there was an insufficient number of samples to calculate the 95% UCL. The chemical constituents detected in surface soil that exceed MDEQ generic criteria are listed in Table 4-14.

**Table 4-14**  
**Railyard Area**  
**Generic IDC, IDWP and IPSIC Criteria Exceeded in Soil**

| Chemical Constituent     | Exposure Point Concentration <sup>1</sup><br>(mg/kg) | MDEQ IDC Value<br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) | MDEQ IPSIC Value<br>(mg/kg) |
|--------------------------|------------------------------------------------------|---------------------------|----------------------------|-----------------------------|
| <b><i>Inorganics</i></b> |                                                      |                           |                            |                             |
| Aluminum                 | 8,000 <sup>1</sup>                                   | --                        | 6,900                      | --                          |
| Arsenic                  | 31.1 <sup>1</sup>                                    | --                        | 23                         | --                          |
| Cadmium                  | 6.4 <sup>1</sup>                                     | --                        | 6                          | --                          |
| Cobalt                   | 143 <sup>1</sup>                                     | --                        | 6.8                        | --                          |
| Iron                     | 79,100 <sup>1</sup>                                  | --                        | 12,000                     | --                          |
| Lead                     | 1,370 <sup>1</sup>                                   | 900 (draft)               | 700                        | --                          |
| Manganese                | 5,030 <sup>1</sup>                                   | --                        | 440                        | 1,500                       |
| Nickel                   | 1,010 <sup>1</sup>                                   | --                        | 100                        | --                          |
| Selenium                 | 4.31 <sup>1</sup>                                    | --                        | 4                          | --                          |

Notes: <sup>1</sup> = maximum detected concentration.. -- criteria not exceeded.

#### ***Technical Assessment of Exceedances***

PCBs were not detected in the post remediation confirmatory samples, indicating that the soils containing PCBs above generic values have been removed from the Railyard Area.

#### **4.5.7 Unpaved Area**

The Unpaved Area is located south of the SMI Plant and is used to store roll-off boxes of municipal waste, steel scrap, and other plant materials. Surface soil samples were collected in the Unpaved Area. No generic IDWP, GCCP, IDC, IPSIC, or CSAT values were exceeded for VOCs or SVOCs. PCBs were detected above the generic IDC value but subsequent samples collected for PCBs indicated that PCBs were above the generic IDC value at only one location. The surface soils containing PCBs were removed during the soil excavation program completed in July 1998. Five confirmatory samples were collected from the sidewalls and the base of the excavation and analyzed for PCBs. PCBs were not detected in the confirmatory samples, indicating that the soils containing PCBs above generic values have been removed from the Unpaved Area. Three inorganic constituents exceeded generic IDWP values, but only manganese exceeded the generic IDW value in the vicinity of the Unpaved Area. The maximum concentration was used as the exposure point concentration because the calculated 95% UCL was greater than the maximum concentration. The chemical constituents detected in surface soil exceeding MDEQ generic criteria are listed below in Table 4-15.

**Table 4-15**  
**Unpaved Area**  
**Generic IDWP Criteria Exceeded in Soil**

| Chemical Constituent     | Exposure Point Concentration <sup>1</sup><br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) |
|--------------------------|------------------------------------------------------|----------------------------|
| <b><i>Inorganics</i></b> |                                                      |                            |
| Iron                     | 19,800                                               | 12,000                     |

| Chemical Constituent | Exposure Point Concentration <sup>1</sup><br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) |
|----------------------|------------------------------------------------------|----------------------------|
| Manganese            | 985 J                                                | 440                        |
| Nickel               | 124                                                  | 100                        |

Notes: 1 = maximum detected concentration. -- = criteria not exceeded. J = concentration is an estimated value.

### Technical Assessment of Exceedances

PCBs were not detected in the post remedial confirmatory samples, indicating that the soils containing PCBs above generic values have been removed from the Unpaved Area.

### 4.5.8 LNAPL Assessment and Remediation Area

A subsurface light non-aqueous phase liquid (LNAPL) was identified during the RI field activities within the Unpaved Area located southwest of the SMI building between the SMI and the adjacent Plant 2 buildings (BBL, 2001). This area has gone through several phases of investigation. The following reports have been submitted to MDEQ: *LNAPL Assessment and Recovery Remedial Investigation Interim Report* (BBL, November 1995) and *LNAPL Assessment and Recovery Report* (BBL, January 1998).

Analytical results indicate that the LNAPL samples contain chemical mixtures characteristic of primarily petroleum-based oil with only minor fractions of PCBs and chlorinated solvents. Results of fingerprinting analysis indicate the LNAPL resembles motor oil. The extent of the LNAPL appears to be associated primarily with the 42-inch diameter storm sewer line that discharges to the onsite stormwater pond (BBL, 2001). As part of an Interim Response Action (IRA), GM is removing LNAPL and impacted groundwater from the area. As of November 2000, more than 10,400 gallons of LNAPL had been removed, and more than 1,300,000 gallons of groundwater had been treated. PCB concentrations have decreased over time as a result of the recovery activities during the IRA (BBL, 2001).

Groundwater samples were collected in the proximity of the LNAPL Assessment and Remediation Area. No generic FESL or WSSL values for VOCs, SVOCs, or PCBs were exceeded in groundwater samples collected from the monitoring wells within the LNAPL Assessment and Remediation Area. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration for groundwater because the 95% UCL is not applicable for comparison to IDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents detected in groundwater exceeding MDEQ generic criteria are given in Table 4-16.

**Table 4-16**  
**LNAPL Assessment and Remediation Area**  
**Generic GCC and IDW Exceeded in Groundwater**

| Chemical Constituent      | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ GCC Value<br>(µg/L) | MDEQ IDW Value<br>(µg/L) | MDEQ IGVIC Value<br>(µg/L) |
|---------------------------|-----------------------------------------------------|--------------------------|--------------------------|----------------------------|
| <b>VOCs</b>               |                                                     |                          |                          |                            |
| 1,1-dichloroethene        | 7.5 J                                               | --                       | 7                        | --                         |
| Cis-1,2-dichloroethene    | 290                                                 | --                       | 70                       | --                         |
| 1,2-dichloroethene, Total | 290                                                 | --                       | 70                       | --                         |

| Chemical Constituent       | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ GCC Value<br>(µg/L) | MDEQ IDW Value<br>(µg/L) | MDEQ IGVHC Value<br>(µg/L) |
|----------------------------|-----------------------------------------------------|--------------------------|--------------------------|----------------------------|
| Trichloroethene            | 88                                                  | --                       | 5                        | --                         |
| Vinyl chloride             | 130                                                 | --                       | 2                        | --                         |
| <b>SVOCs</b>               |                                                     |                          |                          |                            |
| Bis(2-ethylhexyl)phthalate | 8.7                                                 | --                       | 6                        | --                         |
| Pentachlorophenol          | 2.7 J                                               | --                       | 1                        | --                         |
| <b>PCBs (unfiltered) *</b> |                                                     |                          |                          |                            |
| Aroclor-1242               | 58                                                  | *                        | --                       | 45                         |
| Aroclor-1248               | 610                                                 | *                        | 0.5                      | 45                         |
| Aroclor-1260               | 910                                                 | *                        | 0.5                      | 45                         |
| Total Aroclors             | 1,520                                               | *                        | 0.5                      | 45                         |
| <b>Inorganics</b>          |                                                     |                          |                          |                            |
| Arsenic                    | 51                                                  | --                       | 50                       | --                         |
| Manganese                  | 4,370                                               | --                       | 2,100                    | --                         |

Notes: <sup>1</sup> = maximum detected concentration. -- = criteria not exceeded. J = concentration is an estimated value. \* = consistent with MDEQ guidance, unfiltered data are not appropriate for comparison to GCC. PCBs were not detected in filtered samples.

No generic IDC or IDWP values were exceeded for VOCs, SVOCs, or PCBs in soil samples collected. The maximum concentration was used as the exposure point concentration because there was an insufficient number of samples to calculate the 95% UCL. The chemical constituents detected in soil samples exceeding MDEQ generic criteria are listed in Table 4-17.

**Table 4-17**  
**LNAPL Assessment and Remediation Area**  
**Generic IDC and IDWP Exceeded in Soil**

| Chemical Constituents | Exposure Point Concentration <sup>1</sup><br>(mg/kg) | MDEQ IDC Value<br>(mg/kg) | MDEQ IDWP Value<br>(mg/kg) |
|-----------------------|------------------------------------------------------|---------------------------|----------------------------|
| <b>Inorganics</b>     |                                                      |                           |                            |
| Aluminum              | 7,120 J                                              | --                        | 1                          |
| Antimony              | 22.3                                                 | --                        | 4.3                        |
| Arsenic               | 23.6                                                 | --                        | 23                         |
| Cobalt                | 12.6                                                 | --                        | 2                          |
| Copper                | 44,700                                               | --                        | 5,800                      |
| Iron                  | 43,300                                               | --                        | 6                          |
| Lead                  | 1,780                                                | 900 (draft)               | 700                        |
| Manganese             | 1,270 J                                              | --                        | 1                          |
| Nickel                | 105                                                  | --                        | 100                        |
| Zinc                  | 5,560                                                | --                        | 5,000                      |

Notes: <sup>1</sup> = maximum detected concentration. -- = criteria not exceeded. J = concentration is an estimated value.

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## Technical Assessment of Exceedances

Filtered PCB groundwater samples did not exceed the generic GCC value, MDEQ states:

*When comparing onsite groundwater data to Groundwater Contact Criteria (GCC), samples contaminated with substances identified with footnote {AA} should be filtered. (The GCC equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that highly adsorb to soil particulates, the particulates should be removed via filtering so that only contaminants in the dissolved phase will be reported.) (MDEQ, 2000).*

This MDEQ criteria is applicable to the generic GCC value for PCBs, which considers chemical constituents that adsorb to soil particulates. Therefore, only filtered samples were considered for comparison to the GCC value. Additionally, the filtered samples collected at the same locations as the unfiltered samples, which demonstrate the aqueous-phase concentration relevant to water-air partitioning (volatilization), did not exceed the generic IGVIIC. The filtered groundwater samples did not exceed the generic GCC or IGVIIC values; therefore, this exposure pathway has been eliminated from further consideration in this HHE.

### 4.5.9 Oil Sheen Areas

#### 4.5.9.1 B-3 Area Oil Sheen

An oil sheen was observed at the western end of the Central Terminated Landfill and extended to the south toward the northwest corner of the Green Point Landfill. No generic IDWP, GCCP, IDC, SVIIC, IPSIC, VSIC or CSAT values for VOCs or SVOCs and no generic IDC or CSAT values were exceeded in the soil samples.

The generic GCC values for the VOCs and PCBs detected in the groundwater samples were not exceeded. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration for groundwater because the 95% UCL is not applicable for comparison to IDW criteria. Chemical constituents detected in groundwater at concentrations above MDEQ generic criteria are listed below in Table 4-18.

**Table 4-18**  
**B-3 Area Oil Sheen**  
**Generic IDW Exceeded in Groundwater**

| Chemical Constituent       | Exposure Point Concentration <sup>1</sup> (µg/L) | MDEQ IDW Value (µg/L) |
|----------------------------|--------------------------------------------------|-----------------------|
| <b>VOCs</b>                |                                                  |                       |
| Benzene                    | 10                                               | 5                     |
| Vinyl chloride             | 31                                               | 2                     |
| <b>PCBs (unfiltered) *</b> |                                                  |                       |
| Aroclor-1248               | 1.9                                              | 0.5                   |
| Aroclor-1254               | 1.1                                              | 0.5                   |
| Total Aroclors             | 3                                                | 0.5                   |

Notes: <sup>1</sup> = maximum detected concentration. \* = PCBs were not detected in filtered samples.

#### 4.5.9.2 Center Street Oil Sheen

The oil sheen area in the vicinity of Center Street was found to correlate with the waste associated with the Former Queen Street Dump, and not with any known GM source (BBL, 2001). The oil sheen area extends to the northeast past the GM SMI site perimeter. VOCs and SVOCs were detected in soil and groundwater within the area of the oil sheen, but PCBs were not detected. No chemical constituents exceeded the generic IDWP, GCCP, IDC, SVIIC, IPSIC, VSIC or CSAT values for VOCs or SVOCs in the soil samples. No chemical constituents exceeded the generic RDW/IDW, GCC, FESL, IGVIIC or WSSL values for VOCs and no generic FESL or WSSL values for SVOCs were exceeded in the groundwater samples. The generic GCC values for benzo(b)fluoranthene and chrysene were exceeded at one temporary well. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration because the 95% UCL is not applicable for comparison to IDW/RDW criteria and is generally not practical for assessing the GCC exposure pathway. The chemical constituents that exceeded MDEQ generic criteria are listed in Table 4-19.

**Table 4-19**  
**Center Street Oil Sheen**  
**Generic RDW/IDW Exceeded in Groundwater**

| <b>Chemical<br/>Constituent</b> | <b>Exposure Point<br/>Concentration<sup>1</sup><br/>(µg/L)</b> | <b>MDEQ<br/>GCC Value<br/>(µg/L)</b> | <b>MDEQ<br/>RDW Value<br/>(µg/L)</b> | <b>MDEQ<br/>IDW Value<br/>(µg/L)</b> |
|---------------------------------|----------------------------------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| <b>SVOCs</b>                    |                                                                |                                      |                                      |                                      |
| Benzo(a)anthracene              | 5.3 J                                                          | --                                   | 2.1                                  | --                                   |
| Benzo(b)fluoranthene            | 5.9 J                                                          | 2                                    | 2                                    | 2                                    |
| Bis(2-ethylhexyl)phthalate      | 19                                                             | --                                   | 6                                    | 6                                    |
| Chrysene                        | 7 J                                                            | 5                                    | 5                                    | 5                                    |

Notes: <sup>1</sup> = maximum concentration. . J = concentration is an estimated value.

#### *Technical Assessment of Exceedances*

The PAH exceedances (benzo(a)anthracene, benzo(b)fluoranthene and chrysene) were detected in a temporary well (TW-203WT). These chemicals were infrequently detected in that area. Of the 27 temporary wells in the non-river residential perimeter, benzo(a)anthracene, benzo(b)fluoranthene and chrysene were detected in only one temporary monitoring well (TW-203WT). The concentrations reported for these PAHs were qualified, and the following is stated in the *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)*,

*Consider the chemical as a candidate for elimination from the quantitative risk assessment if:*  
*(1) it is detected infrequently in one perhaps two environmental media, (2) if it is not detected in any other sample media or at high concentrations, and (3) there is no reason to believe that the chemical may be present (USEPA, 1989).*

In addition, these chemical constituents tend to absorb to particulate matter, and may be related to sample turbidity.

TW-203WT was installed as a temporary well and as a result was not developed to minimize turbidity, and would be expected to potentially yield groundwater samples that contained artificially high concentrations of

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strongly adsorptive compounds (such as PAHs) due to the inclusion of particulates in the groundwater samples. MDEQ advises,

*When comparing onsite groundwater data to Groundwater Contact Criteria (GCC), samples contaminated with substances identified with footnote {AA} should be filtered. (The GCC equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that highly adsorb to soil particulates, the particulates should be removed via filtering so that only contaminants in the dissolved phase will be reported.) (MDEQ, 2000).*

Although, no filtered results were available from the temporary well, these chemical constituents were not detected in samples collected from any of the nearby permanent monitoring wells. Given the infrequency of detection, potential inclusion of particulates in the sample, and lack of detection in any of the permanent monitoring wells, these groundwater samples were eliminated from further assessment in the HHE.

#### **4.5.10 Surface Water Bodies and Sediment**

Nineteen surface water samples were collected from the following onsite surface water bodies: former Primary Settling Pond, Secondary Settling Pond, Stormwater Pond, Former WRS Channels, Southern Drainage Channels, various locations in the vicinity of Green Point Landfill, marshy areas west of Peninsula Area Property, and in areas of standing water within the Drum Remediation Area. Although regular contact with surface water (wading or swimming) is unlikely at this industrial site, generic GCC values were used to assess incidental contact. No generic GCC values were exceeded in the surface water samples collected in these areas. No further evaluation of surface water is required.

A total of 131 sediment samples and 17 native soil samples were collected from 48 locations including the above mentioned surface water bodies. The generic IDC values for VOCs and PCBs were not exceeded in any sediment samples. Although sediments are not "wet soils," given the industrial nature of the property it is unlikely that workers will come into contact with the sediments on a frequent basis. This, in combination with the conservative adherence factor used in the derivation of the IDC, ensure that the IDC generic criteria are adequately protective if workers infrequently come into contact with sediment. Sediment samples were also compared to generic IVSIC and generic IPSIC to assess whether the sediments could pose inhalation risks. No generic IVSIC values were exceeded in the sediment samples. No generic IPSIC values for organic constituents were exceeded in these samples. Only manganese exceeded the generic IPSIC value; however due to the presence of standing water at these sediment locations, it is unlikely that particulate inhalation would occur. Therefore, the IPSIC pathway is no longer considered for sediments in this HHE.

##### **4.5.10.1 Former Water Recirculation System (WRS)**

The Former Water Recirculation System (WRS) consists of a former Primary Settling Pond, a Secondary Settling Pond, and drainage channels. The WRS was taken off line in January 1997 and replaced with a new Water Recycle System. The Primary Settling Pond has dried up and been regraded. Supplemental soil samples were collected from the sidewalls of the Secondary Settling Pond in August 2000 and analyzed for PCBs. No PCBs exceeded the generic IDC or CSAT values. GM recently received a permit to fill in the drainage channels (BBL, 2001). The nature and extent of the sediment and surface water sampling of these areas is discussed below.



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#### **4.5.10.2 Former Primary Settling Pond**

A sample of surface water was collected from the Former Primary Settling Pond; however, the pond has subsequently dried up and been regarded. Therefore exposure to surface water at this area is no longer a complete pathway. Further, no generic GCC values were exceeded in the surface water sample collected from the Former Primary Settling Pond.

#### **4.5.10.3 Secondary Settling Pond**

Manganese was detected above the generic IPSIC value in sediment samples; however, due to the presence of standing water in this area, inhalation of sediment is highly unlikely. No chemicals exceeded the GCC values in the surface water samples collected from the Secondary Settling Pond in February 2000 and again in March 2000. Based on this evaluation, no further evaluation of human health risk is required for the Secondary Settling Pond.

#### **4.5.10.4 Stormwater Pond**

One surface soil sample was collected from the Stormwater Pond. No generic GCC were exceeded. Supplemental sampling was conducted due to the observance of an oily material on the surface of the Stormwater Pond. Results of the supplemental Stormwater Pond investigation indicated the presence of PCBs in surface water and sediment. However, generic IDC values were not exceeded in the sediment samples. As a result of the supplemental investigation, the oil-stained sediment from the sidewalls of the pond were excavated and disposed of offsite, the pond bottom sediments were stabilized using lime and fly ash, and the pond was lined during the summer of 2000. None of the sediments in the Stormwater Pond need further evaluation (BBL, 2001).

#### **4.5.10.5 Former WRS Drainage Channels**

Since the WRS is no longer in use, MDEQ has issued a permit to fill these channels and a grass cover will be planted after the channels are filled. Therefore, these areas will become terrestrial in nature and no further evaluation of these channels is required.

#### **4.5.10.6 Southern Drainage Channels**

Sediment samples collected in the Southern Drainage Channels did not exceed generic IDC values or IPSIC values.

#### **Underground Storage Tanks (USTs)**

Eleven USTs have been removed from the SMI Plant Property between 1982 and 1991. No further action was required for six of the former UST areas (UST #s 1, 2, 6, 9, 10, and 11). Former Tank #4 Area, which includes UST #s 3, 4, and 5, and Former Tank # 8 were investigated in 1994 and the results of the investigations were submitted to MDEQ. Based on the results of the investigations, further investigation of the Former Tank #4 Area and Former Tank #8 was not required.

#### 4.5.10.7 Former UST #7

The remaining UST, Former UST #7, was investigated in May 1996 and the findings were reported in the *Former UST #7 Area Supplemental Investigation Report* (BBL, May 1997). As a result of that investigation, a quarterly monitoring program was implemented for the Former UST #7 Area in July 1998.

The constituents found in soils and groundwater at the Former UST #7 are associated with a historical gasoline release. Benzene, toluene, ethylbenzene, and xylene (BTEX) and lead were detected in the subsurface soil and groundwater in the immediate vicinity of the Former UST #7. PCBs were detected in two soil samples upgradient of the Former UST #7, but did not exceed the IDC or ISVIIC values. PCBs were not detected in the groundwater samples. No soil samples exceeded the generic IDWP or IDC values for lead. No generic GCC values were exceeded in the groundwater samples. The generic ISVIIC was exceeded for benzene in the central portion of Former UST #7, approximately 120 feet from the employee tunnel. The chemical constituents in groundwater at the Former UST #7 continue to decrease as a result of natural attenuation processes. Groundwater samples are collected from the Former UST #7 area for analysis on a quarterly basis.

The maximum concentration was used as the exposure point concentration for soil data because there was an insufficient number of samples to calculate the 95% UCL. Per MDEQ guidance (MDEQ, 2001b) the maximum concentration was used as the exposure point concentration for groundwater data because the 95% UCL is not applicable for comparison to IDW criteria.

The chemical constituents that exceeded the MDEQ generic criteria in soils in the Former UST #7 area are summarized in Table 4-20. The chemical constituents that exceeded the MDEQ generic criteria in groundwater are summarized in Table 4-21.

**Table 4-20**  
**Former UST #7**  
**Generic ISVIIC and IDWP Exceeded in Soil**

| Chemical Constituent   | Exposure Point Concentration <sup>1</sup> (mg/kg) | MDEQ ISVIIC Value (mg/kg) | MDEQ IDWP Value (mg/kg) |
|------------------------|---------------------------------------------------|---------------------------|-------------------------|
| <b>VOCs</b>            |                                                   |                           |                         |
| 1,2,4-Trimethylbenzene | 84                                                | --                        | 2.1                     |
| 1,3,5-Trimethylbenzene | 18                                                | --                        | 1.8                     |
| Benzene                | 21 J                                              | 8.4                       | 0.1                     |
| Ethylbenzene           | 29 J                                              | --                        | 1.5                     |
| Xylenes                | 120                                               | --                        | 5.6                     |

Notes: <sup>1</sup> = maximum detected concentration. -- = criteria not exceeded. J = concentration is an estimated value.

**Table 4-21**  
**Former UST #7**  
**Generic IDW Exceeded in Groundwater**

| Chemical Constituent   | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ IDW Value<br>(µg/L) |
|------------------------|-----------------------------------------------------|--------------------------|
| <b>VOCs</b>            |                                                     |                          |
| 1,2,4-Trimethylbenzene | 2,400                                               | 63                       |
| 1,3,5-Trimethylbenzene | 650                                                 | 72                       |
| Benzene                | 1,600                                               | 5                        |
| Toluene                | 1,400                                               | 790                      |
| Ethylbenzene           | 1,800                                               | 74                       |
| Xylenes                | 6,900                                               | 280                      |
| <b>Inorganics</b>      |                                                     |                          |
| Lead                   | 114                                                 | 6                        |

Notes: <sup>1</sup> = maximum detected concentration.

## 4.6 SMI Plant Interior

### 4.6.1 Quench Pit

During the Quench Pit investigation, LNAPL was encountered beneath the plant floor in the vicinity of the quench pits at approximately 7 to 8 feet below grade. The chemical constituents detected in the LNAPL samples are presented in Table 4-22.

**Table 4-22**  
**Quench Pit Area**  
**Constituents Detected in LNAPL**

| VOCs         | PCBs           | Inorganics |
|--------------|----------------|------------|
| Benzene      | Aroclor-1254   | Aluminum   |
| Toluene      | Total Aroclors | Calcium    |
| Ethylbenzene |                | Chromium   |
| Xylenes      |                | Copper     |
| Styrene      |                | Iron       |
|              |                | Lead       |
|              |                | Manganese  |
|              |                | Selenium   |
|              |                | Vanadium   |

No VOCs, SVOC, PCBs, or cyanide were detected in groundwater samples above laboratory method detection limits. No generic GCC values were exceeded for inorganics detected in the groundwater samples. Per MDEQ guidance, the maximum concentration was used as the exposure point concentration for groundwater because the 95% UCL is not applicable for comparison to IDW criteria. The chemical constituents exceeding MDEQ generic criteria are summarized in Table 4-23.

**Table 4-23**  
**Quench Pit Area**  
**Generic IDW Exceeded in Groundwater**

| Chemical Constituent | Exposure Point Concentration <sup>1</sup><br>(µg/L) | MDEQ IDW Value<br>(µg/L) |
|----------------------|-----------------------------------------------------|--------------------------|
| <b>Inorganics</b>    |                                                     |                          |
| Arsenic              | 64                                                  | 50                       |
| Iron                 | 29,900                                              | 13,000                   |

Notes: <sup>1</sup> = maximum detected concentration.

#### 4.6.2 Melting Department Area

PCBs were detected in soil samples collected beneath the plant floor in the Melting Department area. Concentrations of PCBs exceeded the generic IDC value of 20 mg/kg. PCB concentrations ranged from non-detect to 650 mg/kg. The generic ISVIIC for PCBs (16,000 mg/kg) was not exceeded in the soil samples. The soils containing PCBs were excavated to the extent practicable. The Melting Department investigation is described in detail in the *Melting Department Area Investigation and Remediation Report* (CRA, April 1997).

#### 4.6.3 Manhole I27.7 Area

PCBs were detected in soil samples collected beneath the plant floor in the area of Manhole I27.7 at concentrations ranging from 0.37 mg/kg to 4,900 mg/kg. PCB concentrations exceeded generic IDC criteria. The PCB-impacted soils are not accessible to plant workers because they are located beneath the plant floor. In addition, a deed restriction to be implemented (as described in the Feasibility Study) will restrict intrusive activities in this area. The generic ISVIIC for PCBs (16,000 mg/kg) was not exceeded in the samples. The investigation completed for this area of the site is described in detail in the *Feasibility Analysis Report* (CRA, May 1998).

### 4.7 Other Areas

#### 4.7.1 Driveway Expansion Area

Soil samples were collected in the area of excavation associated with expansion of the entrance driveway to the GM SMI Plant for PCB analysis. PCBs were not detected in any of the soil samples collected in this area.

#### 4.7.2 POTW Sewer Discharges

Samples were collected for PCB analysis on a weekly basis between September 25, 1995 and May 24, 1996 from within the GM SMI Plant water supply and sewer discharge lines. PCBs were not detected during this period of time. GM has implemented a sewer line sampling program and results are submitted to MDEQ monthly.

#### 4.8 Summary of MDEQ Generic Cleanup Criteria Comparison

The chemicals of potential concern that exceed MDEQ *Generic Cleanup Criteria* are summarized in the following Tables 4-24 and 4-25. The COPCs are presented for each generic criterion that were exceeded.

**Table 4-24**  
**COPCs Exceeding MDEQ Generic Cleanup Criteria in Groundwater**

| RDW                        | IDW                        | GCC                        | RGVHC / IGVHC  |
|----------------------------|----------------------------|----------------------------|----------------|
| <b>VOCs</b>                | <b>VOCs</b>                | <b>VOCs</b>                | <b>VOCs</b>    |
| 1,1-Dichloroethene         | 1,4-Dioxane                | Vinyl Chloride             | Vinyl chloride |
| cis-1,2-Dichloroethene     | 1,1-Dichloroethene         |                            |                |
| 1,2-Dichloroethene, Total  | Cis-1,2-Dichloroethene     | <b>SVOCs</b>               |                |
| Methylene chloride         | 1,2-Dichloroethene, Total  | Bis(2-ethylhexyl)phthalate |                |
| Trichloroethene            | 1,2,4-Trimethylbenzene     | Benzo(b)fluoranthene       |                |
| Vinyl chloride             | 1,3,5-Trimethylbenzene     | Benzo(a)pyrene             |                |
|                            | Benzene                    | Chrysene                   |                |
| <b>SVOCs</b>               | Ethylbenzene               |                            |                |
| Bis(2-ethylhexyl)phthalate | Toluene                    |                            |                |
| Benzo(a)anthracene         | Xylenes                    |                            |                |
| Benzo(b)fluoranthene       | Trichloroethene            | <b>Dioxins/Furans</b>      |                |
| Chrysene                   | Vinyl chloride             | 2,3,7,8-TCDD TEQ           |                |
|                            | Methylene chloride         |                            |                |
|                            |                            |                            |                |
| <b>Inorganics</b>          | <b>SVOCs</b>               |                            |                |
| Aluminum                   | Benzo(a)anthracene         |                            |                |
| Antimony                   | Benzo(b)fluoranthene       |                            |                |
| Arsenic                    | Benzo(a)pyrene             |                            |                |
| Barium                     | Bis(2-ethylhexyl)phthalate |                            |                |
| Iron                       | Chrysene                   |                            |                |
| Sodium                     | Pentachlorophenol          |                            |                |
| Vanadium                   | 4-Methylphenol             |                            |                |
| Thallium                   |                            |                            |                |
|                            | <b>PCBs</b>                |                            |                |
|                            | Aroclor-1016               |                            |                |
|                            | Aroclor-1242               |                            |                |
|                            | Aroclor-1248               |                            |                |
|                            | Aroclor-1254               |                            |                |
|                            | Aroclor-1260               |                            |                |
|                            | Total Aroclors             |                            |                |
|                            |                            |                            |                |
|                            | <b>Dioxins/Furans</b>      |                            |                |
|                            | 2,3,7,8-TCDD TEQ           |                            |                |
|                            |                            |                            |                |

| RDW | IDW               | GCC | RGVIIC / IGVIIIC |
|-----|-------------------|-----|------------------|
|     | <i>Inorganics</i> |     |                  |
|     | Aluminum          |     |                  |
|     | Antimony          |     |                  |
|     | Arsenic           |     |                  |
|     | Barium            |     |                  |
|     | Cadmium           |     |                  |
|     | Chloride          |     |                  |
|     | Iron              |     |                  |
|     | Lead              |     |                  |
|     | Magnesium         |     |                  |
|     | Manganese         |     |                  |
|     | Nickel            |     |                  |
|     | Sodium            |     |                  |
|     | Thallium          |     |                  |

**Table 4-25**  
**COPCs Exceeding MDEQ Generic Cleanup Criteria in Soils**

| IDC               | IPSIC             | ISVIIC      |
|-------------------|-------------------|-------------|
| <i>PCBs</i>       | <i>Inorganics</i> | <i>VOCs</i> |
| Total Aroclors    | Manganese         | Benzene     |
|                   |                   |             |
| <i>Inorganics</i> |                   |             |
| Lead              |                   |             |

## 5. Facility-Specific Generic Cleanup Remedial Action Evaluation

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*Facility-Specific Generic Cleanup Criteria* (FSGCC) are generic criteria that have been modified based upon the characteristics of the property that are not expected to change. One physical characteristic at the GM SMI Plant facility not expected to change concerns the groundwater characteristics. Groundwater quality at the GM SMI Plant facility, in the area of the City of Saginaw, and in Saginaw County has been highly affected by natural brine. The shallow groundwater encountered in the overburden deposits is in an unconfined or “water table” condition. The overburden deposits at the site consist of layers of clay to sand-size sediments that were deposited by fluvial and glaciofluvial processes. Groundwater yield at the site is very poor in these overlying deposits. Depth to groundwater varies from 2 to 10 feet below the land surface and depends on the proximity of recharge areas and seasonal influences. It is doubtful the groundwater at the site represents a true aquifer. Bedrock groundwater quality is poor due to the presence of heavy mineralization and would generally be unfit for use as an aquifer due to high concentrations of chlorides, iron, total and dissolved solids, and other minerals (United States Geological Survey [USGS], 1980). The chloride and sodium levels detected in the groundwater at the site consistently exceed MDEQ generic drinking water criteria. However, the elevated levels of chloride and sodium are not related to the GM SMI Plant.

MDEQ guidance states:

*The remediation action plan (RAP) should identify whether each saturation zone underlying the site is an aquifer. Any formation which serves or may serve as a drinking water source meets the definition of aquifer in R 299.510(c) [TDS, 1998a];*

and

*Part 201 drinking water criteria are applicable to aquifers that are considered marginal as drinking water sources, but serve or may serve as the only viable drinking water source in the area. Consultation with the local health department may assist in resolving the potential use(s) of groundwater to assure application of appropriate groundwater cleanup criteria [TDS, 2001].*

Potable water in the metropolitan Saginaw area is provided by the City of Saginaw. The City of Saginaw water treatment and pumping operation is responsible for management, treatment, and delivery of potable water. Potable water for residences and businesses within the city limits of Saginaw is pumped to the City of Saginaw Water Treatment Plant through the 65-mile long Saginaw-Midland Water System pipeline originating at Whitestone Point north of Au Gres located near the Saginaw Bay of Lake Huron (City of Saginaw website, 2001). The GM SMI Plant and surrounding areas are located within the city limits of Saginaw. John Premo with the Saginaw City Hall confirmed there are no private wells located within a 5-mile radius of the GM SMI Plant. Upon connection to the Saginaw City water supply, all residences were required to disconnect the private well from the household potable water supply as required by Michigan Public Act 399 and the wells were capped in accordance with wellhead protection under the authority of the Saginaw County Health Department (John Premo, Saginaw City Hall).

For the above mentioned reasons, groundwater at the GM SMI Plant facility and in the City of Saginaw is highly unlikely to be used as drinking water. Based on the recording of restrictions on the property deed preventing groundwater use for drinking water purposes, the groundwater will not be used as a source of drinking water in the future. Accordingly, ingestion of groundwater, as residential or industrial drinking water, is not considered a

complete exposure pathway, and therefore is not considered in this risk evaluation. In addition, GM has agreed to impose restrictions on groundwater use at the site.

After eliminating the drinking water pathway from further consideration, the chemical constituents that exceed *Facility-Specific Generic Cleanup Criteria* are summarized in Tables 5-1 and 5-2. The locations where *Facility-Specific Generic Cleanup Criteria* exceedances occur are presented in Figures 4 and 5.

**Table 5-1**  
**COPCs Exceeding MDEQ Facility-Specific Generic Cleanup Criteria in Groundwater**

| <b>GCC</b>                   | <b>IGVIIC</b>      |
|------------------------------|--------------------|
| <b><i>VOCs</i></b>           | <b><i>VOCs</i></b> |
| Vinyl chloride               | Vinyl chloride     |
|                              |                    |
| <b><i>SVOCs</i></b>          |                    |
| Bis(2-ethylhexyl)phthalate   |                    |
|                              |                    |
| <b><i>Dioxins/Furans</i></b> |                    |
| 2,3,7,8-TCDD TEQ             |                    |

**Table 5-2**  
**COPCs Exceeding MDEQ Facility-Specific Generic Cleanup Criteria in Soils**

| <b>IDC</b>               | <b>IPSIC</b>             | <b>ISVIIC</b>      |
|--------------------------|--------------------------|--------------------|
| <b><i>PCBs</i></b>       | <b><i>Inorganics</i></b> | <b><i>VOCs</i></b> |
| Total Aroclors           | Manganese                | Benzene            |
|                          |                          |                    |
| <b><i>Inorganics</i></b> |                          |                    |
| Lead                     |                          |                    |



## **6. Site-Specific Remedial Action Evaluation**

### **6.1 Development of Site-Specific Cleanup Criteria**

For this HHE, *Site-Specific Cleanup Criteria* (SSCC) were developed in accordance with MDEQ guidelines. The process of developing these SSCC is consistent with what is outlined in Operational Memorandum #18 (MDEQ, 2000). These criteria are based on alternative exposure assumptions unique to the GM SMI Plant facility. SSCC are derived from essentially the same equations used to calculate MDEQ *Generic Cleanup Criteria*, except that site-specific parameters are used in the calculations.

A revised site exposure conceptual model, including an exposure assessment is developed as part of the SSCC comparison. The revised site exposure conceptual model and exposure pathway analysis is described in the following sections. Modifications to the MDEQ *Generic Cleanup Criteria* algorithms and the development of the SSCC are also described in the following sections.

#### **6.1.1 Revised Site Exposure Conceptual Model**

A revised site exposure conceptual model was developed to identify potential or suspected sources of chemicals and affected media, potentially exposed populations, and potential exposure pathways. The objective of the exposure assessment is to estimate the type and magnitude of potential human exposures to the chemicals of potential concern (COPCs) identified at the GM SMI Plant facility. According to the USEPA, an exposure assessment is “the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure” (USEPA, 1989). The revised site exposure conceptual model for GM SMI Plant is based on existing data compiled from previous studies of the site and assumes an understanding of the current land-use.

The most significant factor affecting the potential for exposure is land-use. Current and future land uses are considered in the risk assessment process (USEPA, 1989). The GM SMI Plant facility is located in an industrial area of Saginaw that is zoned for industrial usage. Currently, the site is a malleable iron plant whose operations consist of activities associated with casting and heat-treating iron. The primary activity at the property is industrial in nature. The possibility of residential development, while highly unlikely, will be precluded with the imposition of deed restrictions. The site will thus remain an industrial area for the foreseeable future; therefore, current and future land-use is considered as one and the same. Due to the industrial nature of the site, the only potential human populations considered relevant to this HHE are industrial workers and occasional site visitors. A summary of potential receptors and exposure pathways is presented in Table 6-1.

The revised site exposure conceptual model identifies possible release sources (e.g., chemical constituents from operational activities) present at the site and the receiving media (e.g., soils and groundwater). The release source and receiving media are identified regardless of whether there is actual human exposure to the receiving media.

The known release mechanism for the COPCs at the site is activities associated with the manufacturing plant, past waste management activities, and unexpected releases from storage areas located on the property.

The media considered in this assessment are surface soil, subsurface soil, groundwater, sediment, surface water, and volatile and particulate releases to air from these media. Because the groundwater onsite and in the vicinity

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of the site is not considered drinking water, SSCC were not developed for the MDEQ generic residential drinking water (RDW) and generic industrial drinking water (IDW) criteria. Drinking water is not considered a complete exposure pathway in this health assessment.

Based on an understanding of current site activities and land use, the GM SMI Plant facility has been grouped into two areas for this HHE: a production area and a non-production area. The production area is delineated as the active plant areas east to the western side of the Eastern Terminated Type III Landfill; south to the northern side of the Central Terminated Type III Landfill and the Secondary Settling Pond; and north and west to the property boundary line. All other parts of the site are considered the non-production area. The non-production area consists of undeveloped areas which include the Drum Remediation/Hillock Area, the landfills, settling ponds, drainage channels, open fields, and wetland areas. While it is highly unlikely that these areas will ever be developed, deed restrictions will be placed in the Drum Remediation and Former Hillock Area (DRA/Hillock) that restrict the construction of buildings without investigation of possible risks. The delineation of these contact areas is presented in Figure 6. The revised site exposure conceptual models for the production and non-production areas are presented in Figures 7 and 8, respectively. The primary site features/areas of concern for the GM SMI Plant facility are summarized in Appendix B.

## 6.2 Fate and Transport Modeling

The concentration and distribution of chemicals in the environment are constantly subject to change due to dispersal by wind and water and degradation by microorganisms, sunlight, and chemical reactions. Once chemicals are released to the environment, they can partition (distribute) between air, water, sediment, soil, and biota. They may be subject to one or more of the following processes:

- Transportation (e.g., downstream movement in water, on suspended sediment, or through the atmosphere);
- Physical transformation (e.g., volatilization, precipitation);
- Chemical transformation (e.g., photolysis, hydrolysis, oxidation, reduction, etc.);
- Biological transformation (e.g., biodegradation by soil micro-organisms, metabolization by plants or animals); and
- Accumulation in one or more media (including the receiving media).

Advection (the horizontal flow of air) and dispersion are controlled primarily by physical parameters within the system and are essentially the same for all chemical compounds.

## 6.3 Potentially Exposed Populations

The exposure model previously developed during the *Generic Remedial Action Evaluation* has been revised to reflect site-specific conditions at the GM SMI Plant facility. Based on the current and reasonably anticipated future use scenarios, there are two main areas for exposure: production area and non-production area (Figure 6), and four categories of human receptors for which risk-based SSCC were developed. The following paragraphs describe these areas and the human receptors associated with these areas.

- 
- **Production Area:** In this area individuals are generally involved in the day-to day production operations of the plant and may be directly exposed to media associated with production areas. The following receptors are associated with the production area:
    - **Construction Worker:** This receptor was selected to specifically evaluate potential high contact activity to subsurface soil and non-potable groundwater. This individual is involved in certain land intrusive activities at the facility, which may result in exposure to surface soils, subsurface soils, and non-potable groundwater associated with the production area. However, exposure for this individual will be relatively short in duration. As a highly conservative assumption, this worker is assumed to never be indoors.
    - **Production Worker:** This receptor was selected to specifically evaluate *indoor* industrial exposures. This individual spends most, if not all, of the workday indoors. By assuming the production worker is inside all the time (with the exception of walking to and from parking), all of the work related activities, and therefore onsite exposures, occur indoors. Also, exposure will most likely occur only in the production area, as no buildings currently exist or are expected to be constructed in the non-production area (this area is mainly landfills, ponds and wetlands) – although we do consider indoor air issues in the non-production area (e.g., vinyl chloride in groundwater at the DRA/Hillock area). As a result, this individual represents the highest chronic exposure scenario for this area; therefore any risk-based values protective of this receptor will be protective of other receptors in the production area.
  - **Non-Production Area:** This portion of the site is an area void of any manufacturing activity where individuals are involved in outdoor type activities. These areas are undeveloped and are infrequently visited. The non-production area consists primarily of landfills, settling ponds, drainage channels, open fields, and wetland areas. It is highly unlikely that these areas will ever be developed; permanent structures most likely will never be constructed on these parcels of land. The following potential receptors are associated with the non-production area.
    - **Maintenance Worker:** This receptor was selected to specifically evaluate *outdoor* exposures. This individual spends most of the workday conducting maintenance activities outdoors. These activities include, but are not limited to mowing grass and inspecting the landfills. Occasionally this individual may be involved in emergency type activities (i.e. utility line repair) that would require him to be engaged in intrusive type work which may result in exposure to surface and subsurface soils, and non-potable groundwater. This receptor is the only one that will consistently contact soil in the non-production area. Because this individual represents the most heavily, chronically exposed individual for the non-production area, the risk based values developed for this receptor will be conservative and protective of other receptors potentially exposed in this area.
    - **Construction Worker:** This receptor was selected to specifically evaluate potential high contact activity to subsurface soil and non-potable groundwater. This individual is involved in certain land intrusive activities at the facility, which may result in exposure to surface soils, subsurface soils, and non-potable groundwater associated with the non-production area. However, exposure for these individuals will be relatively short in duration. As a highly conservative assumption, this worker is assumed to never be indoors.
    - **Visitor:** For this HHE, the visitor is assumed to be a child of 12 to 14 years of age involved in field trip related activities at the site. Use of this individual provides a sensitive receptor scenario for this HHE.

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An adult visitor also could be considered to visit the site. However, exposure variables assumed for the other adult receptors (e.g., groundkeeper) will also be protective of the adult visitor.

The exposure pathways determined for this HHE are:

- incidental ingestion of, dermal contact with, and inhalation of chemical constituents and dust associated with surface and subsurface soil;
- dermal contact with and inhalation of chemical constituents found in groundwater;
- inhalation of constituents resulting from volatilization of subsurface sources (subsurface soil and groundwater) into ambient air;
- incidental ingestion of, dermal contact with, and inhalation of chemical constituents associated with sediment; and
- dermal contact with chemical constituents found in surface water.

Exposure pathway analysis (Section 6.4) includes a list of the potential exposure sources and an assessment of the completeness of the potential exposure pathways. Since direct exposure measurements are rarely conducted for a particular site, a number of exposure assumptions are required to estimate the degree of human contact with chemicals in site media.

#### **6.4 Identification of Exposure Pathways**

This section of the HHE provides revised human exposure scenarios previously developed for chemicals present at the site. Therefore, this section is termed an “exposure pathway analysis” and describes the course a chemical takes from the source to a potentially exposed individual. An exposure pathway analysis consists of four elements:

- a source and mechanism of chemical release to the environment (e.g., residual PCBs);
- a relevant environmental transport medium (e.g., surface soil);
- a relevant point of human exposure to the chemicals present in that medium (e.g., dermal contact with chemicals in surface soil); and
- a route of uptake at the exposure point (e.g., dermal absorption of chemicals from surface soil).

A pathway is considered complete if all four elements are present and incomplete if one or more of these elements are not present. It is also assumed that a pathway is complete only if there exists a segment of the human population which potentially may contact site chemicals.

The potential exposure pathways for each potential receptor are given in Table 6-1 and represent the most important pathways for which the receptor may be exposed to site-related chemicals. Certain of these potential exposure pathways may appear unlikely or insignificant, but they are nonetheless routinely considered in the HHE process. Table 6-1 lists the exposure pathways, exposure media and potentially exposed site populations, whether or not a particular exposure pathway is complete for a particular population, as well as the rationale for

the selection or exclusion of the exposure pathway. Pathways considered for the potentially exposed population include ingestion, dermal, and inhalation exposure to chemicals in surface soil, subsurface soil, non-potable groundwater, sediment, and surface water. As aforementioned, ingestion of groundwater, as residential or industrial drinking water, is not considered as an exposure pathway in this health assessment.

**Table 6-1**  
**Revised Exposure Analysis**  
**Potential Receptor and Exposure Pathways**

| Potentially Exposed Population                       | Exposure Pathway and Medium                                                                      | Pathway Selected for Evaluation? | Potential for Occurrence (High/Low) | Reason for Selection or Exclusion                                                                                                            |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Site Visitor</b><br><b>(non-production area)</b>  | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                              | Low                                 | Site visitor may contact surface soil during site visit.                                                                                     |
|                                                      | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | No                               | Low                                 | Site visitor is not expected to come in contact with subsurface soil during site visit.                                                      |
|                                                      | Dermal exposure to chemicals in non-potable groundwater.                                         | No                               | Low                                 | Site visitor is not expected to come in contact with non-potable groundwater during site visit.                                              |
|                                                      | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | No                               | Low                                 | Site visitor is not expected to come into contact with volatiles in enclosed spaces since there are no buildings in the non-production area. |
|                                                      | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | Yes                              | Low                                 | Site visitor may come into contact with surface water/sediment.                                                                              |
| <b>Production Worker</b><br><b>(production area)</b> | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                              | Low                                 | Production worker may contact surface soil.                                                                                                  |
|                                                      | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | No                               | Low                                 | Production worker is not expected to come in contact with subsurface soil.                                                                   |
|                                                      | Dermal exposure to chemicals in non-potable groundwater.                                         | No                               | Low                                 | Production worker is not expected to come in contact with non-potable groundwater.                                                           |
|                                                      | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | Yes                              | High                                | Production worker may come into contact with volatiles in enclosed spaces.                                                                   |
|                                                      | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | No                               | Low                                 | Production worker is not expected to come into contact with onsite surface water/sediment.                                                   |

| Potentially Exposed Population                              | Exposure Pathway and Medium                                                                      | Pathway Selected for Evaluation? | Potential for Occurrence (High/Low) | Reason for Selection or Exclusion                                                                         |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>Maintenance Worker (non-production area)</b>             | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                              | High                                | Maintenance worker may contact surface soil during outdoor activities.                                    |
|                                                             | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | Yes                              | Low                                 | Maintenance worker is not expected to come in contact with subsurface soil.                               |
|                                                             | Dermal exposure to chemicals in non-potable groundwater.                                         | Yes                              | Low                                 | Maintenance worker is not expected to come into contact with non-potable groundwater.                     |
|                                                             | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | Yes                              | Low                                 | Maintenance worker may come into contact with volatiles in enclosed spaces (only in the production area). |
|                                                             | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | Yes                              | Low                                 | Maintenance worker may come into contact with surface water/sediment.                                     |
| <b>Construction Worker (production/non-production area)</b> | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in surface soil.    | Yes                              | High                                | Construction worker may come in contact with surface soils.                                               |
|                                                             | Ingestion, dermal, and inhalation (dust and volatiles) exposure to chemicals in subsurface soil. | Yes                              | High                                | Construction worker may come in contact with subsurface soils during intrusive activities.                |
|                                                             | Dermal exposure to chemicals in non-potable groundwater.                                         | Yes                              | High                                | Construction worker may come into contact with non-potable groundwater during intrusive activities.       |
|                                                             | Inhalation of volatiles from subsurface soil or groundwater migrating into enclosed spaces.      | No                               | Low                                 | Construction worker is not expected to come into contact with volatiles in enclosed spaces.               |
|                                                             | Dermal and inhalation (volatiles) exposure to chemicals in surface water/sediment.               | Yes                              | Low                                 | Construction worker may come into contact with surface water/sediment.                                    |

## 6.5 Development of Site-Specific Cleanup Criteria

*Site-Specific Cleanup Criteria* (SSCC) were developed for the GM SMI Plant facility. The following sections describe the methodology for the development of the SSCC.

In accordance with MDEQ Op Memo #18, site-specific remedial actions are allowed under Part 201 Section 20120(a)(2). *Site-Specific Cleanup Criteria* based on alternative exposure assumptions unique to the facility may be developed as part of the remedial action. Site-specific algorithms used to derive the SSCC are the same as those used in the MDEQ *Generic Cleanup Criteria*, but were modified for only those chemicals that exceeded MDEQ *Generic Cleanup Criteria*. Inclusion of site-specific characteristics of potential receptors will result in risk-based cleanup values reflective of conditions found at the GM SMI Plant facility. Given the current and future use considerations at the site, site-specific parameters were developed for onsite receptors exposed to the production area and to the non-production area.

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This section describes the site-specific modifications made to the exposure variables used in the MDEQ *Generic Cleanup Criteria* and the justification for the use of these alternate exposure variables.

### 6.5.1 Justification of Alternate Exposure Variables

#### *Soil Ingestion Rate*

The default assumption for the soil ingestion rate (IRs) adopted for the production worker, assumes that this worker will ingest 50 milligrams (mg) of soil per day. This is the USEPA recommended default value for developing soil screening levels (SSLs) for the "indoor worker" as defined in the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2001a). The application of this activity-specific exposure variable is an appropriate modification to the generic MDEQ default value for Commercial III criteria.

A soil ingestion rate of 100 mg/day, consistent with recent EPA guidance (2001a) for an "outdoor worker", is used for the maintenance worker. "[US]EPA [2001a] selected this value to reflect the increased ingestion exposures experienced by outdoor workers during landscaping or other soil disturbing activities." A soil ingestion rate of 330 mg/day is used for the construction worker, as his/her contact with the soil is more intense than for the production worker or maintenance worker. This is the USEPA (2001a) recommended default for a construction worker scenario. The ingestion rate for the site visitor (e.g. school-age child ) visiting the non-production area of the site is assumed to be 100 mg per day, which is the mean value for children under 6 years of age (study included a pica child) recommended in the *Exposure Factors Handbook* (USEPA, 1997). Since the children visiting the site are older (i.e., adolescent), 100 mg per day is likely an overestimation of soil ingestion for this receptor.

#### *Exposure Frequency (Soils)*

The default assumption for the ingestion exposure frequency (EFi) and dermal exposure frequency (EFd) adopted by MDEQ for industrial exposures assumes that the worker will be exposed for 245 days per year. With regard to site-specific conditions, not all areas are routinely visited by employees or site visitors. The following provides the alternate assumption used as the exposure frequency variable for each potential receptor.

##### Production Area

- Construction Worker: 30 days. This individual is assumed to be onsite for a single construction event lasting a limited amount of time. These activities are expected to be ongoing for 6 weeks, 5 days per week or 30 days.
- Production Worker: 245 days. This individual is assumed to be at the property and inside the facility for 245 days a year. For consistency, this exposure frequency is applied to soil ingestion, dermal exposure and inhalation exposure.

##### Non-Production Area

- Maintenance Worker: For this exposure scenario, direct contact with soil in the non-production area is assumed to occur for 160 days (or 8 months). This value accounts for Michigan winters (e.g., there is a high potential for snow cover or that the ground will be frozen for 4 months of the year). While in theory ingestion of soil by adults occurs on a daily basis, contact with soils associated with the non-production area

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is not continuous. For example, of the 245 days this worker spends on-site only 160 days are spent in the non-production area. Since this receptor is specifically used to characterize the SSCCs for the non-production area, it would be inappropriate and overly conservative to develop facility-specific, risk-based values for these soils assuming that this receptor contacted (and therefore ingested) soil from these non-production areas all 245 days of the year. So this receptor has 85 days of not contacting, and not ingesting, these outdoor non-production area soils. He will be ingesting indoor dust derived from production area soil for these 85 days but this exposure pathway will be adequately addressed by developing risk-based concentrations for the production worker, an individual exposed every day to this dust. This receptor may be involved in occasional emergency type intrusive work 5 times a year. For these 5 events, the maintenance worker is assumed to be exposed to soils at rates consistent with those assumed for the construction worker.

- Construction Worker: 30 days. This individual is assumed to be onsite for a single construction event lasting a limited amount of time. These activities are expected to be ongoing for 6 weeks, 5 days per week or 30 days.
- Visitor: 5 days. The visitor is assumed to visit the non-production area for 5 days a year during scouting type activities.

#### **Exposure Frequency (groundwater)**

The exposure frequency variable used by MDEQ for the GCC exposure scenario was developed using the utility worker as the target receptor, and assumes 20 days per year. An exposure frequency of 5 days per year was assumed for the maintenance worker in this HHE because it is likely that direct contact with groundwater would be related to occasional emergency type intrusive activities. However, 30 days per year was assumed for the construction worker in this HHE. This individual is much more likely to have direct contact with groundwater during intrusive activities. The site visitor and the production worker are not expected to come in contact with onsite groundwater; therefore, a SSCC for the GCC exposure scenario was not developed for these receptors.

#### **Exposure Duration**

The default exposure duration (ED) adopted by MDEQ for industrial exposures is 21 years. A value of 21 years was assumed for both the maintenance worker and the production worker in this HHE. However, the construction worker was assumed to be involved with intrusive type activities in either the production or non-production area for only one year. A value of 3 years was assumed for the visitor, which is during ages 12, 13, and 14.

#### **Skin Surface Area**

The MDEQ default value for exposed skin surface area for an adult is 3,300 cm<sup>2</sup> per event. This assumption is based on a typical scenario that the worker is working in a short-sleeved shirt, long pants, and shoes. Site-specific assumptions for each potential receptor are given below.

##### **Production Area**

- Construction Worker: 3,300 cm<sup>2</sup>/event (MDEQ default).
- Production Worker: 2700 cm<sup>2</sup>/event. The skin surface area for the production worker was amortized: 120 days at 3,300 cm<sup>2</sup>/event, considering him to wear a short-sleeved shirt during the warm weather months; and 125 days at 2100 cm<sup>2</sup>/event, considering him to wear a long-sleeved shirt during the cold weather months.



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## Non-Production Area

- Maintenance Worker: 2800 cm<sup>2</sup>/event. The skin surface area for the maintenance worker was amortized, considering him to wear a short-sleeved shirt and no hat during summer months and a hat and long-sleeve shirt during winter months. During occasional emergency type intrusive work, it was assumed that the maintenance worker's skin surface area would be 3,300 cm<sup>2</sup>/event.
- Construction Worker: 3,300 cm<sup>2</sup>/event (MDEQ default).
- Visitor: 4,700 cm<sup>2</sup>/event. The skin surface area for the visitor is the average surface area of male and females 12 to 14 years of age (USEPA, 1997). A forearm-to-arm ratio of 0.45 and a lower leg-to-leg ratio of 0.4 based on adult skin surface area were used to calculate these body parts (MDEQ, 2001a).

### **Soil Adherence Factor**

Soil adherence (AF) is the amount of soil that remains attached to the skin allowing chemicals associated with the soil to transfer to the skin. The soil adherence factor adopted by MDEQ for industrial exposures is 0.2 mg/cm<sup>2</sup>. The USEPA has developed soil adherence factors as a function of activity. The following provides the alternate assumption used as the exposure frequency variable for each potential receptor.

## Production Area

- Construction Worker: 0.3 mg/cm<sup>2</sup> (USEPA, 2001a).
- Production Worker: 0.01 mg/cm<sup>2</sup>. This value is listed as a default value for MDEQ's Commercial III criteria. This value is recommended by MDEQ for the adult worker with low soil contact, which is consistent with production worker activities. The production worker is not expected to come in contact with the onsite soils, except on an infrequent basis.

## Non-Production Area

- Maintenance Worker: 0.02 mg/cm<sup>2</sup>. This value is the 50<sup>th</sup> percentile value for groundskeepers/maintenance workers recommended in the *Exposure Factors Handbook* (USEPA, 1997) and the *Dermal Risk Assessment* (USEPA, 2001). During occasional emergency type intrusive work, it was assumed that the maintenance worker's skin adherence factor would be 0.2 mg/cm<sup>2</sup>.
- Construction Worker: 0.3 mg/cm<sup>2</sup> (USEPA, 2001a).
- Visitor: 0.04 mg/cm<sup>2</sup>. This exposure assumption is given for both children playing in dry soil and teen soccer players exposed to moist conditions (MDEQ *Generic Soil Direct Contact Criteria Technical Support Document* January, 2001). This value is the 50<sup>th</sup> percentile weighted average of children playing in dry soil and teen soccer players based on exposure to head, forearms, hands, and feet.

### **Adjusted Inhalation Rate**

The industrial default air inhalation rate (AIR) adopted by MDEQ is 2, which is 20 m<sup>3</sup> per day (daily inhalation rate) divided by 10 m<sup>3</sup> per day (inhalation rate at work). The following provides the alternate assumption used as the exposure frequency variable for each potential receptor.

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Production Area – Indoor/Outdoor Air: ISVIIC and IPSIC Exposure Scenarios

- Construction Worker: 2 (MDEQ default).
- Production Worker: 2 (MDEQ default).

Non-Production Area – Indoor/Outdoor Air: IGVIIC and IPSIC Exposure Scenarios

- Maintenance Worker: 2 (MDEQ default)
- Construction Worker: 2 (MDEQ default)
- Visitor: 5. An inhalation rate of 1 m<sup>3</sup> per hour is based on children involved in light activities (USEPA *Exposure Factors Handbook*, 1997). This individual is assumed to be onsite for 4 hours per day for a total of 4 m<sup>3</sup> per day. Therefore, 20 m<sup>3</sup> per day divided by 4 m<sup>3</sup> per day equals an AIR of 5.

**Body Weight**

The MDEQ default body weight (BW) of 70 kg was assumed for all the adult receptors in this HHE, only the BW for the visitor receptor scenario was modified. The BW assumed for the visitor was 49.1 kg, which is the weighted average of body weights for ages 12, 13, and 14 recommended in the *Exposure Factors Handbook* (USEPA, 1997).

**6.5.2 Comparison of Site Data to the Site-Specific Cleanup Criteria**

Using the modified equations, *Site-Specific Cleanup Criteria* (SSCC) were developed for the receptors in the production area (i.e., construction worker, and production worker) and for the receptors in the non-production area (i.e., maintenance worker, construction worker, and site visitor). The products of these calculations, the SSCC for the production area and the SSCC for the non-production area are provided for each chemical constituent that exceeded MDEQ *Generic Cleanup Criteria*. The calculated SSCC for each receptor engaged in activities in the production and /or nonproduction areas are presented in Tables 6-2 through 6-9. The minimum SSCC is also identified, and is the criterion used in the comparison to site concentrations.

**6.5.2.1 Production Area**

The following tables present the SSCC developed for each receptor assumed to be engaged in activities in the production area of the site.

**Table 6-2**  
**Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Soil Direct Contact Criteria (IDC)**  
**(mg/kg)**

| Chemical Constituent | Construction Worker | Production Worker |
|----------------------|---------------------|-------------------|
| Aroclor-1254         | 982                 | 60 *              |
| Aroclor-1260         | 982                 | 60 *              |
| Total Aroclors       | 982                 | 60 *              |
| Lead <sup>1</sup>    | 1,982               | 1,602*            |

Notes: \* = minimum SSCC calculated. 1 = See Appendix D for calculations of lead concentrations.

**Table 6-3**  
**Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Soil Volatilization to Indoor Air Inhalation Criteria (ISVIIC)**  
**(mg/kg)**

| Chemical Constituent | Construction Worker | Production Worker |
|----------------------|---------------------|-------------------|
| Benzene              | --                  | 8.4 *             |

Notes: \* = minimum SSCC calculated. -- = the Construction Worker is not expected to be indoors.

**Table 6-4**  
**Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Particulate Soil Inhalation Criteria (IPSIC)**  
**(mg/kg)**

| Chemical Constituent | Construction Worker | Production Worker |
|----------------------|---------------------|-------------------|
| Manganese            | 24,019*             | --                |

Notes: \* = minimum SSCC calculated; -- = Production worker is not expected to be significantly exposed to outdoor particulates.

**Table 6-5**  
**Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Groundwater Direct Contact Criteria (GCC)**  
**(µg/L)**

| Chemical Constituent | Construction Worker | Production Worker |
|----------------------|---------------------|-------------------|
| 2,3,7,8-TCDD TEQ     | 0.00008*            | --                |

Notes: \* = minimum SSCC calculated. -- = Production worker is not expected to come into contact with onsite groundwater.

### 6.5.2.2 Non-Production Area

The following tables present the SSCCs developed for each receptor assumed to be engaged in activities in the non-production area of the site.

**Table 6-6**  
**Non-Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Particulate Soil Inhalation Criteria (IPSIC)**

| Chemical Constituent | Maintenance Worker | Construction Worker | Site Visitor |
|----------------------|--------------------|---------------------|--------------|
| Manganese            | 4,504*             | 24,019              | 360,288      |

Notes: \* = minimum SSCC calculated.

**Table 6-7**  
**Non-Production Area**  
**Site-Specific Cleanup Criteria for**  
**Groundwater Direct Contact Criteria (GCC)**  
**(µg/L)**

| Chemical Constituent       | Maintenance Worker | Construction Worker | Site Visitor |
|----------------------------|--------------------|---------------------|--------------|
| Vinyl chloride             | 2,923*             | 10,229              | --           |
| Bis(2-ethylhexyl)phthalate | 1,280*             | 4,479               | --           |

Notes: \* = minimum SSCC calculated. -- = Site visitor is not expected to come into contact with onsite groundwater.

**Table 6-8**  
**Non-Production Area**  
**Site-Specific Cleanup Criteria for**  
**Industrial Groundwater Volatilization Indoor Air Inhalation Criteria (IGVIIC)**

| Chemical Constituent | Maintenance Worker | Construction Worker | Site Visitor | Production Worker |
|----------------------|--------------------|---------------------|--------------|-------------------|
| Vinyl chloride       | 1,991              | --                  | --           | 691*              |

Notes: \* = minimum SSCC calculated. -- = not expected to be indoors.

The following tables provide a summary of the production and non-production areas and the *Site-Specific Cleanup Criteria* (SSCC) developed for each chemical constituent where MDEQ *Generic Cleanup Criteria* were exceeded.

**Table 6-9**  
**Production Area**  
**Site-Specific Cleanup Criteria**

| Chemical Constituent  | GCC<br>(µg/L) | IDC<br>(mg/kg) | IPSIC<br>(mg/kg) | ISVIIC<br>(mg/kg) |
|-----------------------|---------------|----------------|------------------|-------------------|
| <b>VOCs</b>           |               |                |                  |                   |
| Benzene               | --            | --             | --               | 8.4               |
| <b>PCBs</b>           |               |                |                  |                   |
| Aroclor-1254          | --            | 60             | --               | --                |
| Aroclor-1260          | --            | 60             | --               | --                |
| Total Aroclors        | --            | 60             | --               | --                |
| <b>Dioxins/Furans</b> |               |                |                  |                   |
| 2,3,7,8-TCDD TEQ      | 0.00008       | --             | --               | --                |
| <b>Inorganics</b>     |               |                |                  |                   |
| Manganese             | --            | --             | 24,019           | --                |
| Lead                  | --            | 1,602          | --               | --                |

Notes: -- = SSCC was not calculated for this chemical constituent because it did not exceed MDEQ *Generic Cleanup Criteria*.

**Table 6-10**  
**Non-Production Area**  
**Site-Specific Cleanup Criteria**

| Chemical Constituent       | GCC<br>(µg/L) | IGVIIC<br>(µg/L) | IDC<br>(mg/kg) | IPSIC<br>(mg/kg) |
|----------------------------|---------------|------------------|----------------|------------------|
| <b>VOCs</b>                |               |                  |                |                  |
| Vinyl chloride             | 2,923         | 691              | --             | --               |
| <b>SVOCs</b>               |               |                  |                |                  |
| Bis(2-ethylhexyl)phthalate | 1,280         | --               | --             | --               |
| <b>Inorganics</b>          |               |                  |                |                  |
| Manganese                  | --            | --               | --             | 4,504            |

Notes: -- = SSCC was not calculated for this chemical constituent because it did not exceed MDEQ generic criteria.

## 6.6 Results of the *Site-Specific Cleanup Criteria* Evaluation

The following tables (6-11 through 6-14) summarize the *Site-Specific Cleanup Criteria* (SSCC) that were developed for those chemical constituents that exceeded MDEQ *Generic Cleanup Criteria*. These tables provide the exposure point concentration for each chemical constituent, along with the AOC and the SSCC value for both the production and non-production area of the site. The chemical constituent exposure point concentrations that exceed the SSCC are italicized.

**Table 6-11  
Production Area  
Groundwater**

| Area of Concern<br>And<br>Chemical Constituent      | Exposure Point<br>Concentration<br>(µg/L) | Site-Specific<br>Cleanup Criteria<br>(µg/L) |
|-----------------------------------------------------|-------------------------------------------|---------------------------------------------|
| <b><i>LNAPL Assessment and Remediation Area</i></b> |                                           |                                             |
| 2,3,7,8-TCDD TEQ                                    | 0.0000558 <sup>1</sup>                    | GCC =0.00008                                |

Notes: <sup>1</sup> = maximum concentration.

**Table 6-12  
Production Area  
Soil**

| Area of Concern<br>And<br>Chemical Constituent        | Exposure Point<br>Concentration<br>(mg/kg) | Site-Specific<br>Cleanup Criteria<br>(mg/kg) |
|-------------------------------------------------------|--------------------------------------------|----------------------------------------------|
| <b><i>Previous Metal Feedstock Area</i></b>           |                                            |                                              |
| Manganese                                             | 859 <sup>2</sup>                           | IPSIC = 24,019                               |
| <b><i>Railyard Area</i></b>                           |                                            |                                              |
| Manganese                                             | 5,030 J <sup>1</sup>                       | IPSIC = 24,019                               |
| Lead                                                  | 1,370 <sup>1</sup>                         | IDC =1,602                                   |
| <b><i>Melting Department Area</i></b>                 |                                            |                                              |
| Total Aroclors                                        | 650 <sup>1</sup>                           | IDC = 60                                     |
| <b><i>Manhole I127.7 Area</i></b>                     |                                            |                                              |
| Total Aroclors                                        | 4,900 <sup>1</sup>                         | IDC =60                                      |
| <b><i>LNAPL Assessment &amp; Remediation Area</i></b> |                                            |                                              |
| Lead                                                  | 1,780 <sup>1</sup>                         | IDC =1,602                                   |
| <b><i>Former UST # 7</i></b>                          |                                            |                                              |
| Benzene                                               | 21 J <sup>1</sup>                          | ISVIIC = 8.4                                 |

Notes: <sup>1</sup> = maximum concentration. <sup>2</sup> = 95% UCL concentration. J = estimated value. Italicized values exceed SSCC.

**Table 6-13  
Non-Production Area  
Groundwater**

| Area of Concern<br>And<br>Chemical Constituent | Exposure Point<br>Concentration <sup>1</sup><br>(µg/L) | Site-Specific<br>Cleanup Criteria<br>(µg/L) |
|------------------------------------------------|--------------------------------------------------------|---------------------------------------------|
| <b><i>Drum Remediation Area</i></b>            |                                                        |                                             |
| Vinyl chloride                                 | 2,300                                                  | GCC = 2,923<br>IGVIIC = 691                 |
| <b><i>Green Point Landfill</i></b>             |                                                        |                                             |
| Bis(2-ethylhexyl)phthalate                     | 450                                                    | GCC = 1,280                                 |

Notes: <sup>1</sup> = maximum concentration. Italicized value exceeds SSCC.

**Table 6-14**  
**Non-Production Area**  
**Soil**

| Area of Concern<br>And<br>Chemical Constituent | Exposure Point<br>Concentration <sup>1</sup><br>(mg/kg) | Site-Specific<br>Cleanup Criteria<br>(mg/kg) |
|------------------------------------------------|---------------------------------------------------------|----------------------------------------------|
| <b><i>Saginaw River Berm</i></b>               |                                                         |                                              |
| Manganese                                      | <i>32,600</i>                                           | IPSIC = 4,504                                |

Notes: <sup>1</sup> = maximum concentration. J = estimated value. avg. = average concentration of original sample and duplicate sample. Italicized value exceeds SSCC.

## 6.7 Summary of the *Site-Specific Cleanup Criteria* Evaluation

The following tables summarize the *Site-Specific Cleanup Criteria* (SSCC) that were exceeded for those chemical constituents that exceeded MDEQ *Generic Cleanup Criteria*. These tables present the chemical constituents that exceeded the SSCC values. The AOC, exposure point concentration, and the SSCC value are also provided. No SSCC values were exceeded in the groundwater in the production area.

**Table 6-15**  
**Production Area**  
**Soil**

| Area of Concern<br>And<br>Chemical Constituent        | Exposure Point<br>Concentration <sup>1</sup><br>(mg/kg) | Site-Specific<br>Cleanup Criteria<br>(mg/kg) |
|-------------------------------------------------------|---------------------------------------------------------|----------------------------------------------|
| <b><i>Manhole I127.7</i></b>                          |                                                         |                                              |
| Total Aroclors                                        | 4,900                                                   | IDC = 60                                     |
| <b><i>Melting Department Area</i></b>                 |                                                         |                                              |
| Total Aroclors                                        | 650                                                     | IDC = 60                                     |
| <b><i>Former UST # 7</i></b>                          |                                                         |                                              |
| Benzene                                               | 21 J <sup>1</sup>                                       | ISVIIC = 8.4                                 |
| <b><i>LNAPL Assessment &amp; Remediation Area</i></b> |                                                         |                                              |
| Lead                                                  | 1,780 <sup>1</sup>                                      | IDC = 1,602                                  |

Notes: <sup>1</sup> = maximum concentration.

The total Aroclors found in the Manhole I127.7 and Melting Department Area are located beneath the concrete slab in these areas. The concrete slab acts as an impermeable barrier, eliminating direct contact as an exposure pathway. The only potential for direct contact of these constituents would be in the event of an emergency situation (i.e., accessing underground utilities) where breaking out the concrete slab would be required. This scenario will be addressed in the Feasibility Study, as part of a deed restriction against intrusive activities within this area.

The single exceedance of benzene was noted in a soil sample located in the former UST #7 Area (approximately 120 feet from the employee tunnel). Additional sample points located closer to the employee tunnel did not contain benzene or other chemical constituents that exceeded generic ISVIIC. It should be noted that the site specific ISVIIC value assumes an eight hour exposure, while the actual employee use of the tunnel will be transient at best, resulting in a much shorter exposure duration. Since the maximum soil value exceeds the

SSCC by only a factor of 2.5, the limited exposure actually experienced by the workers suggests this soil concentration does not present a risk.

Additionally, two air samples were collected over an 8-hour period in the employee tunnel on February 24, 2000 to monitor air quality. The analytical results of the samples were all well below the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH). TLVs are defined by the ACGIH as the "time-weighted" average concentration for a conventional 8-hour work day and a 40-hour work week, to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. These empirical data, when evaluated against relevant occupational criteria (i.e., OSHA, PELs), show there are no health risks associated with the air levels detected in the tunnel. The results of the air sampling are summarized in Table 6-15A. While new construction in this area is unlikely, deed restrictions in the former UST #7 Area will restrict construction of buildings without investigation of potential risks.

**Table 6-15A  
Employee Tunnel Air Sampling Data**

| <b>Chemical Constituent</b> | <b>Sample A01 (ppbv)</b> | <b>Sample A02 (ppbv)</b> | <b>OSHA PEL (ppbv)</b> | <b>TLV (ppm)</b> |
|-----------------------------|--------------------------|--------------------------|------------------------|------------------|
| Benzene                     | ND                       | 2.9                      | 10,000                 | 0.5              |
| Toluene                     | 5.3                      | 4.6                      | 200,000                | 50               |
| Ethylbenzene                | ND                       | ND                       | 100,000                | 100              |
| Xylene, p & m               | 2.4                      | 3.2                      | 100,000                | 100              |
| Xylene, o                   | ND                       | ND                       | 100,000                | 100              |

Notes: ppbv = parts per billion volume. ppm = parts per million. ND = not detected.

The single lead exceedance in the LNAPL Assessment and Remediation Area (1,780 mg/kg) is located at SB-363 at a depth of 4-6 feet. Given this is a direct contact pathway and the sample that exceeds the site specific criteria is at a depth of greater than 2 feet below surface, direct contact with the soils that contain lead at concentrations greater than site-specific cleanup criteria is unlikely. Additionally, the surface soil sample taken from the same location does not contain lead at concentrations above the site-specific criteria. The only potential direct contact would be resulting from excavation work, and the site-specific cleanup criteria developed considering exposure by a construction worker is 1,982 mg/kg. This scenario will be addressed in the Feasibility Study as a deed restriction.

**Table 6-16  
Non-Production Area Soil**

| <b>Area of Concern And Chemical Constituent</b> | <b>Exposure Point Concentration <sup>1</sup> (mg/kg)</b> | <b>Site-Specific Cleanup Criteria (mg/kg)</b> |
|-------------------------------------------------|----------------------------------------------------------|-----------------------------------------------|
| <b><i>Saginaw River Berm</i></b>                |                                                          |                                               |
| Manganese                                       | 32,600                                                   | IPSIC = 4,504                                 |

Notes: <sup>1</sup> = maximum concentration.

Manganese exceeded the site-specific IPSIC in the non-production area. Three samples were reported to exceed the SSCC (SB-378, SB-380 and SB-381). These samples are located on the steeply sloped berm of the Saginaw River. Review of the derivation of the SSCC particulate value indicates that emission of chemicals from soil due to passenger vehicle traffic was considered. In fact, consistent with the MDEQ default, 50 vehicular trips per day are assumed to occur in the area of the exceedances. The nature of the man-made berm where the



samples are located (e.g., thickly vegetated, steeply sloped) makes the area of the exceedances inaccessible to vehicles. Consistent with MDEQ guidance (Part 201, Generic Soil Inhalation Criteria for Ambient Air, Technical Support Document, MDEQ, 1998b), the particulate emission can be reassessed assuming "that vehicle traffic at the facility [specifically along the slope of the berm] differs from the default assumptions". Assuming there is no vehicular traffic along the slope of the berm, results in a revised SSCC for inhalation of manganese in soil of 34,128 mg/kg. The concentrations detected on the slope of the berm are below this SSCC. Although the SSCC for inhalation of manganese would not be exceeded based on expected future use of the Saginaw River Berm area, this area is further addressed in the Feasibility Study.

In addition to the IPSIC exceedance in the river berm area, manganese concentrations exceed the generic residential screening criteria (3300 mg/kg) in the railyard (maximum concentration 5030 mg/kg) and the river berm area. As discussed above, the river berm area is further addressed in the Feasibility Study. The maximum concentration found in the railyard does not pose a risk to the onsite worker assumed to be exposed in this area. Consistent with the MDEQ ERD Technical Memorandum (1998), "the PSIC for the industrial/commercial sites will be based on protection of the on-property worker," as a review of the PSIC values shows on-property values are generally protective of off-property residential scenario. As a result the site specific criteria calculated for on-site receptors are considered adequately protective of offsite receptors.

Additionally, in order to demonstrate that site conditions (e.g., soil manganese concentrations) are protective of off-site residents, exposure to particulates at the site boundary can be quantified. USEPA (2001) *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* provides equations to calculate a manganese soil concentration that will not pose an unnecessary risk of harm to off-site receptors. The receptor considered here is similar to a generic residential receptor, except the receptor is located at the site boundary. This off-site receptor is exposed to fugitive dust both during a six-month construction event (which is likely to exacerbate fugitive dust emissions) and after construction for a total of 30 years.

The exposure scenario assumes chronic exposure by the receptor, fugitive dust emissions from site traffic during construction and emissions from wind erosion after construction is complete. The equations and assumptions used in deriving the site-specific cleanup criteria (SSCC) for the off-site resident are summarized below.

$$\text{SSCC (mg/kg)} = \frac{\text{TH} \times \text{AT} \times 365 \text{ dy/yr}}{\text{EF} \times \text{ED} \times (1/\text{RfC}) \times (1/\text{PEF})}$$

Where:

|     |                                                                                  |
|-----|----------------------------------------------------------------------------------|
| TH  | 1 - Target Hazard Quotient (unitless; MDEQ default)                              |
| AT  | 30 years - Averaging Time (MDEQ default)                                         |
| EF  | 350 days/year - Exposure Frequency (MDEQ default)                                |
| ED  | 30 years - Exposure Duration (MDEQ default)                                      |
| RfC | 5E-05 mg/m <sup>3</sup> - Reference Concentration for manganese (USEPA, 2003)    |
| PEF | 4.40E+08 m <sup>3</sup> /kg - Off-site particulate emission factor (USEPA, 2001) |

$$\text{SSCC (mg/kg)} = \frac{1 \times 30 \text{ yr} \times 365 \text{ dy/yr}}{350 \text{ dy/yr} \times 30 \text{ yr} \times \left( \frac{1}{5\text{E} - 05 \text{ mg/m}^3} \right) \times \left( \frac{1}{4.40\text{E} + 08 \text{ m}^3/\text{kg}} \right)}$$

The resulting SSCC for off-site residents is 23,000 mg/kg. The maximum concentration (5,030 mg/kg) detected in the railyard, which is located nearest any residential property, is well below this acceptable concentration. The average concentration for the railyard (1,845 mg/kg) is more than an order of magnitude less than the SSCC value. This evaluation demonstrates that on-site concentrations are protective of off-site residents, even applying the conservative USEPA (2001) construction scenario. Additionally to demonstrate the appropriateness of this model, perimeter monitoring for manganese in airborne dust is discussed in the Feasibility Study.

**Table 6-17**  
**Non-Production Groundwater**

| Area of Concern<br>And<br>Chemical Constituent | Exposure Point<br>Concentration <sup>1</sup><br>(mg/kg) | Site-Specific<br>Cleanup Criteria<br>(mg/kg) |
|------------------------------------------------|---------------------------------------------------------|----------------------------------------------|
| <b><i>Drum Remediation Area</i></b>            |                                                         |                                              |
| Vinyl chloride                                 | 2,300                                                   | IGVIIC = 691                                 |

Notes: <sup>1</sup> = maximum concentration.

Exposure to vinyl chloride via volatilization of groundwater to indoor air (IGVIIC) is not a current concern. However, predicting future land use for the Drum Remediation/Hillock Area with regard to construction is uncertain. There is the possibility a building could be constructed in this area in the future. Although, it is highly unlikely that this area will ever be developed due to the wetland type environment found in this region of the property, safeguarding against any future potential exposure via this pathway (e.g., restrictions against construction without investigation of possible risks) will be addressed in the Feasibility Study and at the direction of MDEQ, a deed restriction will be included in the Remedial Action Plan.

## 6.8 Uncertainty Analysis

Uncertainty and variability are often dealt with collectively in evaluating the output of risk estimates into a broad category referred to as “uncertainty.” However, conceptually the two are very different. Uncertainty is often considered a lack of knowledge, or ignorance, and additional data collection could be designed to reduce this ignorance. Variability on the other hand is considered the natural variation in a particular parameter, and it cannot be reduced by additional data collection. For example, variability encountered in this health evaluation is associated with the range of responses to the various constituents by individuals exposed at the site. The approach used to address this variability was to toxicity factors developed by USEPA that contain safety factors, sometimes several orders of magnitude, to account for this potential variability. The result is that the probability of overestimating risks associated with exposure to site constituents is high, while the potential for underestimating risk is essentially zero.

Similarly, the generic criteria developed by MDEQ and used in the comparison to *Generic Cleanup Criteria* evaluation assessment, are highly conservative in order to account for any variability in the potentially exposed population. Taking this approach ensures that a particular chemical in any media is not inappropriately eliminated from further consideration, and that all members of the population are still protected.

In terms of ignorance inherent in this analysis, the most significant is associated with the exposure terms used to derive the *Site-Specific Cleanup Criteria* (SSCC) values. Conversely, the analytical data developed for the various media adequately characterize the site, for risk assessment purposes. As such, there is no need for additional data collection to address this component of uncertainty.

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By way of an example illustrating this uncertainty, for exposure to constituents in the non-production area, the maintenance worker was assumed to be active in this area for 160 days a year. This corresponds to 32 weeks of daily activity in the non-production area. The selection of daily activity for just over 8 months was based on the assumption that his/her primary activity in the non-production area is associated with lawn maintenance. Based on meteorological data from the National Weather Service, for three out of the eight months the average maximum temperature in Saginaw does not exceed 60° F. Much of this time is likely to be associated with snow cover. It is not expected that during these periods the maintenance worker would be engaged in activities like lawn maintenance that would result in the level of exposure to soil estimated in the SSCC development.

The uncertainty associated with this estimate is due to the fact that it is based only on the conditions observed at the site (i.e., large areas of maintained lawn) and the regional meteorological data. The assumptions used in the SSCC for direct contact with soil were not based on actual interviews or monitoring of the maintenance worker's activities. The uncertainty associated with the assumption that the individual is engaged in this activity every day for 32 weeks could be reduced by the collection of additional data.

However, the exposure parameters assume relatively intensive activity (every day of the week) for a relatively long period of time (32 weeks). Therefore, it is unlikely that the collection of the additional data would reveal that exposure (and consequently risk) to this receptor was inappropriately underestimated.

The approach outlined in the above example was consistent for all of the revised exposure variables used to derive the SSCCs. They were selected to represent the high end of possible likely exposure, but not be so high as to inappropriately exaggerate risk. Since there are multiple variables in each equation, and these variables are set at the high end of the likely range, and the output of the calculation is a product of these variables, there is still a significant level of safety incorporated into the revised criteria.

Based on a consideration of the relatively conservative approach used to develop the various exposure pathways, combined with the extremely conservative nature of the USEPA toxicity factors used to develop the SSCC, the results of this analysis provided risk-based concentrations that are adequately protective of the site-related population.

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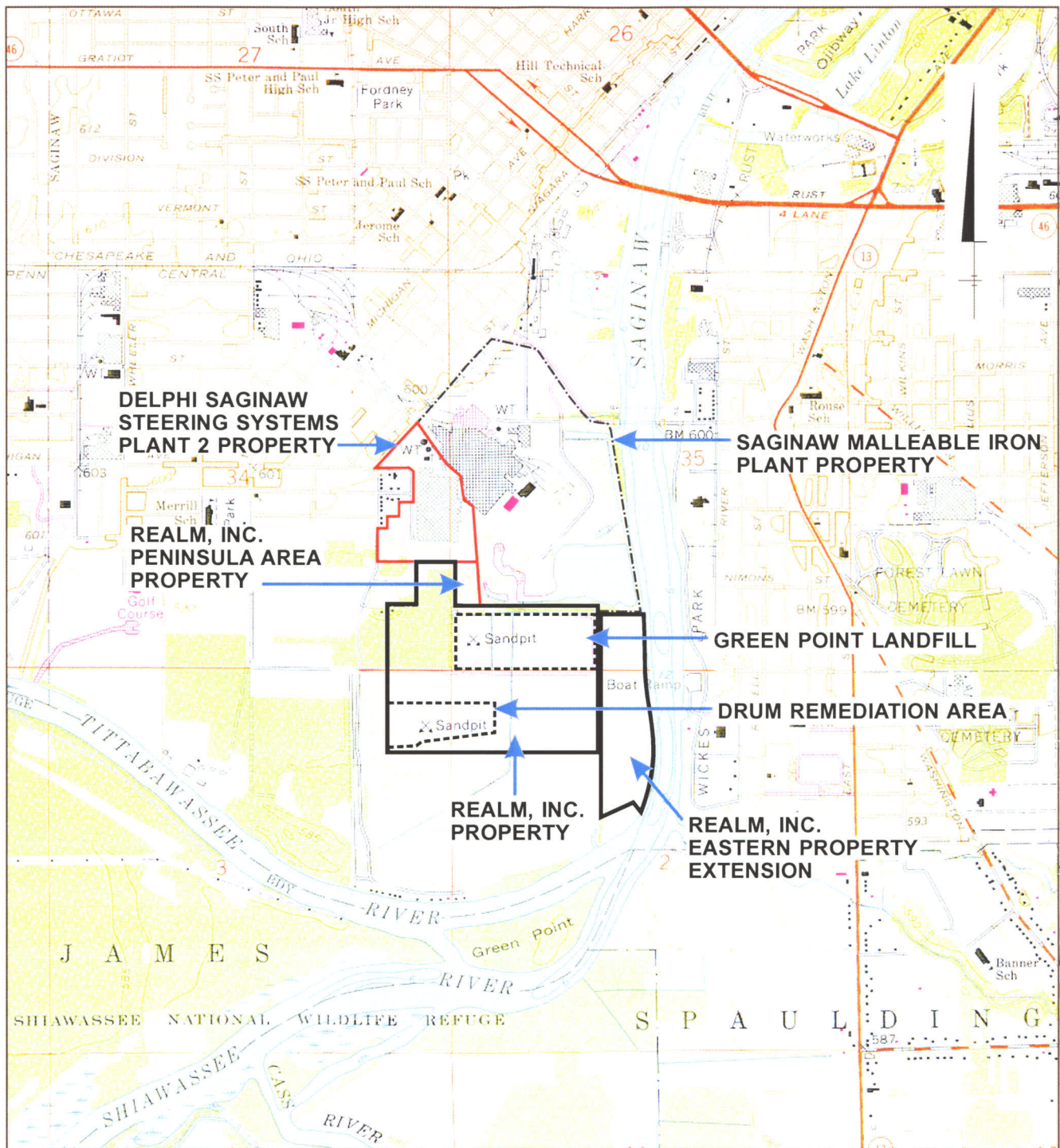
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## ***Figures***

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**NOTES:**

1. Base map source: USGS 7.5 Min. Topo. Quad., Saginaw, Mich. (1967, Photorevised 1973).
2. Locations of Green Point Landfill and Drum Remediation Area are approximate.
3. All property boundary lines are approximate.

2,000 0 2,000

APPROX. SCALE 1" = 2,000 Feet

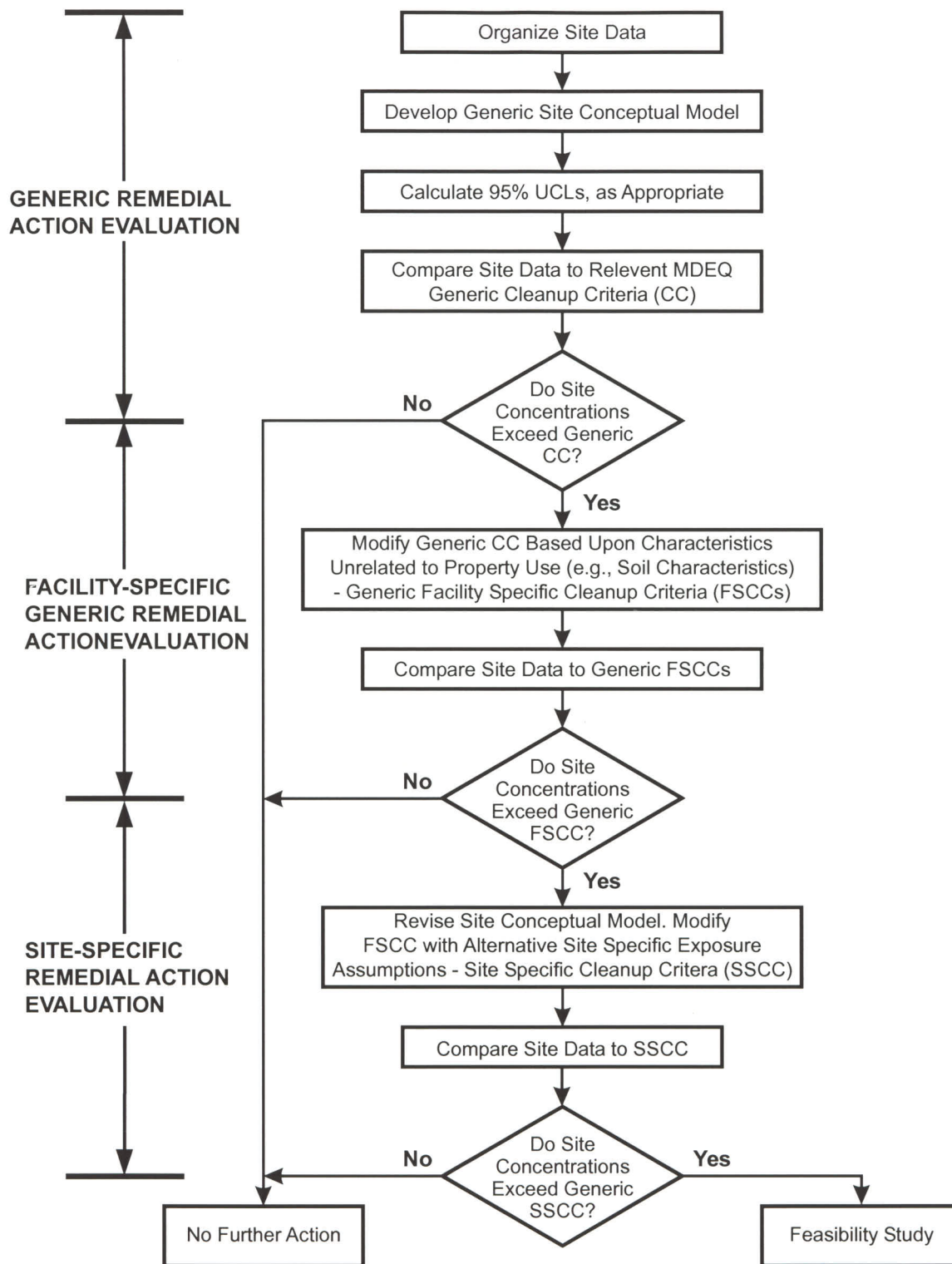


GENERAL MOTORS CORPORATION  
SAGINAW MALLEABLE IRON PLANT PROPERTY, AND REALM  
GREEN POINT LANDFILL AND DRUM REMEDIATION AREA  
SAGINAW, MICHIGAN  
**HUMAN HEALTH EVALUATION REPORT**

**SITE LOCATION MAP**

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

FIGURE  
**1**



GENERAL MOTORS CORPORATION  
SAGINAW MALLEABLE IRON PLANT PROPERTY, AND REALM  
GREEN POINT LANDFILL AND DRUM REMEDIATION AREA  
SAGINAW, MICHIGAN

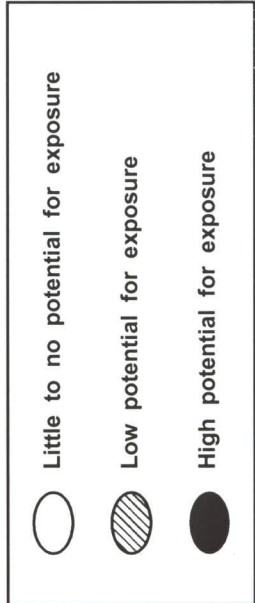
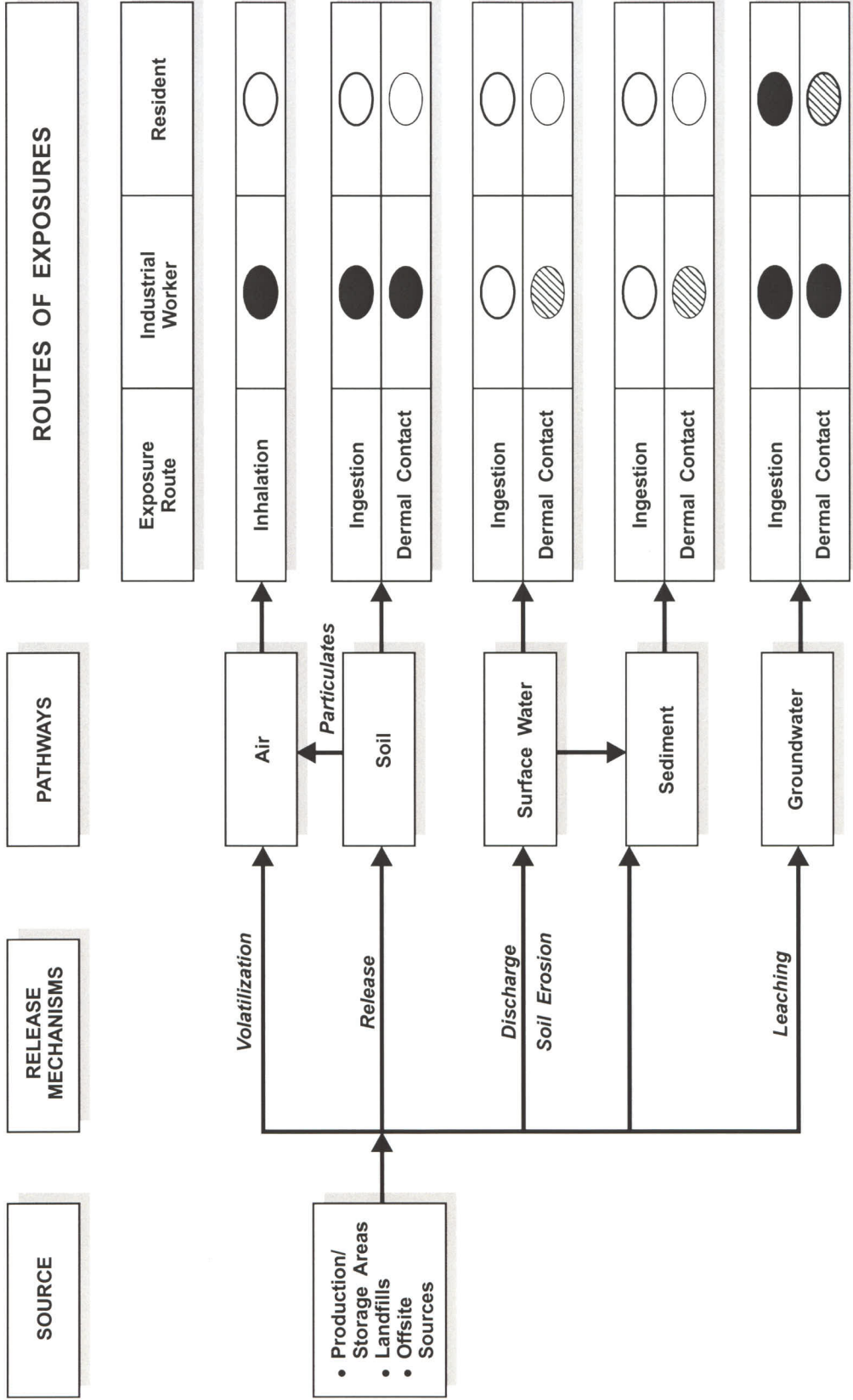
#### HUMAN HEALTH EVALUATION REPORT

#### GENERIC REMEDIAL ACTION EVALUATION

**BBL**<sup>®</sup>  
BLASLAND, BOUCK & LEE, INC.  
engineers & scientists

FIGURE  
**2**



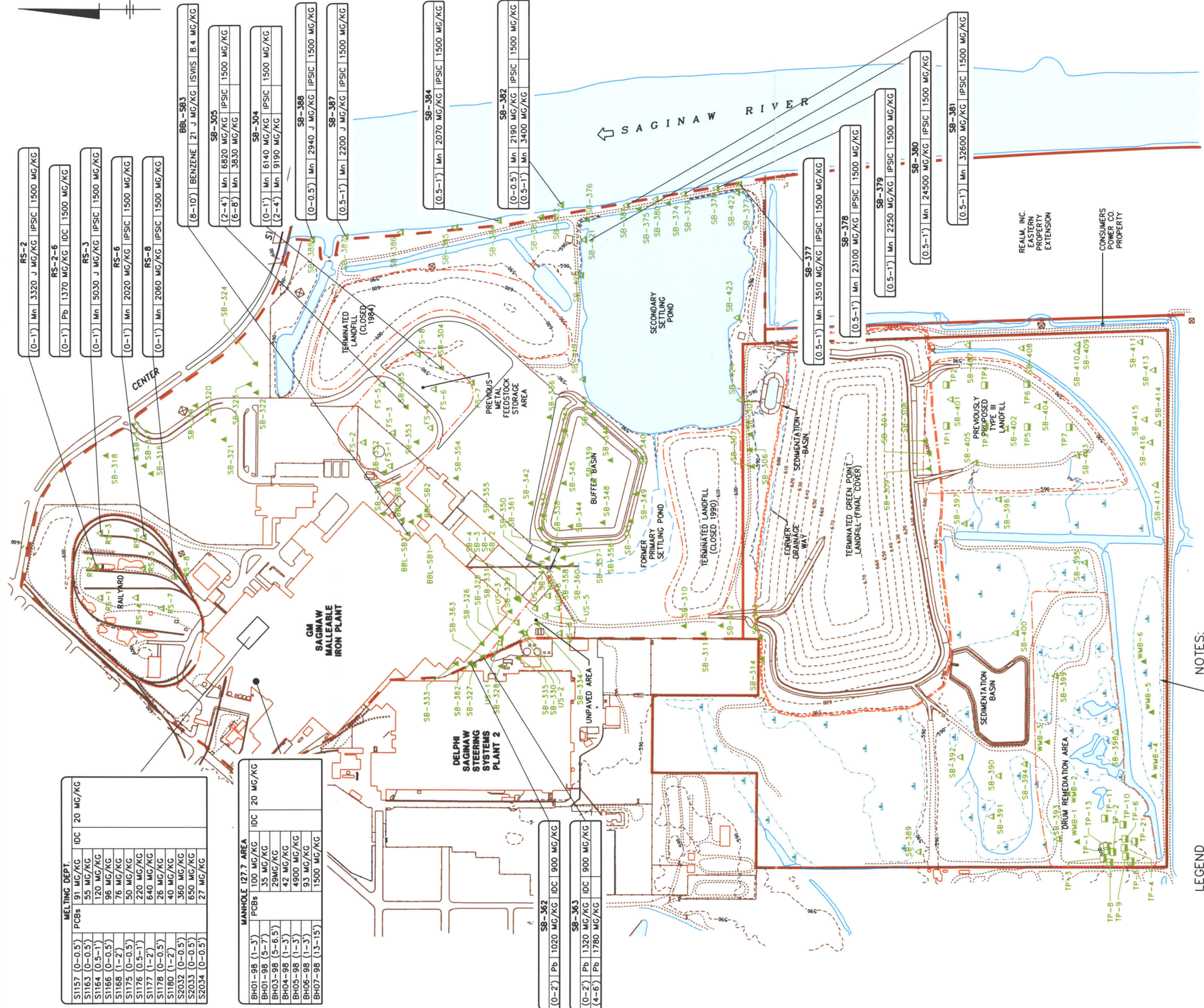


GENERAL MOTORS CORPORATION  
 SAGINAW MALLEABLE IRON PLANT PROPERTY, AND REALM  
 GREEN POINT LANDFILL AND DRUM REMEDIATION AREA  
 SAGINAW, MICHIGAN  
**HUMAN HEALTH EVALUATION REPORT**

**SITE EXPOSURE CONCEPTUAL MODEL**







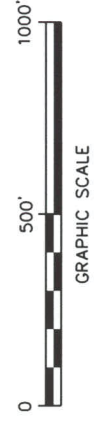
LEGEND

- GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)
- UNPAVED ROAD
- GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)
- FENCE LINE
- SWAMPY AREA
- SOIL BORING SB-318
- SURFACE SOIL SAMPLE RS-3
- TEST PIT TP-10
- ESTIMATED CONCENTRATION J
- MG/KG MILLIGRAMS PER KILOGRAM (PPM)
- GENERIC MDEQ CRITERIA
- IPSC INDUSTRIAL PARTICULATE SOIL INHALATION CRITERIA
- IDC INDUSTRIAL DIRECT CONTACT
- ISVIC INDUSTRIAL SOIL VOLATILIZATION TO INDEED AIR INHALATION CRITERIA

NOTES:

- THIS PHOTOGRAMMETRIC BASE MAP FOR THE GM SAGINAW MALLEABLE IRON PLANT AND DELPHI SAGINAW STEERING SYSTEMS PLANT 2 PROPERTIES WAS PREPARED BY LOCKWOOD MAPPING, INC. OF ROCHESTER, NEW YORK. AERIAL PHOTOGRAPHY WAS CONDUCTED ON 11/11/94. ORIGINAL LOCKWOOD MAP WAS AT A SCALE OF 1"=100' AND WAS INTERPRETED FOR TWO-FOOT CONTOURS.
- SAMPLING LOCATIONS SURVEYED BY ATWELL-HICKS, INC. UTICA, MICHIGAN, FILE NO. M1014SU2, FILE DATE 3/22/96, REVISED 8/8/96, OR SPICER GROUP.
- VERTICAL DATUM REFERENCED TO NGVD OF 1929, HORIZONTAL DATUM REFERENCED TO MICHIGAN SPC-NAD 1983.
- BASE MAP HAS BEEN MODIFIED TO INCORPORATE BUFFER BASIN, SEDIMENTATION BASINS, WETLANDS MITIGATION AREA, AND GREEN POINT LANDFILL (GPL) FINAL COVER FROM THE FINAL ENGINEERING DESIGN REPORT PREPARED BY BBL FOR THE GPL, DATED JANUARY, 1998.
- PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 3/27/98.
- SOIL BORING LOCATIONS FOR SB-390 THROUGH SB-417 DIGITIZED FROM FIGURE PREPARED BY EXPONENT (BASED ON GLOBAL POSITIONING SYSTEM READINGS), DATED 9/18/00.
- TEST PIT LOCATIONS TP-1 THROUGH TP-21 (LOCATED IN THE DRUM REMEDIATION AREA) AND TP1 THROUGH TP7 (LOCATED IN THE PREVIOUSLY PROPOSED TYPE III LANDFILL) WERE NOT SURVEYED AND ARE APPROXIMATE.
- SOIL BORINGS WMB-1 THROUGH WMB-6 WERE NOT SURVEYED AND ARE APPROXIMATE.

| CONSTITUENT | CONCENTRATION                             | GENERIC MDEQ CRITERIA ABBREVIATION | GENERIC MDEQ CRITERIA |
|-------------|-------------------------------------------|------------------------------------|-----------------------|
| SB-380      | (0.5-1') Mn 24500 MG/KG   IPSC 1500 MG/KG |                                    |                       |

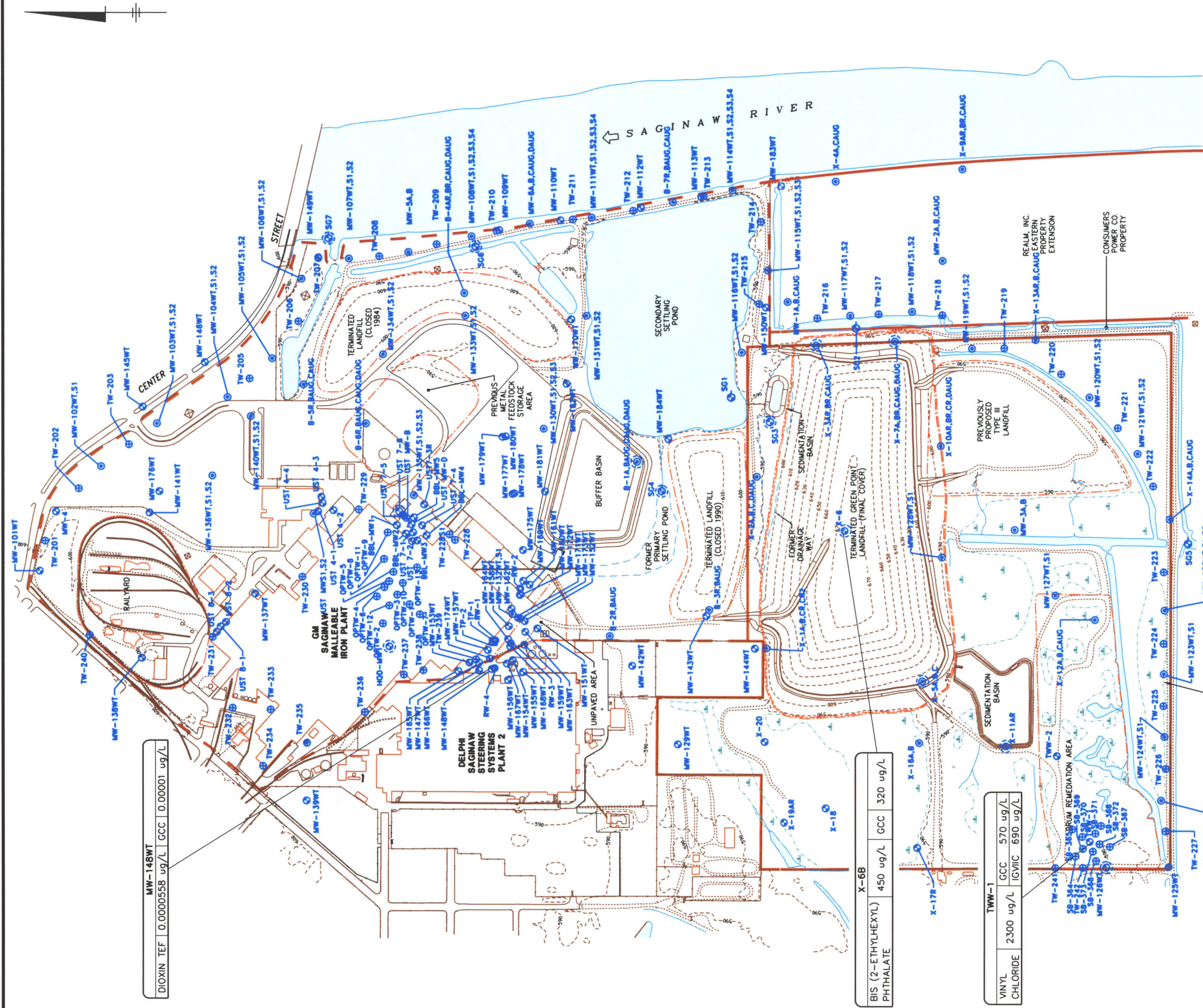


SAGINAW MALLEABLE IRON PLANT PROPERTY,  
GREEN POINT LANDFILL,  
AND DRUM REMEDIATION AREA  
SAGINAW, MICHIGAN

HUMAN HEALTH EVALUATION REPORT

CONSTITUENT DETECTIONS IN SOIL ABOVE  
MDEQ GENERIC CLEANUP CRITERIA  
FOLLOWING FACILITY SPECIFIC EVALUATION





CONSTITUENT

MW-148WT

DIOXIN TEF 0.0000558 ug/L GCC 0.00001 ug/L

CONCENTRATION

GENERIC MDEQ CRITERIA ABBREVIATION

GENERIC MDEQ CRITERIA

0 500' 1000'

GRAPHIC SCALE

NOTES:

1. IF CRITERIA WERE EXCEEDED DURING MORE THAN ONE SAMPLING EVENT, THE MOST RECENT DATA ARE SHOWN.

2. THIS PHOTOGRAMMETRIC BASE MAP FOR THE GM SAGINAW MALLEABLE IRON PLANT AND DELPHI SAGINAW STEERING SYSTEMS PLANT 2 PROPERTIES WAS PREPARED BY LOCKWOOD MAPPING, INC. OF ROCHESTER, NEW YORK. AERIAL PHOTOGRAPHY WAS CONDUCTED ON 11/11/94. ORIGINAL LOCKWOOD MAP WAS AT A SCALE OF 1"=100' AND WAS INTERPRETED FOR TWO-FOOT CONTOURS.

3. VERTICAL DATUM REFERENCED TO NGVD OF 1929, HORIZONTAL DATUM REFERENCED TO MICHIGAN SPC-NAD 1983.

4. BASE MAP HAS BEEN MODIFIED TO INCORPORATE BUFFER BASIN, SEDIMENTATION BASINS, WETLANDS MITIGATION AREA, AND GREEN POINT LANDFILL (GPL) FINAL COVER FROM THE FINAL ENGINEERING DESIGN REPORT PREPARED BY BBL FOR THE GPL, DATED JANUARY, 1998.

5. PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 3/27/98.

6. SOIL BORING LOCATIONS FOR SOUTHERN PROPERTY DIGITIZED FROM ECOLOGICAL RISK ASSESSMENT BY EXPONENT, DATED 9/18/00.

7. PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 3/27/98.

LEGEND

GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)

REALM, INC. PROPERTY LINE (APPROX.)

UNPAVED ROAD

GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)

FENCE LINE

SWAMPY AREA

MONITORING WELL

MONITORING WELL CLUSTER

STAFF GAGE

TEMPORARY MONITORING WELL

PIEZOMETER

RECOVERY WELL

ABANDONED MONITORING WELL

ABANDONED STAFF GAGE

TEF

TOXICITY EQUIVALENCE FACTOR

ug/L

MICROGRAMS PER LITER (PPB)

GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)

REALM, INC. PROPERTY LINE (APPROX.)

UNPAVED ROAD

GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)

FENCE LINE

SWAMPY AREA

MONITORING WELL

MONITORING WELL CLUSTER

STAFF GAGE

TEMPORARY MONITORING WELL

PIEZOMETER

RECOVERY WELL

ABANDONED MONITORING WELL

ABANDONED STAFF GAGE

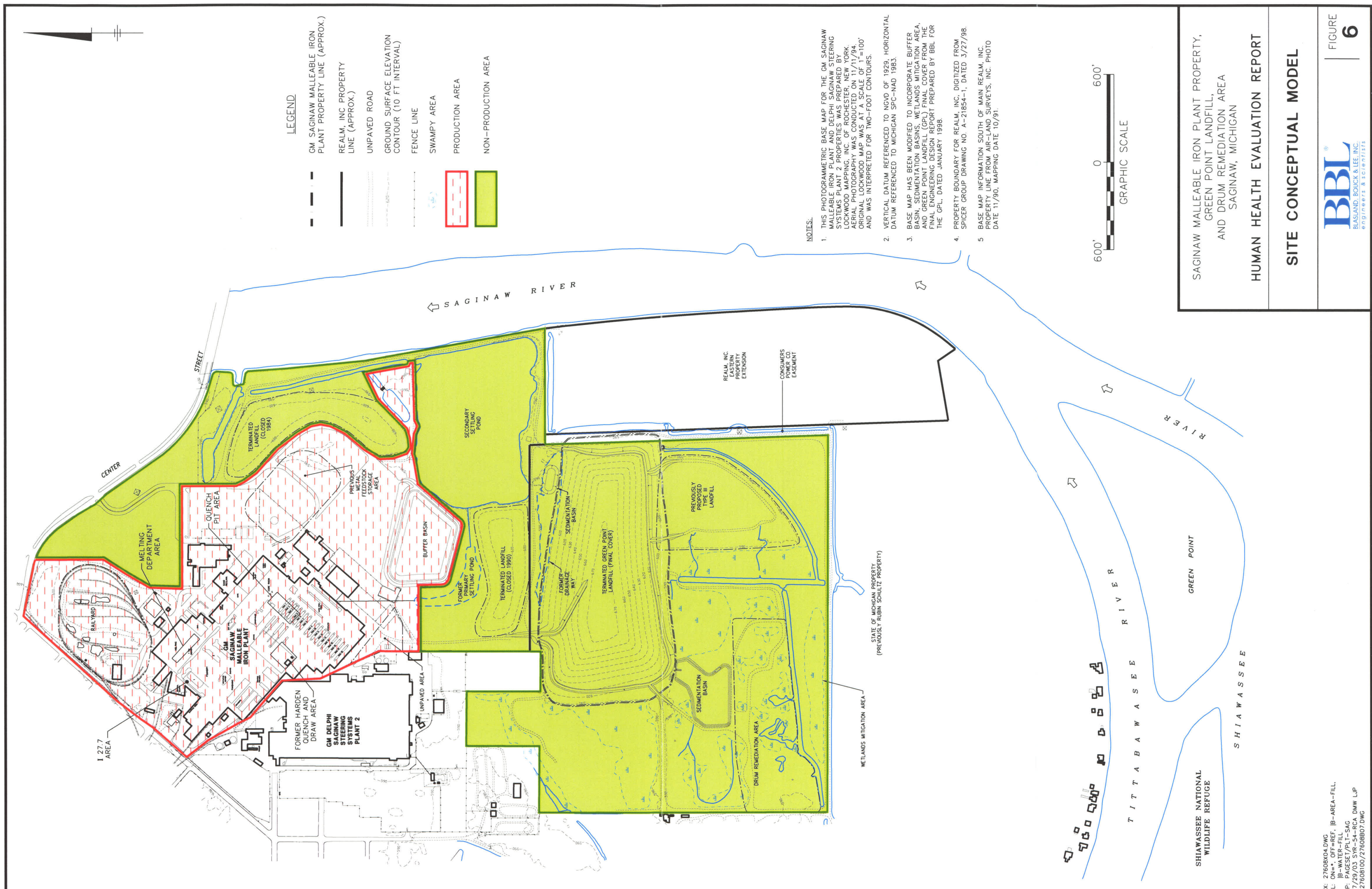
TEF

TOXICITY EQUIVALENCE FACTOR

ug/L

MICROGRAMS PER LITER (PPB)





LEGEND

- GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)
- REALM, INC. PROPERTY LINE (APPROX.)
- UNPAVED ROAD
- GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)
- FENCE LINE
- SWAMPY AREA
- PRODUCTION AREA
- NON-PRODUCTION AREA

NOTES:

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- PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 3/27/98.
- BASE MAP INFORMATION SOUTH OF MAIN REALM, INC. PROPERTY LINE FROM AIR-LAND SURVEYS, INC. PHOTO DATE 11/790, MAPPING DATE 10/91.



SHIAWASSEE NATIONAL  
WILDLIFE REFUGE

GREEN POINT  
RIVER

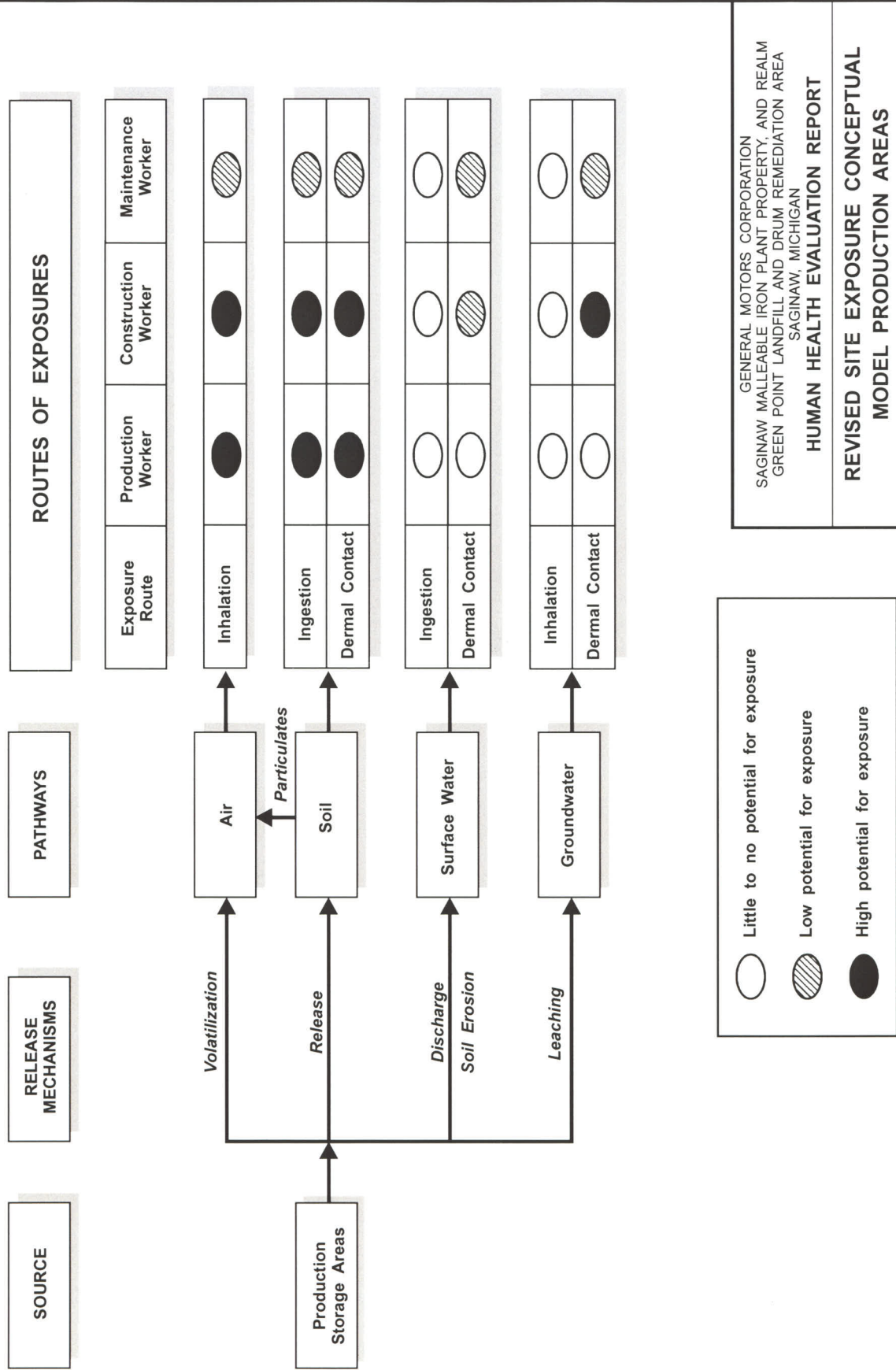
TITTABAWASSEE RIVER

SHIAWASSEE

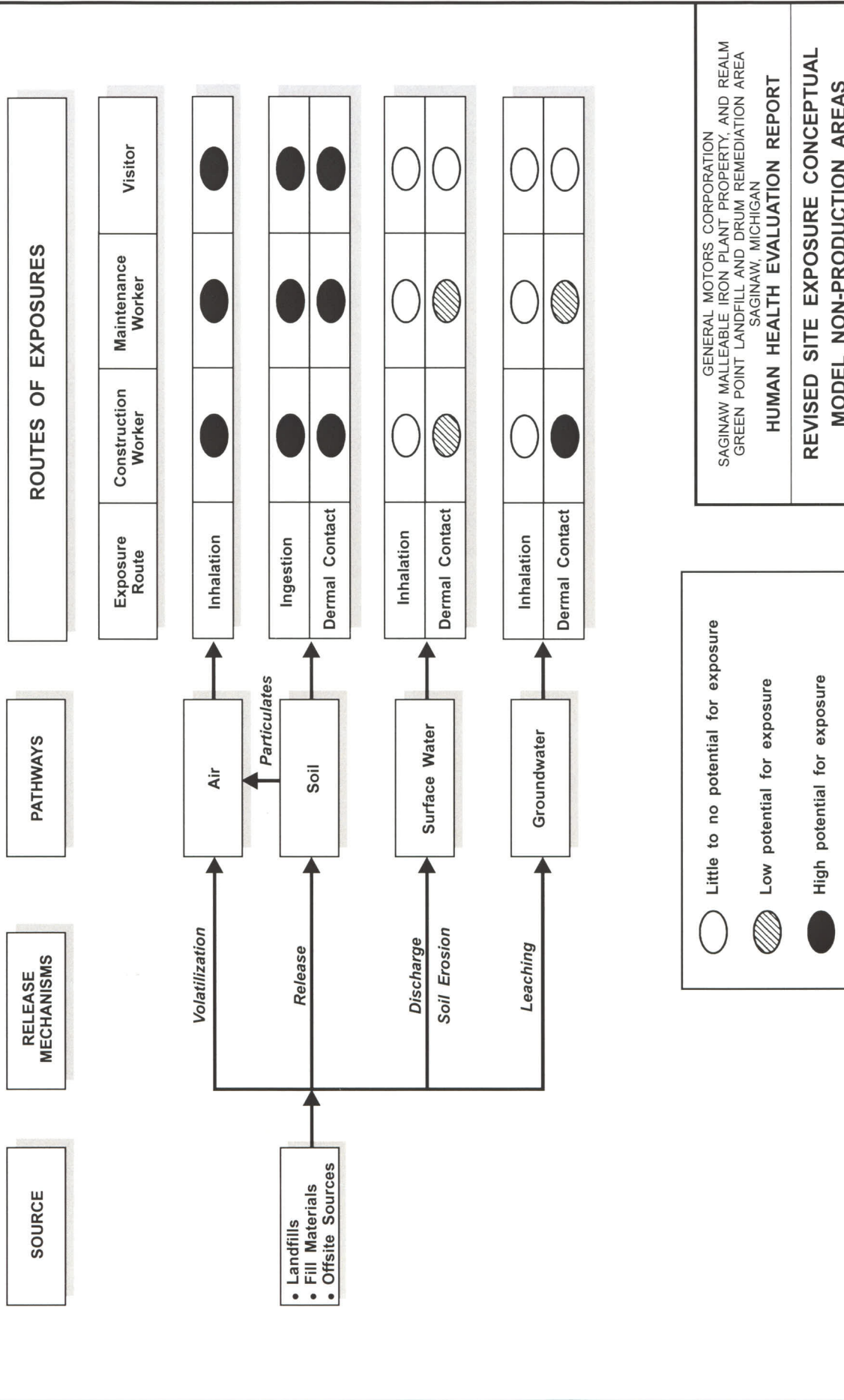
SAGINAW MALLEABLE IRON PLANT PROPERTY,  
GREEN POINT LANDFILL,  
AND DRUM REMEDIATION AREA  
SAGINAW, MICHIGAN

HUMAN HEALTH EVALUATION REPORT

SITE CONCEPTUAL MODEL









## ***Appendices***

---

# **Appendix A**

## **Description of MDEQ Generic Cleanup Criteria**

## APPENDIX A: Description of MDEQ Generic Cleanup Criteria

| ACRONYM     | DESCRIPTION                                                                                                       | EXPOSURE PATHWAY(S)                                                                                                                                                                                                                                                                                                                     |
|-------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SOIL</b> |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                         |
| GCCP        | Groundwater Contact Protection Criteria                                                                           | <u>GROUNDWATER CONTACT PROTECTION</u><br>Generic GCCP criteria identify a soil concentration that is not expected to contaminate groundwater at levels greater than the groundwater contact criteria.                                                                                                                                   |
| IDC         | Industrial Direct Contact Criteria                                                                                | <u>INGESTION/DERMAL</u><br>The generic IDC criteria identify chemical constituent concentrations in soil that are protective against adverse health effects due to long-term ingestion of and dermal exposure to contaminated soil in an industrial or commercial II land use.                                                          |
| IDWP        | Industrial and Commercial II, III, & IV Drinking Water Protection Criteria                                        | <u>INDUSTRIAL DRINKING WATER PROTECTION</u><br>The generic IDWP criteria identify chemical constituent concentrations in soil that are not expected to leach and contaminate groundwater at levels greater than IDW criteria.                                                                                                           |
| RDC         | Residential Direct Contact Criteria                                                                               | <u>INGESTION/DERMAL</u><br>The generic RDC criteria identify chemical constituent concentrations in soil that are protective against adverse health effects due to long-term ingestion of and dermal exposure to contaminated soil.                                                                                                     |
| RDWP        | Residential Drinking Water Protection Criteria                                                                    | <u>RESIDENTIAL DRINKING WATER PROTECTION</u><br>The generic RDWP criteria identify chemical constituent concentrations in soil that are not expected to leach and contaminate groundwater at levels greater than RDW criteria.                                                                                                          |
| ISVIIC      | Industrial and Commercial II, III, & IV Soil Volatilization to Indoor Air Inhalation Criteria                     | <u>INHALATION-Indoor Air</u><br>Generic ISVIIC criteria identify chemical constituent concentrations in soil that protect workers from exposure to indoor air concentrations that may cause adverse health effects. These criteria address the migration of contaminate vapors from soil into buildings.                                |
| IVSIC       | Industrial and Commercial II, III, & IV 5-Meter Source Thickness Volatile Soil Inhalation Criteria to Ambient Air | <u>INHALATION-Ambient Air</u><br>For situations where the source thickness is 5 meters or less, the generic IVSIC identifies chemical constituent concentrations in soil that are not expected to yield an ambient air concentration that would cause adverse human health effects at an industrial or commercial II, III, IV land use. |

## APPENDIX A: Description of MDEQ Generic Cleanup Criteria

| ACRONYM            | DESCRIPTION                                                                                       | EXPOSURE PATHWAY(S)                                                                                                                                                                                                                                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SOIL</b>        |                                                                                                   |                                                                                                                                                                                                                                                                                                                                       |
| IPSIC              | Industrial and Commercial II, III, & IV Particulate Soil Inhalation Criteria for Ambient Air      | <u>INHALATION-Ambient Air</u><br>The generic IPSIC identifies chemical constituent concentrations in soil that are not expected to yield ambient air concentrations of contaminated particulates that would cause adverse human health effects through inhalation of ambient air in an industrial or commercial II, III, IV land use. |
| RSVIIC             | Residential and Commercial I Soil Volatilization to Indoor Air Inhalation Criteria                | <u>INHALATION-Indoor Air</u><br>Generic RSVIIC criteria identify chemical constituent concentrations in soil that protect occupants from exposure to indoor air concentrations that may cause adverse health effects. These criteria address the migration of contaminate vapors from soil into buildings.                            |
| RVSIC              | Residential Finite Volatile Soil Inhalation Criteria for 5-Meter Source Thickness for Ambient Air | <u>INHALATION-Ambient Air</u><br>For situations where the source thickness is 5 meters or less, the generic RVSIC identifies chemical constituent concentrations in soil that are not expected to yield an ambient air concentration that would cause adverse human health effects through inhalation in a residential land use.      |
| RPSIC              | Residential and Commercial I Particulate Soil Inhalation Criteria for Ambient Air                 | <u>INHALATION-Ambient Air</u><br>The generic RPSIC identifies chemical constituent concentrations in soil that are not expected to yield ambient air concentrations of contaminated particulates that would cause adverse human health effects through inhalation of ambient air in a residential or commercial I land use.           |
| <b>GROUNDWATER</b> |                                                                                                   |                                                                                                                                                                                                                                                                                                                                       |
| GCC                | Groundwater Contact Criteria                                                                      | <u>DERMAL</u><br>Generic GCC were derived to address human health risk from dermal (i.e., skin) exposure to hazardous substances in groundwater.                                                                                                                                                                                      |
| GSI                | Groundwater Surface Water Interface Criteria                                                      | <u>SURFACE WATER PROTECTION</u><br>Generic GSI criteria identify groundwater concentrations of substances that are protective of the receiving surface water body.                                                                                                                                                                    |

## APPENDIX A: Description of MDEQ Generic Cleanup Criteria

| ACRONYM            | DESCRIPTION                                                                                          | EXPOSURE PATHWAY(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>GROUNDWATER</b> |                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| IDW                | Industrial Drinking Water Cleanup Criteria                                                           | <u>INGESTION-Consumption at Work</u><br>Generic IDW criteria identify concentrations of chemical constituents in drinking water that are safe for long-term, daily consumption while at work. Adverse aesthetic impacts are taken into account for select substances.                                                                                                                                                                                                                                                                                          |
| RDW                | Residential Drinking Water Cleanup Criteria                                                          | <u>INGESTION-Residential Consumption</u><br>Generic RDW criteria identify concentrations of chemical constituents in drinking water that are safe for long-term, daily residential consumption. Adverse aesthetic impacts are taken into account for select hazardous substances.                                                                                                                                                                                                                                                                              |
| AISL               | Acute Inhalation Toxicity Screening Level                                                            | <u>INHALATION-Enclosed Spaces</u><br>The AISL identify concentrations of chemical constituents in groundwater that are protective against unacceptable air concentrations within enclosed spaces that would cause acute inhalation toxicity.                                                                                                                                                                                                                                                                                                                   |
| IGVIIC             | Industrial and Commercial II, III, & IV Groundwater Volatilization to Indoor Air Inhalation Criteria | <u>INHALATION-Indoor Air</u><br>Generic IGVIIC criteria identify concentrations of chemical constituents in groundwater that protects workers from the inhalation of contaminate concentrations in indoor air which may cause adverse health effects. These criteria address the migration of hazardous substance vapors from groundwater through soil into the workplace indoor air. This pathway is relevant for both groundwater in an aquifer and groundwater not in an aquifer. This pathway is relevant only for hazardous substances that are volatile. |
| RGVIIC             | Residential & Commercial I Groundwater Volatilization to Indoor Air Inhalation Criteria              | <u>INHALATION-Indoor Air</u><br>Generic RGVIIC criteria identify concentrations of chemical constituents in groundwater that protects occupants from the inhalation of contaminate concentrations in indoor air which may cause adverse health effects. These criteria address the migration of hazardous substance vapors from groundwater through soil into buildings. This pathway is relevant for both groundwater in an aquifer and groundwater not in an aquifer. This pathway is relevant only for hazardous substances that are volatile.              |
| FESL               | Flammability and Explosivity Screening Level                                                         | Values used to evaluate groundwater data with respect to potential flammability and explosivity.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| WSSL               | Water Solubility Screening Level                                                                     | Values established as possible indicators of the presence of non-aqueous phase liquid (NAPL).                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## **Appendix B**

### **Primary Site Features/Areas of Concern**

## APPENDIX B:

### Primary Site Features / Areas of Concern

The following table summarizes the primary site features/areas of concern (AOCs) evaluated in this HHE based on information provided in the *Remedial Investigation Report* (BBL, November 2000).

**Summary of Primary Site Features / Areas of Concern**

| Primary Site Feature / Area of Concern                                  | Contact Area   | Previous Use / Area Description                                                                                      | Current Use | Comments                                                                                                                                                                                  |
|-------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Former UST #s 1, 2, 6, 9, 10 and 11                                     | Production     | Storage of petroleum products                                                                                        | None        | Removed – No further action.                                                                                                                                                              |
| Former UST #s 3, 4, and 5 – Collectively referred to as Former Tank # 4 | Production     | Storage of petroleum products                                                                                        | None        | Removed – No further investigation required as part of RI.                                                                                                                                |
| Former UST #8                                                           | Production     | Storage of petroleum products                                                                                        | None        | Removed – No further investigation required as part of RI.                                                                                                                                |
| Former UST #7                                                           | Production     | Storage of petroleum products                                                                                        | None        | Removed – Quarterly monitoring program implemented in July 1998. COCs = BTEX and lead.                                                                                                    |
| Previous ASTs                                                           | Production     | Storage of petroleum products                                                                                        | None        | 5 ASTs previously located adjacent to northern side of plant building. BTEX and TPH did not exceed detection limits during September 1989 investigation.                                  |
| Drum Remediation Area (DRA) and Former Hillock Area                     | Non-production | Disposal of drums                                                                                                    | None        | Various investigations and remedial actions from 1987 through 1995. Soils in Hillock Area of DRA were removed in February 1997. IDC, ISVIC, and IPSIC exceeded for numerous constituents. |
| Green Point Landfill                                                    | Non-production | Disposal of municipal waste, foundry sand, and industrial wastes.                                                    | Closed      | Closed in 1978. Cap completed as an Interim Response in January 2000 is consistent with MDEQ requirements (Part 115 of Michigan Act 451).                                                 |
| Southern Property                                                       | Non-production | Previously purposed Type III Landfill area.                                                                          | None        | Located south of Green Point Landfill. IPSIC exceeded for manganese.                                                                                                                      |
| Central Terminated Type III Landfill                                    | Non-production | Disposal of spent foundry sands, scrubber residues, slag, and other industrial waste.                                | Closed      | Received wastes from 1984 to 1990.                                                                                                                                                        |
| Eastern Terminated Type III Landfill                                    | Non-production | Disposal of spent foundry sands, scrubber residues, slag, and other industrial waste.                                | Closed      | Received wastes from 1979 to 1984. GCC for PCBs exceeded.                                                                                                                                 |
| Former Water Recirculation System (WRS)                                 | Non-production | Used to decrease turbidity and temperature of non-contact process water and route water back to the plant for reuse. | None        | WRS taken off line in January 1997 and replaced with a new water recycle system.                                                                                                          |
| Former WRS – Primary Settling Pond                                      | Non-production | Settling pond                                                                                                        | None        | Dried up and regraded.                                                                                                                                                                    |
| Former WRS – Secondary Settling Pond                                    | Non-production | Settling pond                                                                                                        | None        | Based on analytical data, no further evaluation is required.                                                                                                                              |
| Former WRS – Drainage Channels                                          | Non-production | Drainage channels                                                                                                    | None        | Based on analytical data, no further evaluation is required. MDEQ has issued permit to fill these channels.                                                                               |



## APPENDIX B: Primary Site Features / Areas of Concern

| Primary Site Feature / Area of Concern | Contact Area   | Previous Use / Area Description                                                                           | Current Use                                   | Comments                                                                                                                                                                                                            | Retained in HHE Y/N |
|----------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Southern Drainage Channels             | Non-production | Drainage channels                                                                                         | None                                          | Based on analytical data, no further evaluation is required.                                                                                                                                                        | N                   |
| Stormwater Pond                        | Non-production | Receives stormwater runoff                                                                                | Stormwater runoff                             | Oily sheen was observed in mid-1998. Oil-stained sediments from the sidewalls of the pond were excavated and the pond bottom sediments were stabilized with lime and fly ash. The pond has been lined in July 2000. | N                   |
| Previous Metal Feedstock Area          | Production     | Storage of metal feedstock                                                                                | None                                          | Soil may pose risk to workers based on inhalation of particulates. IPSIC for Mn exceeded.                                                                                                                           | Y                   |
| Railyard Area                          | Production     | Temporary storage of metal feedstock and process materials and equipment.                                 |                                               | Surface soils containing PCBs were removed in July 1998. Soil may pose risk to workers based on inhalation of particulates. IPSIC for Mn exceeded. Risks due to dermal contact have been addressed.                 | Y                   |
| Unpaved Area                           | Production     |                                                                                                           |                                               | PCB impacted soils were removed in July 1998. Soil may pose risk to workers based on direct contact with the soils containing residual PCBs.                                                                        | Y                   |
| LNAPL Assessment and Remediation Area  | Production     | Light non-aqueous phase liquid identified within the Unpaved Area                                         |                                               | Based on fingerprinting, LNAPL resembles motor oil. As part of an Interim Response, LNAPL is being removed.                                                                                                         | ?                   |
| B-3 Area Oil Sheen                     | Production     | Sheen observed at western end of Central Terminated Landfill extending southward to Green Point Landfill. |                                               | Source remains unknown. COCs = various VOCs, SVOCs, and PCBs.                                                                                                                                                       | Y                   |
| Central Street Oil Sheen               | Production     | Sheen observed in vicinity of Center Street.                                                              |                                               | Oil sheen correlates to waste associated with the Former Queen Street Dump, not with any known GM source. COCs = VOCs and SVOCs. No PCBs.                                                                           | Y                   |
| Former Harden, Quench, Draw Area (HQD) | Production     | 10 HQD units were used to cool metal castings.                                                            | Unit 10 used for testing quench oil formulas. | Units 1 through 9 taken out of service between 1973 and 1991. LNAPL observed in 1996. Soil borings did not appear stained and no odors observed in 1996 investigation.                                              | N                   |
| Quench Pit Area                        | Production     | LNAPL located inside the SMI Plant beneath the plant floor in the vicinity of the quench pits.            |                                               | LNAPL is manually bailed daily from monitoring wells. COCs = VOCs, PCBs, and metals.                                                                                                                                | Y                   |
| Melting Department Area                | Production     | PCBs detected beneath plant floor in the Melting Department.                                              |                                               | Soils containing PCBs were excavated to the extent practical.                                                                                                                                                       | Y                   |
| Manhole I27.7 Area                     | Production     | PCBs detected beneath plant floor in the area of Manhole I27.7.                                           |                                               | PCBs are not accessible to plant workers because they are beneath the plant floor.                                                                                                                                  | Y                   |
| Driveway Expansion Area                | Production     | Entrance driveway to SMI Plant.                                                                           |                                               | PCBs were not detected in the area of excavation associated with the driveway expansion.                                                                                                                            | N                   |
| POTW Sewer Discharge                   | Non-production | SMI Plant water supply and sewer discharge lines.                                                         |                                               | GM has implemented PCBs sampling program and results are reported to MDEQ monthly.                                                                                                                                  | ?                   |

## **APPENDIX B:**

### **Primary Site Features / Areas of Concern**

**Notes:**

|        |   |                                                                              |
|--------|---|------------------------------------------------------------------------------|
| AST    | = | Aboveground Storage Tank                                                     |
| BTEX   | = | Benzene, Toluene, Ethylbenzene, Xylenes                                      |
| COCs   | = | Chemicals of Concern                                                         |
| GCC    | = | Groundwater Contact Criteria                                                 |
| GSI    | = | Groundwater Surface Water Interface                                          |
| IDC    | = | Industrial Direct Contact Criteria                                           |
| IDW    | = | Industrial Drinking Water Cleanup Criteria                                   |
| IDWP   | = | Industrial and Commercial II, III, and IV Drinking Water Protection Criteria |
| IPSIC  | = | Industrial Particulate Soil Inhalation Criteria                              |
| ISVIIC | = | Industrial Soil Volatilization to Indoor Air Inhalation Criteria             |
| LNAPL  | = | Light non-aqueous phase liquid                                               |
| MDEQ   | = | Michigan Department of Environmental Quality                                 |
| PCB    | = | Polychlorinated biphenyl                                                     |
| RDW    | = | Residential Drinking Water Cleanup Criteria                                  |
| RI     | = | Remedial Investigation                                                       |
| SVOC   | = | Semivolatile Organic Compound                                                |
| TPH    | = | Total Petroleum Hydrocarbons                                                 |
| UST    | = | Underground Storage Tank                                                     |
| VOC    | = | Volatile Organic Compound                                                    |

## **Appendix C**

### **Algorithms for Each Receptor – SSCC**

## APPENDIX C: Production Area: Direct Contact Criteria (DCC)

$$\text{Carcinogens DCC} = \frac{TR \times BW \times AT \times CF \times RSC}{SF \times ED \times [(EF \times IR \times AE_i) + (EF \times SA \times EV \times AF \times AE_d)] \times AUF}$$

$$\text{Non-carcinogens DCC} = \frac{THQ \times RfD \times BW \times AT \times CF \times RSC}{ED \times [(EF \times IR \times AE_i) + (EF \times SA \times EV \times AF \times AE_d)] \times AUF}$$

| Exposure Variable               | Code | Tier 1<br>MDEQ<br>Generic<br>Criteria                | Tier 2<br>Maintenance<br>Worker* | Tier 2<br>Construction<br>Worker | Tier 2<br>Production<br>Worker |
|---------------------------------|------|------------------------------------------------------|----------------------------------|----------------------------------|--------------------------------|
| Target Risk Level               | TR   | 1.00E-05                                             | --                               | NC                               | NC                             |
| Target Hazard Quotient          | THQ  | 1                                                    | --                               | NC                               | NC                             |
| Soil Ingestion Rate             | IRs  | 50 mg/day                                            | --                               | 100                              | 50                             |
| Ingestion Absorption Efficiency | AEi  | 100% VOCs<br>50% SVOCs<br>50% PCBs<br>50% Inorganics | --                               | NC                               | NC                             |
| Dermal Absorption Efficiency    | AEd  | 10% VOCs<br>10% SVOCs<br>1% Inorganics               | --                               | NC                               | NC                             |
| Ingestion Exposure Frequency    | EFi  | 245 days/year                                        | --                               | 30                               | 245                            |
| Dermal Exposure Frequency       | EFd  | 160 days/year                                        | --                               | 30                               | 245                            |
| Skin Surface Area               | SA   | 3300 cm <sup>2</sup> /event                          | --                               | 3300                             | 2700                           |
| Soil Adherence Factor           | AF   | 0.2 mg/cm <sup>2</sup>                               | --                               | 0.3                              | 0.01                           |
| Dermal Contact Event            | EV   | 1 event/day                                          | --                               | NC                               | NC                             |
| Conversion Factor               | CF   | 1.00E+09 µg/kg                                       | --                               | NC                               | NC                             |
| Oral Slope Factor               | SF   | Chemical specific<br>(mg/kg-day) <sup>-1</sup>       | --                               | NC                               | NC                             |
| Oral Reference Dose             | RfD  | Chemical specific<br>Mg/kg-day                       | --                               | NC                               | NC                             |
| Exposure Duration               | ED   | 21 years                                             | --                               | 1                                | 21                             |
| Relative Source Contribution    | RSC  | 1 (or site-specific)                                 | --                               | NC                               | NC                             |
| Area Utilization Factor         | AUF  | 1 (or site-specific)                                 | --                               | 1                                | 1                              |
| Body Weight                     | BW   | 70 kg                                                | --                               | NC                               | NC                             |
| Averaging Time-cancer           | ATc  | 25550 days<br>(70 yrs x 365 days/yr)                 | --                               | NC                               | NC                             |
| Averaging Time-noncancer        | ATnc | 7665 days<br>(ED x 365 days/yr)                      | --                               | 365                              | 7665                           |

Notes: NC = exposure variable was not modified

\*Groundskeeper/maintenance worker is involved in intrusive activities on an emergency basis 5 times a year; -- = the predominant exposure by the maintenance worker is in the non-production area.

## APPENDIX C:

### Production Area: Groundwater Contact Criteria (GCC)

$$\text{Carcinogens GCC} = \frac{BW \times AT \times TR \times CF1}{SF \times SA \times SP \times EV \times EF \times ED \times CF2 \times AUF}$$

$$\text{Non-carcinogens GCC} = \frac{THQ \times RfD \times BW \times AT \times CF1}{SA \times SP \times EV \times EF \times ED \times CF2 \times AUF}$$

| Exposure Variable          | Code            | Tier 1<br>MDEQ<br>Generic Criteria             | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Production<br>Worker |
|----------------------------|-----------------|------------------------------------------------|---------------------------------|----------------------------------|--------------------------------|
| Target Risk Level          | TR              | 1.00E-05                                       | --                              | NC                               | --                             |
| Target Hazard Quotient     | THQ             | 1                                              | --                              | NC                               | --                             |
| Skin Penetration Per Event | SP <sup>1</sup> | Chemical-specific (cm/event)                   | --                              | NC                               | --                             |
| Skin Surface Area          | SA              | 3300 cm <sup>2</sup> /event                    | --                              | 3300                             | --                             |
| Event Frequency            | EV              | 1 event/day                                    | --                              | NC                               | --                             |
| Exposure Frequency         | EF              | 20 days/year                                   | --                              | 30                               | --                             |
| Conversion Factor 1        | CF1             | 1.00E+03 µg/kg                                 | --                              | NC                               | --                             |
| Conversion Factor 2        | CF2             | 1.00E-3 L/cm <sup>3</sup>                      | --                              | NC                               | --                             |
| Oral Slope Factor          | SF              | Chemical specific<br>(mg/kg-day) <sup>-1</sup> | --                              | NC                               | --                             |
| Oral Reference Dose        | RfD             | Chemical specific<br>(mg/kg-day)               | --                              | NC                               | --                             |
| Exposure Duration          | ED              | 21 years                                       | --                              | 1                                | --                             |
| Area Utilization Factor    | AUF             | 1 (or site-specific)                           | --                              | 1                                | --                             |
| Body Weight                | BW              | 70 kg                                          | --                              | NC                               | --                             |
| Averaging Time-cancer      | ATc             | 25550 days<br>(70 yrs x 365 days/yr)           | --                              | NC                               | --                             |
| Averaging Time-noncancer   | ATnc            | 7665 days<br>(ED x 365 days/yr)                | --                              | 365                              | --                             |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Groundwater Contact Criteria: Technical Support Document, January 5, 2001. NC = exposure variable was not modified. -- = production worker is not expected to come into contact with on-site groundwater; and the predominant exposure by the maintenance worker is in the non-production area.

# **APPENDIX C:** **Production Area: Industrial Volatile Soil Inhalation Criteria (IVSIC)** **(Outdoor Air)**

$$\text{Carcinogens IVSIC} = \frac{TR \times AT \times AIR}{IURF \times EF \times ED \times (1/VF) \times AUF}$$

$$\text{Non-carcinogens IVSIC} = \frac{THQ \times AT \times AIR}{EF \times ED \times (1/RfC \times 1/VF) \times AUF}$$

| Exposure Variable           | Code            | Tier 1<br>MDEQ<br>Generic Criteria     | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Production<br>Worker |
|-----------------------------|-----------------|----------------------------------------|---------------------------------|----------------------------------|--------------------------------|
| Target Risk Level           | TR              | 1.00E-05                               | --                              | NC                               | --                             |
| Target Hazard Quotient      | THQ             | 1                                      | --                              | NC                               | --                             |
| Adjusted Inhalation Rate    | AIR             | 2 [20 m3/d / 10m3/d]                   | --                              | 2                                | --                             |
| Inhalation Unit Risk Factor | IURF            | Chemical specific (µg/m3) <sup>1</sup> | --                              | NC                               | --                             |
| Reference Concentration     | RfC             | Chemical specific (µg/m3)              | --                              | NC                               | --                             |
| Exposure Frequency          | EF              | 245 days/year                          | --                              | 30                               | --                             |
| Exposure Duration           | ED              | 21 years                               | --                              | 1                                | --                             |
| Volatilization Factor       | VF <sup>1</sup> | Chemical specific (m3/kg)              | --                              | NC                               | --                             |
| Area Utilization Factor     | AUF             | 1 (or site-specific)                   | --                              | 1                                | --                             |
| Averaging Time-cancer       | ATc             | 25550 days<br>(70 yrs x 365 days/yr)   | --                              | NC                               | --                             |
| Averaging Time-noncancer    | Atnc            | 7665 days<br>(ED x 365 days/yr)        | --                              | 365                              | --                             |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Soil Inhalation Criteria for Ambient Air Technical Support Document, August 31, 1998. NC = exposure variable was not modified. -- = production worker is not expected to come into contact with on-site groundwater; and the predominant exposure by the maintenance worker is in the non-production area.

## APPENDIX C:

### Production Area: Industrial Particulate Soil Inhalation Criteria (IPSIC)

$$\text{Carcinogens IPSIC} = \frac{TR \times AT \times AIR}{IURF \times EF \times ED \times (1 / PEF) \times AUF}$$

$$\text{Non-carcinogens IPSIC} = \frac{THQ \times AT \times AIR}{EF \times ED \times (1 / RfC \times 1 / PEF) \times AUF}$$

| Exposure Variable           | Code             | Tier 1<br>MDEQ<br>Generic Criteria                   | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Production<br>Worker |
|-----------------------------|------------------|------------------------------------------------------|---------------------------------|----------------------------------|--------------------------------|
| Target Risk Level           | TR               | 1.00E-05                                             | --                              | NC                               | --                             |
| Target Hazard Quotient      | THQ              | 1                                                    | --                              | NC                               | --                             |
| Adjusted Inhalation Rate    | AIR              | 2 [20 m <sup>3</sup> /d / 10m <sup>3</sup> /d]       | --                              | 2                                | --                             |
| Inhalation Unit Risk Factor | IURF             | Chemical specific (µg/m <sup>3</sup> ) <sup>-1</sup> | --                              | NC                               | --                             |
| Reference Concentration     | RfC              | Chemical specific (µg/m <sup>3</sup> )               | --                              | NC                               | --                             |
| Exposure Frequency          | EF               | 245 days/year                                        | --                              | 30                               | --                             |
| Exposure Duration           | ED               | 21 years                                             | --                              | 1                                | --                             |
| Particulate Emission Factor | PEF <sup>1</sup> | Chemical specific (m <sup>3</sup> /kg)               | --                              | NC                               | --                             |
| Area Utilization Factor     | AUF              | 1 (or site-specific)                                 | --                              | 1                                | --                             |
| Averaging Time-cancer       | ATc              | 25550 days<br>(70 yrs x 365 days/yr)                 | --                              | NC                               | --                             |
| Averaging Time-noncancer    | ATnc             | 7665 days<br>(ED x 365 days/yr)                      | --                              | 365                              | --                             |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Soil Inhalation Criteria for Ambient Air Technical Support Document, August 31, 1998. NC = exposure variable was not modified. -- = production worker is not expected to come into contact with on-site groundwater; and the predominant exposure by the maintenance worker is in the non-production area.

**APPENDIX C:**  
**Production Area: Industrial Soil Volatilization Indoor Air Inhalation**  
**Criteria (ISVIIC) and Industrial Groundwater Volatilization Indoor**  
**Air Inhalation Criteria (IGVIIC)**

$$\text{Carcinogens ISVIIC / IGVIIC} = \frac{TR \times AT \times AIR}{IURF \times EF \times ED \times CR_{\text{building}} \times AUF}$$

$$\text{Non-carcinogens ISVIC / IGVIIC} = \frac{THQ \times AT \times AIR}{(1 / RfC) \times EF \times ED \times CR_{\text{building}} \times AUF}$$

| Exposure Variable                                                                      | Code                   | Tier 1<br>MDEQ Generic<br>Criteria      | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Production<br>Worker |
|----------------------------------------------------------------------------------------|------------------------|-----------------------------------------|---------------------------------|----------------------------------|--------------------------------|
| Target Risk Level                                                                      | TR                     | 1.00E-05                                | --                              | --                               | NC                             |
| Target Hazard Quotient                                                                 | THQ                    | 1                                       | --                              | --                               | NC                             |
| Adjusted Inhalation Rate                                                               | AIR                    | 2 [(20m3/day)/(10m3/day)]               | --                              | --                               | 2                              |
| Inhalation Unit Risk Factor                                                            | IURF                   | Chemical specific (µg/m3) <sup>-1</sup> | --                              | --                               | NC                             |
| Reference Concentration                                                                | RfC                    | Chemical specific (µg/m3)               | --                              | --                               | NC                             |
| Exposure Frequency                                                                     | EF                     | 245 days/year                           | --                              | --                               | 245                            |
| Exposure Duration                                                                      | ED                     | 21 years                                | --                              | --                               | 21                             |
| Ratio of indoor vapor concentration to soil or groundwater vapor source concentration. | CR <sub>building</sub> | Chemical specific (µg/m3)/ (µg/kg)      | --                              | --                               | NC                             |
| Area Utilization Factor                                                                | AUF                    | 1 (or site-specific)                    | --                              | --                               | 1                              |
| Averaging Time-cancer                                                                  | ATc                    | 25550 days<br>(70 yrs x 365 days/yr)    | --                              | --                               | NC                             |
| Averaging Time-noncancer                                                               | ATnc                   | 7665 days<br>(ED x 365 days/yr)         | --                              | --                               | 7665                           |

Notes: NC = exposure variable was not modified. -- = intrusive worker is not expected to be exposed to indoor air; he works outdoors, and the predominant exposure by the maintenance worker is in the non-production area.



## APPENDIX C: Non-Production Area: Direct Contact Criteria (DCC)

$$\text{Carcinogens DCC} = \frac{TR \times BW \times AT \times CF \times RSC}{SF \times ED \times [(EF_i \times IR \times AE_i) + (EF_d \times SA \times EV \times AF \times AE_d)] \times AUF}$$

$$\text{Non-carcinogens DCC} = \frac{THQ \times RfD \times BW \times AT \times CF \times RSC}{ED \times [(EF_i \times IR \times AE_i) + (EF_d \times SA \times EV \times AF \times AE_d)] \times AUF}$$

| Exposure Variable               | Code | Tier 1<br>MDEQ<br>Generic Criteria                   | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Visitor |
|---------------------------------|------|------------------------------------------------------|---------------------------------|----------------------------------|-------------------|
| Target Risk Level               | TR   | 1.00E-05                                             | NC                              | NC                               | NC                |
| Target Hazard Quotient          | THQ  | 1                                                    |                                 |                                  |                   |
| Soil Ingestion Rate             | IRs  | 50 mg/day                                            | 100                             | 330                              | 100               |
| Ingestion Absorption Efficiency | AEi  | 100% VOCs<br>50% SVOCs<br>50% PCBs<br>50% Inorganics | NC                              | NC                               | NC                |
| Dermal Absorption Efficiency    | AEd  | 10% VOCs<br>10% SVOCs<br>1% Inorganics               | NC                              | NC                               | NC                |
| Ingestion Exposure Frequency    | EFi  | 245 days/year                                        | 160                             | 30                               | 5                 |
| Dermal Exposure Frequency       | EFd  | 160 days/year                                        | 160                             | 30                               | 5                 |
| Skin Surface Area               | SA   | 3300 cm <sup>2</sup> /event                          | 2800                            | 3300                             | 4680              |
| Soil Adherence Factor           | AF   | 0.2 mg/cm <sup>2</sup>                               | 0.02                            | 0.3                              | 0.04              |
| Dermal Contact Event            | EV   | 1 event/day                                          | NC                              | NC                               | NC                |
| Conversion Factor               | CF   | 1.00E+09 µg/kg                                       | NC                              | NC                               | NC                |
| Relative Source Contribution    | RSC  | 1<br>(or site-specific)                              | 1                               | 1                                | 1                 |
| Area Utilization Factor         | AUF  | 1 (or site-specific)                                 | 1                               | 1                                | 1                 |
| Oral Slope Factor               | SF   | Chemical specific<br>(mg/kg-day) <sup>-1</sup>       | NC                              | NC                               | NC                |
| Oral Reference Dose             | RfD  | Chemical specific<br>mg/kg-day                       | NC                              | NC                               | NC                |
| Exposure Duration               | ED   | 21 years                                             | 21                              | 21                               | 3                 |
| Body Weight                     | BW   | 70 kg                                                | 70                              | 70                               | 49.1              |
| Averaging Time-cancer           | ATc  | 25550 days<br>(70 yrs x 365 days/yr)                 | NC                              | NC                               | NC                |
| Averaging Time-noncancer        | ATnc | 7665 days<br>(ED x 365 days/yr)                      | 7665                            | 7665                             | 1095              |

Notes: NC = exposure variable was not modified.

## APPENDIX C: Non-Production Area: Groundwater Contact Criteria (GCC)

$$\text{Carcinogens GCC} = \frac{BW \times AT \times TR \times CF1}{SF \times SA \times SP \times EV \times EF \times ED \times CF2 \times AUF}$$

$$\text{Non-carcinogens GCC} = \frac{THQ \times RfD \times BW \times AT \times CF1}{SA \times SP \times EV \times EF \times ED \times CF2 \times AUF}$$

| Exposure Variable          | Code            | Tier 1<br>MDEQ<br>Generic Criteria             | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Visitor |
|----------------------------|-----------------|------------------------------------------------|---------------------------------|----------------------------------|-------------------|
| Target Risk Level          | TR              | 1.00E-05                                       | NC                              | NC                               | --                |
| Target Hazard Quotient     | THQ             | 1                                              | NC                              | NC                               | --                |
| Skin Penetration Per Event | SP <sup>1</sup> | Chemical-specific<br>(cm/event)                | NC                              | NC                               | --                |
| Skin Surface Area          | SA              | 3300 cm <sup>2</sup> /event                    | 3300                            | 3300                             | --                |
| Event Frequency            | EV              | 1 event/day                                    | NC                              | NC                               | --                |
| Exposure Frequency         | EF              | 20 days/year                                   | 5                               | 30                               | --                |
| Conversion Factor 1        | CF1             | 1.00E+03 µg/kg                                 | NC                              | NC                               | --                |
| Conversion Factor 2        | CF2             | 1.00E-3 L/cm <sup>3</sup>                      | NC                              | NC                               | --                |
| Oral Slope Factor          | SF              | Chemical specific<br>(mg/kg-day) <sup>-1</sup> | NC                              | NC                               | --                |
| Oral Reference Dose        | RfD             | Chemical specific<br>(mg/kg-day)               | NC                              | NC                               | --                |
| Exposure Duration          | ED              | 21 years                                       | 21                              | 1                                | --                |
| Body Weight                | BW              | 70 kg                                          |                                 |                                  | --                |
| Area Utilization Factor    | AUF             | 1 (or site-specific)                           | 1                               | 1                                | --                |
| Averaging Time-cancer      | ATc             | 25550 days<br>(70 yrs x 365 days/yr)           | NC                              | NC                               | --                |
| Averaging Time-noncancer   | ATnc            | 7665 days<br>(ED x 365 days/yr)                | 7665                            | 365                              | --                |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Groundwater Contact Criteria: Technical Support Document, January 5, 2001. NC = exposure variable was not modified. -- = visitor is not expected to come into contact with on-site groundwater.

**APPENDIX C:**  
**Non-Production Area: Industrial Volatile Soil Inhalation Criteria**  
**(IVSIC)**  
**(Outdoor Air)**

$$\text{Carcinogens IVSIC} = \frac{TR \times AT \times AIR}{IURF \times EF \times ED \times (1/VF) \times AUF}$$

$$\text{Non-carcinogens IVSIC} = \frac{THQ \times AT \times AIR}{EF \times ED \times (1/RfC \times 1/VF) \times AUF}$$

| Exposure Variable           | Code            | Tier 1<br>MDEQ<br>Generic Criteria      | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Visitor |
|-----------------------------|-----------------|-----------------------------------------|---------------------------------|----------------------------------|-------------------|
| Target Risk Level           | TR              | 1.00E-05                                | NC                              | NC                               | NC                |
| Target Hazard Quotient      | THQ             | 1                                       | NC                              | NC                               | NC                |
| Adjusted Inhalation Rate    | AIR             | 2 [20 m3/d / 10m3/d]                    | 2                               | 2                                | 5                 |
| Inhalation Unit Risk Factor | IURF            | Chemical specific (µg/m3) <sup>-1</sup> | NC                              | NC                               | NC                |
| Reference Concentration     | RfC             | Chemical specific (µg/m3)               | NC                              | NC                               | NC                |
| Exposure Frequency          | EF              | 245 days/year                           | 160                             | 30                               | 5                 |
| Exposure Duration           | ED              | 21 years                                | 21                              | 1                                | 3                 |
| Volatilization Factor       | VF <sup>1</sup> | Chemical specific (m3/kg)               | NC                              | NC                               | NC                |
| Area Utilization Factor     | AUF             | 1 (or site-specific)                    | 1                               | 1                                | 1                 |
| Averaging Time-cancer       | ATc             | 25550 days<br>(70 yrs x 365 days/yr)    | NC                              | NC                               | NC                |
| Averaging Time-noncancer    | ATnc            | 7665 days<br>(ED x 365 days/yr)         | 7665                            | 365                              | 1095              |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Soil Inhalation Criteria for Ambient Air Technical Support Document, August 31, 1998. NC = exposure variable was not modified.

## APPENDIX C:

### Non-Production Area: Industrial Particulate Soil Inhalation Criteria (IPSIC)

$$\text{Carcinogens IPSIC} = \frac{TR \times AT \times AIR}{IURF \times EF \times ED \times (1 / PEF) \times AUF}$$

$$\text{Non-carcinogens IPSIC} = \frac{THQ \times AT \times AIR}{EF \times ED \times (1 / RfC \times 1 / PEF) \times AUF}$$

| Exposure Variable           | Code             | Tier 1<br>MDEQ<br>Generic Criteria      | Tier 2<br>Maintenance<br>Worker | Tier 2<br>Construction<br>Worker | Tier 2<br>Visitor |
|-----------------------------|------------------|-----------------------------------------|---------------------------------|----------------------------------|-------------------|
| Target Risk Level           | TR               | 1.00E-05                                | NC                              | NC                               | NC                |
| Target Hazard Quotient      | THQ              | 1                                       | NC                              | NC                               | NC                |
| Adjusted Inhalation Rate    | AIR              | 2 [20 m3/d / 10m3/d]                    | 2                               | 2                                | 5                 |
| Inhalation Unit Risk Factor | IURF             | Chemical specific (µg/m3) <sup>-1</sup> | NC                              | NC                               | NC                |
| Reference Concentration     | RfC              | Chemical specific (µg/m3)               | NC                              | NC                               | NC                |
| Exposure Frequency          | EF               | 245 days/year                           | 160                             | 30                               | 5                 |
| Exposure Duration           | ED               | 21 years                                | 21                              | 1                                | 3                 |
| Particulate Emission Factor | PEF <sup>1</sup> | Chemical specific (m3/kg)               | NC                              | NC                               | NC                |
| Area Utilization Factor     | AUF              | 1 (or site-specific)                    | 1                               | 1                                | 1                 |
| Averaging Time-cancer       | ATc              | 25550 days<br>(70 yrs x 365 days/yr)    | NC                              | NC                               | NC                |
| Averaging Time-noncancer    | ATnc             | 7665 days<br>(ED x 365 days/yr)         | 7665                            | 365                              | 1095              |

Notes: <sup>1</sup> = MDEQ Part 201 Generic Soil Inhalation Criteria for Ambient Air Technical Support Document, August 31, 1998.  
NC = exposure variable was not modified.

# **Appendix D**

## **Adult Lead Model**

## Appendix D Adult Lead Model

### Derivation of SSCCs Using the Adult Lead Biokinetic Model

The adult lead biokinetic model (USEPA, 1996) was used to develop the generic cleanup criteria (MDEQ, 2000). The generic criterion for direct contact with soil in an industrial setting is 990 ppm. The adult lead biokinetic model developed by Bowers and Cohen (1998), which is conceptually identical to the USEPA model, was used to develop the SSCCs for lead at the GM Saginaw facility. The USEPA has chosen to focus on protection of pregnant women in the workplace and their unborn children and therefore specified that exposure must be limited to ensure that the fetus has a 95% probability of having a blood lead level below 10 µg/dl. The fetal blood concentration has been determined by USEPA and the Centers for Disease Control (CDC) to be protective of the neurodevelopmental effects of lead.

In order to develop the IDC specific to the exposure conditions developed for the GM facility, soil lead concentrations corresponding to the target fetal blood level concentration were developed.

The model is used to predict an adult lead blood level using the following relationship:

$$\text{PbB}_{\text{adult}} = \text{PbB}_{\text{baseline}} + (\text{BSF} \times \text{C} \times \text{I} \times \text{A} \times \text{FS} \times \text{EF} \times \text{K})$$

Where:

|                                |                                                                                                                           |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| $\text{PbB}_{\text{adult}}$    | = adult blood lead level                                                                                                  |
| $\text{PbB}_{\text{baseline}}$ | = baseline blood lead level attributed to non-site exposure (µg/dl)                                                       |
| BSF                            | = biokinetic slope factor (µg/dl blood lead per mg/day lead uptake)                                                       |
| C                              | = concentration of lead in soil (µg/g)                                                                                    |
| I                              | = soil ingestion rate (g/day)                                                                                             |
| A                              | = fraction of lead in soil that is absorbed into the body                                                                 |
| FS                             | = fraction of ingested soil that is from the site                                                                         |
| EF                             | = exposure frequency, equal to the number of days per year during which an individual is exposed to site soil (days/year) |
| K                              | = conversion constant (years/day)                                                                                         |

In order to achieve a target fetal blood lead concentration of 10 µg/dl ( $\text{PbB}_{\text{target}}$ ), the adult lead concentration must satisfy this relationship:

$$\text{PbB}_{\text{target}} = \text{PbB}_{\text{adult}} \times \text{R}_{\text{fetal/adult}} \times \text{GSD}^{1.645}$$

Where:

|                                 |                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\text{R}_{\text{fetal/adult}}$ | = ratio of fetal PbB levels to maternal PbB levels                                                                                                                                                                                                                                                                                                       |
| $\text{GSD}^{1.645}$            | = geometric standard deviation of PbB levels among women of childbearing age. For the purposes of this model, it is assumed that the distributions of blood lead concentrations fit a log-normal distribution. Under these assumed conditions, the 95 <sup>th</sup> percentile PbB level in the population is $\text{GSD}^{1.645}$ times higher than the |

geometric mean PbB level, which in this case is equal to the product of  $PbB_{adult}$  and  $R_{fetal/adult}$ .

To derive SSCCs for each of the receptors contacting soil in the high and low contact areas, the model equations were rearranged (to solve for C).

$$IDC_{lead} = \frac{PbB_{target} - PbB_{baseline}}{BSF \times I \times A \times FS \times EF \times K}$$

Additionally, parameters specific to the exposure scenarios were incorporated into the model. The following model parameters remained constant for each of the six exposure scenarios:

- $PbB_{baseline}$  = 1.48 µg/dl. The geometric mean blood lead concentration for women of childbearing age in the Midwest US from Phase 2 of NHANES III (as described by Bowers and Cohen, 1998 and verified by a review of the electronic database).
- BSF = 0.375 (from USEPA, 1996)
- A = 0.12 (USEPA, 1996)
- FS = 1
- K = 1/365 or 0.00274
- GSD = 1.89 The geometric standard deviation for women of childbearing age in the Midwest US from Phase 2 of NHANES III (as described by Bowers and Cohen, 1998 and verified by a review of the electronic database).

The following model parameters were modified to account for different exposure variable for the different receptors:

- I = Production worker – 50 mg/day; Construction Worker – 330 mg/day; Maintenance Worker – 107 mg/day (weighted average assuming 5 days/yr at 330 mg/day and 155 days/yr at 100 mg/day); Visitor 50 mg/day.
- EF = Production worker – 245 days only in the production area; Construction Worker – 30 days in either the production area or non-production area; Maintenance Worker – 160 days in the non-production area; Visitor – 5 days only in the non-production area.

#### **Uncertainty Associated With The Model:**

The resulting IDC criteria for each of these receptors, with the exception of the production worker, is likely overprotective since the conditions established with our site-specific exposure model violate one important requirement for the model. Since the receptors other than the production worker are exposed for relatively short periods of time, under these hypothetical conditions they will not achieve steady-state conditions. As noted by USEPA (2001):

*The exposure duration should be sufficiently long to allow blood lead concentrations to approach quasi-steady state. As discussed in the guidance, the shortest period of time appropriate for the exposure duration is 3 months (90 days).*

Since some of these receptors, for example the construction worker, are not assumed to be exposed for 3 months, the predicted blood lead concentration associated with exposure to the IDC for that exposure scenario (1,982 ppm in both the production and non-production area) will not reach the  $PbB_{target}$ . Thus, although the IDC for these types of receptors is not accurate, the value will overpredict blood lead levels, and therefore should be considered protective.

References:

MDEQ-ERD. 2000. *Operational Memorandum #18: Part 201 Generic Cleanup Criteria*.

USEPA. 1996. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996

USEPA. 2001. Frequently asked questions (FAQs) on the Adult Lead Model. Technical Workgroup for Lead. August, 2001.

Bowers, T.S. and Cohon, J.T. 1998. Blood lead slope factor models for adults: Comparisons of observations and predictions. J. Environ. Health Persp. 106, Supplement 6:1569-1576.



## **Appendix E**

### **95% Upper Confidence Limit Calculations**

# **Appendix E - Upper Confidence Limit Calculations**

## **Introduction**

The evaluation of groundwater and soil analytical data at the GM SMI Plant facility included calculation of the 95% upper confidence limit (UCL) of the arithmetic mean for each chemical detected within a given areas. Where appropriate, the 95% UCL of the arithmetic mean was used to determine compliance with the generic criteria for select pathways following MDEQ Op Memo 18 guidance for determining final cleanup criterion for a given hazardous substance in soil and groundwater.

The use of the 95% UCL with comparison to MDEQ criteria was limited to data sets with significant statistical robustness. Within the USEPA's *Supplemental Guidance to RAGS: Calculating the Concentration Term*, data sets with 10 to 20 samples per exposure area provide somewhat better estimates of the mean, and data sets with 20 to 30 samples provide fairly consistent estimates of the mean (USEPA, 1992). The 95% UCL was used in comparison with MDEQ criteria except for where the 95% UCL exceeded the maximum concentration. For these instances, the maximum detected concentration was used as the exposure point concentration (USEPA, 1992).

## **Data Analysis**

The groundwater and soil data for constituents of concern (as identified in the remedial investigation) were broken up into nine areas as shown in the attached Table 1. For each constituent, the data was statistically summarized and tested for normality. The Kolmogorov-Smirnov normality test was used for all constituent data using statistical software. Attached to this appendix is a summary of normality test results for each constituent within each area.

After determining whether or not a constituent data set is normal, calculation of the UCL of the arithmetic mean is evaluated using either the lognormal or normal distribution formulae as shown in the guidance (USEPA 1992). These formulas are shown below:

The UCL of the arithmetic mean for a lognormal distribution:

$$UCL = e^{(\bar{x} + 0.5s^2 + sH / \sqrt{n-1})}$$

where:

- UCL = upper confidence limit
- e = constant (base of the natural log, equal to 2.718)
- $\bar{x}$  = mean of transformed data
- s = standard deviation of the transformed data
- H = H-statistic (e.g.; from table published in Gilbert, 1987)
- n = number of samples

The UCL of the arithmetic mean for a normal distribution:

$$UCL = \bar{x} + t(s / \sqrt{n})$$

---

where:

UCL = upper confidence limit

$\bar{x}$  = mean of untransformed data

s = standard deviation of the untransformed data

t = Student t-statistic (e.g., from table published in Gilbert, 1987)

n = number of samples

The UCL calculations for each constituent are provided as attachment 3 to this appendix.

**References:**

Gilbert, R.O. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold, New York, New York. 1987.

USEPA. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Office of Solid Waste and Emergency Response, Washington, DC. Publication 9285.7-08I. May 1992.

## ***Attachment 1***

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### **Table 1 – Summary of 95% UCL Calculations for Groundwater and Soil Constituents of Concern**

**GM SMI PLANT**  
**RI/FS RISK ASSESSMENT**  
**SAGINAW, MICHIGAN**

**SUMMARY OF 95% UCL CALCULATIONS FOR GROUNDWATER AND SOIL CONSTITUENTS OF CONCERN**

| Areas                                                                | # Samples | Transformed Mean | Std Deviation | Distribution | Max. Detection | Frequency of Detection | 95% UCL         |
|----------------------------------------------------------------------|-----------|------------------|---------------|--------------|----------------|------------------------|-----------------|
| <b>Non-River Residential Perimeter Temporary and Permanent Wells</b> |           |                  |               |              |                |                        |                 |
| <b>Groundwater (ug/L)</b>                                            |           |                  |               |              |                |                        |                 |
| 1,2-Dichloroethene                                                   | 46        | -0.53            | 0.917         | lognormal    | 220            | 1/46                   | 1,220           |
| Cis-1,2-Dichloroethene                                               | 46        | -0.545           | 0.926         | lognormal    | 220            | 1/46                   | 1,216           |
| Trichloroethene                                                      | 46        | -0.585           | 0.557         | lognormal    | 17             | 1/46                   | 0,763           |
| Vinyl Chloride                                                       | 46        | -0.525           | 0.947         | lognormal    | 270            | 1/46                   | 1,278           |
| Bis(2-ethylhexyl)phthalate                                           | 56        | 0.995            | 1.035         | lognormal    | 500            | 21/56                  | 6,401           |
| Benzo(a)anthracene                                                   | 27        | 0.944            | 0.145         | lognormal    | 5.3            | 1/27                   | 2,728           |
| Benzo(b)fluoranthene                                                 | 27        | 0.948            | 0.165         | lognormal    | 5.9            | 1/27                   | 2,768           |
| Chrysene                                                             | 27        | 0.954            | 0.198         | lognormal    | 7              | 1/27                   | 2,835           |
| Aluminum                                                             | 54        | 4.130            | 0.462         | lognormal    | 320            | 10/54                  | 77.76           |
| Antimony                                                             | 47        | 0.938            | 0.148         | lognormal    | 6.9            | 1/47                   | 2,681           |
| Arsenic                                                              | 50        | 1.210            | 1.107         | lognormal    | 54             | 35/50                  | 9,094           |
| Barium                                                               | 54        | 5.364            | 0.924         | lognormal    | 2,290          | 25/54                  | 433.8           |
| Iron                                                                 | 61        | 7.737            | 2.225         | lognormal    | 31,000         | 51/61                  | 80,905          |
| Sodium                                                               | 62        | 11.70            | 1.543         | lognormal    | 4,660,000      | 60/62                  | 699,582         |
| Vanadium                                                             | 47        | 2.396            | 0.373         | lognormal    | 56             | 3/47                   | 13.00           |
| <b>Non-River Industrial Perimeter and Site Interior</b>              |           |                  |               |              |                |                        |                 |
| <b>Groundwater (ug/L)</b>                                            |           |                  |               |              |                |                        |                 |
| Vinyl Chloride                                                       | 183       | -0.109           | 1.550         | lognormal    | 2,300          | 16/183                 | 4,054           |
| Bis(2-ethylhexyl)phthalate                                           | 169       | 1.050            | 0.978         | lognormal    | 450            | 44/169                 | 5,418           |
| Benzo(a)pyrene                                                       | 169       | 1.046            | 0.543         | lognormal    | 7.6            | 3/169                  | 3,562           |
| Benzo(b)fluoranthene                                                 | 169       | 1.052            | 0.547         | lognormal    | 12             | 5/169                  | 3,593           |
| Chrysene                                                             | 169       | 1.055            | 0.545         | lognormal    | 9.4            | 6/169                  | 3,599           |
| 2,3,7,8-TCDD TEQ                                                     | 11        | -10.07           | 4.235         | lognormal    | 0.217          | 3/11                   | 418,394         |
| <b>Drum Remediation Area</b>                                         |           |                  |               |              |                |                        |                 |
| <b>Soil (ug/kg)</b>                                                  |           |                  |               |              |                |                        |                 |
| Ethylbenzene                                                         | 10        | 2.757            | 3.584         | lognormal    | 170,000        | 2/10                   | 675,005,720     |
| Xylenes, Total                                                       | 10        | 3.088            | 4.144         | lognormal    | 1,300,000      | 2/10                   | 325,758,823,738 |
| Benzo(a)anthracene                                                   | 10        | 6.372            | 3.022         | lognormal    | 630,000        | 6/10                   | 164,672,989     |
| Benzo(a)pyrene                                                       | 10        | 6.427            | 2.933         | lognormal    | 600,000        | 6/10                   | 84,706,466      |
| Benzo(b)fluoranthene                                                 | 10        | 6.551            | 2.980         | lognormal    | 680,000        | 6/10                   | 139,874,920     |
| Dibenzo(a,h)anthracene                                               | 10        | 6.178            | 2.441         | lognormal    | 87,000         | 1/10                   | 1,842,354       |
| Indeno(1,2,3-cd)pyrene                                               | 10        | 6.360            | 2.640         | lognormal    | 330,000        | 5/10                   | 8,668,248       |
| Aroclor-1248                                                         | 10        | 5.857            | 2.044         | lognormal    | 21,000         | 2/10                   | 120,427         |
| Total Aroclors                                                       | 10        | 5.883            | 2.061         | lognormal    | 21,000         | 2/10                   | 135,374         |

**GM SMI PLANT  
RI/FS RISK ASSESSMENT  
SAGINAW, MICHIGAN**

**SUMMARY OF 95% UCL CALCULATIONS FOR GROUNDWATER AND SOIL CONSTITUENTS OF CONCERN**

| Areas<br>Matrix/Constituent                                       | # Samples | Transformed Mean | Std Deviation | Distribution | Max. Detection | Frequency of Detection | 95% UCL       |
|-------------------------------------------------------------------|-----------|------------------|---------------|--------------|----------------|------------------------|---------------|
| <b>Southern Property - South and West of Green Point Landfill</b> |           |                  |               |              |                |                        |               |
| <b>Soil (ug/kg)</b>                                               |           |                  |               |              |                |                        |               |
| Manganese                                                         | 28        | 12.795           | 1.001         | lognormal    | 7,840,000      | 28/28                  | 955,949       |
| <b>Previous Metal Feedstock Area</b>                              |           |                  |               |              |                |                        |               |
| <b>Soil Borings (ug/kg)</b>                                       |           |                  |               |              |                |                        |               |
| Manganese                                                         | 6         | 14.794           | 1.420         | lognormal    | 9,190,000      | 6/6                    | 300,722,035   |
| <b>Surface Soil (ug/kg)</b>                                       |           |                  |               |              |                |                        |               |
| Manganese                                                         | 8         | 12.845           | 0.627         | lognormal    | 1,200,000      | 8/8                    | 859,359       |
| <b>Railyard Storage Area</b>                                      |           |                  |               |              |                |                        |               |
| <b>Surface Soil (ug/kg)</b>                                       |           |                  |               |              |                |                        |               |
| Aroclor-1254                                                      | 16        | 6.127            | 1.574         | lognormal    | 55,000         | 1/16                   | 7,116         |
| Total Aroclors                                                    | 16        | 7.607            | 1.608         | lognormal    | 55,000         | 14/16                  | 34,927        |
| Manganese                                                         | 8         | 1,845,438        | 1,645,872     | normal       | 5,030,000      | 8/8                    | 2,948,145     |
| <b>Unpaved Area</b>                                               |           |                  |               |              |                |                        |               |
| <b>Surface Soil (ug/kg)</b>                                       |           |                  |               |              |                |                        |               |
| Aroclor-1260                                                      | 16        | 7.174            | 1.915         | lognormal    | 41,000         | 16/16                  | 69,522        |
| Total Aroclors                                                    | 16        | 7.174            | 1.915         | lognormal    | 41,000         | 16/16                  | 69,522        |
| <b>Center Street Oil Sheen</b>                                    |           |                  |               |              |                |                        |               |
| <b>Groundwater (ug/L)</b>                                         |           |                  |               |              |                |                        |               |
| Bis(2-ethylhexyl)phthalate                                        | 36        | 0.890            | 0.895         | lognormal    | 19             | 16/36                  | 5.132         |
| Benzo(a)anthracene                                                | 36        | 0.995            | 0.226         | lognormal    | 5.3            | 4/36                   | 2.966         |
| Benzo(b)fluoranthene                                              | 36        | 0.959            | 0.181         | lognormal    | 5.9            | 2/36                   | 2.798         |
| Chrysene                                                          | 36        | 1.003            | 0.253         | lognormal    | 7              | 4/36                   | 3.034         |
| <b>LNAPL Assessment and Remediation Area</b>                      |           |                  |               |              |                |                        |               |
| <b>Soil (ug/kg)</b>                                               |           |                  |               |              |                |                        |               |
| Lead                                                              | 6         | 12.239           | 2.147         | lognormal    | 1,270,000      | 6/6                    | 8,261,356,963 |

## ***Attachment 2***

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# **Kolmogorov-Smirnov Normality Test Results**

**Non-River Residential Perimeter Temporary and Permanent Wells**



**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:04:53

**Data source:** Non-River Residential Groundwater

1,2-DCE:      K-S Dist. = 0.518      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:09:07

**Data source:** Non-River Residential Groundwater

TCE: K-S Dist. = 0.521      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:08:09

**Data source:** Non-River Residential Groundwater

cis-1,2-DCE:     K-S Dist. = 0.518     P < 0.001     Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:09:46

**Data source:** Non-River Residential Groundwater

Vinyl Chloride: K-S Dist. = 0.521      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 07:24:20

Data source: Non-River Residential Groundwater

Bis: K-S Dist. = 0.476 P < 0.001 Failed

(Bis(2-ethylhexyl)phthalate

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 14:17:15

Data source: Non-River Residential Groundwater

Benzo(a)A: K-S Dist. = 0.539 P < 0.001 Failed

(Benzo(a)anthracene)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:32:38

**Data source:** Non-River Residential Groundwater

Benzo(b)fluoran: K-S Dist. = 0.539      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 07:32:56

**Data source:** Non-River Residential Groundwater

Chrysene:      K-S Dist. = 0.539      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.



**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:52:10

**Data source:** Non-River Residential Groundwater

Aluminum:      K-S Dist. = 0.430       $P < 0.001$       Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:53:15

**Data source:** Non-River Residential Groundwater

Antimony:      K-S Dist. = 0.537      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:44:10

**Data source:** Non-River Residential Groundwater

Arsenic:           K-S Dist. = 0.332           P < 0.001           Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:45:26

**Data source:** Non-River Residential Groundwater

Barium:            K-S Dist. = 0.275            P < 0.001            Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:46:39

**Data source:** Non-River Residential Groundwater

Iron: K-S Dist. = 0.195      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:48:18

**Data source:** Non-River Residential Groundwater

Sodium:            K-S Dist. = 0.372            P < 0.001            Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 08:49:36

**Data source:** Non-River Residential Groundwater

Vanadium:      K-S Dist. = 0.531      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## **Non-River Industrial Perimeter and Site Interior**



**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 09:01:46

**Data source:** Non-River Industrial Perimeter and Site Interior

Vinyl Chloride: K-S Dist. = 0.431      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 09:16:07

Data source: Non-River Industrial Perimeter and Site Interior

Bis: K-S Dist. = 0.435 P < 0.001 Failed

(Bis(2-ethylhexyl)phthalate)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 09:13:20

**Data source:** Non-River Industrial Perimeter and Site Interior

Benzo(a)pyrene: K-S Dist. = 0.454      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 09:14:42

**Data source:** Non-River Industrial Perimeter and Site Interior

Benzo(b)flouran: K-S Dist. = 0.454      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 09:17:33

**Data source:** Non-River Industrial Perimeter and Site Interior

Chrysene:      K-S Dist. = 0.453      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Thursday, August 23, 2001, 15:39:36

**Data source:** Non-River Industrial Perimeter and Site Interior

2,3,7,8-TCDD TE:      K-S Dist. = 0.436      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## **Drum Remediation Area**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 10:01:30

**Data source:** Drum Remediation Area

Ethylbenzene: K-S Dist. = 0.522 P < 0.001 Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.



**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 10:03:29

**Data source:** Drum Remediation Area

Xylenes, Total: K-S Dist. = 0.524      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 10:53:55

Data source: Drum Remediation Area

Benzo(a)A: K-S Dist. = 0.492 P < 0.001 Failed

(Benzo(a) anthracene)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 10:55:35

**Data source:** Drum Remediation Area

Benzo(a)pyrene: K-S Dist. = 0.494       $P < 0.001$       Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 10:56:43

Data source: Drum Remediation Area

Benzo(b)F: K-S Dist. = 0.493 P < 0.001 Failed

(Benzo(b)-fluoranthene)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 10:59:34

**Data source:** Drum Remediation Area

Dibenz(a,h)anth: K-S Dist. = 0.417

P < 0.001

Failed

*(Dibenzo(a,h)anthracene)*

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:02:11

**Data source:** Drum Remediation Area

Ind(1,2,3-cd)py: K-S Dist. = 0.496      P < 0.001      Failed

*(Indeno(1,2,3-cd)pyrene)*

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:08:57

**Data source:** Drum Remediation Area

Aroclor-1248: K-S Dist. = 0.418 P < 0.001 Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:10:21

**Data source:** Drum Remediation Area

Total Aroclors: K-S Dist. = 0.402      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.



**Southern Property – South and West of Green Point Landfill**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:27:58

**Data source:** Southern Property - South and West of Green Point Landfill

Manganese:      K-S Dist. = 0.407      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Previous Metal Feedstock Area (Soil Boring)**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:35:45

**Data source:** Previous Metal Feedstock Area (Soil Boring)

Manganese:      K-S Dist. = 0.000      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Previous Metal Feedstock Area (Surface Soil)**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:50:17

**Data source:** Previous Metal Feedstock Area (Surface Soil)

Manganese:      K-S Dist. = 0.320      P = 0.016      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## **Railyard Storage Area**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 11:59:49

**Data source:** Railyard Storage Area

Aroclor-1254: K-S Dist. = 0.498 P < 0.001 Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.



**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 12:01:20

**Data source:** Railyard Storage Area

Total Aroclors: K-S Dist. = 0.410      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 12:06:17

**Data source:** Railyard Storage Area

Manganese:      K-S Dist. = 0.206       $P > 0.200$       Passed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Unpaved Area**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 13:26:27

**Data source:** Unpaved Area (Surface Soil)

Aroclor-1260: K-S Dist. = 0.402 P < 0.001 Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 13:31:57

**Data source:** Unpaved Area (Surface Soil)

Total Aroclors: K-S Dist. = 0.402      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## **Center Street Oil Sheen**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 13:53:24

**Data source:** Center Street Oil Sheen

Bis: K-S Dist. = 0.372      P < 0.001      Failed

(Bis(2-ethylhexyl)phthalate)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 13:50:23

Data source: Center Street Oil Sheen

Benzo(a)A: K-S Dist. = 0.525 P < 0.001 Failed

(Benzo(a) anthracene)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.



Normality Test (Kolmogorov-Smirnov)

Wednesday, August 22, 2001, 13:51:55

Data source: Center Street Oil Sheen

Benzo(b)F: K-S Dist. = 0.538 P < 0.001 Failed

(Benzo(b)fluoranthene)

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 13:55:23

**Data source:** Center Street Oil Sheen

Chrysene:      K-S Dist. = 0.519      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## **LNAPL Assessment and Remediation Area**

**Normality Test (Kolmogorov-Smirnov)**

Wednesday, August 22, 2001, 14:01:29

**Data source:** LNAPL Assessment and Remediation Area

Lead: K-S Dist. = 0.000      P < 0.001      Failed

A test that fails indicates that the data varies significantly from the pattern expected if the data was drawn from a population with a normal distribution.

A test that passes indicates that the data matches the pattern expected if the data was drawn from a population with a normal distribution.

## ***Attachment 3***

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### **95% UCL Calculations**

**Non-River Residential Perimeter Temporary and Permanent Wells**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | 1,2-DCE                               |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|                   |         |
|-------------------|---------|
| Maximum detected: | 220.000 |
|-------------------|---------|

|    |        |
|----|--------|
| n: | 46     |
| x: | -0.530 |
| s: | 0.917  |
| H: | 2.250  |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | cis-1,2-DCE                           |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 1.216

|                   |         |
|-------------------|---------|
| Maximum detected: | 220.000 |
|-------------------|---------|

|    |        |
|----|--------|
| n: | 46     |
| x: | -0.545 |
| s: | 0.926  |
| H: | 2.259  |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).



Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | TCE                                   |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 0.763 |
|--------------|-------|

|                   |        |
|-------------------|--------|
| Maximum detected: | 17.000 |
|-------------------|--------|

|    |        |
|----|--------|
| n: | 46     |
| x: | -0.585 |
| s: | 0.557  |
| H: | 1.931  |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | Vinyl chloride                        |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 1.278 |
|--------------|-------|

|                   |         |
|-------------------|---------|
| Maximum detected: | 270.000 |
|-------------------|---------|

|    |        |
|----|--------|
| n: | 46     |
| x: | -0.525 |
| s: | 0.947  |
| H: | 2.280  |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration (mg/kg) | Natural log (LN) of concentration |
|-----------------------|-----------------------------------|
| 23                    | 3.14                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 0.98                  | -0.02                             |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 0.6                   | -0.51                             |
| 6                     | 1.79                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 0.8                   | -0.22                             |
| 2.5                   | 0.92                              |
| 0.8                   | -0.22                             |
| 2.5                   | 0.92                              |
| 1.2                   | 0.18                              |
| 2.5                   | 0.92                              |
| 0.8                   | -0.22                             |
| 2.5                   | 0.92                              |
| 0.7                   | -0.36                             |
| 5                     | 1.61                              |
| 2.5                   | 0.92                              |
| 0.43                  | -0.84                             |
| 0.9                   | -0.11                             |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 3                     | 1.10                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 3                     | 1.10                              |
| 5                     | 1.61                              |
| 7.2                   | 1.97                              |
| 0.83                  | -0.19                             |
| 2.5                   | 0.92                              |
| 2.5                   | 0.92                              |
| 7                     | 1.95                              |
| 2.5                   | 0.92                              |
| 0.81                  | -0.21                             |
| 2.5                   | 0.92                              |
| 4.4                   | 1.48                              |
| 2.5                   | 0.92                              |
| 1.3                   | 0.26                              |
| 2.5                   | 0.92                              |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Bis-(2-ethylhexyl)phthalate           |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 6.401

Maximum detected: 500.000

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 56    |
| x: | 0.995 |
| s: | 1.035 |
| H: | 2.334 |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 23                       | 3.14                                    |
| 3.85                     | 1.35                                    |
| 6.8                      | 1.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 500                      | 6.21                                    |
| 6.7                      | 1.90                                    |
| 14                       | 2.64                                    |
| 2.5                      | 0.92                                    |
| 6.25                     | 1.83                                    |
| 2.5                      | 0.92                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Bis-(2-ethylhexyl)phthalate           |

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| <b>Concentration<br/>(mg/kg)</b> | <b>Natural log<br/>(LN) of<br/>concentration</b> |
|----------------------------------|--------------------------------------------------|
| 2.5                              | 0.92                                             |
| 5.3                              | 1.67                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
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| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
|                                  |                                                  |
|                                  |                                                  |
|                                  |                                                  |
|                                  |                                                  |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Benzo(a)anthracene                    |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 2.728 |
|--------------|-------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 5.300 |
|-------------------|-------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 27    |
| x: | 0.944 |
| s: | 0.145 |
| H: | 1.729 |

n = number of samples

$\bar{x}$  = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 2.5                      | 0.92                                    |
| 5.9                      | 1.77                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
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| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
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|                          |                                         |
|                          |                                         |

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | Benzo(b)fluoranthene                  |

$$95\% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 2.768 |
|--------------|-------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 5.900 |
|-------------------|-------|

|    |       |
|----|-------|
| n: | 27    |
| x: | 0.948 |
| s: | 0.165 |
| H: | 1.738 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 2.5                      | 0.92                                    |
| 7                        | 1.95                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
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| 2.5                      | 0.92                                    |
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| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
|                          |                                         |
|                          |                                         |
|                          |                                         |
|                          |                                         |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Chrysene                              |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 2.835 |
|--------------|-------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 7.000 |
|-------------------|-------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 27    |
| x: | 0.954 |
| s: | 0.198 |
| H: | 1.753 |

n = number of samples

$\bar{x}$  = mean of the log transformed data

s = standard deviation of the transformed data

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | Aluminum                              |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 77.757

|                   |         |
|-------------------|---------|
| Maximum detected: | 320.000 |
|-------------------|---------|

|           |       |
|-----------|-------|
| <b>n:</b> | 54    |
| <b>x:</b> | 4.130 |
| <b>s:</b> | 0.462 |
| <b>H:</b> | 1.849 |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).



***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below:

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 56.5                     | 4.03                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 51                       | 3.93                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Aluminum                              |

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | Antimony                              |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 2.681

|                   |       |
|-------------------|-------|
| Maximum detected: | 6.900 |
|-------------------|-------|

|    |       |
|----|-------|
| n: | 47    |
| x: | 0.938 |
| s: | 0.148 |
| H: | 1.704 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

**Enter the data points in the green shaded cells below.**

**The yellow shaded areas are calculated values please do not overwrite.**

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 6.9                      | 1.93                                    |
| 2.5                      | 0.92                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Antimony                              |

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 2.5                      | 0.92                                    |
| 0.5                      | -0.69                                   |
| 2.5                      | 0.92                                    |
| 5.3                      | 1.67                                    |
| 5.3                      | 1.67                                    |
| 1                        | 0.00                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.9                      | 1.06                                    |
| 2.8                      | 1.03                                    |
| 5.1                      | 1.63                                    |
| 12                       | 2.48                                    |
| 5.4                      | 1.69                                    |
| 2.3                      | 0.83                                    |
| 1.2                      | 0.18                                    |
| 1                        | 0.00                                    |
| 31                       | 3.43                                    |
| 1.2                      | 0.18                                    |
| 2.5                      | 0.92                                    |
| 1.3                      | 0.26                                    |
| 2.5                      | 0.92                                    |
| 54                       | 3.99                                    |
| 50                       | 3.91                                    |
| 16                       | 2.77                                    |
| 19                       | 2.94                                    |
| 2                        | 0.69                                    |
| 1.7                      | 0.53                                    |
| 6.5                      | 1.87                                    |
| 5.8                      | 1.76                                    |
| 5.6                      | 1.72                                    |
| 0.5                      | -0.69                                   |
| 2.5                      | 0.92                                    |
| 3.6                      | 1.28                                    |
| 2.5                      | 0.92                                    |
| 0.5                      | -0.69                                   |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 0.5                      | -0.69                                   |
| 2.5                      | 0.92                                    |
| 7                        | 1.95                                    |
| 2.5                      | 0.92                                    |
| 3.4                      | 1.22                                    |
| 6.9                      | 1.93                                    |
| 4.2                      | 1.44                                    |
| 16                       | 2.77                                    |
| 20                       | 3.00                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Arsenic                               |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 9.094

Maximum detected: 54.000

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 50    |
| x: | 1.210 |
| s: | 1.107 |
| H: | 2.431 |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 2.5                      | 0.92                                    |
| 1.7                      | 0.53                                    |
| 2.5                      | 0.92                                    |
| 1                        | 0.00                                    |
| 2.5                      | 0.92                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Arsenic                               |

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration (mg/kg) | Natural log (LN) of concentration |
|-----------------------|-----------------------------------|
| 248                   | 5.51                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 409                   | 6.01                              |
| 449                   | 6.11                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 1030                  | 6.94                              |
| 914                   | 6.82                              |
| 365                   | 5.90                              |
| 326                   | 5.79                              |
| 657                   | 6.49                              |
| 657                   | 6.49                              |
| 2290                  | 7.74                              |
| 1440                  | 7.27                              |
| 245                   | 5.50                              |
| 326                   | 5.79                              |
| 688                   | 6.53                              |
| 663                   | 6.50                              |
| 100                   | 4.61                              |
| 361                   | 5.89                              |
| 650                   | 6.48                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 267                   | 5.59                              |
| 470                   | 6.15                              |
| 360                   | 5.89                              |
| 215                   | 5.37                              |
| 100                   | 4.61                              |
| 202                   | 5.31                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 100                   | 4.61                              |
| 999                   | 6.91                              |
| 865                   | 6.76                              |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Barium                                |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 433.774

Maximum detected: 2290.000

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 54    |
| x: | 5.364 |
| s: | 0.924 |
| H: | 2.224 |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

**Reference for the 95% UCL-AM equation and methodology:**

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 248                      | 5.51                                    |
| 587                      | 6.38                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |
| 100                      | 4.61                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Barium                                |

***The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.***

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration (mg/kg) | Natural log (LN) of concentration |
|-----------------------|-----------------------------------|
| 1220                  | 7.11                              |
| 237                   | 5.47                              |
| 50                    | 3.91                              |
| 25900                 | 10.16                             |
| 27700                 | 10.23                             |
| 843                   | 6.74                              |
| 2960                  | 7.99                              |
| 1160                  | 7.06                              |
| 6770                  | 8.82                              |
| 18600                 | 9.83                              |
| 16700                 | 9.72                              |
| 21300                 | 9.97                              |
| 22850                 | 10.04                             |
| 27600                 | 10.23                             |
| 20700                 | 9.94                              |
| 21800                 | 9.99                              |
| 31000                 | 10.34                             |
| 20400                 | 9.92                              |
| 21600                 | 9.98                              |
| 2400                  | 7.78                              |
| 8640                  | 9.06                              |
| 16400                 | 9.71                              |
| 5740                  | 8.66                              |
| 7850                  | 8.97                              |
| 1500                  | 7.31                              |
| 1520                  | 7.33                              |
| 394.5                 | 5.98                              |
| 22700                 | 10.03                             |
| 20200                 | 9.91                              |
| 10500                 | 9.26                              |
| 9460                  | 9.15                              |
| 4090                  | 8.32                              |
| 4200                  | 8.34                              |
| 16600                 | 9.72                              |
| 14600                 | 9.59                              |
| 14300                 | 9.57                              |
| 10800                 | 9.29                              |
| 9830                  | 9.19                              |
| 9880                  | 9.20                              |
| 7340                  | 8.90                              |
| 50                    | 3.91                              |
| 100                   | 4.61                              |
| 1770                  | 7.48                              |
| 1340                  | 7.20                              |
| 50                    | 3.91                              |
| 100                   | 4.61                              |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Iron                                  |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 80,904.665

Maximum detected: 31000.000

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 61    |
| x: | 7.737 |
| s: | 2.225 |
| H: | 3.792 |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

**Reference for the 95% UCL-AM equation and methodology:**

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).



**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 1220                     | 7.11                                    |
| 206                      | 5.33                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 165                      | 5.11                                    |
| 50                       | 3.91                                    |
| 642                      | 6.46                                    |
| 468                      | 6.15                                    |
| 2140                     | 7.67                                    |
| 11800                    | 9.38                                    |
| 13400                    | 9.50                                    |
| 8390                     | 9.03                                    |
| 114                      | 4.74                                    |
| 50                       | 3.91                                    |
| 50                       | 3.91                                    |
| 100                      | 4.61                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Iron                                  |

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 220000                   | 12.30                                   |
| 82400                    | 11.32                                   |
| 87100                    | 11.37                                   |
| 54700                    | 10.91                                   |
| 44300                    | 10.70                                   |
| 106000                   | 11.57                                   |
| 122000                   | 11.71                                   |
| 419000                   | 12.95                                   |
| 386000                   | 12.86                                   |
| 561000                   | 13.24                                   |
| 504000                   | 13.13                                   |
| 4140000                  | 15.24                                   |
| 4315000                  | 15.28                                   |
| 1630000                  | 14.30                                   |
| 2000000                  | 14.51                                   |
| 301000                   | 12.61                                   |
| 355000                   | 12.78                                   |
| 4170000                  | 15.24                                   |
| 3910000                  | 15.18                                   |
| 41800                    | 10.64                                   |
| 381000                   | 12.85                                   |
| 1430000                  | 14.17                                   |
| 44100                    | 10.69                                   |
| 54300                    | 10.90                                   |
| 39900                    | 10.59                                   |
| 39200                    | 10.58                                   |
| 121000                   | 11.70                                   |
| 162000                   | 12.00                                   |
| 45300                    | 10.72                                   |
| 34900                    | 10.46                                   |
| 98100                    | 11.49                                   |
| 89000                    | 11.40                                   |
| 152000                   | 11.93                                   |
| 171000                   | 12.05                                   |
| 38900                    | 10.57                                   |
| 115000                   | 11.65                                   |
| 91100                    | 11.42                                   |
| 117000                   | 11.67                                   |
| 100000                   | 11.51                                   |
| 25200                    | 10.13                                   |
| 36000                    | 10.49                                   |
| 2500                     | 7.82                                    |
| 2500                     | 7.82                                    |
| 27400                    | 10.22                                   |
| 30200                    | 10.32                                   |
| 24900                    | 10.12                                   |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Sodium                                |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 699,581.840

Maximum detected: ##### 4,315,000.000

**Determination and definition of variables used in the above calculations.**

|    |        |
|----|--------|
| n: | 62     |
| x: | 11.695 |
| s: | 1.543  |
| H: | 2.898  |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

**Enter the data points in the green shaded cells below.**

**The yellow shaded areas are calculated values please do not overwrite.**

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 220000                   | 12.30                                   |
| 16800                    | 9.73                                    |
| 55400                    | 10.92                                   |
| 64300                    | 11.07                                   |
| 63900                    | 11.07                                   |
| 80200                    | 11.29                                   |
| 68100                    | 11.13                                   |
| 272000                   | 12.51                                   |
| 317000                   | 12.67                                   |
| 306000                   | 12.63                                   |
| 81900                    | 11.31                                   |
| 100000                   | 11.51                                   |
| 131000                   | 11.78                                   |
| 22900                    | 10.04                                   |
| 120000                   | 11.70                                   |
| 81100                    | 11.30                                   |
| 76750                    | 11.25                                   |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Sodium                                |

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | Non-River Residential Perimeter Wells |
| <b>Constituent:</b> | Vanadium                              |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|                   |        |
|-------------------|--------|
| Maximum detected: | 56.000 |
|-------------------|--------|

|    |       |
|----|-------|
| n: | 47    |
| x: | 2.396 |
| s: | 0.373 |
| H: | 1.807 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 10                       | 2.30                                    |
| 10                       | 2.30                                    |

|              |                                       |
|--------------|---------------------------------------|
| Site info:   | Non-River Residential Perimeter Wells |
| Constituent: | Vanadium                              |

## **Non-River Industrial Perimeter and Site Interior**

|         |                               |           |      |             |
|---------|-------------------------------|-----------|------|-------------|
| SUBJECT | PROJ. NO.                     | BY        | DATE | SHEET       |
|         | GM SMI RI/FS- RISK ASSESSMENT | 276.08.63 | JCV  | 8/23/01 1/2 |

CALCS. BY \_\_\_\_\_; DATE \_\_\_\_\_ CHECKED BY \_\_\_\_\_; DATE \_\_\_\_\_

Non-River Industrial Perimeter and Site Interior

Groundwater

Constituent: Vinyl Chloride

# of samples : 183

$\bar{x}$  : -0.109

S.D. : 1.550

H-statistic : 2.675

H-Statistic Interpolation

@ 160 = 2.691

@ 200 = 2.662

@ 182 = 2.675

$$UCL = e^{(\bar{x} + 0.5s^2 + 5H/(n-1))}$$

$$= e^{(-0.109 + 0.5(1.55)^2 + \frac{1.55(2.675)}{\sqrt{182}})}$$

95% UCL = 4.054

Constituent: Benzo(a) pyrene

# of samples : 169

$\bar{x}$  : 1.046

S.D. : 0.543

H-statistic : 1.833

H-Statistic Interpolation

@ 160 = 1.834

@ 200 = 1.833

@ 168 = 1.833

95% UCL = 3.562

|                         |                        |           |                 |              |
|-------------------------|------------------------|-----------|-----------------|--------------|
| SUBJECT<br><u>cont.</u> | PROJ. NO.<br>276.08.63 | BY<br>JCV | DATE<br>8/23/01 | SHEET<br>2/2 |
|-------------------------|------------------------|-----------|-----------------|--------------|

CALCS. BY \_\_\_\_\_; DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_; DATE \_\_\_\_\_

Constituent: Benzo(b)fluoranthene

# of samples: 169

$\bar{X}$  : 1.052

S.D. : 0.547

H-Statistic: 1.834

H-Statistic Interpolation

@ 160 = 1.836

@ 200 = 1.828

@ 168 = 1.834

95% UCL = 3.593

Constituent: Bis (2-ethylhexyl)phthalate

# of samples: 169

$\bar{X}$  : 1.050

S.D. : 0.978

H-Statistic: 2.139

H-Statistic Interpolation

@ 160 = 2.142

@ 200 = 2.125

@ 168 = 2.139

95% UCL = 5.418

Constituent: Chrysene

# of samples: 169

$\bar{X}$  : 1.055

S.D. : 0.545

H-Statistic: 1.833

H-Statistic Interpolation

@ 160 = 1.835

@ 200 = 1.827

@ 168 = 1.833

95% UCL = 3.599

Constituent: ~~2,3,7,8-TCDD TCDF~~

~~# of samples: 11~~

~~$\bar{X}$  :~~



Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                                                  |
|--------------|--------------------------------------------------|
| Site info:   | Non-River Industrial Perimeter and Site Interior |
| Constituent: | 2,3,7,8-TCDD TEQ                                 |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |             |
|--------------|-------|-------------|
| 95% UCL-AM = | ##### | 418,394.038 |
|--------------|-------|-------------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 0.217 |
|-------------------|-------|

|    |         |
|----|---------|
| n: | 11      |
| x: | -10.070 |
| s: | 4.235   |
| H: | 10.490  |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

## **Drum Remediation Area**

**Do not** use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                       |
|---------------------|-----------------------|
| <b>Site info:</b>   | Drum Remediation Area |
| <b>Constituent:</b> | Ethylbenzene          |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 675,005,720.182

Maximum detected: ##### 170,000.000

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 10    |
| x: | 2.757 |
| s: | 3.584 |
| H: | 9.331 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Do not** use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                       |
|---------------------|-----------------------|
| <b>Site info:</b>   | Drum Remediation Area |
| <b>Constituent:</b> | Xylenes, Total        |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 325,758,823,737.878

Maximum detected: ##### 1300,000.000

**Determination and definition of variables used in the above calculations.**

|    |        |
|----|--------|
| n: | 10     |
| x: | 3.088  |
| s: | 4.144  |
| H: | 10.742 |

n = number of samples

$\bar{x}$  = mean of the log transformed data

**s** = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                    |
|--------------|--------------------|
| Site info:   | DRA                |
| Constituent: | Benzo(a)anthracene |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |                 |
|--------------|-------|-----------------|
| 95% UCL-AM = | ##### | 164,672,988.675 |
|--------------|-------|-----------------|

|                   |       |             |
|-------------------|-------|-------------|
| Maximum detected: | ##### | 630,000.000 |
|-------------------|-------|-------------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 10    |
| x: | 6.372 |
| s: | 3.022 |
| H: | 7.920 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                |
|--------------|----------------|
| Site info:   | DRA            |
| Constituent: | Benzo(a)pyrene |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 84,706,465.883

Maximum detected: ##### 600,000.000

**Determination and definition of variables used in the above calculations.**

|           |       |
|-----------|-------|
| <b>n:</b> | 10    |
| <b>x:</b> | 6.427 |
| <b>s:</b> | 2.933 |
| <b>H:</b> | 7.698 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                      |
|---------------------|----------------------|
| <b>Site info:</b>   | DRA                  |
| <b>Constituent:</b> | Benzo(b)fluoranthene |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 139,874,919.895

|                   |       |             |
|-------------------|-------|-------------|
| Maximum detected: | ##### | 680,000.000 |
|-------------------|-------|-------------|

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 10    |
| x: | 6.551 |
| s: | 2.980 |
| H: | 7.815 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

|                                                                                                           |  |
|-----------------------------------------------------------------------------------------------------------|--|
| <b><u>Do not</u> use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.</b> |  |
|-----------------------------------------------------------------------------------------------------------|--|

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                       |
|--------------|-----------------------|
| Site info:   | DRA                   |
| Constituent: | Dibenz(a,h)anthracene |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 1,842,354.370

|                   |           |
|-------------------|-----------|
| Maximum detected: | 87000.000 |
|-------------------|-----------|

**Determination and definition of variables used in the above calculations.**

|           |       |
|-----------|-------|
| <b>n:</b> | 10    |
| <b>x:</b> | 6.178 |
| <b>s:</b> | 2.441 |
| <b>H:</b> | 6.476 |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).



Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                        |
|--------------|------------------------|
| Site info:   | DRA                    |
| Constituent: | Indeno(1,2,3-cd)pyrene |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 8,668,247.690

Maximum detected: ##### 330,000.00

**Determination and definition of variables used in the above calculations.**

|           |       |
|-----------|-------|
| <b>n:</b> | 10    |
| <b>x:</b> | 6.360 |
| <b>s:</b> | 2.640 |
| <b>H:</b> | 6.968 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |              |
|--------------|--------------|
| Site info:   | DRA          |
| Constituent: | Aroclor-1248 |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |             |
|--------------|-------|-------------|
| 95% UCL-AM = | ##### | 120,427.476 |
|--------------|-------|-------------|

|                   |           |
|-------------------|-----------|
| Maximum detected: | 21000.000 |
|-------------------|-----------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 10    |
| x: | 5.857 |
| s: | 2.044 |
| H: | 5.505 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                |
|--------------|----------------|
| Site info:   | DRA            |
| Constituent: | Total Aroclors |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 135,374.253

|                   |           |
|-------------------|-----------|
| Maximum detected: | 21000.000 |
|-------------------|-----------|

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 10    |
| x: | 5.883 |
| s: | 2.061 |
| H: | 5.545 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Southern Property – South and West of Green Point Landfill**

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

| Concentration (mg/kg) | Natural log (LN) of concentration |
|-----------------------|-----------------------------------|
| 1930000               | 14.47                             |
| 151000                | 11.93                             |
| 125000                | 11.74                             |
| 208000                | 12.25                             |
| 7840000               | 15.87                             |
| 61100                 | 11.02                             |
| 392000                | 12.88                             |
| 404000                | 12.91                             |
| 281000                | 12.55                             |
| 217000                | 12.29                             |
| 3550000               | 15.08                             |
| 220000                | 12.30                             |
| 678000                | 13.43                             |
| 341000                | 12.74                             |
| 396000                | 12.89                             |
| 1190000               | 13.99                             |
| 272000                | 12.51                             |
| 316000                | 12.66                             |
| 247000                | 12.42                             |
| 220000                | 12.30                             |
| 226000                | 12.33                             |
| 280000                | 12.54                             |
| 198000                | 12.20                             |
| 250000                | 12.43                             |
| 207000                | 12.24                             |
| 410000                | 12.92                             |
| 248000                | 12.42                             |
| 424000                | 12.96                             |
|                       |                                   |
|                       |                                   |
|                       |                                   |

|              |                                                 |
|--------------|-------------------------------------------------|
| Site info:   | Southern Property - S&W of Green Point Landfill |
| Constituent: | Manganese                                       |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 955,948.874

Maximum detected: ##### 7,840,000.000

**Determination and definition of variables used in the above calculations.**

|    |        |
|----|--------|
| n: | 28     |
| x: | 12.795 |
| s: | 1.001  |
| H: | 2.466  |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Previous Metal Feedstock Area (Soil Boring)**

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                                             |
|---------------------|---------------------------------------------|
| <b>Site info:</b>   | Previous Metal Feedstock Area (Soil Boring) |
| <b>Constituent:</b> | Manganese                                   |

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 300,722,035.053

|                   |       |              |
|-------------------|-------|--------------|
| Maximum detected: | ##### | 9190,000.000 |
|-------------------|-------|--------------|

**Determination and definition of variables used in the above calculations.**

|    |        |
|----|--------|
| n: | 6      |
| x: | 14.794 |
| s: | 1.420  |
| H: | 5.853  |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Previous Metal Feedstock Area (Surface Soil)**



Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                                              |
|---------------------|----------------------------------------------|
| <b>Site info:</b>   | Previous Metal Feedstock Area (Surface Soil) |
| <b>Constituent:</b> | Manganese                                    |

$$95\% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 859,358.599

Maximum detected: ##### 1200,000.000

**Determination and definition of variables used in the above calculations.**

|    |        |
|----|--------|
| n: | 8      |
| x: | 12.845 |
| s: | 0.627  |
| H: | 2.627  |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

## **Railyard Storage Area**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|              |                       |
|--------------|-----------------------|
| Site info:   | Railyard Storage Area |
| Constituent: | Aroclor-1254          |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |           |
|--------------|-----------|
| 95% UCL-AM = | 7,115.689 |
|--------------|-----------|

|                   |           |
|-------------------|-----------|
| Maximum detected: | 55000.000 |
|-------------------|-----------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 16    |
| x: | 6.127 |
| s: | 1.574 |
| H: | 3.698 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Do not** use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                       |
|---------------------|-----------------------|
| <b>Site info:</b>   | Railyard Storage Area |
| <b>Constituent:</b> | Total Aroclors        |

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 34,927.058

|                   |           |
|-------------------|-----------|
| Maximum detected: | 55000.000 |
|-------------------|-----------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 16    |
| x: | 7.607 |
| s: | 1.608 |
| H: | 3.760 |

$H$  = Land's  $H$ -statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

|                                |           |     |         |       |
|--------------------------------|-----------|-----|---------|-------|
| SUBJECT                        | PROJ. NO. | BY  | DATE    | SHEET |
| GM SMI RI/FS - RISK ASSESSMENT | 276.08.63 | JCV | 8/23/01 | 1/1   |

CALCS. BY \_\_\_\_\_; DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_; DATE \_\_\_\_\_

Railyard Storage Area

Surface Soil

Constituent: Manganese (normal distribution)

# of samples: 8

$\bar{X}$  : 1,845,437.5

SD : 1645872

t-statistic : 1.895

$$95\% UCL = \bar{X} + t (s/\sqrt{n})$$

$$95\% UCL = 1,845,437.5 + 1.895 (1645872/\sqrt{8})$$

$$95\% UCL = 2,948,145$$

**Unpaved Area**

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

Unpaved Area

Aroclor-1260

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |            |
|--------------|-------|------------|
| 95% UCL-AM = | ##### | 69,521.639 |
|--------------|-------|------------|

|                   |           |
|-------------------|-----------|
| Maximum detected: | 41000.000 |
|-------------------|-----------|

***Determination and definition of variables used in the above calculations.***

|    |       |
|----|-------|
| n: | 16    |
| x: | 7.174 |
| s: | 1.915 |
| H: | 4.332 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                |
|---------------------|----------------|
| <b>Site info:</b>   | Unpaved Area   |
| <b>Constituent:</b> | Total Aroclors |

$$95\% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 69,521.639

|                   |           |
|-------------------|-----------|
| Maximum detected: | 41000.000 |
|-------------------|-----------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 16    |
| x: | 7.174 |
| s: | 1.915 |
| H: | 4.332 |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).



## **Center Street Oil Sheen**

**The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.**

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

**Enter the data points in the green shaded cells below.**

**The yellow shaded areas are calculated values please do not overwrite.**

| Concentration<br>(mg/kg) | Natural log<br>(LN) of<br>concentration |
|--------------------------|-----------------------------------------|
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 0.6                      | -0.51                                   |
| 6.0                      | 1.79                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 0.8                      | -0.22                                   |
| 2.5                      | 0.92                                    |
| 0.8                      | -0.22                                   |
| 2.5                      | 0.92                                    |
| 1.2                      | 0.18                                    |
| 2.5                      | 0.92                                    |
| 2                        | 0.69                                    |
| 5                        | 1.61                                    |
| 0.475                    | -0.74                                   |
| 0.7                      | -0.36                                   |
| 2.7                      | 0.99                                    |
| 19                       | 2.94                                    |
| 12                       | 2.48                                    |
| 2.5                      | 0.92                                    |
| 1.2                      | 0.18                                    |
| 2.5                      | 0.92                                    |
| 0.7                      | -0.36                                   |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 0.81                     | -0.21                                   |
| 2.5                      | 0.92                                    |
| 4.4                      | 1.48                                    |
| 2.5                      | 0.92                                    |
| 5                        | 1.61                                    |
| 2.5                      | 0.92                                    |
| 2.5                      | 0.92                                    |
| 18                       | 2.89                                    |
| 12                       | 2.48                                    |
| 1.9                      | 0.64                                    |

|              |                            |
|--------------|----------------------------|
| Site info:   | Center Street Oil Sheen    |
| Constituent: | bis(2-Ethylhexyl)phthalate |

$$95\% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 5.132

Maximum detected: 19.000

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 36    |
| x: | 0.890 |
| s: | 0.895 |
| H: | 2.279 |

n = number of samples

x = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

**Reference for the 95% UCL-AM equation and methodology:**

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

Center Street Oil Sheen

Benzo(a)anthracene

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = 2.966

|                   |       |
|-------------------|-------|
| Maximum detected: | 5.300 |
|-------------------|-------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 36    |
| x: | 0.995 |
| s: | 0.226 |
| H: | 1.749 |

H = Land's H-statistic, based upon n and s

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Do not** use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]**Site info:**

## Center Street Oil Sheen

**Constituent:**

Benzo(b)fluoranthene

$$95 \% UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 2.798 |
|--------------|-------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 5.900 |
|-------------------|-------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 36    |
| x: | 0.959 |
| s: | 0.181 |
| H: | 1.729 |

H = Land's H-statistic, based upon  $n$  and  $s$

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

**Do not** use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.

The yellow shaded areas are calculated values please do not overwrite.

| <b>Concentration<br/>(mg/kg)</b> | <b>Natural log<br/>(LN) of<br/>concentration</b> |
|----------------------------------|--------------------------------------------------|
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 5                                | 1.61                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 5                                | 1.61                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 5                                | 1.61                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 7                                | 1.95                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |
| 2.5                              | 0.92                                             |

## Center Street Oil Sheen

Chrysene

$$95 \% \text{ } UCL = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

|              |       |
|--------------|-------|
| 95% UCL-AM = | 3.034 |
|--------------|-------|

|                   |       |
|-------------------|-------|
| Maximum detected: | 7.000 |
|-------------------|-------|

**Determination and definition of variables used in the above calculations.**

|    |       |
|----|-------|
| n: | 36    |
| x: | 1.003 |
| s: | 0.253 |
| H: | 1.762 |

n = number of samples

$\bar{x}$  = mean of the log transformed data

s = standard deviation of the transformed data

H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:

USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

## **LNAPL Assessment and Remediation Area**

The purpose of this spreadsheet is to calculate the Lognormal 95% UCL-AM for a data set.

**Do not use zero (0.00) for non-detects, rather use 1/2 of the SQL as a proxy concentration.**

Enter the data points in the green shaded cells below.

The yellow shaded areas are calculated values please do not overwrite.

[illegible]

|                     |                                       |
|---------------------|---------------------------------------|
| <b>Site info:</b>   | LNAPL Assessment and Remediation Area |
| <b>Constituent:</b> | Lead                                  |

$$95 \% \text{ UCL} = e^{\left[ X + (.5)(S^2) + \frac{(S)(H)}{\sqrt{n-1}} \right]}$$

95% UCL-AM = ##### 8,261,356,962.898

Maximum detected: ##### 1,780,000.000

**Determination and definition of variables used in the above calculations.**

|           |        |
|-----------|--------|
| <b>n:</b> | 6      |
| <b>x:</b> | 12.239 |
| <b>s:</b> | 2.147  |
| <b>H:</b> | 8.636  |

n = number of samples  
x = mean of the log transformed data  
s = standard deviation of the transformed data  
H = Land's H-statistic, based upon n and s

Reference for the 95% UCL-AM equation and methodology:  
USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term, 1992 (Publication 9285.7-081).

## ***Appendix B***

---

# **Ecological Risk Assessment**



***GM Saginaw Malleable Iron Plant  
Ecological Risk Assessment Report***

*Prepared for*

*General Motors Corporation*

*and*

*REALM, Inc.*

*and*

*Waste Management, Inc.*

*Prepared by*

**Exponent**

**15373 SE 30<sup>th</sup> Place, Suite 250**

**Bellevue, WA 98007**

**FINAL**

**January 2003**

**Exponent®**

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## Acronyms and Abbreviations

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|          |                                              |
|----------|----------------------------------------------|
| BAF      | bioaccumulation factor                       |
| CoPC     | chemical of potential concern                |
| EA       | ecological assessment                        |
| HQ       | hazard quotient                              |
| MDEQ     | Michigan Department of Environmental Quality |
| NOAEL    | no-observed-adverse-effect level             |
| PAH      | polycyclic aromatic hydrocarbon              |
| PCB      | polychlorinated biphenyl                     |
| RI       | remedial investigation                       |
| TRV      | toxicity reference value                     |
| U.S. EPA | U.S. Environmental Protection Agency         |
| WRS      | water recirculation system                   |

# Ecological Assessment

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## Introduction

This ecological assessment (EA) is an evaluation of ecological exposure pathways of potential concern identified in the preliminary EA, as presented in the Saginaw Malleable Iron Plant final remedial investigation (RI) report (BBL 2001). The EA is based on data collected during habitat evaluations conducted in 1997 and 2000, and on analytical chemistry data collected during the RI, including the supplemental ecological sampling in 2000. The ecological sampling focused on the site areas most likely to be used as habitat by wildlife, and was developed by General Motors and approved by the Michigan Department of Environmental Quality (MDEQ) specifically to assess ecological risk.

The EA consists of the following:

- A summary of the ecological exposure pathways and chemicals of potential concern (CoPCs) identified in the preliminary EA
- A problem formulation, which describes the potential risks from complete exposure pathways and defines assessment endpoints to evaluate these risks
- A risk assessment study design, including definition of measurement endpoints
- A quantitative assessment of risk from complete exposure pathways
- A discussion of ecological significance and uncertainties associated with the assessment
- An ecological risk characterization and recommendations.

## Summary of Preliminary Ecological Assessment

The preliminary EA included a habitat characterization of the site and risk-based screening of detected compounds in surface water, sediment, and soil. The preliminary EA was not intended to identify or quantify ecological risk, only to identify those pathways and CoPCs which warranted further consideration.

## Preliminary Ecological Habitat Assessment

The primary areas of the site which function as habitat for ecological receptors are located south of the active industrial areas, especially the undeveloped areas south and west of the closed Green Point Landfill. These areas were sampled in 2000 to assess ecological risk, as shown in

Figure B-1. The habitats and cover types present are described in detail in the preliminary EA habitat characterization presented in the RI report.

Surface soil, sediment, and water were sampled in four areas during the ecological sampling (see Figure B-1). Two of these, Area 1 and Area 2, have diverse plant cover and contain significant amounts of terrestrial habitat. Area 1 is a mixed wetland and wooded upland area directly west of the Green Point Landfill, extending to the western REALM property boundary. Area 2 is a mixed wetland and wooded upland area south of the Green Point Landfill. Area 2 includes a large open-water area directly south of the Landfill, and extends south to the east-west ditch near the south property boundary. It is bordered on the east by a north-south ditch and on the west by the drum remediation area and the sedimentation basin. Area 3 is the footprint of the former proposed Type III landfill site. It is covered by compacted soil with sparse vegetation. Area 4 is a dense stand of cattail and purple loosestrife in the southeast corner of the site. Numerous surface water impoundments exist on the site, including the remaining drainage channels and settling ponds of the former water recirculation system (WRS), a small, lined stormwater pond north of the Green Point Landfill, stormwater ditches, and the constructed sedimentation basin, which receives runoff from the Green Point Landfill cap. The former WRS is now used only for stormwater management. Portions of it have been filled, and additional ditches are scheduled to be filled.

Wildlife observed at the site during the ecological reconnaissance and sampling include white-tailed deer (*Odocoileus virginicus*), woodchuck (*Marmota monax*), and a large variety of songbirds and waterfowl. Details on wildlife observations and the findings of a fish survey conducted in 1997 were presented in the RI report.

## **Preliminary Identification of Chemicals of Potential Concern and Pathways of Exposure**

In the preliminary EA, a risk-based screening identified the following chemicals in site media and potential exposure pathways for evaluation:

- **Surface Water**—Aluminum, iron, lead, and zinc exposure via direct contact or ingestion. Potential receptors include aquatic life, and terrestrial avian and mammalian wildlife.
- **Sediment**—Chromium, copper, lead, zinc, polycyclic aromatic hydrocarbon (PAH), and polychlorinated biphenyl (PCB) exposure via direct contact or ingestion. Potential receptors include aquatic life, and terrestrial avian and mammalian wildlife.
- **Soil**—Aluminum, antimony, arsenic, barium, chromium, copper, lead, manganese, selenium, thallium, vanadium, zinc, and PCB exposure via direct contact or ingestion. Potential receptors include soil macroinvertebrates, and terrestrial avian and mammalian wildlife.

## **Problem Formulation**

As described by federal ecological risk assessment guidance (U.S. EPA 1997; Fed. Reg. 63(93):26846–26924), problem formulation includes a qualitative evaluation of potential adverse effects caused by CoPCs, a site-specific analysis of relevant exposure pathways, and identification of ecosystems potentially at risk. This information is then used to select representative assessment endpoints, which are then evaluated in a quantitative ecological risk assessment.

## **Ecological Effects Profile**

### **Adverse Effects of Metals**

Many metals, including zinc and copper, are essential dietary nutrients, and organisms have developed complex and regulatory mechanisms to maintain appropriate physiological levels of these metals. Toxicity occurs when exposure is high enough to overwhelm these regulatory mechanisms. Chronic dietary exposure to toxic levels of metals may cause a variety of tissue-specific and systemic-adverse effects in mammals and birds, including weakness, paralysis, conjunctivitis, dermatitis, decreased growth, liver and kidney damage, neurological damage, reproductive failure, and developmental effects in offspring (Eisler 1988). Some metals, including arsenic and lead, are suspected carcinogens. Sensitivity to metals tends to vary widely among animal species. Both uptake and toxicity are highly dependant on the chemical form of the metal and the geochemical environment in which it is found.

### **Adverse Effects of PCBs**

PCBs are hydrophobic anthropogenic pollutants, which are highly persistent in the environment. The published toxicology literature on PCBs to fish, mammals, and birds indicates that commercial PCB mixtures (e.g., Aroclors<sup>®</sup>) may elicit a broad range of toxic responses in laboratory animals, including lethality, hepatotoxicity, porphyria, body weight loss, dermal toxicity, thymic atrophy, immunosuppressive effects, reproductive and developmental effects, carcinogenesis, and neurotoxicity (Seegal 1996; Tilson et al. 1990; Safe 1994). The most sensitive PCB toxicity endpoint in the majority of tested species appears to be reproduction, including egg production and hatching success in birds (Hoffman et al. 1996). The potency of PCB mixtures depends on the chlorine content of the mixture and, in general, mixtures with higher chlorine content (i.e., Aroclors<sup>®</sup> 1242, 1248, 1254, and 1260) are more potent than mixtures with lower chlorine content (i.e., Aroclors<sup>®</sup> 1221 and 1232).

### **Adverse Effects of PAHs**

PAHs are constituents of petroleum and are also formed during incomplete combustion of fossil fuels and other organic substances. PAHs are readily metabolized by most higher-order consumer species, and therefore do not tend to biomagnify. Due to inefficient uptake and efficient metabolism, significant tissue accumulation does not occur in vertebrates, though metabolism may result in toxicity (Suedel et al. 1994; U.S. EPA 1991). Controlled studies of



aquatic food chains have shown that tissue concentrations of PAHs decrease with an increase in trophic level (Broman et al. 1990). Adverse effects in mammals and birds attributable to chronic dietary exposure to toxic levels of PAHs include decreased body weight, liver damage, cancer, reproductive failure, and developmental defects (Eisler 1987).

## **Analysis of Completed Exposure Pathways**

A complete pathway of exposure exists if the following conditions are present:

- A contaminant source
- A potential point of exposure
- A viable route of exposure and receptor at the exposure point.

If any one of these conditions is missing, then the pathway is not complete and exposure cannot occur. Ecological risk from chemical exposure cannot occur in the absence of complete exposure pathways.

## **Aquatic Exposure Pathways**

Aquatic food webs are present in some surface water bodies at the site. Fish were observed to be present in the secondary settling pond, and in the southern stormwater drainage ditches during electrofishing surveys in 1997. Aquatic invertebrates, including insect larvae and crayfish, were also present in these areas.

All onsite ditches and ponds are man-made structures that were originally installed as an integral part of the operating facility for water treatment and/or management purposes or were installed for agricultural drainage purposes. Presently, surface water bodies serve water management functions. Any fish or invertebrate communities that exist in these water bodies are a result of colonization by opportunistic species. These communities exist on the facility only so long as the routine operation and maintenance of water control systems provide suitable conditions. Operational activities at the facility may result in the significant alteration or disappearance of these communities. For these reasons, this EA does not consider aquatic organisms residing in onsite ditches and ponds as ecological receptors. However, terrestrial receptors such as birds and mammals may use these water bodies as resources for food, resting, or watering. Both sediment and water exposure pathways are addressed in this EA.

## **Terrestrial Exposure Pathways**

Mammalian species that use site habitats include representatives of the following feeding guilds:

- **Browsing Herbivores**—White-tailed deer have been frequently observed in the undeveloped southern areas of the site during site visits. Deer feed on grasses, forbs, and other terrestrial vegetation, and could be exposed to soil

contaminants through uptake into plant tissues and incidental soil ingestion during browsing.

- **Omnivores**—Rodents, such as mice and woodchuck, are likely to be present in open fields and wooded habitats, where they would consume plant material and soil invertebrates. Woodchuck burrows have been observed in the earthen berm along the Saginaw River. Raccoons (*Procyon lotor*) may also forage for aquatic prey along the margins of the secondary settling pond and southern stormwater ditches. Raccoons are opportunistic omnivores. They do not typically eat substantial quantities of fish, but crustaceans (such as crayfish), when abundant, are a preferred food item of raccoons (U.S. EPA 1993).

Avian species that use site habitats include representatives of the following feeding guilds:

- **Omnivorous Birds**—The varied field, woodland, and wetland habitats present in the southern portion of the site support a diverse songbird community. Diets of these species include a variety of plants, soil invertebrates, and flying insects with both aquatic and terrestrial larval stages.
- **Piscivorous Waterfowl**—Wading birds, such as herons and egrets, are likely to forage in the surface water bodies that support aquatic food webs. Both fish and aquatic invertebrates may be eaten by wading birds.
- **Herbivorous Waterfowl**—Ducks, geese, and other migratory species are likely to be attracted to open water areas, and have been frequently observed at the site. Foraging habitat in the larger water bodies, including the settling ponds of the former WRS, is limited by the paucity of submerged aquatic vegetation, though these areas are still used as loafing habitat by a variety of species. The southern undeveloped areas offer good quality foraging and rearing habitat for waterfowl.
- **Carnivores**—Raptors, such as hawks, kestrels, and owls, are likely to prey on small mammals in the open field habitats present in the southern portion of the site as part of their foraging range.

## Receptors and Ecosystems Potentially at Risk

Based on the analysis of completed exposure pathways presented above, the following receptor species and communities are potentially at risk from contaminants in soil, sediment, or surface water.

### **Soil Contaminants**

- Browsing mammalian herbivores are potentially at risk from food-web exposure (uptake of soil contaminants into plants) and from incidental soil ingestion during browsing.
- Mammalian omnivores are potentially at risk from food-web exposure (uptake of soil contaminants into plants and soil invertebrates) and from incidental soil ingestion during foraging and prey capture for the terrestrial component of their diet. Burrowing mammals may be exposed to soil contaminants via the inhalation and dermal exposure pathways.
- Avian omnivores are potentially at risk from food-web exposure (uptake of soil contaminants into plants and soil invertebrates) and from incidental soil ingestion during foraging/prey capture.
- Avian carnivores are potentially at risk from food-web exposure (uptake of soil contaminants into small mammals) and from incidental soil ingestion during prey capture.

### **Sediment Contaminants**

- Mammalian omnivores are potentially at risk from food-web exposure (uptake of sediment contaminants into aquatic prey species) and from incidental sediment ingestion during foraging and prey capture for the aquatic component of their diet
- Avian piscivores are potentially at risk from food-web exposure (uptake of sediment contaminants into aquatic prey species) and from incidental sediment ingestion during prey capture.

### **Water Contaminants**

- Mammalian and avian wildlife species are potentially at risk from water ingestion
- Waterfowl and wading birds are potentially at risk from contact with surface water during loafing and foraging behavior.

### **Assessment Endpoints**

As described by U.S. Environmental Protection Agency (U.S. EPA) ecological risk assessment guidance, assessment endpoints are "...explicit expressions of the actual environmental values (e.g., ecological resources) that are to be protected" (U.S. EPA 1997). Appropriate measurement endpoints are then developed to enable evaluation of the assessment endpoints. An assessment endpoint must be an appropriate environmental attribute for the site conditions,

species and communities present, and CoPCs and exposure pathways present. It must also be something for which methodology exists to permit measurement and evaluation.

The assessment endpoints selected for this EA are as follows:

- **Assessment Endpoint 1**—Maintenance of browsing herbivorous mammal populations
- **Assessment Endpoint 2**—Maintenance of omnivorous mammal populations
- **Assessment Endpoint 3**—Maintenance of piscivorous bird populations
- **Assessment Endpoint 4**—Maintenance of carnivorous bird populations.

Some completed exposure pathways identified above have not been selected as the basis for assessment endpoints. It is not necessary to quantitatively assess risk to avian omnivores because their diet is substantially the same as mammalian omnivores. Furthermore, birds tend to have larger home ranges than small mammals, and many species migrate, resulting in lower annual exposure levels. There are no bioaccumulative soil or sediment CoPCs to which birds are believed to be substantially more sensitive than mammals.

The following completed exposure pathways cannot be assessed quantitatively because exposure assessment methods and knowledge of adverse effect thresholds are inadequate:

- Inhalation and dermal exposure of burrowing mammals to soil contaminants
- Direct contact of waterfowl and wading birds to water and sediment contaminants.

These pathways will be qualitatively assessed in the discussion of uncertainty and risk characterization following the quantitative assessment.

## Risk Assessment Study Design

Evaluation of the assessment endpoints described above is achieved by application of a standard food-web exposure modeling approach that is consistent with U.S. EPA guidance (U.S. EPA 1993, 2000). The food-web model is a tool for estimating dietary exposure as a body-weight-normalized total daily dose. The general structure of the food-web exposure model is described by the equation:

$$IR_{\text{chemical}} = \frac{\sum_i (C_i \times M_i \times A_i \times F_i)}{W}$$

where:

$IR_{\text{chemical}}$  = total ingestion rate of chemical from all dietary components (mg/kg-body weight/day)

- $C_i$  = concentration of the chemical in a given dietary component and medium (mg/kg dry weight)  
 $M_i$  = rate of ingestion of an abiotic medium (kg/day dry weight)  
 $A_i$  = relative gastrointestinal absorption efficiency for the chemical in a given dietary component or medium (fraction)  
 $F_i$  = fraction of the daily intake of a given dietary component or medium derived from the study area (unitless area-use factor)  
 $W$  = body weight of receptor species (kg)

The term  $IR_{\text{chemical}}$  can be expanded to specify each ingestion medium, which includes one or more primary food items, drinking water, and incidentally ingested sediment or soil:

$$IR_{\text{chemical}} = [\Sigma (C_{\text{food}} \times M_{\text{food}} \times A_{\text{food}} \times F_{\text{food}}) + (C_{\text{water}} \times M_{\text{water}} \times A_{\text{water}} \times F_{\text{water}}) + (C_{\text{sediment/soil}} \times M_{\text{sediment/soil}} \times A_{\text{sediment/soil}} \times F_{\text{sediment/soil}})]/W$$

For species-specific input parameters, such as body weight, ingestion rate, and area-use factor, there is a range of possible values that can be used. For example, adult body weights for any species are variable and may depend on several factors, including region of the country, habitat, local climate, and the availability of food. Similarly, the feeding behavior of receptor species can vary greatly, depending on geographical location and habitat type. For the purposes of this risk assessment, single-value point estimates are used for all food-web model exposure parameters, and the variability associated with different input parameters is assessed in a discussion of uncertainty in the risk characterization section of this EA.

The food-web models for assessment of risk to mammalian and avian receptors are developed to be a conservative estimate (i.e., overestimate) of dietary exposure to site contaminants. Published life-history information for representative receptors is used to estimate daily intakes of CoPCs. Because concentrations of CoPCs in biota have not been measured at the site, they are estimated for risk assessment purposes using published bioaccumulation factors (BAFs). BAFs are quantitative relationships between soil or sediment concentrations and biota, and they are derived from empirical measurement.

## Representative Receptors

In order to quantitatively assess risk to an ecological community or feeding guild, it is necessary to select representative receptors. The diversity of potentially exposed species and the lack of fundamental knowledge of the interactions between contaminants and many exposed species preclude assessment of risk to all species. According to U.S. EPA guidance, selection of representative receptors may be based on a number of factors, including the following (U.S. EPA 1997):

- Species which are known to be present at the site
- Species which are likely to be highly exposed

- Species which are typical of the community or guild they represent in their behavior, physiology, or sensitivity to CoPCs
- Species for which adequate data exist to allow assessment of exposure and risk.

Risk assessments for representative receptors are therefore interpreted to apply not only to the species which are assessed, but to other species in the community or guild which are represented.

The following representative receptors are selected to evaluate the assessment endpoints:

- Browsing herbivorous mammal: white-tailed deer
- Omnivorous mammal: raccoon
- Piscivorous bird: great blue heron (*Ardea herodias*)
- Carnivorous bird: red-tailed hawk (*Buteo jamaicensis*).

All of these species are known to be present or are likely to forage at the site, and all are well described in the scientific literature in terms of their life history and feeding behaviors.

### **Life History Parameters for Representative Receptors**

Life history parameters for representative receptors are provided in Table B-1. Data reported from studies in the Midwestern United States were selected when available.

Body weights are based on data from the U.S. EPA *Wildlife Exposure Factors Handbook* (U.S. EPA 1993). Food consumption and water ingestion rates for all receptors are estimated from body weight using the allometric approach of Nagy (1987). Sediment/soil ingestion rates are estimated as percentages of the dry weight food ingestion rates based on the limited published information available. Beyer et al. (1994) reported that raccoons ingest a quantity of soil/sediment equivalent to 9.4 percent of their total diet on a dry weight basis, based on analysis of insoluble material in scat. In the same study, white-tailed deer were found to have an incidental soil ingestion of less than 2 percent of their diet. This value was the resolution limit of the study, and the actual soil ingestion rate is likely to be less than 2 percent. No measurements of sediment/soil ingestion are known to exist for heron or hawk. For deer, heron, and hawk, the soil ingestion rates were assumed to be 2 percent of the total diet on a dry weight basis. This soil ingestion rate is likely to be conservative for both herons and hawks. Herons are water column fishers, and may be expected to have low incidental ingestion of sediment relative to birds that extract their prey directly from the sediment. Similarly, hawks capture and consume their prey above ground, and would be expected to have low soil ingestion rates.

Modeled diets are intended to represent an entire group of potential receptors, or feeding guild. While most animals are opportunistic in their feeding behavior and will take advantage of food resources that are available to them, the purpose of the modeling exercise is to identify exposure

from specific sources. For purposes of the food-web models, the following assumptions were made for dietary composition:

- White-tailed deer: 100 percent vegetation
- Raccoon: 33.3 percent vegetation, 33.3 percent soil invertebrates, 33.3 percent aquatic prey
- Great blue heron: 100 percent aquatic prey
- Red-tailed hawk: 100 percent small mammals.

### Bioaccumulation Factors

Four sets of BAFs were developed to estimate dietary exposure of representative receptors to CoPCs:

- A soil to plant BAF (used for the deer and raccoon)
- A soil to small mammal BAF (used for the hawk)
- A soil to earthworm BAF (used for the raccoon)
- A sediment to aquatic life BAF (used for the raccoon and heron).

Reference BAFs have been taken from published sources. The simplest BAFs are expressed as constant ratios between biota and soil/sediment concentrations. Simple ratio BAFs predict that the relationship between soil chemistry and biological uptake is constant over all concentration levels. In fact, bioaccumulation may be highly dependent on absolute concentration, resulting in a nonlinear uptake factor. When available, nonlinear regression models offer more reliable estimates of uptake potential over a broad range of concentrations. Such models are typically of the following form:

$$\log \text{ or } \ln[\text{biota}] = B0 + B1 \times \log \text{ or } \ln[\text{soil}]$$

where:

- $\log \text{ or } \ln[\text{biota}]$  = Base 10 or natural log of the chemical concentration in plant, soil invertebrate, or aquatic prey tissue (dry weight)
- $B0$  and  $B1$  = empirically derived, chemical-specific constants
- $\log \text{ or } \ln[\text{soil}]$  = Base 10 or natural log of the chemical concentration in soil (dry weight)

BAFs were not available for all CoPCs. It was necessary to estimate uptake of some metals by using metals likely to have similar geochemical properties as surrogates.

In order to conservatively model dietary exposure of representative receptors, average detected soil concentrations of all CoPCs are used to estimate bioaccumulation. For CoPCs with low detection frequency, this assumption may represent a significant overestimation of exposure. The uncertainty associated with this assumption is considered in the risk characterization.

### **Soil to Plant Bioaccumulation Factors**

Soil to plant BAFs are shown in Table B-2. They are taken from work compiled for the Department of Energy by Bechtel Jacobs (1998a). No BAF was available for thallium, therefore the lead uptake factor is used as a surrogate. PCBs are only sparingly soluble in water, and are not appreciably taken up into plant tissue (O'Connor et al. 1991). Exposure to soil PCBs for terrestrial herbivores can be expected to be driven by incidental soil ingestion.

### **Soil to Earthworm Bioaccumulation Factors**

Soil to earthworm BAFs are shown in Table B-3. They are taken from Sample et al. (1998a). Earthworm uptake of metals and organic substances is especially nonlinear as a function of soil concentration, therefore the use of simple ratio BAFs was avoided. Uptake of several metals was modeled using the following surrogate uptake factors:

- Zinc was used as a surrogate for aluminum
- Arsenic as a surrogate for antimony
- Nickel as a surrogate for cobalt
- Lead as a surrogate for thallium
- Manganese as a surrogate for vanadium.

No appropriate surrogates are identified for two additional metals:

- Barium is the only Group 2 element in the CoPC list. It would be inappropriate to model barium uptake using a transition metal.
- Chromium has an especially variable uptake rate in earthworms. Total chromium measurements are known to be a poor predictor of earthworm body burden (Sample et al. 1998a).

Uptake of barium and chromium into earthworms is modeled by assuming a BAF of 1.0. That is, earthworm concentrations are assumed to be equal to soil concentrations.

A review of available PCB bioaccumulation measurements was performed to develop a nonlinear earthworm bioaccumulation model. This review is presented as Attachment B1.



### **Soil to Small Mammal Bioaccumulation Factors**

Soil to small mammal BAFs are presented in Table B-4. They are taken from Sample et al. (1998b) for metals and O'Brien & Gere (1999) for PCBs. No BAF is available for antimony, therefore, the arsenic uptake factor is used as a surrogate.

### **Sediment to Aquatic Life Bioaccumulation Factors**

Sediment to aquatic life BAFs are presented in Table B-5. They are taken from Bechtel Jacobs (1998b) for metals and from Corps (1999) for PAHs.

### **Area Use Factors**

Area use factors in food-web models are estimates of the percentage of the total exposure (primarily from diet) that is derived from the site by a given receptor. While simple in concept, area use factors are very difficult to determine in practice, because most wildlife species are opportunistic in their feeding habits. Wildlife will concentrate their foraging in areas which are most productive, and these areas may change over time. In addition, movements of wildlife due to migratory behavior may be relevant to assessments of chronic exposure to chemicals. Receptors of a migratory species may be exposed to site conditions only during portions of the year. Of the receptors in this EA, great blue heron and red-tailed hawk are migratory species, which are summer residents in Michigan, whereas white-tailed deer and raccoon are year-round residents. For purposes of initial assessment, the area use factor for all representative receptors is conservatively assumed to be 1.0, meaning that the entire exposure, including diet, is assumed to be derived from forage on the site. This worst-case assumption will result in an overestimate of exposure for any receptor that does not obtain its entire diet from the site. The uncertainty associated with this assumption is examined in the ecological significance and uncertainty discussions, and incorporated into the risk characterization.

### **Absorption Factors**

The gastrointestinal absorption efficiency of all CoPCs is conservatively assumed to be 100 percent. That is, all ingested CoPCs are assumed to be fully absorbed by representative receptors. Actual absorption factors for wildlife receptors are generally unknown and difficult to predict, though studies in laboratory animals demonstrate that uptake of both metals and organic contaminants in the digestive tract is typically far from complete (U.S. EPA 1992). This worst-case assumption will over-estimate dietary exposure of receptors to CoPCs, and must also be considered an important source of uncertainty.

### **Measurement Endpoints**

A measurement endpoint is a "measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint" (U.S. EPA 1997). U.S. EPA guidance specifies that measurement endpoints may be expressed as either measures of exposure (such as dietary exposure levels or measured environmental concentrations) or measures of effect (such as indications of toxicity) (U.S. EPA 1997). In this EA, the measurement endpoints are defined

as point estimates of exposure, or measured concentrations. In the quantitative risk assessment, these values are compared to reference exposure levels, which are potentially associated with adverse effects.

A summary of measurement endpoints is as follows:

- **Measurement Endpoint 1**—Estimated daily dietary exposure of white-tailed deer to CoPCs in soil, water, and food
- **Measurement Endpoint 2**—Estimated daily dietary exposure of raccoon to CoPCs in soil, sediment, water, and food
- **Measurement Endpoint 3**—Estimated daily dietary exposure of great blue heron to CoPCs in soil, sediment, water, and food
- **Measurement Endpoint 4**—Estimated daily dietary exposure of red-tailed hawk to CoPCs in soil, water, and food.

## Quantitative Assessment of Risk

A quantitative assessment of risk has been developed using the hazard quotient (HQ) approach. The HQ is the unitless ratio of estimated or measured exposure to a toxicity reference value (TRV):

$$\text{Hazard Quotient} = \frac{\text{Exposure}}{\text{TRV}}$$

In this EA, the exposure term for a given CoPC is the estimated daily dietary exposure for representative receptors. The corresponding TRV is developed from a published estimate of an adverse effect threshold. A calculated HQ less than 1 indicates that the exposure estimate is below the adverse effect threshold and, therefore, is unlikely to cause adverse effects in the exposed receptor. A calculated HQ greater than 1 indicates that the exposure exceeds the effect threshold and adverse effects are possible. That is, an HQ greater than 1 is not necessarily indicative of unacceptable risk, only that further evaluation may be warranted. Quantitative interpretation of HQs requires careful evaluation of all relevant information related to both the exposure and TRV terms, including reliability and uncertainty. This analysis is the risk characterization.

Calculation of an HQ, therefore, involves two separate processes: exposure assessment and effects assessment.

## Food Web Exposure Assessment

The assessment endpoints are evaluated through the application of food-web models to estimate dietary exposure of the representative receptors. The results of the food-web models are shown in Tables B-6 through B-9. Exposure to soil CoPCs was modeled for terrestrial components of

the diet and exposure to sediment CoPCs was modeled for aquatic components. All dietary concentrations of CoPCs were estimated by applying the BAF relationships described above to average detected soil and sediment concentrations from the ecological risk assessment data set defined in the RI.

#### **Dietary Exposure of Mammalian Herbivores**

The estimated dietary exposure of the white-tailed deer to surface soil CoPCs is summarized in Table B-6. CoPC levels in plants are estimated by applying the BAFs from Table B-2 to the average CoPC concentrations in surface soil. Average surface water concentrations are used to estimate the daily drinking water exposure to all soil CoPCs. Incidental direct ingestion of soil is estimated as two percent of the diet. With the exception of barium, chromium, manganese, selenium, and zinc, exposure to all CoPCs is predicted by the model to be primarily driven by incidental, direct soil ingestion rather than food-web uptake (see Table B-6). Plants are not expected to accumulate toxic quantities of soil CoPCs at concentrations detected onsite. Water exposure is predicted by the model to be a relatively minor component of the total exposure for all soil CoPCs. Water concentrations detected onsite are not predicted to be toxic to wildlife.

#### **Dietary Exposure of Mammalian Omnivores**

The estimated dietary exposure of the raccoon to surface soil and sediment CoPCs is summarized in Table B-7. CoPC levels in vegetation were estimated as described above for white-tailed deer. CoPC levels in earthworms were estimated by applying the BAFs from Table B-3 to the average detected CoPC concentrations in surface soil. CoPC levels in aquatic prey were estimated by applying the BAFs from Table B-5 to the average detected CoPC concentrations in sediment. The omnivore diet is varied, and may consist of many different food items. In order to estimate typical exposure, each of the three dietary components (vegetation, earthworms, and aquatic prey) was assumed to comprise one-third of the total diet. Average surface water concentrations were used to estimate the daily drinking water exposure to CoPCs. Total direct ingestion of soil and sediment was estimated as 9.4 percent of the dry weight dietary intake, two-thirds being soil, and one-third sediment, in accordance with the modeled diet. With the exception of barium, chromium, benz[a]anthracene, and PCBs, exposure to all CoPCs is predicted by the model to be primarily driven by direct soil or sediment ingestion rather than food-web uptake (see Table B-6). Water exposure is predicted to be a relatively minor component of the total exposure for all soil and sediment CoPCs.

#### **Dietary Exposure of Avian Piscivores**

The estimated dietary exposure of the great blue heron to sediment CoPCs is summarized in Table B-8. CoPC levels in aquatic prey are estimated as described above for raccoon. Incidental direct ingestion of sediment is estimated as two percent of the diet.

The exposure to most sediment CoPCs is predicted by the model to be primarily driven by food-web uptake (see Table B-8). Exposure to chromium, copper, and zinc is predicted by the model to be driven by direct sediment ingestion. Water exposure is predicted to be a relatively minor component of the total exposure for all sediment CoPCs.

## **Dietary Exposure of Avian Carnivores**

The estimated dietary exposure of the red-tailed hawk to surface soil CoPCs is summarized in Table B-9. CoPC levels in small mammals are estimated by applying the BAFs from Table B-4 to the average CoPC concentrations in surface soil. Incidental direct ingestion of soil is estimated as two percent of the diet. Exposure to aluminum, barium, manganese, thallium and PCBs, exposure to all CoPCs is predicted by the model to be primarily driven by food-web uptake (see Table B-9). Exposure to all other soil CoPCs is predicted by the model to be driven by direct soil ingestion. Water exposure is predicted to be a relatively minor component of the total exposure for all soil CoPCs.

## **Effects Assessment**

Mammalian and avian TRVs for comparison to estimated dietary exposure to CoPCs are taken directly from the literature or derived from published studies on laboratory animals. The lowest possible threshold, the chronic no-observed-adverse-effect level (NOAEL), is used as a conservative estimate of the adverse effects threshold. The NOAEL is the highest dose administered during a chronic toxicity study that did not produce adverse toxic effects. The true effect threshold, under the tested exposure conditions, is somewhere above the NOAEL. At an exposure level equal to the NOAEL, there is no adverse effect. As the concentration increases above the NOAEL, the probability of effect increases.

Because controlled laboratory experiments are rarely conducted with wildlife species, it is typically necessary to derive TRVs by extrapolation of data from related laboratory or domestic species to the representative receptors. In this EA, source studies were selected that considered survival, growth, reproductive and developmental effects, or other critical effects indicative of overt impacts to individual organisms that may affect population size or stability. Studies incorporating chronic exposure durations, multiple exposure levels, and statistical evaluation of test results were preferentially selected. The mammalian and avian TRVs are summarized in Tables B-10 and B-11, respectively.

## **Quantitative Risk Assessment**

### **Food Web Model Hazard Quotients**

Calculated HQ values for the food-web models used to evaluate Assessment Endpoints 1 through 4 are presented in Tables B-6 through B-9, respectively. All estimated exposure levels are well below the corresponding TRVs, with the exception of the following two receptor-CoPC combinations:

- Raccoon exposure to aluminum (HQ = 4.4)
- Raccoon exposure to Aroclor<sup>®</sup> 1248 (HQ = 2.2).

This finding indicates that, given the assumptions of the models, risk from chronic dietary exposure to soil and sediment CoPCs can be expected to be negligible for browsing herbivorous mammals, piscivorous birds, and carnivorous birds. Dietary exposure to aluminum and Aroclor® 1248 are predicted to have the potential to cause adverse effects in omnivorous mammals, and therefore possibly in other omnivorous species that are represented by this receptor. An evaluation of the ecological significance and uncertainties associated with the model assumptions is required in order to characterize this risk.

## **Ecological Significance of Predicted Risk**

Following a quantitative analysis of risk, it is appropriate to evaluate and revisit the risk-driving assumptions of the calculations and assess uncertainties, which should be considered in the final risk characterization (U.S. EPA 1997).

### **Risk to Wildlife from Food Web Exposure**

The only potential risks identified by the food web modeling exercise were to omnivorous mammals (and, by extension, other omnivores) due to aluminum and Aroclor® 1248 exposure.

The predicted dietary exposure to aluminum is driven almost entirely by direct soil and sediment ingestion (see Table B-7). Ninety-eight percent of the predicted total daily dose of aluminum is derived from incidental soil and sediment ingestion. In large part, this is driven by the assumption that raccoons ingest a very large quantity of soil or sediment during foraging or prey capture. This assumption is highly conservative and may not be accurate for other omnivorous species.

The other risk-driving assumption is that the aluminum TRV is reflective of actual risk from ingestion of soil containing aluminum. There are several indications that this assumption should be questioned. Aluminum is one of the most abundant inorganic soil constituents. The average aluminum concentration in surface soil in the 29-sample data set used by the EA is approximately 8,000 mg/kg. This only exceeds the MDEQ generic state-wide background level for aluminum in Michigan soils (6,900 mg/kg) by 16 percent. If the background soil level were substituted into the food-web model, the HQ would be reduced by approximately 16 percent, resulting in an HQ of approximately 3.7. In other words, the incremental exposure to aluminum and predicted incremental risk from elevated soil and sediment concentrations at the site are very low.

The problem with the use of bulk soil aluminum concentrations to evaluate risk from ingestion is well known to ecological risk assessors, and is recognized by the most recent U.S. EPA guidance on evaluation of soil contaminants:

EPA recognizes that due to the ubiquitous nature of aluminum, the natural variability of aluminum soil concentrations and the availability of conservative soil screening benchmarks (Efroymson 1997b), aluminum is often identified as a contaminant of concern (COC) for ecological risk assessments. The commonly used soil screening benchmarks (Efroymson 1997b) are based on laboratory

toxicity testing using aluminum solution amendments to test soils. Comparisons of total aluminum soil concentrations to solution based screening values are deemed by EPA to be inappropriate. (U.S. EPA 2000).

Toxicity bioassays are performed with soluble aluminum salts, which are in the most bioavailable and toxic form. Use of such data for screening purposes is protective, but will result in a high level of overprotection when applied to substances which occur naturally in relatively benign mineralized forms. Aluminum is such a substance, and the ecological significance of this risk prediction should be considered low.

The average detected Aroclor® 1248 concentration in soil and sediments was predicted to result in food-web exposure slightly exceeding the TRV. This exposure prediction is driven almost entirely by exposure to soil PCBs via earthworms (see Table B-7). Ninety-six percent of the total estimated daily exposure is derived from the estimated exposure from the portion of the diet comprised of earthworms, assumed to be one-third of the diet. An omnivore with a lower consumption of soil macroinvertebrates such as earthworms would have proportionally lower exposure to PCBs. More importantly, the predicted Aroclor® 1248 exposure is an artifact of the low detection frequency of Aroclor® 1248 (3 of 29 samples), and does not represent a true average concentration in site soils. When risk from total PCBs is assessed (detection frequency = 19 of 29 samples), a better average value is derived (0.182 mg/kg), and an HQ value well below 1.0 (HQ=0.26) is obtained using the same TRV. The ecological significance of risk from Aroclor® 1248 should be considered low.

## **Risk Characterization**

U.S. EPA policy states that “[w]ell-balanced risk characterizations present risk conclusions and information regarding the strengths and limitations of the assessment for other risk assessors, U.S. EPA decision-makers, and the public” (U.S. EPA 1995).

This risk assessment is deliberately designed to be protective of wildlife receptors in the following ways:

- Conservative exposure parameters (e.g., area use, absorption, dietary fractions) are modeled, resulting in deliberate overestimation of dietary exposure.
- Conservative NOAEL TRVs are used as indicators of potential toxicity, resulting in deliberate overestimation of adverse effects from exposure.
- Food web modeling is based on the mean of detected concentrations to consider potential risk from all CoPCs, including those with low detection frequencies. Actual exposure to these CoPCs across the site will be lower than predicted.

The fact that conservatively modeled assumptions resulted in such low overall estimations of exposure and risk provides a high level of confidence for the risk manager that unknown or

uncertain pathways or conditions at the site do not represent significant exposure hazards to wildlife.

Given the findings of low to negligible risk from all CoPCs, the following conclusions can be drawn about the assessment endpoints:

- **Assessment Endpoint 1**—Soil CoPCs do not pose any significant risk to the maintenance of browsing herbivorous mammal populations
- **Assessment Endpoint 2**—Soil and sediment CoPCs do not pose any significant risk to the maintenance of omnivorous mammal populations
- **Assessment Endpoint 3**—Sediment CoPCs do not pose any significant risk to the maintenance of piscivorous bird populations
- **Assessment Endpoint 4**—Soil CoPCs do not pose any significant risk to the maintenance of carnivorous bird populations.

## Uncertainty Analysis

As with any ecological risk assessment, some uncertainty exists about the conclusions drawn. This assessment is based on modeled rather than observed estimates of exposure and effect. Because of significant knowledge uncertainty that exists with respect to the actual effects of chemical exposure on wildlife species at the site, sources of uncertainty include:

- Biouptake of CoPCs from sampled media may be higher or lower than those predicted by the empirical approach taken. However, the modeling approach makes underestimation of biouptake unlikely.
- Feeding behavior of modeled species may be different from the assumptions used in the food-web models, resulting in higher or lower actual exposure. However, the assumptions about area use and absorption make underestimation unlikely.
- Generally speaking, none of the representative receptors has been directly tested for sensitivity to CoPCs under controlled conditions in the laboratory. Data from surrogate test species have been used to estimate sensitivity to CoPCs. The sensitivity of ecological receptors may be higher or lower than that predicted by the TRVs and toxicity benchmarks used to quantitatively evaluate risk. However, conservative estimates of NOAELs have been used from the published toxicology literature.

There are complete exposure pathways that have not been quantitatively evaluated in this EA, including:

- Risk to omnivorous birds was not evaluated because their diets contain the same components assessed for omnivorous mammals, and exposure of birds

to site CoPCs is likely to be lower, due to migratory behavior and larger home ranges. Furthermore, sensitivity of mammals is believed to be higher to CoPCs that are predicted by the model to accumulate significantly in potential food items (e.g., aluminum, PCBs).

- Risk to burrowing mammals from soil inhalation and dermal contact pathways cannot be quantitatively evaluated because no exposure quantification methods have been established for these pathways, and controlled exposure studies of wildlife receptors via these pathways generally do not exist.
- Risk to waterfowl, including wading birds from direct contact with surface water and sediment, cannot be quantitatively evaluated because of similar technical limitations for burrowing mammals described above.

These exposure pathways are not likely to result in significant incremental risk to ecological receptors, given the low potential risk estimated for the dominant dietary exposure pathway.

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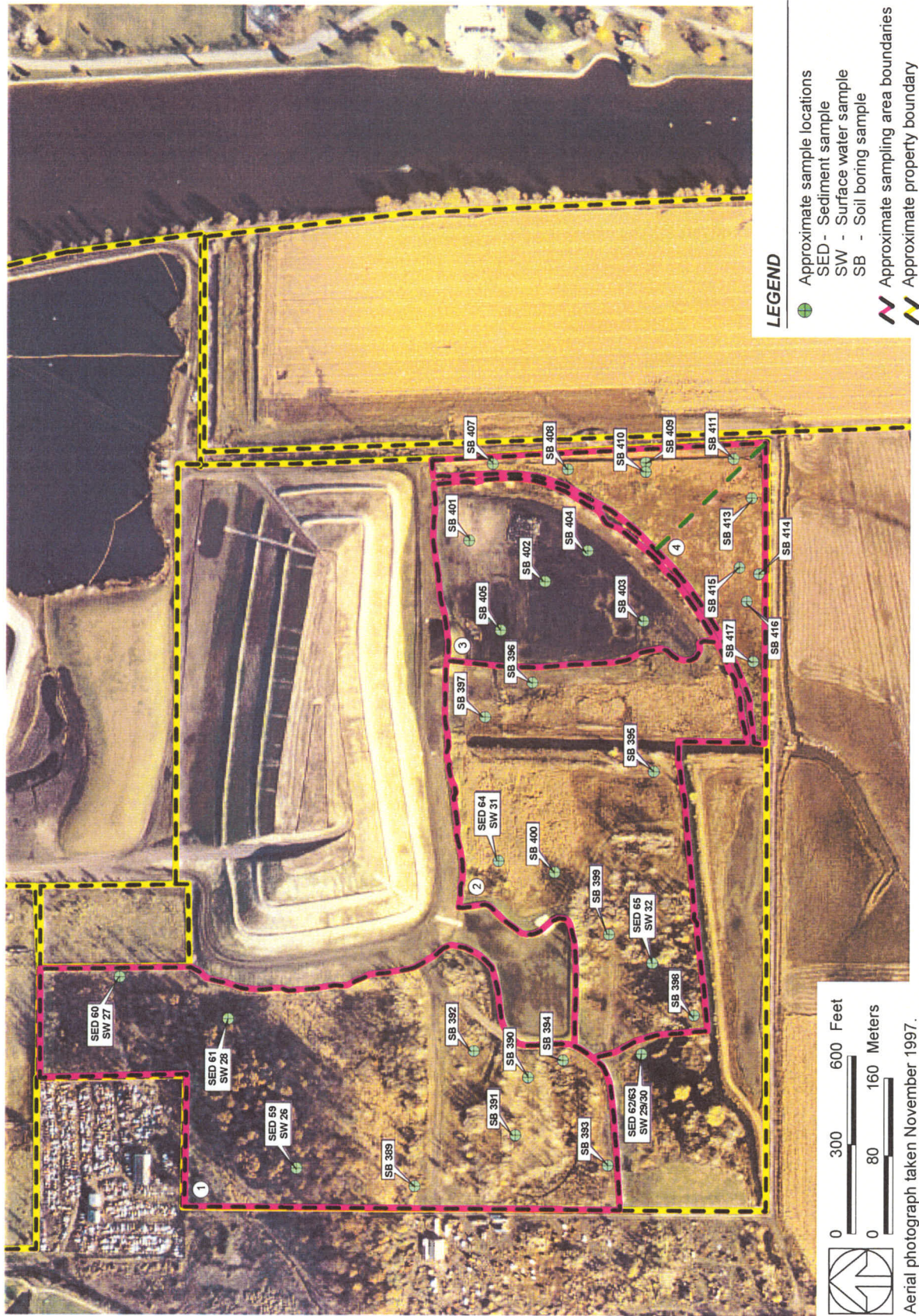


Figure B-1. Ecological assessment supplemental sampling areas

**Table B-1. Representative receptor life history parameters**

| Receptor          | Body Weight <sup>a</sup><br>(kg) | Food Ingestion <sup>b</sup><br>(kg/day dry wt.) | Water Ingestion <sup>b</sup><br>(L/day) | Soil/Sediment Ingestion <sup>c</sup><br>(kg/d dry wt.) |
|-------------------|----------------------------------|-------------------------------------------------|-----------------------------------------|--------------------------------------------------------|
| White-tailed deer | 45                               | 1.57                                            | 3.04                                    | 0.031                                                  |
| Raccoon           | 6.0                              | 0.30                                            | 0.50                                    | 0.028                                                  |
| Red-tailed hawk   | 1.2                              | 0.066                                           | 0.067                                   | 0.0013                                                 |
| Great blue heron  | 2.2                              | 0.097                                           | 0.10                                    | 0.0019                                                 |

<sup>a</sup> From U.S. EPA (1993).

<sup>b</sup> Calculated according to Nagy (1987).

<sup>c</sup> Estimated from Beyer et al. (1994).

**Table B-2. Bioaccumulation factors from soil to plants**

| CoPC                      | Linear BAF | Nonlinear BAF |       | Source                 |
|---------------------------|------------|---------------|-------|------------------------|
|                           |            | B0            | B1    |                        |
| Metals                    |            |               |       |                        |
| Aluminum                  | 0.00287    |               |       | Bechtel Jacobs (1998a) |
| Antimony                  | 0.0102     |               |       | Bechtel Jacobs (1998a) |
| Arsenic                   |            | -1.992        | 0.564 | Bechtel Jacobs (1998a) |
| Barium                    | 0.156      |               |       | Bechtel Jacobs (1998a) |
| Chromium                  | 0.041      |               |       | Bechtel Jacobs (1998a) |
| Cobalt                    | 0.00745    |               |       | Bechtel Jacobs (1998a) |
| Copper                    |            | 0.669         | 0.394 | Bechtel Jacobs (1998a) |
| Lead                      |            | -1.328        | 0.561 | Bechtel Jacobs (1998a) |
| Manganese                 | 0.0792     |               |       | Bechtel Jacobs (1998a) |
| Selenium                  |            | -0.678        | 1.104 | Bechtel Jacobs (1998a) |
| Thallium                  |            | -1.328        | 0.561 | Lead used as surrogate |
| Vanadium                  | 0.00485    |               |       | Bechtel Jacobs (1998a) |
| Zinc                      |            | 1.575         | 0.555 | Bechtel Jacobs (1998a) |
| Polychlorinated Biphenyls |            |               |       |                        |
| Aroclor® 1248             | N/A        | N/A           | N/A   |                        |
| Aroclor® 1254             | N/A        | N/A           | N/A   |                        |
| Aroclor® 1260             | N/A        | N/A           | N/A   |                        |
| Total PCBs                | N/A        | N/A           | N/A   |                        |

**Note:** Linear BAF has form:  $[biota] = BAF \times [soil]$

Nonlinear BAF has form:  $\ln[biota] = B 0 + B 1 \times \ln[soil]$

BAF - bioaccumulation factor

CoPC - chemical of potential concern

N/A - not applicable; PCBs are not significantly taken up by plants

PCB - polychlorinated biphenyl

**Table B-3. Bioaccumulation factors from soil to earthworms**

| CoPC                      | Linear BAF | Nonlinear BAF |        | Source                                           |
|---------------------------|------------|---------------|--------|--------------------------------------------------|
|                           |            | B0            | B1     |                                                  |
| Metals                    |            |               |        |                                                  |
| Aluminum                  |            | 4.449         | 0.328  | Zinc used as surrogate.                          |
| Antimony                  |            | -1.421        | 0.706  | Arsenic used as surrogate.                       |
| Arsenic                   |            | -1.421        | 0.706  | Sample et al. (1998a)                            |
| Barium                    | 1          |               |        | No reliable info available. BAF set at 1.0.      |
| Chromium                  | 1          |               |        | No reliable info available. BAF set at 1.0.      |
| Cobalt                    |            | 7.033         | -1.548 | Sample et al. (1998a). Nickel used as surrogate. |
| Copper                    |            | 1.675         | 0.264  | Sample et al. (1998a)                            |
| Lead                      |            | -0.218        | 0.807  | Sample et al. (1998a)                            |
| Manganese                 |            | -0.809        | 0.682  | Sample et al. (1998a)                            |
| Selenium                  |            | -0.075        | 0.733  | Sample et al. (1998a)                            |
| Thallium                  |            | -0.218        | 0.807  | Lead used as surrogate.                          |
| Vanadium                  |            | -0.809        | 0.682  | Manganese used as surrogate.                     |
| Zinc                      |            | 4.449         | 0.328  | Sample et al. (1998a)                            |
| Polychlorinated Biphenyls |            |               |        |                                                  |
| Aroclor® 1248             |            | 0.1352        | 1.0347 | See Attachment 1                                 |
| Aroclor® 1254             |            | 0.1352        | 1.0347 | See Attachment 1                                 |
| Aroclor® 1260             |            | 0.1352        | 1.0347 | See Attachment 1                                 |
| Total PCBs                |            | 0.1352        | 1.0347 | See Attachment 1                                 |

**Note:** Linear BAF has form:  $[biota] = BAF \times [soil]$

Nonlinear BAF has form:  $\ln[biota] = B 0 + B 1 \times \ln[soil]$

Cadmium and PCB nonlinear BAFs have form:  $\log[biota] = B 0 + B 1 \times \log[soil]$

BAF - bioaccumulation factor

CoPC - chemical of potential concern

PCB - polychlorinated biphenyl



**Table B-4. Bioaccumulation factors from soil to small mammals**

| CoPC                      | Linear BAF | Nonlinear BAF |        | Source                     |
|---------------------------|------------|---------------|--------|----------------------------|
|                           |            | B 0           | B 1    |                            |
| Metals                    |            |               |        |                            |
| Aluminum                  | 0.0263     |               |        | Sample et al. (1998b)      |
| Antimony                  |            | -4.8417       | 0.8188 | Arsenic used as surrogate. |
| Arsenic                   |            | -4.8417       | 0.8188 | Sample et al. (1998b)      |
| Barium                    | 0.0566     |               |        | Sample et al. (1998b)      |
| Chromium                  |            | -0.4158       | 0.3764 | Sample et al. (1998b)      |
| Cobalt                    | 0.0205     |               |        | Sample et al. (1998b)      |
| Copper                    |            | 2.1042        | 0.1783 | Sample et al. (1998b)      |
| Lead                      |            | 0.4819        | 0.4869 | Sample et al. (1998b)      |
| Manganese                 | 0.0205     |               |        | Sample et al. (1998b)      |
| Selenium                  |            | -0.4158       | 0.3764 | Sample et al. (1998b)      |
| Thallium                  | 0.1124     |               |        | Sample et al. (1998b)      |
| Vanadium                  | 0.0123     |               |        | Sample et al. (1998b)      |
| Zinc                      |            | 4.4713        | 0.0738 | Sample et al. (1998b)      |
| Polychlorinated Biphenyls |            |               |        |                            |
| Aroclor® 1248             | 1.78       |               |        | O'Brien & Gere (1999)      |
| Aroclor® 1254             | 1.78       |               |        | O'Brien & Gere (1999)      |
| Total PCBs                | 1.78       |               |        | O'Brien & Gere (1999)      |

**Note:** Linear BAF has form:  $[biota] = BAF \times [soil]$   
Nonlinear BAF has form:  $\ln[biota] = B 0 + B 1 \times \ln[soil]$   
BAF - bioaccumulation factor  
CoPC - chemical of potential concern  
PCB - polychlorinated biphenyl

**Table B-5. Bioaccumulation factors from sediment to aquatic life**

| CoPC                           | Linear BAF | Nonlinear BAF |       | Source                 |
|--------------------------------|------------|---------------|-------|------------------------|
|                                |            | B 0           | B 1   |                        |
| Metals                         |            |               |       |                        |
| Chromium                       |            | 0.2092        | 0.365 | Bechtel Jacobs (1998b) |
| Copper                         |            | 1.089         | 0.278 | Bechtel Jacobs (1998b) |
| Lead                           |            | -0.776        | 0.801 | Bechtel Jacobs (1998b) |
| Zinc                           |            | 1.8           | 0.208 | Bechtel Jacobs (1998b) |
| Semivolatile Organic Compounds |            |               |       |                        |
| Benzo[a]pyrene                 | 0.023      |               |       | Corps (1999)           |
| Benzo[b]fluoranthene           | 0.038      |               |       | Corps (1999)           |
| Benzo[ghi]perylene             | 0.023      |               |       | Corps (1999)           |
| Chrysene                       | 0.085      |               |       | Corps (1999)           |
| Indeno[1,2,3-cd]pyrene         | 0.015      |               |       | Corps (1999)           |
| Naphthalene                    | 0.062      |               |       | Corps (1999)           |
| Polychlorinated Biphenyls      |            |               |       |                        |
| Total PCBs                     |            | 0.59          | 1.11  | Bechtel Jacobs (1998b) |

**Note:** Linear BAF has form:  $[biota] = BAF \times [soil]$

Nonlinear BAF has form:  $\ln[biota] = B 0 + B 1 \times \ln[soil]$

BAF - bioaccumulation factor

CoPC - chemical of potential concern

PCB - polychlorinated biphenyl

**Table B-6. White-tailed deer food-web model and hazard quotient results**

|                                  |                                                   |                                                    |                                                   |                                              | Normalized                                |                                    |                    |
|----------------------------------|---------------------------------------------------|----------------------------------------------------|---------------------------------------------------|----------------------------------------------|-------------------------------------------|------------------------------------|--------------------|
| Soil CoPC                        | Daily Intake<br>via Food<br>( $\mu\text{g/day}$ ) | Daily Intake<br>via Water<br>( $\mu\text{g/day}$ ) | Daily Intake<br>via Soil<br>( $\mu\text{g/day}$ ) | Total Daily<br>Intake<br>( $\text{mg/day}$ ) | Daily Dose<br>( $\text{mg/kg}$<br>BW/day) | TRV<br>( $\text{mg/kg}$<br>BW/day) | Hazard<br>Quotient |
| <b>Metals</b>                    |                                                   |                                                    |                                                   |                                              |                                           |                                    |                    |
| Aluminum                         | 35,963.11                                         | 2,318.76                                           | 250,614.02                                        | 288.90                                       | 6.42                                      | 9.65                               | 0.7                |
| Antimony                         | 12.69                                             | 7.31                                               | 24.88                                             | 0.04                                         | 0.0010                                    | 0.657                              | 0.002              |
| Arsenic                          | 24.26                                             | 10.45                                              | 137.74                                            | 0.17                                         | 0.0038                                    | 1.26                               | 0.003              |
| Barium                           | 13,694.76                                         | 397.72                                             | 1,755.74                                          | 15.85                                        | 0.35                                      | 5.10                               | 0.07               |
| Chromium                         | 2,215.98                                          | 5.58                                               | 1,080.97                                          | 3.30                                         | 0.073                                     | 2053                               | 0.00004            |
| Cobalt                           | 47.63                                             | --                                                 | 127.87                                            | 0.18                                         | 0.0039                                    | 0.5                                | 0.01               |
| Copper                           | 212.62                                            | 26.91                                              | 1,478.82                                          | 1.72                                         | 0.038                                     | 11.70                              | 0.003              |
| Lead                             | 113.52                                            | 56.32                                              | 690.24                                            | 0.86                                         | 0.019                                     | 8.8                                | 0.002              |
| Manganese                        | 172,278.16                                        | 695.05                                             | 43,504.58                                         | 216.48                                       | 4.81                                      | 88.0                               | 0.05               |
| Selenium                         | 1,673.88                                          | --                                                 | 32.08                                             | 1.71                                         | 0.038                                     | 0.200                              | 0.2                |
| Thallium                         | 29.73                                             | 22.16                                              | 63.35                                             | 0.12                                         | 0.0026                                    | 0.07                               | 0.03               |
| Vanadium                         | 126.84                                            | --                                                 | 523.05                                            | 0.65                                         | 0.014                                     | 0.2                                | 0.07               |
| Zinc                             | 3,895.62                                          | 1,941.89                                           | 2,404.42                                          | 8.24                                         | 0.18                                      | 160.00                             | 0.001              |
| <b>Polychlorinated Biphenyls</b> |                                                   |                                                    |                                                   |                                              |                                           |                                    |                    |
| Aroclor® 1248                    | --                                                | --                                                 | 52.86                                             | 0.053                                        | 0.0012                                    | 0.15                               | 0.008              |
| Aroclor® 1254                    | --                                                | --                                                 | 7.52                                              | 0.008                                        | 0.00017                                   | 0.15                               | 0.001              |
| Aroclor® 1260                    | --                                                | --                                                 | 9.22                                              | 0.009                                        | 0.00020                                   | 0.15                               | 0.001              |
| Total PCBs                       | --                                                | --                                                 | 16.79                                             | 0.017                                        | 0.00037                                   | 0.15                               | 0.002              |

**Note:** -- - negligible  
CoPC - chemical of potential concern  
PCB - polychlorinated biphenyl  
TRV - toxicity reference value

**Table B-7. Raccoon food-web model and hazard quotient results**

| Soil CoPC                             | Daily Intake<br>via Food<br>( $\mu\text{g/day}$ ) | Daily Intake<br>via Water<br>( $\mu\text{g/day}$ ) | Daily Intake<br>via Soil and<br>Sediment<br>( $\mu\text{g/day}$ ) | Total Daily<br>Intake<br>( $\text{mg/day}$ ) | Normalized<br>Daily Dose<br>( $\text{mg/kg}$<br>$\text{BW/day}$ ) | TRV<br>( $\text{mg/kg}$<br>$\text{BW/day}$ ) | Hazard<br>Quotient |
|---------------------------------------|---------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------------|----------------------------------------------|--------------------|
| <b>Metals</b>                         |                                                   |                                                    |                                                                   |                                              |                                                                   |                                              |                    |
| Aluminum                              | 3,916.17                                          | 378.18                                             | 250,612.06                                                        | 254.91                                       | 42.48                                                             | 9.65                                         | 4.4                |
| Antimony                              | 3.49                                              | 1.19                                               | 41.85                                                             | 0.05                                         | 0.01                                                              | 0.657                                        | 0.01               |
| Arsenic                               | 10.53                                             | 1.70                                               | 141.94                                                            | 0.15                                         | 0.03                                                              | 1.26                                         | 0.02               |
| Barium                                | 6,456.04                                          | 64.87                                              | 1,766.01                                                          | 8.29                                         | 1.38                                                              | 5.10                                         | 0.3                |
| Chromium                              | 3,586.37                                          | 0.91                                               | 927.71                                                            | 4.51                                         | 0.75                                                              | 2053                                         | 0.00               |
| Cobalt                                | 3.03                                              | --                                                 | 130.14                                                            | 0.13                                         | 0.02                                                              | 0.5                                          | 0.04               |
| Copper                                | 50.04                                             | 4.39                                               | 1,550.24                                                          | 1.60                                         | 0.27                                                              | 11.70                                        | 0.02               |
| Lead                                  | 364.42                                            | 9.19                                               | 901.81                                                            | 1.28                                         | 0.21                                                              | 8.8                                          | 0.02               |
| Manganese                             | 11,646.56                                         | 113.36                                             | 32,723.71                                                         | 44.48                                        | 7.41                                                              | 88.0                                         | 0.08               |
| Selenium                              | 121.37                                            | --                                                 | 36.06                                                             | 0.16                                         | 0.03                                                              | 0.200                                        | 0.1                |
| Thallium                              | 39.20                                             | 3.61                                               | 57.02                                                             | 0.10                                         | 0.02                                                              | 0.07                                         | 0.2                |
| Vanadium                              | 41.74                                             | --                                                 | 459.91                                                            | 0.50                                         | 0.08                                                              | 0.2                                          | 0.4                |
| Zinc                                  | 704.42                                            | 316.72                                             | 12,160.16                                                         | 13.18                                        | 2.20                                                              | 160.00                                       | 0.01               |
| <b>Semivolatile Organic Compounds</b> |                                                   |                                                    |                                                                   |                                              |                                                                   |                                              |                    |
| Benz[a]anthracene                     | 49.42                                             | --                                                 | 7.28                                                              | 0.057                                        | 0.009                                                             | 1.00                                         | 0.01               |
| Benzo[a]pyrene                        | 1.51                                              | --                                                 | 9.69                                                              | 0.011                                        | 0.002                                                             | 1.00                                         | 0.002              |
| Benzo[b]fluoranthene                  | 2.98                                              | --                                                 | 11.25                                                             | 0.014                                        | 0.002                                                             | 1.00                                         | 0.002              |
| Benzo[ghi]perylene                    | 1.16                                              | --                                                 | 7.85                                                              | 0.009                                        | 0.002                                                             | 1.00                                         | 0.002              |
| Chrysene                              | 4.17                                              | --                                                 | 8.49                                                              | 0.013                                        | 0.002                                                             | 1.00                                         | 0.002              |
| Indeno[1,2,3-cd]pyrene                | 1.38                                              | --                                                 | 11.85                                                             | 0.013                                        | 0.002                                                             | 1.00                                         | 0.002              |
| Naphthalene                           | 19.35                                             | 0.99                                               | 34.74                                                             | 0.055                                        | 0.009                                                             | 1.00                                         | 0.01               |
| <b>Polychlorinated Biphenyls</b>      |                                                   |                                                    |                                                                   |                                              |                                                                   |                                              |                    |
| Aroclor® 1248                         | 1,895.80                                          | --                                                 | 50.48                                                             | 1.94                                         | 0.32                                                              | 0.15                                         | 2.2                |
| Aroclor® 1254                         | 284.39                                            | --                                                 | 9.58                                                              | 0.29                                         | 0.05                                                              | 0.15                                         | 0.3                |
| Aroclor® 1260                         | 331.14                                            | --                                                 | 9.83                                                              | 0.34                                         | 0.06                                                              | 0.15                                         | 0.4                |
| Total PCBs                            | 601.38                                            | --                                                 | 17.52                                                             | 0.62                                         | 0.10                                                              | 0.15                                         | 0.7                |

**Note:** -- - negligible  
CoPC - chemical of potential concern  
PCB - polychlorinated biphenyl  
TRV - toxicity reference value

**Table B-8. Great blue heron food-web model and hazard quotient results**

| Sediment<br>CoPC               | Daily Intake<br>via Food | Daily<br>Intake via<br>Water | Daily Intake<br>via Sediment | Total Daily<br>Intake | Normalized<br>Daily Dose | TRV               | Hazard<br>Quotient |
|--------------------------------|--------------------------|------------------------------|------------------------------|-----------------------|--------------------------|-------------------|--------------------|
|                                | ( $\mu\text{g/day}$ )    | ( $\mu\text{g/day}$ )        | ( $\mu\text{g/day}$ )        | (mg/day)              | (mg/kg<br>BW/day)        | (mg/kg<br>BW/day) |                    |
| Metals                         |                          |                              |                              |                       |                          |                   |                    |
| Chromium                       | 6.77                     | 0.18                         | 58.18                        | 0.065                 | 0.030                    | 0.86              | 0.03               |
| Copper                         | 26.65                    | 0.88                         | 138.40                       | 0.17                  | 0.075                    | 47.00             | 0.002              |
| Lead                           | 98.17                    | 1.85                         | 101.89                       | 0.20                  | 0.092                    | 1.85              | 0.05               |
| Zinc                           | 111.86                   | 63.82                        | 2,241.96                     | 2.42                  | 1.10                     | 132.00            | 0.01               |
| Semivolatile Organic Compounds |                          |                              |                              |                       |                          |                   |                    |
| Benz[a]anthracene              | 48.11                    | --                           | 0.95                         | 0.049                 | 0.022                    | 0.14              | 0.2                |
| Benzo[a]pyrene                 | 1.47                     | --                           | 1.28                         | 0.0028                | 0.0013                   | 0.14              | 0.01               |
| Benzo[b]fluoranthene           | 2.90                     | --                           | 1.53                         | 0.0044                | 0.0020                   | 0.14              | 0.01               |
| Benzo[ghi]perylene             | 1.13                     | --                           | 0.98                         | 0.0021                | 0.0010                   | 0.14              | 0.01               |
| Chrysene                       | 4.06                     | --                           | 0.96                         | 0.0050                | 0.0023                   | 1.00              | 0.002              |
| Indeno[1,2,3-cd]pyrene         | 1.34                     | --                           | 1.79                         | 0.0031                | 0.0014                   | 0.14              | 0.01               |
| Naphthalene                    | 18.84                    | 0.20                         | 6.08                         | 0.025                 | 0.011                    | 0.14              | 0.08               |
| Polychlorinated Biphenyls      |                          |                              |                              |                       |                          |                   |                    |
| Aroclor® 1248                  | 38.35                    | --                           | 0.64                         | 0.039                 | 0.018                    | 0.41              | 0.04               |
| Aroclor® 1254                  | 36.63                    | --                           | 0.59                         | 0.037                 | 0.017                    | 0.41              | 0.04               |
| Aroclor® 1260                  | 25.79                    | --                           | 0.33                         | 0.026                 | 0.012                    | 0.41              | 0.03               |
| Total PCBs                     | 33.61                    | --                           | 0.51                         | 0.034                 | 0.016                    | 0.41              | 0.04               |

**Note:** -- - negligible  
CoPC - chemical of potential concern  
PCB - polychlorinated biphenyl  
TRV - toxicity reference value

**Table B-9. Red-tailed hawk food-web model and hazard quotient results**

| Soil CoPC                        | Daily Intake<br>via Food<br>( $\mu$ g/day) | Daily Intake<br>via Water<br>( $\mu$ g/day) | Daily Intake<br>via Soil<br>( $\mu$ g/day) | Total Daily<br>Intake<br>(mg/day) | Normalized<br>Daily Dose<br>(mg/kg<br>BW/day) | TRV<br>(mg/kg<br>BW/day) | Hazard<br>Quotient |
|----------------------------------|--------------------------------------------|---------------------------------------------|--------------------------------------------|-----------------------------------|-----------------------------------------------|--------------------------|--------------------|
| <b>Metals</b>                    |                                            |                                             |                                            |                                   |                                               |                          |                    |
| Aluminum                         | 13,756.36                                  | 50.77                                       | 10,461.11                                  | 24.27                             | 20.22                                         | 122                      | 0.2                |
| Antimony                         | 0.12                                       | 0.16                                        | 1.04                                       | 0.0013                            | 0.0011                                        | 1,400.00                 | 0.0000008          |
| Arsenic                          | 0.50                                       | 0.23                                        | 5.75                                       | 0.0065                            | 0.0054                                        | 4.60                     | 0.001              |
| Barium                           | 207.40                                     | 8.71                                        | 73.29                                      | 0.29                              | 0.24                                          | 20.80                    | 0.01               |
| Chromium                         | 2.21                                       | 0.12                                        | 45.12                                      | 0.047                             | 0.040                                         | 0.86                     | 0.05               |
| Cobalt                           | 5.47                                       | --                                          | 5.34                                       | 0.011                             | 0.009                                         | N/A                      | N/A                |
| Copper                           | 3.66                                       | 0.59                                        | 61.73                                      | 0.066                             | 0.055                                         | 47.00                    | 0.001              |
| Lead                             | 13.80                                      | 1.23                                        | 28.81                                      | 0.044                             | 0.037                                         | 1.85                     | 0.02               |
| Manganese                        | 1,861.36                                   | 15.22                                       | 1,815.97                                   | 3.69                              | 3.08                                          | 977.00                   | 0.003              |
| Selenium                         | 0.59                                       | --                                          | 1.34                                       | 0.0019                            | 0.0016                                        | 0.40                     | 0.004              |
| Thallium                         | 14.86                                      | 0.49                                        | 2.64                                       | 0.02                              | 0.015                                         | 0.024                    | 0.63               |
| Vanadium                         | 13.43                                      | --                                          | 21.83                                      | 0.04                              | 0.029                                         | 11.40                    | 0.003              |
| Zinc                             | 13.15                                      | 42.52                                       | 100.36                                     | 0.16                              | 0.13                                          | 132.00                   | 0.001              |
| <b>Polychlorinated Biphenyls</b> |                                            |                                             |                                            |                                   |                                               |                          |                    |
| Aroclor® 1248                    | 196.36                                     | --                                          | 2.21                                       | 0.20                              | 0.17                                          | 0.41                     | 0.4                |
| Aroclor® 1254                    | 27.93                                      | --                                          | 0.31                                       | 0.028                             | 0.024                                         | 0.41                     | 0.06               |
| Aroclor® 1260                    | 34.24                                      | --                                          | 0.38                                       | 0.035                             | 0.029                                         | 0.41                     | 0.07               |
| Total PCBs                       | 62.39                                      | --                                          | 0.70                                       | 0.063                             | 0.053                                         | 0.41                     | 0.1                |

**Note:** -- - negligible  
CoPC - chemical of potential concern  
PCB - polychlorinated biphenyl  
TRV - toxicity reference value

**Table B-10. Mammalian toxicity reference values**

| CoPC                                                                                                                  | TRV<br>(mg/kg<br>BW/day) | Source                        |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------|
| <b>Metals</b>                                                                                                         |                          |                               |
| Aluminum                                                                                                              | 9.65                     | Ondreicka et al. (1966)       |
| Antimony                                                                                                              | 0.657                    | Schroeder et al. (1970)       |
| Arsenic                                                                                                               | 1.26                     | Schroeder and Mitchner (1971) |
| Barium                                                                                                                | 5.1                      | Perry et al. (1983)           |
| Chromium                                                                                                              | 2,053                    | Mackenzie et al. (1958)       |
| Cobalt                                                                                                                | 0.5                      | Nation et al. (1983)          |
| Copper                                                                                                                | 11.7                     | Aulerich et al. (1982)        |
| Lead                                                                                                                  | 8.8                      | Azar et al. (1973)            |
| Manganese                                                                                                             | 88                       | Laskey et al. (1982)          |
| Selenium                                                                                                              | 0.2                      | Rosenfeld and Beath (1954)    |
| Thallium                                                                                                              | 0.074                    | Formigli et al. (1986)        |
| Vanadium                                                                                                              | 0.2                      | Domingo et al. (1986)         |
| Zinc                                                                                                                  | 160                      | Schlicker and Cox (1968)      |
| <b>Semivolatile Organic Compounds</b>                                                                                 |                          |                               |
| Benz[a]anthracene                                                                                                     | 1                        | Mackenzie and Angevine (1981) |
| Benzo[a]pyrene                                                                                                        | 1                        | Mackenzie and Angevine (1981) |
| Benzo[b]fluoranthene                                                                                                  | 1                        | Mackenzie and Angevine (1981) |
| Benzo[ghi]perylene                                                                                                    | 1                        | Mackenzie and Angevine (1981) |
| Chrysene                                                                                                              | 1                        | Mackenzie and Angevine (1981) |
| Indeno[1,2,3-cd]pyrene                                                                                                | 1                        | Mackenzie and Angevine (1981) |
| Naphthalene                                                                                                           | 1                        | Mackenzie and Angevine (1981) |
| <b>Polychlorinated Biphenyls</b>                                                                                      |                          |                               |
| PCBs                                                                                                                  | 0.15                     | Aulerich et al. (1985)        |
| <b>Note:</b> CoPC - chemical of potential concern<br>PCB - polychlorinated biphenyl<br>TRV - toxicity reference value |                          |                               |

**Table B-11. Avian toxicity reference values**

| CoPC                                  | TRV<br>(mg/kg<br>BW/day) | Source                                                          |
|---------------------------------------|--------------------------|-----------------------------------------------------------------|
| <b>Metals</b>                         |                          |                                                                 |
| Aluminum                              | 122                      | Carriere et al. (1986)                                          |
| Antimony                              | 1,400                    | Damron and Wilson (1975)                                        |
| Arsenic                               | 4.6                      | USFWS (1964)                                                    |
| Barium                                | 20.8                     | Johnson et al. (1960)                                           |
| Chromium                              | 0.864                    | Haseltine et al. (unpublished) as cited in Sample et al. (1996) |
| Cobalt                                | N/A                      | N/A                                                             |
| Copper                                | 47                       | Mehring et al. (1960)                                           |
| Lead                                  | 1.85                     | Edens et al. (1976)                                             |
| Manganese                             | 977                      | Laskey and Edens (1985)                                         |
| Selenium                              | 0.4                      | Heinz et al. (1989)                                             |
| Thallium                              | 0.0237                   | Hudson et al. (1984)                                            |
| Vanadium                              | 11.4                     | White and Dieter (1978)                                         |
| Zinc                                  | 132                      | Stahl et al. (1990)                                             |
| <b>Semivolatile Organic Compounds</b> |                          |                                                                 |
| Benz[a]anthracene                     | 0.143                    | Hough et al. (1993)                                             |
| Benzo[a]pyrene                        | 0.143                    | Hough et al. (1993)                                             |
| Benzo[b]fluoranthene                  | 0.143                    | Hough et al. (1993)                                             |
| Benzo[ghi]perylene                    | 0.143                    | Hough et al. (1993)                                             |
| Chrysene                              | 1                        | Hough et al. (1993)                                             |
| Indeno[1,2,3-cd]pyrene                | 0.143                    | Hough et al. (1993)                                             |
| Naphthalene                           | 0.143                    | Hough et al. (1993)                                             |
| <b>Polychlorinated Biphenyls</b>      |                          |                                                                 |
| PCBs                                  | 0.414                    | Dahlgren et al. (1972)                                          |

**Note:** CoPC - chemical of potential concern  
 N/A - not available  
 PCB - polychlorinated biphenyl  
 TRV - toxicity reference value



## **Attachment B1**

### **Development of Soil- Earthworm BAF for PCBs**

## Development of Soil-Earthworm BAF for PCBs

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A review of available published literature on earthworm accumulation of polychlorinated biphenyls (PCBs) from soil produced the list of studies shown below. The relevant data from these studies were compiled (see plot below) and a regression was computed of the form:

$$\log[biota] = B0 + B1 \times \log[soil]$$

where:

- $\log[biota]$  = base 10 log of the chemical concentration in plant, soil invertebrate, or aquatic prey tissue (dry weight)
- $B0$  and  $B1$  = empirically derived, chemical specific constants
- $\log[soil]$  = base 10 log of the chemical concentration in soil (dry weight)

The final relationship developed was as follows:

$$\text{Wet weight worm concentration: } \log[biota] = 0.1352 + 1.0347 \times \log[soil]$$

Worms were assumed to have an average moisture content of 84 percent (from U.S. EPA 1993), resulting in the following dry weight-corrected equation:

$$\text{Dry weight worm concentration: } 6.25 (\log[biota] = 0.1352 + 1.0347 \times \log[soil])$$

Summary statistics of the regression are also shown below.

### List of Studies

#### Wågman et al. (1999), Environ. Tox. Chem. 18:1157–1163

- Examined PCB levels in three household composts and in worms (*Eisenia foetida*) naturally occurring in the composts (i.e., worms had potentially different resident times).
- Worms depurated for 48 hours before analysis.
- Measured PCB concentrations on a congener-specific and total-PCB basis. Total PCB concentrations (compost = dry weight, worms = wet weight):
  - 32 ng/g in Compost 1; 23 ng/g in worms
  - 120 ng/g in Compost 2; 129 ng/g in worms
  - 444 ng/g in Compost 3; 291 ng/g in worms.

- On a lipid and organic matter normalized basis, worms contained approximately 23 times more PCBs than compost.
  - Bioaccumulation factors (BAFs) were reported for six congeners (52, 101, 118, 138, 153, 180). Values ranged between 8 and 24 on a lipid and organic matter normalized basis.

**Belfroid et al. (1995), Environ. Tox. Chem. 14:605–612**

- Examined PCB levels in topsoil from a household waste dump and in earthworms (*Eisenia andrei*) exposed to that soil for 5–120 days.
- Worms depurated for 24 hours before analysis.
- Analyzed seven PCB congeners (101, 118, 138, 153, 156, 167, 180). Concentrations in soil ranged from 19.8 to 629  $\mu\text{g/kg}$ , dry weight. Concentrations in worms ranged from 5.6 to 197  $\mu\text{g/kg}$  (not specified as wet or dry weight).
- Biota-sediment accumulation factor (BSAF) values were calculated for each congener and reported three ways:
  - BSAF (g soil/g worm) ranged from 0.26 to 0.37
  - BSAF (g organic matter/g lipid) ranged from 5.3 to 7.4 (note that these values are much lower than Wågman reported for the same congeners)
  - BSAF (g OC/g lipid) ranged from 3.1 to 4.3.

**Hendriks et al. (1995), Arch. Environ. Contam. Toxicol. 29:115–127**

- Measured PCBs in the floodplain soils at two sites in the Rhine-Delta and in earthworms (*Lumbriculus rubellus*) collected at the same sites. Shrews, *Sorex araneus*, were also trapped and analyzed.
- Worms depurated for 24 hours before analysis.
- Measured PCB concentrations on a congener-specific and total-PCB basis. Total PCB concentrations (soil = dry weight, worms = lipid normalized):
  - Ochten: 200  $\mu\text{g/kg}$  in soil; 3,900  $\mu\text{g/kg}$  in worms
  - Gelderse Port: 1,000  $\mu\text{g/kg}$  in soil; 1,000  $\mu\text{g/kg}$  in worms.

- PCB residues in fat were on average 0.76 times greater than levels in organic matter. For congeners 52, 101, 138, and 153, the BAFs range between 0.66 and 1.2 at one site and 0.34 and 0.59 at the other site when normalized to lipid and organic matter. (Note that these values are much lower still than values that Belfroid and Wågman reported for the same congeners in their studies.)

**Larsen et al. (1992), Intern. J. Environ. Anal. Chem. 46:149–162**

- Prepared Askarel-spiked soil (150  $\mu\text{g/g}$ ) and measured PCBs in earthworms (*Lumbriculus rubellus*) exposed to the soil for 48 hours and in worms subsequently exposed to low-contaminated soil (1.5  $\mu\text{g/g}$ ) for 60 days.
- Worms depurated for 48 hours before analysis.
- Study measured 17 PCB congeners in soils and worms, and calculated equilibrium soil-to-earthworm bioconcentration factors (BCFs) for each congener. The study reports that BCFs ranged from 4 to 20, but it is not clear from the write-up or tables what basis was used for measuring PCB concentrations in soil or in worms (dry weight, wet weight, lipid-normalized?).

**Beyer and Stafford (1993), Environ. Monitor. Assess. 24:151–165**

- Collected 18 co-located soil and worm (multiple species) samples from nine Great Lakes confined disposal facilities.
- Worms were not depurated before analysis.
- PCBs were below detection limits (0.4–0.6 ppm, dry weight) in worms at 15 sites, and ranged from 0.66 to 1.8 ppm at the other three sites. For these three sites, the PCB accumulation factor was about 1.8–3.4 based on a simple worm:soil dry-weight ratio.

**Diercxsens et al. (1985), Chemosphere 14:511–522**

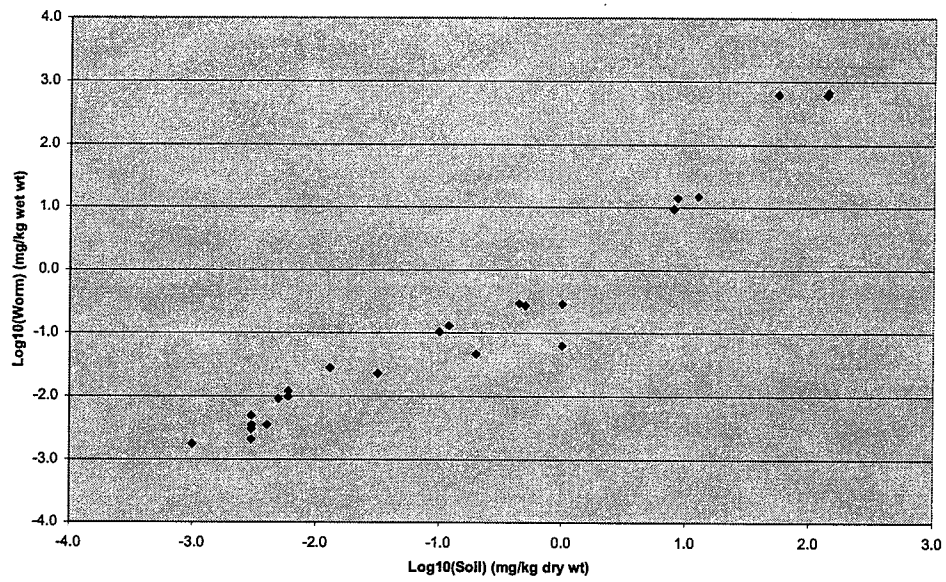
- Compared PCB concentrations in soil and worms at a nature reserve and a vineyard amended with compost.
- Worms depurated prior to analysis, gut contents analyzed separately.

- PCB concentrations in nature reserve soils ranged from 8 to 12.5 mg/kg, dry weight, and concentrations in worms ranged from 9.4 to 15.2 mg/kg, wet weight, giving accumulation factors of 1.2–1.7.
- PCB concentrations in vineyard soils ranged from 55 to 139 mg/kg, dry weight, and concentrations in worms ranged from 330 to 685 mg/kg, wet weight, giving accumulation factors of 2.3–11.5 (two depuration methods were used, producing slightly different final concentrations in worms).
- PCBs in the digestive tracts of worms from the vineyard were 2.9 to 8.1 times greater than concentrations in soil (dry weight:dry weight basis). The authors think this indicates that earthworms choose to ingest soil fractions with a high organic carbon content and thus higher PCB concentrations.

**Kreis et al. (1987), *Pedobiologia* 30:379–388**

- Compared PCB concentrations in soil and worms (*Nicodrilus caliginosus*) from two fields, one treated with liquid sewage sludge and one untreated, with five co-located samples per location.
- Worms were depurated 48 hours before analysis.
- PCB concentrations in surface soils at the untreated field ranged from 1 to 3  $\mu\text{g/kg}$  and worm concentrations ranged from 11 to 31  $\mu\text{g/kg}$  (all values dry weight), resulting in accumulation factors of 4.3–11.0.
- PCB concentrations in surface soils at the treated field ranged from 4 to 13  $\mu\text{g/kg}$  and worm concentrations ranged from 22 to 174  $\mu\text{g/kg}$  (all values dry weight), resulting in accumulation factors of 5.5–13.4.

Soil-worm PCB Bioaccumulation



\*\*\*\*\*Linear Regression Analysis Results\*\*\*\*\*

Variables: X = "Log\_Soil", Y = "Log\_worm"

Equation:  $\text{Log\_worm} = 0.1352 + 1.0347 \cdot \text{Log\_Soil}$

| Variable | N  | Mean    | Variance |
|----------|----|---------|----------|
| Log_Soil | 24 | -0.8308 | 2.7054   |
| Log_worm | 24 | -0.7244 | 3.1013   |

Regression Coefficient = 1.034725  
Standard Error of B = 0.058650  
Y-Intercept = 0.135222  
R-Squared = 0.933983  
Adjusted R-Squared = 0.930983  
Standard Error of Estimate = 0.462652

The 95.0% confidence limits for the slope are: [0.913092, 1.15636]

Analysis of Variance Table

| Source    | DF | SS      | MS      | F        | P          |
|-----------|----|---------|---------|----------|------------|
| Linear    | 1  | 66.6219 | 66.6219 | 311.2500 | 1.801E-014 |
| Deviation | 22 | 4.7090  | 0.2140  |          |            |
| Total     | 23 | 71.3310 | 3.1013  |          |            |

Goodness of Fit Statistics ...

Coefficient of Determination: 0.933983499

Correlation Coefficient: 0.966428217

Model Selection Criterion: 2.551183881

Parameter Statistics

95.00% Confidence Intervals

Parameter a: 0.135222295

StdDev: 0.106267794

Univariate ...

LOW: -0.085163621

HIGH: 0.355608210

Supporting Plane:

LOW: -0.143651486

HIGH: 0.414096076  
Parameter b: 1.034725187  
StdDev: 0.058650313  
Univariate ...  
LOW: 0.913091883  
HIGH: 1.156358490  
Supporting Plane:  
LOW: 0.880811816  
HIGH: 1.188638557



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