

4. LAKE HURON

Lake Huron has only one U.S. Great Lakes AOC, the Saginaw River and Bay AOC.

4.1 SAGINAW RIVER AND BAY AOC, ARENAC, BAY, CLARE, GENESEE, GLADWIN, GRATIOT, HURON, IOSCO, ISABELLA, LAPEER, LIVINGSTON, MECOSTA, MIDLAND, MONTCALM, OGEMAW, OSCEOLA, ROSCOMMON, SAGINAW, SANILAC, SHIAWASSEE, AND TUSCOLA COUNTIES, MI

The Saginaw River and Bay AOC includes all of Saginaw Bay out to its interface with open Lake Huron at an imaginary line drawn between Au Sable Point and Point Aux Barques, as well as the entire 35 km length of the Saginaw River, which flows into Saginaw Bay (see AOC map in the appendix).

4.1.1 Hazardous Waste Sites Relevant to the Saginaw River and Bay AOC

ATSDR has evaluated the data for hazardous waste sites in the 21 counties relevant to this AOC, and reached conclusions regarding the public health threat posed by these sites. These conclusions, along with information regarding the type and location of the site, and the date and type of assessment document, are summarized in Table 4.1-A, for sites that had public health hazard categories of 1-3 at some point during their assessment history, and all NPL sites. Not all counties had waste sites in these categories.

For hazardous waste sites in the relevant Michigan counties that, at any time, had Public Health Hazard Categories of 1-3, the number of contaminant records in HazDat that exceeded health based-screening values was 1,550, as shown in Table 4.1-B. Most of the records were for the soil media group; the water media group had the next highest number of records.

The IJC Great Lakes critical pollutants accounted for 197 (13%) of these records, with the majority for the soil media group. The specific IJC critical pollutants whose concentrations exceeded health-based screening values are: PCBs, TCDD, B(A)P, DDT and metabolites, aldrin, dieldrin, lead, mercury, and hexachlorobenzene. Details are provided in Table 4.1-B.

Further evaluations of the data for the sites with Public Health Hazard Categories of 1-3, as conducted by ATSDR in the Public Health Assessment and other health-related documents listed in Table 4.1-A, are discussed in the following subsections.

4.1.1.1 Bay City Middlegrounds

The Bay City Middlegrounds site is an abandoned 40-acre landfill located on Middleground Island in the Saginaw River in southwestern Bay City, Bay County, MI. It operated as a landfill from 1956 to 1984. The landfill is partially capped, and has a leachate collection system. The cap was not fully sealed to the lower cap, and leachate has seeped out into ditches along the nearby roads. It was fenced on three sides, but not on the fourth, which borders the river, at the time that the 1996 health assessment was prepared by ATSDR. Information on this site is taken from that health assessment and from the 2003 EPA NPL fact sheet for this site.

Table 4.1-A Hazardous Waste Sites in Counties Relevant to the Saginaw River and Bay AOC

Site Name, County	Public Health Hazard Category	EPA NPL Status	Site ID	City
Bay City Middlegrounds, Bay	2 (1996 HA)	Proposed	MID981092935	Bay City
Keit Property, Bay	3 (1998 HC)	Non NPL	MISFN0507867	Bay City
Clare Water Supply, Clare	3 (1989 HA) 3 (n.d. SR)	Final	MID980002273	Clare
Berlin and Farrow, Genesee	3 (1985 HA) 2 (1992 HA)	Deleted Post SARA	MID000605717	Swartz Creek
Forest Waste Products, Genesee	3 (1988 HA) 3 (1994 HA)	Final	MID980410740	Otisville
Gratiot County Landfill, Gratiot	3 (1982 HA) 4 (n.d. SR)	Final	MID980506281	St. Louis
Velsicol Chemical Corp., Gratiot	3 (1988 HA) 3 (n.d. SR)	Final	MID000722439	St. Louis
Hedblum Industries, Iosco	3 (1989 HA)	Final	MID980794408	Oscoda
Wurtsmith Air Force Base, Iosco	4 (2001 HA)	Proposed		
Metamora Landfill, Lapeer	3 (1989 HA) 3 (1992 HA) 4 (n.d. SR)	Final	MID980506562	Metamora
Spiegelberg and Rasmussen Dump Sites, Livingston	3 (1989 HA) 2 (1992 HA)	Final	MID980794481, MID095402210	Brighton
Shiawassee River, Livingston	3 (1989 HA) 2 (n.d. SR)	Final	MID980794473	Howell
Dow Chemical Co., MI Div., Midland Loc, Midland	3 (2002 HC)	Non NPL	MID000724724	Midland
Tittabawassee River, Saginaw	3 (2002 HC)	Non NPL	MID980994354	Midland
Lufkin Rule, Saginaw	2 (1997 HC)	Non NPL	MID985584598	Saginaw
Laingsburg, Shiawassee	3 (2000 HC)	Non NPL	MISFN0507944	Laingsburg

2 = Public Health Hazard, 3 = Indeterminate Public Health Hazard, 4 = No Apparent Public Health Hazard

HA = Public Health Assessment, HC = Health Consultation SR = Site Review and Update

n.d. = no date provided

Category of Public Health Hazard: This site was categorized as a *Public Health Hazard* (Category 2) because the surface soil contains organic chemicals and metals at concentrations potentially of human health concern, and trespassing occurs. In addition, the PCB-containing discharge from the landfill contributes to PCB contamination in the fish of the Saginaw River.

Contaminants of Concern in Completed Exposure Pathways: Many organic and inorganic chemicals, including the IJC critical pollutants PCBs, B(a)P, aldrin, dieldrin, hexachlorobenzene, lead, and mercury, are found in onsite soil, groundwater, and sediment at concentrations exceeding health-based screening values. Actual exposure doses, however, are not likely to be of health concern for trespassers on the site, except upon frequent or prolonged exposure, which is not likely to occur. Soil and sediment concentrations of PAHs, including B(a)P, were typical of urban soils. Lead concentrations in soil were well above background, but lower than 400 ppm. Groundwater contaminated with PCBs discharges from the site into the Saginaw River, and PCBs have been found in the river water and sediment, at higher concentrations downstream of the site than upstream. Methylene chloride, detected in air at concentrations of human health concern including upwind of the site, may not be site-related.

Bioaccumulation of the PCBs through the food chain into fish that are ingested by humans is considered a pathway of great concern. Although this site is not the only source of PCBs discharged to the river, it contributes to the contamination, and levels of PCBs in fish are high enough to pose a risk of adverse health effects. This site was proposed for the NPL in 1995.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	793
Females aged 15-44	1,662
Adults 65 and older	1,000

Public Health Outcome Data: The Michigan Department of Community Health evaluated cancer incidence data for the area because of community health concerns. Statistics for 1990-1992 showed no statistically significant difference in cancer incidence or mortality between Bay County and Michigan as a whole. Cancer incidence for the zip code area including the site and Bay City west of the Saginaw River (48706) and for the zip code area including Bay City east of the Saginaw River (48708) for 1990 through 1993 indicate a slight, statistically significant elevation in the cancer incidence and rate for the entire period 1990-1993 in 48706, as compared with age- and sex-specific cancer incidence rates for Michigan. None of the cancer incidences or rates for 48708 was statistically significantly increased.

Conclusions: This site has contributed and continues to contribute to the environmental burden of the IJC critical pollutants PCBs, which are discharging from the landfill into the Saginaw River. PCBs are the major concern. PCB concentrations in fish are high enough to pose a health threat, and although this site is not the only contributor, concentrations in the river water and sediment are higher downstream than upstream of the site.

4.1.1.2 Keit Property

The Keit property is approximately 18 acres of wetlands, grasslands, and woods in southwest Bay City, Bay Count, MI. It was used for agriculture since 1886. A large portion of the property has been filled in with material reportedly generated during a sewer project in the 1980s.

ATSDR performed a health consultation on this site in 1998, as part of a Brownfields project; the information regarding this site is taken from that report, and from HazDat.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because of the potential threat to human health from exposure to asbestos if the asbestos panels are not been removed from the property before it is used for a park.

Contaminants of Concern in Completed Exposure Pathways: None identified. Soil concentrations of the IJC critical pollutant B(a)P exceeded health based screening values in a few locations, but were considered typical for urban soils. Subsurface soil in one location contained PCBs above health-based screening values, but this was not a generalized finding, and surface soil concentrations of PCBs were not of concern. The primary hazard was a pile of Transite

panels, containing 40% chrysotile asbestos. If the panels are allowed to weather or are handled improperly, they could release asbestos fibers.

Demographics: Not reported.

Public Health Outcome Data: Not reported.

Conclusions: This site does not appear to have contributed significantly to the environmental burden of IJC critical pollutants or other chemicals, or to direct human exposure at levels that currently pose a health risk.

4.1.1.3 Clare Water Supply

This site, a municipal water supply wellfield, is located in Clare, Clare County, MI. Information regarding this site is taken from the 1989 ATSDR preliminary public health assessment, HazDat, and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: ATSDR categorized this site as an *Indeterminate Public Health Hazard* (Category 3) in 1989 because of the potential threat to human health from exposure to municipal water containing VOCs, and the lack of up-to-date data to determine whether cleanup efforts have ameliorated the hazard. A subsequent ATSDR site review and update also concluded that the site was a Category 3.

Contaminants of Concern in Completed Exposure Pathways: No IJC critical pollutants were discussed. In 1985, VOCs, including trichloroethylene and other chlorinated compounds, and also benzene and xylenes were present in the groundwater used as the municipal water supply at concentrations that pose a public health concern. Past completed exposure pathways included ingestion, inhalation, and dermal contact with the water. Contaminated soil from the suspected industrial sites northwest of the wellfield was then removed, but updated monitoring data were not available at the time of the 1989 health assessment. Air strippers were installed in 1991 and are removing over 90% of the volatile contaminants from the water supply. Additional remedial action, including groundwater collection and extraction initiated in 1996, soil vapor extraction initiated in 1999, and *in situ* ozonation of groundwater hot spots, is expected to continue for an indefinite number of years until cleanup goals are achieved.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	323
Females aged 15-44	718
Adults 65 and older	640

Public Health Outcome Data: Not reported.

Conclusions: This site has contributed to the environmental burden of VOCs and to potential human exposure. Remediation efforts, which are ongoing, are minimizing current and future impacts.

4.1.1.4 Berlin and Farrow

This 40-acre site, located in Gaines Township near Swartz Creek, Genesee County, MI, was used as a licensed waste incinerator from 1971 to 1978. Violations included construction and operation of unlicensed waste lagoons and underground storage tanks, and burial of liquid wastes. Information regarding this site is taken from the 1992 interim public health assessment performed by ATSDR, HazDat, and the 2003 EPA NPL fact sheet. Cleanup activities prior to 1992 included removal of contaminated lagoon sludges and soils, removal of underground tanks and their contents, and removal of barrels. The chemicals in these materials included organochlorine intermediates (hexachlorobenzene, hexachlorocyclopentadienes, and octachlorocyclopentene) used in the production of certain pesticides, and also PCBs, benzene, and ethylbenzene.

Category of Public Health Hazard: In an early (1985) health assessment, ATSDR categorized this site as an *Indeterminate Public Health Hazard* (Category 3). In the 1992 interim public health assessment, this site was categorized as a *Public Health Hazard* (Category 2) because of the risk to human health from exposure to contaminants that may result in adverse health effects. Since that time, however, remediation of the site has been completed.

Contaminants of Concern in Completed Exposure Pathways: Not explicitly discussed. Onsite soil and sediment contained high levels of the IJC critical pollutant hexachlorobenzene; onsite surface water also was contaminated. Offsite sediment in the Slocum Drain, a stream draining the site, was contaminated with high levels of hexachlorobenzene. Offsite garden soil also contained hexachlorobenzene, but at much lower concentrations. Comparisons with health-based screening values were not presented for hexachlorobenzene. Onsite soil and groundwater were contaminated with VOCs, including vinyl chloride and benzene at levels of concern for human health. PCBs, found in drums removed from the site, were not detected in sampling of site media as reported in the 1992 ATSDR health assessment. None of the offsite residential wells were contaminated with any of these compounds. From 1995 to 1996 final cleanup of the site was accomplished by excavation and removal of all remaining contaminated materials (soils, sediments, and aquifer materials), for disposal in a RCRA landfill. The site meets standards for unrestricted use and was deleted from the NPL in 1998.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	54
Females aged 15-44	148
Adults 65 and older	55

Public Health Outcome Data: Health surveys of households within the approximately two square miles surrounding the site were conducted in 1981. Surveys of a random sampling of the population, followed by a survey of all 122 households (418 people), found that respiratory symptoms were statistically significantly higher among persons who reported exposure to incinerator smoke as compared with those who reported no exposure to incinerator smoke. This information may suggest that the former industrial activity (incineration of hazardous wastes) at the site was potentially linked to health problems, but it does not provide insight into the potential health hazard from waste site-related contaminants.

Laboratory analyses of blood samples from 52 local residents revealed the presence of PCBs, DDT, and DDE at concentrations within the ranges generally found in Michigan residents, and thus, do not indicate a specific impact from the waste site.

Conclusions: In the past, this site contributed to the environmental burden of the IJC critical pollutant hexachlorobenzene, as well as other contaminants including VOCs. Although PCBs had been found in barrels at the site, they were not detected in environmental media. As reported in the EPA fact sheet, remediation of the site through removal and proper disposal of all contaminated materials and media is complete. The site was deleted from the NPL list in 1998.

4.1.1.5 Forest Waste Products

This 112-acre site is located 2 miles northwest of Otisville, Genesee County, MI. It includes an 11-acre landfill, which accepted general refuse and industrial and liquid waste from 1972 to 1978. Nine lagoons in another area of the site, covering a total of about 1 acre, also were used for disposal of industrial waste. Wastes included sludge and residues from a chemical warehouse fire, roofing material contaminated with PCBs, and cattle feed contaminated with PBBs. In 1978, the landfill was covered with soil. An estimated 3,000 waste drums may have been buried in the landfill. As of ATSDR's 1994 public health assessment, the site had been fenced, the waste material in the lagoons excavated and disposed offsite, and some of the drums removed and disposed offsite. The information on this waste site is taken from the 1994 ATSDR public health assessment, HazDat, and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) in a 1988 health assessment as well as in the 1994 health assessment. The rationale in the 1994 assessment was that although human exposure did not appear to be occurring at levels of concern, uncertainty exists regarding the large number of drums reported to be buried in the landfill, which may release their contents into the environment.

Contaminants of Concern in Completed Exposure Pathways: The only chemical found at levels of concern for human health in a completed exposure pathway was arsenic, found in residential wells near the site, but the arsenic was thought to be of natural origin, rather than site-related. Although the IJC critical pollutant PCBs were disposed at the site and formerly were found in subsurface soil, the PCBs had been removed during earlier remediation actions. Several contaminants were found at levels of concern in potential exposure pathways, including the IJC critical pollutant B(a)P, but the concentration of B(a)P in soil was not significantly above that

commonly found in agricultural soil. VOCs have been found in groundwater, but not in residential wells. The IJC critical pollutants DDT and metabolites were found in game captured at the site boundary, but these contaminants were not site-related.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	34
Females aged 15-44	81
Adults 65 and older	48

Public Health Outcome Data: Health outcome data were not evaluated in conducting the 1994 public health assessment because there were no indications that humans had been significantly exposed to site-related contaminants, and no record of community reports of illnesses or health effects associated with the site.

Conclusions: Whether this site contributed to environmental contamination with IJC critical pollutant PCBs in the past is uncertain. No current exposure of humans to site-related contaminants at levels of concern is known to be occurring. Additional remediation activities, as described in the EPA NPL fact sheet, included excavation and removal of buried drums and associated contaminated soil, and installation of a landfill cap. Monitoring of groundwater continues, particularly of a plume of VOCs that is migrating northward off the property.

4.1.1.6 Gratiot County Landfill

This 40-acre landfill site is located southeast of St. Louis, in Gratiot County, MI. This landfill accepted general refuse, but was owned by a chemical corporation (Michigan Chemical Company), and disposed of chemical wastes, including 269,000 pounds of PBBs, prior to 1977. The information regarding this site is taken from the 1982 ATSDR health assessment, HazDat, and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) in the 1982 health assessment, which focused on PBBs because of the potential threat to human health from exposure to contaminants and the poor quality of the support document that presented the monitoring data. A subsequent site review and update by ATSDR ranked the site as *No Apparent Health Hazard* (Category 4), possibly because remedial activities had mitigated the hazard. Remedial actions in 1984 included construction of a slurry wall and clay cap, and regrading of the landfill to minimize migration of contaminants from the landfill. In 1992, monitoring of the effectiveness of these remedies indicated that the slurry wall was ineffective in halting groundwater flow, and that VOCs (but not PBBs) were detected outside the slurry wall. A groundwater extraction system, constructed in 1998, appears to be effective in containing the plume. Further options are being evaluated by the Michigan Department of Environmental Quality, according to the EPA NPL fact sheet.

Contaminants of Concern in Completed Exposure Pathways: Not reported. The 1982 health assessment by ATSDR was primarily a review of a technical report regarding potential control strategies for the PBB contamination at the site. PBBs were detected in groundwater at concentrations above health-based screening values. No IJC critical pollutants were mentioned in the health assessment or the NPL fact sheet, but VOCs were apparently released from the site.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	170
Females aged 15-44	390
Adults 65 and older	252

Public Health Outcome Data: None reported.

Conclusions: This site may have contributed to the environmental burden of PBBs and VOCs in the past. The PBBs and VOCs have not been removed, but rather are contained by a slurry wall, cap, and groundwater extraction system.

4.1.1.7 Velsicol Chemical

This 52-acre site is located in the City of St. Louis, Gratiot County, MI, and is surrounded on three sides by the Pine River, which drains into the Tittabawasse River, which joins the Saginaw River near the city of Saginaw. Velsicol Chemical Corporation, previously known as the Michigan Chemical Company, produced a variety of chemicals, including PBBs and DDT, at the Velsicol Chemical site plant from 1936 to 1978. Velsicol completed construction of a containment system at this site in 1985. This system consisted of a slurry wall around the entire site and a clay cap over the site. Information regarding this site is taken from the 1988 ATSDR preliminary health assessment, HazDat, and the 2003 EPA NPL fact sheet.

Category of Public Health Hazard: In 1988, ATSDR categorized this site as an *Indeterminate Public Health Hazard* (Category 3) because exposure to PBBs through the food chain (fish and wildlife) has occurred and may possibly be still occurring, even though fish consumption advisory was issued. A subsequent site review and update also placed the site in this health hazard category.

Contaminants of Concern in Completed Exposure Pathways: None identified in the 1988 health assessment. The potential exposure of concern was to PBBs bioaccumulated in fish and wildlife. ATSDR noted that fish and river water and sediment concentrations of PBBs were declining. Subsequent developments included deterioration of the slurry wall in 1994, admitting water into the containment system; discovery of very high levels of DDT and metabolites in sediment of the Pine River/St. Louis impoundment; and the migration of dense non-aqueous phase liquids (DNAPL) from the containment area into the glacial till underlying the river sediments. The sediment and DNAPL were in the process of being removed and treated, according to the 2003 EPA NPL fact sheet.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	365
Females aged 15-44	821
Adults 65 and older	676

Public Health Outcome Data: In 1976, the Michigan Department of Public Health recruited many Velsicol workers for a PBB health study, which placed workers and their families in a registry to study the long-term effects of PBB exposure. The study, conducted in cooperation with the CDC, FDA, and EPA, was in operation at the time of the 1988 health assessment. Subsequent findings of this study included some evidence of an association between high PBB exposure with an elevated risk of cancers of the breast and the digestive system and of lymphomas. Because of the small number of cases, no definitive conclusions may be drawn from these findings. In addition, higher rates of neurologic, immunologic, dermatologic, and musculoskeletal health effects have also been observed in the registry cohort. However, no consistent pattern of an association between these health effects and serum PBB levels have been determined. The study results were drawn from a fact sheet of Frequently Asked Questions about PBBs in Michigan, published by the Michigan Department of Community Health (accessed 2006 at http://www.michigan.gov/documents/mdch_PBB_FAQ_92051_7.pdf).

Conclusions: This site has contributed to the environmental burden of the IJC critical pollutant DDT and metabolites, and also PBBs, with particular impacts on the Pine River/St. Louis impoundment sediments and fish. According to the EPA NPL fact sheet, although PBB concentrations are declining, DDT and metabolite concentrations in sediment are not. Remediation is underway. In addition, dense non-aqueous phase liquids have migrated from the site into the glacial till under the river sediments and are also being remediated.

4.1.1.8 Hedblum Industries

The Hedblum Industries site is a 10-acre parcel located in Oscoda, Iosco County, MI, 1.2 miles west of Lake Huron. The site was leased to a series of industrial firms that manufactured parts for the automotive industry. Waste chemicals, including an estimated 4,000 gallons of spent trichloroethylene from a degreasing operation, were dumped in a pit near the main building. A pipe connecting an underground storage tank for trichloroethylene leaked. A number of residential wells in the area were found to be contaminated in 1973-1977. Most of the residents in the area of contamination were connected to municipal water in 1978, but a number were not. Trichloroethylene also was found in the bayou into which groundwater from the site discharges. The bayou feeds the Au Sable River. The information regarding this site is taken from the 1989 ATSDR health assessment and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because of the potential threat to human health from exposure to trichloroethylene and other VOCs.

Contaminants of Concern in Completed Exposure Pathways: None identified. No IJC critical pollutants are associated with this site. TCE has been identified in residential well water; eight households were estimated to have used contaminated well water at their household for an indeterminate time before they were switched to municipal water, but data were not adequate to measure the risks. One resident, as reported by EPA (2006), still has not switched to municipal water, and others use well water for gardens and lawns. Exposure pathways include ingestion, dermal contact, and inhalation of trichloroethylene volatilized from the water. As of 1990, no VOC contaminants were detected in residential wells. The groundwater is being treated by a system constructed in 1993. EPA reported (2006) that the potential for exposure to trichloroethylene via subsurface vapor intrusion is being addressed.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	135
Females aged 15-44	331
Adults 65 and older	349

Public Health Outcome Data: None reported.

Conclusions: This site has contributed to human exposure and to the environmental burden of trichloroethylene in the past through contamination of groundwater used for household water and discharge of contaminated groundwater into a bayou feeding the Au Sable River where trichloroethylene, as reported by EPA (2006), was expected to volatilize. The groundwater, however, has been under remediation since 1993 (date reported by EPA 2006). EPA has also stated (2006) that the system has not been fully effective and will be upgraded in the near future.

4.1.1.9 Metamora Landfill

This 160-acre site, located near the village of Metamora, Lapeer County, MI, contains a 25-acre landfill and 2 drum disposal areas, which may have contained many thousands of drums, believed to contain primarily paint and solvents. Testing of the drum wastes revealed that they contained VOCs, SVOCs, PAHs, and metals, at concentrations as high as 15%, and PCBs at as much as 1,200,000 ppb. As of 1990, excavation and offsite disposal of the drums and associated contaminated soil was underway. The information regarding this site was taken from the 1992 ATSDR public health assessment, HazDat, and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: This site was categorized in the 1992 health assessment (and in an earlier health assessment, not provided for inclusion) as an *Indeterminate Public Health Hazard* (Category 3) because although no current exposures at levels of concern had been documented, there was the potential for future exposure through groundwater use as household water. A subsequent ATSDR site review and update concluded that the site poses *No Apparent Public Health Hazard* (Category 4).

Contaminants of Concern in Completed Exposure Pathways: None. In 1992, ATSDR was concerned about the potential for exposure to VOCs and metals (particularly arsenic) at concentrations that may result in adverse health effects if, in the future, the shallow groundwater plume extends as far as private wells that tap the shallow aquifer. Although the IJC critical pollutant PCBs was found at high concentrations in drums at the site, no further mention was made of this pollutant in the health assessment, implying that it had not contaminated the environment significantly. Site remediation has included the incineration of approximately 35,000 drums and 10,000 tons of soil offsite, and inclusion of minimally contaminated soil under a landfill cap. Groundwater studies in 1997, 1999, and 2000 indicate the VOC groundwater plume is stabilized. Therefore, monitored natural attenuation has been adopted as the remedy for groundwater.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	98
Females aged 15-44	205
Adults 65 and older	93

Public Health Outcome Data: Local health authorities have said that they have received no complaints of adverse health effects that can be plausibly associated with the site. Because ATSDR's analysis of the potential for human exposure to site-related chemicals did not indicate that adverse health effects were likely, no further investigation of health outcome data was performed.

Conclusions: This site may have contributed to the environmental burden of VOCs, but it has been remediated. As reported in the EPA fact sheet, extensive remediation of the site, including onsite incineration of wastes and disposal of the resulting ash in the landfill, capping, vegetating, installation of a runoff treatment system, and installation of a groundwater extraction system, has largely eliminated releases of contaminants from the site.

4.1.1.10 Spiegelberg and Rasmussen Dump Sites

The 115-acre Spiegelberg Site and the 33-acre Rasmussen Dump are two separate sites in Livingston County, MI, that share a common property line. They are considered together in ATSDR health assessments. Both sites were used for the disposal of municipal and industrial wastes. Paint wastes were disposed on the Spiegelberg Site, and drummed industrial wastes were disposed on the Rasmussen site. Many of the drums were removed, along with contaminated soil, in 1984. A few residences are located on the sites. Information regarding these sites is taken from the 1989 public health assessment and the 1992 public health assessment addendum prepared by ATSDR, and from the 2003 EPA NPL fact sheets for the sites.

Category of Public Health Hazard: These sites were categorized as an *Indeterminate Public Health Hazard* (Category 3) in 1989 because of the potential threat to human health from exposure to contaminants at levels that may result in adverse health effects and incomplete

monitoring data. In the 1992 health assessment, the sites were categorized as *Public Health Hazard* (Category 2) because of the threat of exposure to contaminated groundwater that was likely to occur unless the remedial actions indicated for this site were carried out.

Contaminants of Concern in Completed Exposure Pathways: None. In 1989, chemicals of concern in potential exposure pathways included the IJC critical pollutants PCBs (groundwater and soil) and lead (groundwater and soil). Other contaminants of concern in potential exposure pathways were VOCs, including vinyl chloride and methylene chloride, in groundwater. In 1992, additional testing results were found to support the findings from the 1989 health assessment. Subsequent remedial actions included the removal of additional drums and contaminated soil, with disposal offsite, installation of a landfill cap, and installation of groundwater treatment. These actions have been found to be protective of public health and the environment.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of these sites:

	Spiegelberg	Rasmussen
Children 6 years and younger	119	59
Females aged 15-44	223	121
Adults 65 years and older	73	54

Public Health Outcome Data: Health outcome data were not evaluated because of a lack of community health concerns and of evidence that humans had not been significantly exposed to site-related contaminants.

Conclusions: This site may have contributed to the environmental burden of the IJC critical pollutant PCBs and lead, as well as other contaminants including VOCs, in the past. Remediation of these sites, including removal of much of the contamination, groundwater treatment, and ongoing monitoring make it unlikely that there will be further releases of contaminants or exposure of human populations.

4.1.1.11 Shiawassee River

The Shiawassee River site, Livingston County, MI was contaminated by the Cast Forge Company, which discharged wastewater contaminated by hydraulic fluids containing PCBs into the South Branch of the Shiawassee River from 1969 to 1973. From 1973 to 1977, waster was discharged into a 400,000 gallon lagoon onsite. Discharges and overflows from this lagoon contaminated nearby wetlands and the Shiawassee River. Starting in 1982, the company removed the lagoon, cleaned up the PCB-contaminated soil and sediment from its property, and provided funds for restoration of the river. Dredging of the South Branch began in 1982, but only the first mile downstream from the plant was treated, removing approximately 2,600 pounds of PCBs. Both the company property and the river were still contaminated as of the ATSDR 1989 health assessment, from which information on this site is taken. Additional more recent information is taken from HazDat and the 2003 EPA NPL fact sheet for this site.

Category of Public Health Hazard: In the 1989 health assessment, this site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because of the risk to human health that could result from potential exposure to PCBs at levels that may result in adverse health effects. A subsequent ATSDR site review and update concluded that the site is a *Public Health Hazard* (Category 2).

Contaminants of Concern in Completed Exposure Pathways: Not identified. The concern was for potential exposure pathways including direct contact with PCB-contaminated river sediments or by eating PCB-contaminated fish or wildlife. PCB levels in fish tissue downstream from Cast Forge were very high; advisories against consumptions of fish from the contaminated zone were issued in 1979. The NPL fact sheet reports that remediation of the flood plain and contaminated areas near Cast Forge to 10 ppm PCBs, and of the river to 5 ppm PCBs for the first mile only, was occurring with an expected completion date of fall 2003.

Demographics: Demographic profile, from the 2000 U.S. Census, for vulnerable populations living within one mile of this site:

Children 6 years and younger	397
Females aged 15-44	885
Adults 65 and older	615

Public Health Outcome Data: None reported.

Conclusions: This Cast Forge Company's releases of PCBs to the Shiawassee River greatly contributed to the environmental burden of the IJC critical pollutant PCBs. Remediation of the company property, floodplain, and first mile of the river will mitigate, but not eliminate, the contamination.

4.1.1.12 Dow Chemical Co., Michigan Division, Midland Location

The Dow Chemical Company plant in the city of Midland, Midland County, MI was the subject of an ATSDR health consultation that was triggered by community concerns regarding high levels of PCDDs in soil in Midland and in fish in the nearby Tittabawassee River downstream of Midland. The Dow plant encompasses approximately 1,900 acres on the southern perimeter of the city. The Tittabawassee River forms the southern boundary of the plant site and flows southeast to join with the Saginaw River in the vicinity of the city of Saginaw. EPA reported (2006) that in the late 1800s, the Dow plant began production of chlorine from brine using an electrolytic cell process. PCDDs, PCDFs, and octachlorostyrene are known to be by products of the electrolytic cell process. A variety of chemicals have been produced at this Dow plant, including Agent Orange [which contains 2,4,5-trichlorophenoxyacetic acid (2,4,5-T)], and 2,4,5-trichlorophenol. PCDDs and PCDFs are known to be impurities in some chlorinated phenolic chemicals, such as 2,4,5-trichlorophenol and 2,4,5-T. Chlorophenol production started in 1915. Wastes generated from this process were initially transferred to 600 acres of onsite waste ponds. During high flow periods in the early 1900s, wastes from these ponds were intentionally released to the Tittabawassee River. Some site waste has been and is taken by truck from the Dow plant to local landfills. Since that time, Dow has operated its own wastewater treatment plant onsite,

but a significant flood in 1986 overwhelmed the wastewater treatment plant and flooded areas of the plant where soils were contaminated with PCDDs. The runoff and untreated or partially treated chemical wastes entered the Tittabawassee River. Two incinerators are used for treatment of liquid and solid hazardous and non-hazardous wastes generated from manufacturing at the plant. Incineration of chlorine-containing wastes also produces PCDDs and PCDFs. Information regarding this site is taken from the 2002 health consultation prepared by ATSDR. This health consultation focused on contamination of Midland soil. A separate health consultation was prepared regarding contamination in the Tittabawassee River floodplain near the city of Saginaw, in Saginaw County (see Section 4.1.1.13).

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because the data necessary to determine if dioxin contaminated soil in the Midland area poses a public health risk are not available. However, EPA reported (2006) that the Michigan Department of Public Health and the EPA had concluded that dioxin contamination (as PCDD and PCDF) found in some Midland residential soils, and in fish presented an unacceptable public health risk.

Contaminants of Concern in Completed Exposure Pathways: Not identified. The IJC critical pollutants PCDDs and PCDFs were found at very high concentrations (expressed as total toxic equivalent, TEQ) concentrations in soil at the Dow plant. The residential areas to the northeast are expected to have the highest impact from historical incinerator emissions, but no data are available concerning dioxin concentrations in these areas of Midland. Most of the TEQ concentration data for the community fall within the range (>50 but <1000 ppt TEQs) that triggers additional ATSDR evaluation, including consideration of background and bioavailability data in order to evaluate the incremental contribution of soil exposure; this information was not available. EPA also reported that an initial investigation for other contaminants besides PCDDs and PCDFs is expected to be completed in 2007.

Demographics: Residential neighborhoods are located in close proximity to the northeast perimeter of the Dow plant and within a quarter of a mile from a soil sampling site where total TEQs were above the ATSDR action level of 1,000 ppt.

Public Health Outcome Data:

- EPA reported (2006) that mortality rates from soft and connective tissue cancers among white females from Midland County were confirmed to be 3.8 and 4.0 times the national average for the periods of 1960 – 1969 and 1970 – 1978, respectively. While the statistically significant excess cancer rates may have occurred by chance alone, it was believed unlikely suggesting that some other exposure factor was involved.
- An analysis of cancer incidence data for zip codes 48640 (southwest area of Midland including the Dow plant site) and 48642 (area northeast of the Dow plant) as compared with Midland County, Bay County, and the state of Michigan showed no elevated incidences of specific cancer types in these two zip code areas. There was a higher-than-expected incidence of all cancers combined in 48640 (but not 48642) as compared with Midland County, Bay County, and the state of Michigan for individual years 1994

through 1998 and all years combined. A higher-than-expected incidence of all cancers combined was seen in this zip code area upwind and including the site, but not the zip code area downwind of the site, which was considered more highly contaminated with PCDDs and PCDFs from the Dow Chemical Company's onsite incineration of chemical wastes. The interpretation of this data is not easily ascertained. Age-adjusted incidence rates for thyroid cancer in the two zip code areas were also computed and were considered statistically unreliable. This was documented in a table from the Michigan Department of Community Health (June 5, 2001) without numeric values being shown to justify this conclusion.

- A Dow Cohort mortality study of workers in the Midland plant compared 2,187 male employees who worked at any time between 1940 and 1983 in areas of the plant where there was potential exposure to dioxin, with exposure classified on the basis of job history. Causes of death were compared to those of the U.S. population and an internal "unexposed" group of employees. Rates for all causes of death were lower in the exposed cohort than in the U.S. population, likely due to the healthy worker effect (workers being healthy or they would not be working). However, there was a slightly higher rate for some cancers when the workers were compared to a group of unexposed employees. The relevance of this study to the non-Dow-employee residents of the community was considered questionable since the exposure situation is probably very different for workers as compared to the area residents.
- An analysis of birth defects data for 1992 through 1996 from the Michigan Birth Defects Registry did not show any consistent pattern of excesses in any particular category or for birth defects overall for Midland County (about 1,000 births/year). No excess was seen for types of birth defects, such as anencephaly, spina bifida, and cleft lip, which had been reported as related to dioxin exposure.
- In addition, EPA reported (2006) that the Michigan Department of Public Health Evaluations of Congenital Malformation Rates and Soft and Connective Tissue Cancer Mortality Rates determined higher than expected birth defects and cancer in Midland (Michigan Department of Public Health, 1983). Specifically, data from birth and fetal death records showed significantly higher rates in Midland County for four anomalies, when the number of these anomalies were contrasted to those documented for the entire State of Michigan. The data was for grouped years from 1970 to 1975. The defects included cleft lip with or without cleft palate, cleft palate without cleft lip, hypospadias, and hip dislocation without CNS defects.

Conclusions: This site has contributed to the environmental burden of the IJC critical pollutants PCDDs and PCDFs. Whether residents of the community near the plant experienced a level of exposure sufficient to be considered a public health risk could not be determined. This was due to the lack of soil monitoring in areas where exposure could have occurred and the lack of bioavailability data to evaluate incremental contribution of soil exposure. However, EPA reported (2006) that the agency had collected sufficient soil and fish data in the 1980s to conclude that a public health risk did exist from consumption of fish. Fish consumption advisories were subsequently established for PCDDs and PCDFs.

4.1.1.13 Tittabawassee River

The Dow Chemical Company plant in the city of Midland, Midland County, MI was the subject of an ATSDR health consultation that was triggered by community concerns regarding high levels of PCDDs in soil in the city of Midland and in fish in the nearby Tittabawassee River downstream of Midland. An additional concern arose when sampling of the Tittabawassee floodplain near the confluence of the Tittabawassee and Saginaw Rivers revealed high levels of dioxin contamination. The soil contamination issue was considered in the ATSDR health consultation on the Dow Chemical Co. site, presented in Section 4.1.1.12, which provides a description of the plant location and releases to the environment. The issue of contamination of the floodplain of the Tittabawassee River is considered in a separate 2002 ATSDR health consultation, summarized below. The Tittabawassee floodplain area that is potentially of concern extends from the City of Midland in Midland County to the City of Saginaw in Saginaw County. The sampling sites were within Saginaw County.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because of the potential threat to human health from exposure to PCDDs and PCDFs and the lack of monitoring data for the residential area. Initial findings of a University of Michigan study, as reported by EPA (2006), are suggestive of an exposure-related elevated blood levels for dioxin in residents consuming fish from the area and in those participating in the area's recreational activities (see Public Health Outcome data).

Contaminants of Concern in Completed Exposure Pathways: Elevated dioxin TEQs (as high as 7,261 ppt, includes PCDDs and PCDFs) were found in soil samples from a floodplain area near the confluence of the Tittabawassee and Saginaw Rivers in Saginaw County, analyzed as part of a wetland mitigation project, and in other floodplain areas (golf course, wildlife refuge) upstream from the mitigation site. These levels were considered to be high enough to pose an urgent public health hazard if people were routinely exposed to soil at these locations, but ATSDR concluded that the level of exposure on these properties is not known, and was concerned regarding the lack of sampling on nearby residential properties. The only known source of dioxin contamination was the Dow Chemical Company plant upstream at Midland. ATSDR concluded that the contamination likely resulted from deposition of contaminated river sediments in the Tittabawassee River floodplain. As discussed in Section 4.1.1.12, fish in the Tittabawassee River below the city of Midland have elevated levels of PCDDs and PCBs. Based on the floodplain soil data together with the fish data, ATSDR concluded that dioxin contamination may be widespread throughout the Tittabawassee River watershed below Midland, but data were lacking on possible exposures. EPA reported (2006) that fish contamination by PCDDs and PCDFs, which have resulted in fish consumption advisories, represented a potential completed exposure pathway for residents of the area. EPA also reported that subsequent sampling found dioxin TEQs as high as 41,000 ppt within the first six miles downstream of the Dow plant. In addition, an initial investigation for other contaminants besides PCDDs and PCDFs is expected to be completed by 2007.

Demographics: Twelve homes are located adjacent to the river less than half a mile upstream from the mitigation site where very high TEQs were detected. Numerous other residential properties are located within the floodplain upstream of the wetland mitigation site.

Public Health Outcome Data: EPA reported (2006) that, in 2006, the University of Michigan conducted a dioxin exposure study which was funded by Dow. EPA further reported some of the key initial findings of the study as:

- Residents living in regions expected to have dioxin contamination (Midland/Saginaw) have higher concentrations of dioxins in their blood than do residents in a control area without dioxin contamination.
- Residents in areas with higher levels of dioxins in soil have a higher TEQ (total dioxin-like activity) in their blood.
- Populations consuming fish from the Tittabawassee River, Saginaw River, and Saginaw Bay waterways have higher concentrations of dioxins in their blood than people who do not eat fish from these waterways.
- Populations participating in recreational activities in the Tittabawassee River, Saginaw River, and Saginaw Bay have higher concentrations of dioxins in their blood than persons who do not participate.

Conclusions: This site is contaminated with the IJC critical pollutants PCDDs and PCDFs, probably from releases from the Dow Chemical Company plant upstream at Midland, Midland County. The dioxin contamination, as reported by EPA (2006), is widespread throughout the Tittabawassee River watershed below Midland, but initial data were lacking on possible exposures. More recently (2006), EPA reported the availability of analytical sampling data combined with information on human activities in the watershed areas which indicate that statistically significant exposures to dioxin could be occurring, especially within populations who consume significant quantities of locally harvested fish and/or wild game. In addition, a wild game study for the flood plain of the Tittabawassee River downstream of Midland was conducted by Dow in 2004. State of Michigan health assessors have reviewed the wild game data and found that levels of dioxins in the wild game harvested in the floodplain for the study were up to 7 times higher than samples taken upstream of Midland in deer muscle meat, 118 times higher in deer liver, 66 times higher in turkey, and 40 times higher in squirrel. The assessors concluded that eating contaminated deer, turkey, or squirrel containing dioxin, at the levels found in the Dow wild game study, could result in adverse health effects.

4.1.1.14 Lufkin Rule

The 14-acre Lufkin Rule property is a large abandoned industrial property in a mostly residential area of Saginaw, Saginaw County MI. After being sold, the property was rented out to a large number of tenants. In 1994, a dry cleaning establishment on the property burned, and the remnants were later demolished. Since that time, the entire property has been vacant. Drums of dry-cleaning solvents, transformers, capacitors, and other electrical equipment containing PCBs were found on the property. Some of the equipment had been scavenged, and the PCB-containing oil spilled on the ground. The PCB-containing oil and soil, drummed solvents, and other waste materials were removed in 1995 for disposal at an approved facility. Information regarding this site is taken from the ATSDR 1997 health consultation.

Category of Public Health Hazard: This site was categorized as a *Public Health Hazard* (Category 2) because of the physical hazards in the abandoned and decrepit buildings on the property, and contaminants in soil that would pose health hazards to anyone working on the property for long periods. The site is not secured from trespassers, and there is evidence of extensive trespassing.

Contaminants of Concern in Completed Exposure Pathways: None identified. There are hot spots of soil contamination with the IJC critical pollutant PCBs and also of bis(2-3ethylhexyl)phthalate that could pose health hazards through inadvertent ingestion to anyone working in those areas for long periods or visiting those areas daily over a long period of time, but this exposure scenario was considered unlikely. Levels of the IJC critical pollutants B(a)P and lead in soil and storm sewer sediment exceeded health based screening values, but were within ranges typically found in urban areas. Groundwater was contaminated with trichloroethylene, but is not used as a drinking water source. Levels of trichloroethylene and other VOCs in storm sewer water were above drinking water standards, and indicate release from the site through runoff.

Demographics: Not reported, but the site is located in a residential area.

Public Health Outcome Data: None reported.

Conclusions: This site may have contributed to the environmental burden of the IJC critical pollutant PCBs, and also of VOCs, but the extent of onsite contamination is limited.

4.1.1.15 Laingsburg

The Laingsburg property is a former gasoline and automotive service station located in the city of Laingsburg, Shiawassee County, MI, which stopped operations in 1984, and since then, has been used for automotive repair and body shop work. In 2000, a health consultation was performed by ATSDR as part of a Brownfields project; that document is the source of information regarding this site. Records indicate that there may have been three underground fuel storage tanks on the property, and there is no clear indication that the tanks were removed from the property.

Category of Public Health Hazard: This site was categorized as an *Indeterminate Public Health Hazard* (Category 3) because of the potential threat to human health from exposure to contaminants and the lack of adequate monitoring data.

Contaminants of Concern in Completed Exposure Pathways: Not reported. Access to the site was denied, so no onsite monitoring data are available. Subsurface soil sampled around the perimeter of the site contained trimethylbenzene and xylenes above screening values for industrial or commercial use. Shallow groundwater at the site perimeter was similarly contaminated had a floating oily layer liquid (one monitoring well) containing trimethylbenzenes and other VOCs. Concentrations exceeded drinking water standards or screening levels. The contamination was consistent with gasoline leaking from the underground storage tanks.

Demographics: Not reported, but there are eight private wells within 0.2 miles of the site, and Laingsburg has no municipal water system; residents use individual private wells.

Public Health Outcome Data: None reported.

Conclusions: This site may be releasing gasoline from underground storage tanks, but access to the site was denied and the available monitoring data are inadequate to assess the potential threat to public health.

4.1.2 TRI Data for the Saginaw River and Bay AOC

The TRI onsite chemical releases for the 21 counties (combined) that are relevant to this AOC are summarized in Table 4.1-C. Total onsite releases for the 21 counties in 2001 were 7,831,200 pounds, the majority of which were released to air, followed by releases to soil. Considerably less was released to surface water.

The IJC critical pollutants accounted for 92,142 pounds or 1.2% of the total onsite releases. The IJC critical pollutants released were PCDDs and PCDFs (primarily to land), lead and lead compounds (primarily to land); and mercury and mercury compounds (primarily to air and land). The facilities that released these pollutants are listed in Table 4.1-D. PCDDs (and PCDFs) were the focus of ATSDR health consultations for soil contamination by the Dow Chemical Co. in the city of Midland, Midland County, MI (Section 4.1.1.10) and for contamination of the Tittabawassee River Flood Plain south of Midland (Section 4.1.1.11). The major TRI releases of these chemicals in the counties relevant to the Saginaw River and Bay AOC were in Midland County, by the Dow Chemical Company (1,618 pounds total onsite releases, primarily to land). Much smaller amounts were reported released by other facilities in Bay County and Saginaw County.

The major releases ($\geq 500,000$ pounds) of non-IJC chemicals were of hydrochloric acid aerosols to air and barium compounds (primarily to land). Other non-IJC chemicals released in substantial onsite quantities (300,000-499,999 pounds) were toluene (primarily to air); and barium compounds, manganese compounds, and zinc compounds (primarily to land); and ammonia (to air, water and land).

Looking at total onsite releases of all chemicals combined, the counties with the highest reported releases, 500,000-1,000,000 pounds, were Midland and Saginaw Counties. Counties with total onsite releases of 250,000-499,999 pounds were Bay, Genesee, and Huron counties. Counties in the range of 100,000-249,000 pounds total onsite releases were Montcalm, Osceola, and Sanilac. Counties in the range of 10,000-99,000 pounds total onsite releases were Gratiot, Isabella, Lapeer, Livingston, Mecosta, Ogemaw, Shiawassee, and Tuscola. Counties in the range of 0-9,999 pounds total onsite releases were Arenac, Clare, Gladwin, Iosco, and Roscommon.

4.1.3 NPDES Data for the Saginaw River and Bay AOC

The NPDES permitted discharges for the counties that encompass and surround the Saginaw River and Bay AOC are summarized in Table 4.1-E. The total average annual permitted

discharges in 2004 were 3,973,206 pounds, the majority of which was ammonia nitrogen, and also phosphorus.

The IJC critical pollutants PCBs (0.004 pounds), DDT (0.00007 pounds), lead (84 pounds), and mercury (2 pounds) were permitted to be discharged. Facilities permitted to release these pollutants are listed in Table 4.1-F.

4.1.4 County Demographics and Health Status Data for the Saginaw River and Bay AOC

The demographic profiles, from the 2000 U.S. Census, for vulnerable populations living in the 21 counties of this AOC are shown in Table 4.1-G.

According to the 2000 HRSA community health status reports, health status indicators that compared unfavorably with those of the U.S. and also with the median of the peer counties for the 21 counties of this AOC were as shown in Table 4.1-G.

4.1.5 Summary and Conclusions for the Saginaw River and Bay AOC

4.1.5.1 Hazardous Waste Sites

Sixteen sites in the counties relevant to the Saginaw River and Bay AOC have been categorized by ATSDR in health hazard categories 1-3 at some time in their assessment history. Several of these sites have completed exposure pathways to the IJC critical pollutants PCDDs, PCDFs, PCBs, and/or DDT and metabolites and/or released these pollutants into the rivers that ultimately feed the Saginaw River. Sites that have not yet been completely remediated and may be continuing to serve as a source of exposure are:

- Bay City Middlegrounds (Section 4.1.1.1)
- Velsicol Chemical Corp. (Section 4.1.1.7)
- Shiawassee River (Section 4.1.1.11)
- Dow Chemical Co., Midland Location (Section 4.1.1.12)
- Tittabawassee River (Section 4.1.1.13) – lack of data on possible exposures.
- Laingsburg (Section 4.1.1.5) – Possible release of gasoline from underground storage tanks.

A pathway of major concern for these chemicals is bioaccumulation through the food chain into fish that are ingested by humans. Incidental ingestion, direct dermal contact, and inhalation of soil and dust from PCDD- and PCDF-contaminated soil also were of concern.

Public health outcome data, available for four of the sites, generally did not indicate unusual rates of health conditions, or consisted of occupational data, which were considered of questionable relevance to the general population. An analysis of cancer incidence data for the Dow Chemical Co. site found no elevated incidences of specific cancer types in the two zip code areas studied, as compared with county and state. A higher-than-expected incidence of all cancers combined was seen in the zip code area upwind and including the site, but not the zip

code area downwind of the site, which was considered more highly contaminated with PCDDs and PCDFs from the Dow Chemical Company's onsite incineration of chemical wastes. ATSDR considered that interpretation of these data as problematic. The dioxin contamination may be widespread throughout the Tittabawassee River watershed below Midland, but data were lacking on possible exposures.

Issues for Follow-Up

The sites listed as still possibly contributing to environmental contamination and human exposure may need follow-up to determine whether the potential hazards have been mitigated. Additional monitoring data and other data also were needed to more fully assess the hazard.

4.1.5.2 TRI Data

Onsite TRI releases in the 21 counties (combined) of the Saginaw River and Bay AOC totaled 7,831,200 pounds, the majority of which were released to air, followed by releases to soil. Considerably less was released to surface water.

The highest release counties, Midland and Saginaw Counties, accounted for 10.5 and 12.3%, respectively, of the total onsite releases. The lowest release counties, Arenac, Gladwin, and Roscommon, had zero reported releases.

The IJC critical pollutants accounted for 92,142 pounds or 1.2% of the total onsite releases. The IJC critical pollutants released were PCDDs and PCDFs (primarily to land); lead and lead compounds (primarily to land); and mercury and mercury compounds (primarily to air and land).

The major releases ($\geq 500,000$ pounds) of non-IJC chemicals were of hydrochloric acid aerosols, xylenes, certain glycol ethers, n-butyl alcohol, and toluene (primarily to air); and nickel compounds, selenium, and arsenic compounds (primarily to land).

4.1.5.3 NPDES Data

The NPDES permitted discharges for the counties that encompass and surround the Saginaw River and Bay AOC are summarized in Table 4.1-E. The total average annual permitted discharges in 2004 were 3,973,206 pounds, the majority of which was ammonia nitrogen, and also phosphorus.

The IJC critical pollutants PCBs (0.004 pounds), DDT (0.00007 pounds), lead (84 pounds), and mercury (2 pounds) were permitted to be discharged. Facilities permitted to release these pollutants are listed in Table 4.1-F.

4.1.5.4 County Demographics and Health Status Indicators

According to the 2000 HRSA community health status reports, health status indicators that compared unfavorably with those of the U.S. and also with the median of the peer counties for the 21 counties of this AOC were as shown in Table 4.1-G.

The health status indicators that compared unfavorably with the comparison populations included 1) infant mortality rates in Arenac, Bay, Genesee, Gladwin, Gratiot, Huron, Mecosta, Midland, Montcalm, Roscommon, Saginaw, and Tuscola counties; 2) birth measures such, as low birth weight, in Arenac, Clare, Genesee, Gladwin, Huron, Iosco, Isabella, Mecosta, Montcalm, Ogemaw, Osceola, Roscommon, Saginaw, and Sanilac counties; and 3) deaths from breast cancer in Arenac, Genesee, Gladwin, Gratiot, Huron, Iosco, Livingston, Midland, Ogemaw, Roscommon, and Tuscola counties; 4) deaths from colon cancer in Bay, Clare, Genesee, Huron, Iosco, Lapeer, Livingston, Mecosta, Midland, Ogemaw, Saginaw, Shiawassee, and Tuscola counties; 5) deaths from coronary heart disease in Arenac, Bay, Clare, Genesee, Gladwin, Gratiot, Huron, Iosco, Isabella, Lapeer, Mecosta, Midland, Ogemaw, Osceola, Roscommon, Saginaw, Sanilac, and Tuscola counties; 6) deaths from lung cancer in Clare, Genesee, Gladwin, Iosco, Lapeer, Montcalm, Osceola, and Roscommon counties; and 7) deaths from stroke in Gratiot, Huron, Iosco, Isabella, Lapeer, Ogemaw, Roscommon, Saginaw, Sanilac, and Shiawassee counties.

Some counties had health indicator rates that exceeded the upper end of the peer county range and these included: 1) black infant mortality and post-neonatal mortality in Genesee county; 2) post-neonatal infant mortality in Arenac county; 3) infant, white, and neonatal mortality in Tuscola county; 4) breast cancer deaths in Arenac, Iosco, and Tuscola counties; 5) coronary heart disease deaths in Bay, Gratiot, Iosco, and Sanilac counties; and 6) stroke deaths in Huron county.

There is considerably variation across counties of the Saginaw River and Bay AOC in vulnerable population demographics and in the pattern of health indicators that compared unfavorably with U.S. indicators and with the peer counties' indicators. The two counties with the highest vulnerable population demographics, Genesee and Saginaw, also had the greatest number of unfavorable health status indicators.

Saginaw Bay region counties that are upwind of the industrial facilities have a higher rate of health problems than those residing downwind as reported by EPA (June 2004). Although this may seem counter intuitive, EPA believes it is because exposure to contaminants is by fish consumption. Residents living upstream fish more than those living downstream. Socioeconomic status in the form of income may be a factor. Residents in the lower income group reside upstream and tend to fish more.

4.1.5.5 Beneficial Use Impairment (BUIs)

Of the three health-related BUIs, restrictions on fish and wildlife consumption and drinking water and beach closings were all listed as impaired at this AOC site. Further information is available at the EPA web site (<http://www.epa.gov/glnpo/aoc/>).

**Table 4.1-B Waste Site Contaminants that Exceeded Health-Based Screening Values
Saginaw River and Bay AOC**

CAS No.	Chemical Name	IJC Tracking Number	Number of Records						Total
			Air	Biota	Human Material	Other Media	Soil	Water	
011097-69-1	AROCOR 1254	1					4		4
011096-82-5	AROCOR 1260	1					4		4
001336-36-3	POLYCHLORINATED BIPHENYLS	1		15		4	31	9	59
001746-01-6	2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	2				3	3		6
000050-32-8	BENZO(A)PYRENE	4					12	3	15
000072-54-8	DDD, P,P'	5		1			6	3	10
000072-55-9	DDE, P,P'	5		2			3	1	6
000050-29-3	DDT, P,P'	5		6		1	7	2	16
000309-00-2	ALDRIN	6					4	4	8
000060-57-1	DIELDRIN	6		2			5	3	10
007439-92-1	LEAD	8		2			24	12	38
007439-97-6	MERCURY	9		2			10	3	15
000118-74-1	HEXACHLOROENZENE	11		1			2	3	6
		Total IJC	0	31	0	8	115	43	197
000071-55-6	1,1,1-TRICHLOROETHANE		1			2	11	8	22
000079-34-5	1,1,2,2-TETRACHLOROETHANE						1	1	2
000079-00-5	1,1,2-TRICHLOROETHANE					1	4	7	12
000075-34-3	1,1-DICHLOROETHANE		1			1	6	17	25
000075-35-4	1,1-DICHLOROETHENE					1	1	7	9
000634-66-2	1,2,3,4-TETRACHLOROENZENE						2	2	4
000087-61-6	1,2,3-TRICHLOROENZENE						2		2
000120-82-1	1,2,4-TRICHLOROENZENE						5	4	9
000095-63-6	1,2,4-TRIMETHYLBENZENE					1	1	1	3
000107-06-2	1,2-DICHLOROETHANE		1			1	4	9	15
000156-59-2	1,2-DICHLOROETHENE, CIS-							4	4
000156-60-5	1,2-DICHLOROETHENE, TRANS-					1	5	11	17
000540-59-0	1,2-DICHLOROETHYLENE						8	12	20
000078-87-5	1,2-DICHLOROPROPANE							1	1
000108-67-8	1,3,5-TRIMETHYLBENZENE		1			1	1	1	4
000106-99-0	1,3-BUTADIENE		1						1
000541-73-1	1,3-DICHLOROENZENE		1			1	4		6
010061-02-6	1,3-DICHLOROPROPENE, TRANS-		1			1	1	1	4
000106-46-7	1,4-DICHLOROENZENE		1			1	7	8	17
000105-67-9	2,4-DIMETHYLPHENOL							2	2
000078-93-3	2-BUTANONE						6	4	10
000591-78-6	2-HEXANONE							1	1
000091-57-6	2-METHYLNAPHTHALENE					1	12	3	16
000100-02-7	4-NITROPHENOL							1	1
000083-32-9	ACENAPHTHENE						4		4
000208-96-8	ACENAPHTHYLENE						3		3
000067-64-1	ACETONE						3	2	5
007429-90-5	ALUMINUM						1	1	2
000120-12-7	ANTHRACENE						6		6
007440-36-0	ANTIMONY						9	2	11
007440-38-2	ARSENIC						14	12	26
001332-21-4	ASBESTOS					1			1
007440-39-3	BARIIUM						13	13	26
000071-43-2	BENZENE		2			1	9	19	31
000092-87-5	BENZIDINE						2		2
000056-55-3	BENZO(A)ANTHRACENE						12	2	14
000203-33-8	BENZO(A)FLUORANTHENE						2		2

CAS No.	Chemical Name	IJC Tracking Number	Number of Records						
			Air	Biota	Human Material	Other Media	Soil	Water	Total
000205-99-2	BENZO(B)FLUORANTHENE						11	2	13
000191-24-2	BENZO(GHI)PERYLENE						12	1	13
000207-08-9	BENZO(K)FLUORANTHENE						10	3	13
000065-85-0	BENZOIC ACID							2	2
007440-41-7	BERYLLIUM						13	4	17
000075-27-4	BROMODICHLOROMETHANE					1	1	3	5
000074-83-9	BROMOMETHANE						1	1	2
000085-68-7	BUTYL BENZYL PHTHALATE						7	3	10
007440-43-9	CADMIIUM			2			9	4	15
000086-74-8	CARBAZOLE						10	2	12
000075-15-0	CARBON DISULFIDE							1	1
000056-23-5	CARBON TETRACHLORIDE		2					4	6
000057-74-9	CHLORDANE			1				1	2
016887-00-6	CHLORIDE							1	1
HZ0400-01-T	CHLORINATED DIOXINS, UNSPECIFIED						6		6
000108-90-7	CHLOROBENZENE		3			1	12	7	23
000124-48-1	CHLORODIBROMOMETHANE							1	1
000075-00-3	CHLOROETHANE		1					7	8
000067-66-3	CHLOROFORM		2			1	5	7	15
000074-87-3	CHLOROMETHANE		1			1	1	2	5
007440-47-3	CHROMIUM			2			15	11	28
000218-01-9	CHRYSENE						12	4	16
005103-71-9	CIS-CHLORDANE						3		3
007440-48-4	COBALT						14	3	17
007440-50-8	COPPER			2			15	6	23
000095-48-7	CRESOL, ORTHO-						1	2	3
000106-44-5	CRESOL, PARA-						5	5	10
000098-82-8	CUMENE						1		1
000057-12-5	CYANIDE						5		5
000117-81-7	DI(2-ETHYLHEXYL)PHTHALATE						8	5	13
000053-70-3	DIBENZO(A,H)ANTHRACENE						5	1	6
025321-22-6	DICHLOROBENZENE						2		2
001300-21-6	DICHLOROETHANE							1	1
000084-66-2	DIETHYL PHTHALATE							1	1
000107-99-3	DIMETHYLAMINOETHYL CHLORIDE							1	1
000084-74-2	DI-N-BUTYL PHTHALATE						5	2	7
000117-84-0	DI-N-OCTYL PHTHALATE						5	2	7
HZ0400-05-T	DIOXINS N.O.S.			3			1		4
HZ0400-04-T	DIOXINS/FURANS, UNSPECIFIED						2		2
001031-07-8	ENDOSULFAN SULFATE						2		2
000959-98-8	ENDOSULFAN, ALPHA						1		1
033213-65-9	ENDOSULFAN, BETA						1		1
000072-20-8	ENDRIN						2		2
007421-93-4	ENDRIN ALDEHYDE						4		4
053494-70-5	ENDRIN KETONE						3		3
000100-41-4	ETHYLBENZENE		3				12	12	27
000206-44-0	FLUORANTHENE						7	1	8
000086-73-7	FLUORENE						4		4
HZ0500-03-T	FURANS, UNSPECIFIED			2			6		8
HZ0900-02-T	HEAVY METALS, UNSPECIFIED						6		6
000076-44-8	HEPTACHLOR						3	2	5
001024-57-3	HEPTACHLOR EPOXIDE			1			5	2	8
000087-82-1	HEXABROMOBENZENE					1	3		4

CAS No.	Chemical Name	IJC Tracking Number	Number of Records						
			Air	Biota	Human Material	Other Media	Soil	Water	Total
000087-68-3	HEXACHLOROBUTADIENE						2	2	4
000319-84-6	HEXACHLOROCYCLOHEXANE, ALPHA-						3	2	5
000319-85-7	HEXACHLOROCYCLOHEXANE, BETA-						1		1
000319-86-8	HEXACHLOROCYCLOHEXANE, DELTA-						6	3	9
000058-89-9	HEXACHLOROCYCLOHEXANE, GAMMA-						6	2	8
HZ1000-01-T	HYDROCARBONS, UNSPECIFIED					4	5	1	10
000193-39-5	INDENO(1,2,3-CD)PYRENE						12	1	13
HZ0900-18-T	INORGANICS, N.O.S.							1	1
007439-89-6	IRON						1	2	3
007439-95-4	MAGNESIUM						1		1
001309-42-8	MAGNESIUM HYDROXIDE					1			1
001309-48-4	MAGNESIUM OXIDE					1			1
007439-96-5	MANGANESE						14	11	25
HZ0900-01-T	METALS N.O.S.					3	1	1	5
000072-43-5	METHOXYCHLOR						3		3
000108-10-1	METHYL ISOBUTYL KETONE						1	1	2
000075-09-2	METHYLENE CHLORIDE		4			1	10	12	27
000091-20-3	NAPHTHALENE					1	15	8	24
007440-02-0	NICKEL						11	8	19
000103-65-1	N-PROPYL BENZENE					1	1	1	3
029082-74-4	OCTACHLOROSTYRENE			1					1
HZ0600-01-T	OIL/GREASE, UNSPECIFIED						1		1
027858-07-7	PBB'S (OCTOBROMOMIXTURE)			4	1		8	7	20
000059-50-7	P-CHLORO-M-CRESOL						1	3	4
000087-86-5	PENTACHLOROPHENOL							3	3
HZ1200-01-T	PESTICIDES N.O.S.					1	2	1	4
000085-01-8	PHENANTHRENE						12	4	16
000108-95-2	PHENOL						2	4	6
064743-03-9	PHENOLICS						1		1
067774-32-7	POLYBROMINATED BIPHENYLS			3		1	3	4	11
130498-29-2	POLYCYCLIC AROMATIC HYDROCARBONS					1	1		2
000129-00-0	PYRENE						7	1	8
007782-49-2	SELENIUM						3		3
HZ1900-02-T	SEMIVOLATILE ORGANIC COMPOUNDS N.O.S.					1	1	2	4
007440-22-4	SILVER						3		3
000100-42-5	STYRENE						6	3	9
014808-79-8	SULFATE							1	1
HZ0400-03-T	TCDD EQUIVALENTS			2		5	7		14
000127-18-4	TETRACHLOROETHYLENE		2			2	14	12	30
000109-99-9	TETRAHYDROFURAN							4	4
007440-28-0	THALLIUM						4	1	5
000108-88-3	TOLUENE		3			1	14	11	29
005103-74-2	TRANS-CHLORDANE						6	2	8
025323-89-1	TRICHLOROETHANE							2	2
000079-01-6	TRICHLOROETHYLENE		5			3	18	29	55
000077-86-1	TRIS					1	2		3
007440-62-2	VANADIUM						14	1	15
000075-01-4	VINYL CHLORIDE					1	4	18	23
HZ1900-01-T	VOLATILE ORGANIC COMPOUNDS N.O.S.						1	4	5

CAS No.	Chemical Name	IJC Tracking Number	Number of Records						
			Air	Biota	Human Material	Other Media	Soil	Water	Total
001330-20-7	XYLENES, TOTAL		3			1	11	11	26
007440-66-6	ZINC			2			14	10	26
000132-64-9	DIBENZOFURAN						11		11
MEDEXP-00-0			9	14		1	16	26	66
			1	6		1	12	6	26
		Total Non-IJC	49	45	1	52	707	499	1353
		Total	49	76	1	60	822	542	1550

Table 4.1-C TRI Releases (in pounds, 2001) for the Saginaw River and Bay AOC

Chemical	IJC Tracking Number	Total Air Emissions	Surface Water Discharges	Under-ground Injection	Releases to Land	Total Onsite Releases	Total Offsite Releases	Total On- and Offsite Releases
DIOXIN AND DIOXIN-LIKE COMPOUNDS (PCDDs and PCDFs)	2 3	0.013254255	0.005655825	0	1.6102674	1.62917748	0.05532345	1.68450093
LEAD	8	243.18	15.2	0	0	258.38	20665.9	20924.28
LEAD COMPOUNDS	8	4521.6	1.1	0	86883.8	91406.5	6029.6	97436.1
MERCURY	9	10.2	0	0	44	54.2	0.8	55
MERCURY COMPOUNDS	9	270.6	1	0	150	421.6	3.7	425.3
	Total IJC	5045.593254	17.30565583	0	87079.4103	92142.30918	26700.05532	118842.3645
1,1,1,2-TETRACHLOROETHANE		588	0	0	0	588	0	588
1,1-DICHLORO-1-FLUOROETHANE		101906	0	0	0	101906	250	102156
1,2,4-TRIMETHYLBENZENE		97955	0	0	0	97955	0	97955
1,2-DICHLOROETHANE		472	0	0	0	472	0	472
1,2-DICHLOROPROPANE		7	0	0	0	7	0	7
1,3-BUTADIENE		2751	0	0	0	2751	0	2751
2,4,6-TRICHLOROPHENOL		41	64	0	1	106	0	106
2,4-D		167	0	0	0	167	0	167
2,4-D BUTYL ESTER		1	1	0	0	2	0	2
2,4-DICHLOROPHENOL		181	0	0	1	182	0	182
2-METHOXYETHANOL		4524	0	0	0	4524	0	4524
2-PHENYLPHENOL		1	0	0	0	1	0	1
3-CHLORO-2-METHYL-1-PROPENE		68	0	0	0	68	0	68
4,4'-ISOPROPYLIDENE-DIPHENOL		754	0	0	0	754	4215	4969
ACETONITRILE		40902	3252	0	7	44161	0	44161
ACROLEIN		1700	0	0	0	1700	0	1700
ACRYLAMIDE		18	7	0	0	25	0	25
ACRYLIC ACID		12018	2	0	0	12020	0	12020
ACRYLONITRILE		7453	0	0	0	7453	0	7453
ALLYL ALCOHOL		630	0	0	0	630	0	630
ALLYL CHLORIDE		2128	0	0	0	2128	0	2128
ALLYLAMINE		3	0	0	0	3	0	3
ALUMINUM (FUME OR DUST)		1060	5	0	0	1065	11497	12562
AMMONIA		168025	116434	0	60000	344459	0	344459
ANTIMONY		250	0	0	0	250	750	1000
ANTIMONY COMPOUNDS		568	0	0	11011	11579	0	11579
BARIUM COMPOUNDS		2494	249	0	947010	949753	41012	990765
BENZENE		37544	1	0	101	37646	0	37646
BENZO(G,H,I)PERYLENE		0.3898	0	0	0	0.3898	0	0.3898
BIPHENYL		146	0	0	0	146	0	146
BROMINE		388	0	0	0	388	0	388
BUTYL ACRYLATE		1	0	0	0	1	0	1
CARBON DISULFIDE		515	0	0	2	517	0	517
CERTAIN GLYCOL ETHERS		265755	3100	0	4000	272855	11670	284525
CHLORINE		33689	0	0	0	33689	0	33689
CHLOROACETIC ACID		34	0	0	0	34	0	34
CHLOROBENZENE		56	0	0	0	56	0	56
CHLORODIFLUORO-METHANE		75572	0	0	0	75572	0	75572
CHLOROETHANE		36655	0	0	0	36655	0	36655
CHLOROFORM		273	0	0	0	273	0	273
CHLOROMETHANE		10073	0	0	0	10073	0	10073
CHLOROMETHYL METHYL ETHER		1091	0	0	0	1091	0	1091
CHLOROPHENOLS		4	27	0	1	32	0	32
CHROMIUM		2777	1	0	6205	8983	110366	119349

Chemical	IJC Tracking Number	Total Air Emissions	Surface Water Discharges	Under-ground Injection	Releases to Land	Total Onsite Releases	Total Offsite Releases	Total On-and Offsite Releases
CHROMIUM COMPOUNDS (EXCEPT CHROMITE ORE MINED IN THE TRANSSVAAL REGION)		4973	130	0	53452	58555	33085	91640
COBALT		750	5	0	0	755	11265	12020
COBALT COMPOUNDS		754	250	0	41700	42704	0	42704
COPPER		2249	270	0	5	2524	37338	39862
COPPER COMPOUNDS		2675	2400	0	68400	73475	351	73826
CUMENE		116	0	0	0	116	0	116
CUMENE HYDROPEROXIDE		800	0	0	0	800	560	1360
CYCLOHEXANE		2584	0	0	0	2584	0	2584
DECABROMODIPHENYL OXIDE		3741	0	0	23600	27341	0	27341
DICHLOROMETHANE		10667	1	0	0	10668	0	10668
DIISOCYANATES		1529	0	0	0	1529	12351	13880
DIMETHYLAMINE		2185	131	0	0	2316	0	2316
DINITROBUTYL PHENOL		36	0	0	0	36	0	36
EPICHLOROHYDRIN		6	0	0	0	6	0	6
ETHYL ACRYLATE		45	0	0	0	45	0	45
ETHYLBENZENE		54591	1	0	5	54597	0	54597
ETHYLENE		40179	0	0	0	40179	0	40179
ETHYLENE GLYCOL		4455	283	0	0	4738	51500	56238
ETHYLENE OXIDE		904	0	0	0	904	0	904
FORMALDEHYDE		28051	21	0	7000	35072	242	35314
FORMIC ACID		252	118	0	0	370	0	370
HYDROCHLORIC ACID (1995 AND AFTER 'ACID AEROSOLS' ONLY)		2755268	0	0	0	2755268	0	2755268
HYDROGEN FLUORIDE		200090	0	0	0	200090	0	200090
MANGANESE		1795	1	0	0	1796	108939	110735
MANGANESE COMPOUNDS		9347	9190	0	341800	360337	36335	396672
METHACRYLONITRILE		945	0	0	0	945	0	945
METHANOL		100222	0	0	2	100224	0	100224
METHYL ACRYLATE		759	0	0	0	759	0	759
METHYL ETHYL KETONE		102164	0	0	0	102164	0	102164
METHYL ISOBUTYL KETONE		24110	0	0	0	24110	0	24110
METHYL METHACRYLATE		1018	0	0	0	1018	0	1018
METHYL TERT-BUTYL ETHER		854	0	0	0	854	0	854
N,N-DIMETHYLFORMAMIDE		16	0	0	0	16	0	16
NAPHTHALENE		20055	0	0	191	20246	0	20246
N-BUTYL ALCOHOL		86571	1	0	0	86572	0	86572
N-HEXANE		2982	0	0	0	2982	0	2982
NICKEL		2974	266	0	1905	5145	168144	173289
NICKEL COMPOUNDS		11309	12	0	32000	43321	18922	62243
NITRATE COMPOUNDS		500	10000	0	0	10500	21	10521
NITRIC ACID		3331	5	0	5	3341	0	3341
N-METHYL-2-PYRROLIDONE		9766	0	0	0	9766	0	9766
PHENOL		105740	0	0	1903	107643	3935	111578
PHOSGENE		23	0	0	0	23	0	23
PICLORAM		1	257	0	0	258	0	258
POLYCHLORINATED ALKANES		0	0	0	0	0	63100	63100
POLYCYCLIC AROMATIC COMPOUNDS		2.81	0	0	53	55.81	0.8	56.61
PROPYLENE		240	0	0	0	240	0	240

Chemical	IJC Tracking Number	Total Air Emissions	Surface Water Discharges	Under-ground Injection	Releases to Land	Total Onsite Releases	Total Offsite Releases	Total On-and Offsite Releases
PROPYLENE OXIDE		1234	0	0	0	1234	0	1234
PYRIDINE		201	0	0	0	201	0	201
QUINOLINE		3	0	0	0	3	0	3
SODIUM NITRITE		0	0	0	0	0	720	720
STYRENE		188607	23	0	38959	227589	498.2	228087.2
SULFURIC ACID (1994 AND AFTER 'ACID AEROSOLS' ONLY)		144005	0	0	0	144005	0	144005
TETRACHLORO-ETHYLENE		22458	0	0	1	22459	0	22459
TOLUENE		373364	2	0	32	373398	0	373398
TOLUENE-2,4-DIISOCYANATE		578	0	0	0	578	0	578
TRICHLOROETHYLENE		11319	0	0	0	11319	0	11319
TRIETHYLAMINE		18928	0	0	4	18932	0	18932
VANADIUM COMPOUNDS		12011	0	0	106700	118711	0	118711
VINYL ACETATE		92	0	0	0	92	0	92
VINYL CHLORIDE		969	0	0	1	970	0	970
VINYLDENE CHLORIDE		21474	3	0	0	21477	0	21477
XYLENE (MIXED ISOMERS)		228329	33	0	0	228362	0	228362
ZINC (FUME OR DUST)		5400	0	0	0	5400	2900	8300
ZINC COMPOUNDS		15569	170	0	288880	304619	111490	416109
	Total Non-IJC	5557404.2	146716	0	2034937	7739057.2	841457	8580514.2
	Total	5562449.793	146733.3057	0	2122016.41	7831199.509	868157.0553	8699356.564

**Table 4.1-D TRI Facilities Releasing IJC Critical Pollutants Onsite for the
Saginaw River and Bay AOC**

IJC Critical Pollutant	Number of Facilities	Facility Name	TRIF ID	City
Dioxin and dioxin-like compounds (PCDDs and PCDFs)	4			
Bay County, MI	1	DE KARN - JC WEADOCK GENERATING PLANT	48732DKRNJNWEAD	ESSEXVILLE
Midland County, MI	1	DOW CHEMICAL CO. MIDLAND OPS.	48667THDWCMICHI	MIDLAND
Saginaw County, MI	2	ALCHEM ALUMINUM INC.	48601LCHML2600N	SAGINAW
		GMC SAGINAW METAL CASTING OPS.	48605SGNWG1629N	SAGINAW
Lead and lead compounds	27			
Bay County, MI	1	DE KARN - JC WEADOCK GENERATING PLANT	48732DKRNJNWEAD	ESSEXVILLE
Genesee County, MI	6	DELPHI ENERGY & CHASSIS SYS. FLINT WEST	48555CFLNT300NO	FLINT
		GMC GRAND BLANC METAL FAB	48439CDLLC10800	GRAND BLANC
		GMC MFD FLINT METAL CENTER	48553GMCTRG2238	FLINT
		GMC POWERTRAIN FLINT ENGINE SOUTH	48552GMPWR2100B	FLINT
		GMC POWERTRAIN FLINT NORTH	48550BCFLN902EH	FLINT
		GMVM - FLINT ASSEMBLY PLANT	48551GMCTRG3100	FLINT
Gratiot County, MI	1	CONTECH DIV. OF SPX CORP.	48801CNTCH205NG	ALMA
Huron County, MI	4	DETROIT EDISON CO. HARBOR BEACH POWER PLANT	48441DTRTD755NH	HARBOR BEACH
		MICHIGAN SUGAR CO. SEBEWAING PLANT	48759MCHGN763BE	SEBEWAING
		TOWER AUTOMOTIVE TECH. PRODS. INC.	48759TWRTM249NC	SEBEWAING
		TOWER AUTOMOTIVE TOOL L.L.C.	48731TWRTM81DRE	ELKTON
Iosco County, MI	2	ITT INDS. FHS	48750TTNDS4700N	OSCODA
		NEW NGC INC.	48748NTNLG2375N	NATIONAL CITY
Isabella County, MI	1	EP HILLSDALE TOOL DIVISION-MT. PLEASANT	48858PHLLS1799G	MOUNT PLEASANT
Livingston County MI	1	PROGRESSIVE METAL FORMING INC.	48139PRGRS10850	HAMBURG
Montcalm County, MI	1	FEDERAL MOGUL GREENVILLE	48838FDRLM510EG	GREENVILLE
Saginaw County, MI	3	GMC SAGINAW METAL CASTING OPS.	48605SGNWG1629N	SAGINAW
		GMPT SAGINAW MALLEABLE IRON	48605GMCSG77WCE	SAGINAW
		MICHIGAN SUGAR CO.	48724MCHGN341SU	CARROLLTON
Sanilac County, MI	2	MICHIGAN SUGAR CROSWELL FACTORY	48422MCHGN159SO	CROSWELL
		TRELLEBORG YSH INC. SANDUSKY PLANT	48471YLBBB180ND	SANDUSKY
Shiawassee County, MI	1	MOTOR PRODS. - OWOSSO CORP.	48867MTRPR201SD	OWOSSO
Tuscola County, MI	4	GENERAL CABLE INDS.	48726GNRLC6285G	CASS CITY
		GREDE FOUNDRIES INC. VASSAR FNDY.	48768GRDVS700EH	VASSAR
		MICHIGAN SUGAR CO. - CAROFACTORY	48723MCHGN725AL	CARO
		WALBRO ENGINE MANAGEMENT	48726WLBRN6242G	CASS CITY
Mercury and mercury compounds	5			
Bay County, MI	1	DE KARN - JC WEADOCK GENERATING PLANT	48732DKRNJNWEAD	ESSEXVILLE
Genesee County, MI	2	DELPHI ENERGY & CHASSIS SYS. FLINT EAST	48556CSPRK1300N	FLINT
		GMC GRAND BLANC METAL FAB	48439CDLLC10800	GRAND BLANC
Huron County, MI	1	DETROIT EDISON CO. HARBOR BEACH POWER PLANT	48441DTRTD755NH	HARBOR BEACH
Saginaw County, MI	1	GMC SAGINAW METAL CASTING OPS.	48605SGNWG1629N	SAGINAW

**Table 4.1-E NPDES Permitted Average Annual Discharges (in pounds, 2004)
to Surface Water, Saginaw River AOC**

Chemical	IJC Tracking Number	Discharge
POLYCHLORINATED BIPHENYLS (PCBS)	1	0.004
DDT	5	0.00007
LEAD, TOTAL (AS PB)	8	83.95
MERCURY, TOTAL (AS HG)	9	2.10
	Total IJC	86.05
CADMIUM, TOTAL (AS CD)		91.25
CHROMIUM, HEXA VALENT (AS CR)		21.90
CHROMIUM, TOTAL (AS CR)		109.50
COPPER, TOTAL (AS CU)		1142.45
CYANIDE, FREE (AMEN. TO CHLORINATION)		135.05
FLUORIDE, TOTAL (AS F)		6570
LINDANE		0.04
NICKEL, TOTAL (AS NI)		219
NITROGEN, AMMONIA TOTAL (AS N)		3159182.73
PHOSPHORUS, TOTAL (AS P)		798934
POLYBROMINATED BIPHENYLS		0.001
SELENIUM, TOTAL (AS SE)		167.90
SILVER, TOTAL (AS AG)		250.97
THALLIUM, TOTAL (AS TL)		1788.50
TIN, TOTAL (AS SN)		657
TOLUENE		12.05
XYLENE		3.10
ZINC, TOTAL (AS ZN)		3835.06
	Total Non-IJC	3973120.50
	Total	3973206.55

**Table 4.1-F NPDES Facilities Permitted to Discharge IJC Critical Pollutants,
Saginaw River and Bay AOC**

IJC Critical Pollutant	Number of Facilities	Facility Name	NPDES	City
Polychlorinated Biphenyls (PCBs)	4			
Bay County, MI	2	GM-BAY CITY PLANT	MI0001121	BAY CITY
		BAY CITY WWTP	MI0022284	BAY CITY
Saginaw County, MI	2	SAGINAW TWP-CENTER ROAD LF	MI0054739	SAGINAW
		SAGINAW WWTP	MI0025577	SAGINAW
DDTs	1			
Gratiot County, MI	1	US EPA-VELSICOL	MIU990020	ST LOUIS
Lead	1			
Montcalm County, MI	1	FEDERAL MOGUL CORP- GREENVILLE	MI0002836	GREENVILLE
Mercury	11			
Genesee County, MI	1	GENESSEE COUNTY #3 WWTP	MI0022993	LINDEN
Gratiot County, MI	2	ALMA WWTP	MI0020265	ALMA
		ST LOUIS WWTP	MI0021555	ST LOUIS
Livingston County, MI	1	NORTHFIELD TWP WWTP	MI0023710	WHITMORE LAKE
Mecosta County, MI	1	BIG RAPIDS WWTP	MI0022381	BIG RAPIDS
Montcalm County, MI	1	FEDERAL MOGUL CORP- GREENVILLE	MI0002836	GREENVILLE
Saginaw County, MI	2	FRANKENMUTH WWTP	MI0022942	FRANKENMUTH
		SAGINAW TWP WWTP	MI0023973	SAGINAW
Sanilac County, MI	1	CROSWELL WWTP	MI0021083	CROSWELL
Tuscola County, MI	2	CARO WWTP	MI0022551	CARO
		CASS CITY WWTP	MI0022594	CASS CITY

**Table 4.1-G County Health Status Indicators that Compared Unfavorably
with U.S. Indicators and with the Median of the Peer Counties*
Saginaw River and Bay AOC**

	Arenac	Bay	Clare	Genesee	Gladwin	Gratiot
Demographic Profile						
Children 6 years and younger	1333	9543	2656	45136	2034	3532
Females aged 15-44	3159	22560	5707	96320	4522	8420
Adults 65 years and older	2860	16170	5398	50607	4768	5723
Infant Mortality (per 1,000 births)						
Infant mortality	X	X		X		X
White infant mortality	X	X		X	X	X
Black infant mortality				X		
Neonatal infant mortality		X		X	X	X
Post-neonatal infant mortality	X			X		
Birth Measures (%)						
Low Birth Wt				X		
Very Low Birth Wt				X		
Premature Births						
Teen Mothers						
Older Mothers						
Unmarried Mothers	X		X	X		
No care in 1 st trimester					X	
Death measures (per 100,000)						
Breast cancer (female)	X			X	X	X
Colon Cancer		X	X	X		
Coronary heart disease	X	X	X	X	X	X
Homicide						
Lung cancer			X	X	X	
Stroke						X
	Huron	Iosco	Isabella	Lapeer	Livingston	
Demographic Profile						
Children 6 years and younger	2871	1893	4614	8606	16313	
Females aged 15-44	6400	4537	18980	18585	33324	
Adults 65 years and older	7006	5897	5722	8399	13037	
Infant Mortality (per 1,000 births)						
Infant mortality						
White infant mortality						
Black infant mortality						
Neonatal infant mortality						
Post-neonatal infant mortality	X					
Birth Measures (%)						
Low Birth Wt						
Very Low Birth Wt						
Premature Births						
Teen Mothers						
Older Mothers						
Unmarried Mothers		X				
No care in 1 st trimester	X		X			
Death measures (per 100,000)						
Breast cancer (female)	X	X			X	
Colon Cancer	X	X		X	X	
Coronary heart disease	X	X	X	X		
Homicide						
Lung cancer		X		X		
Stroke	X	X	X	X		

**Table 4.1-G (cont) County Health Status Indicators that Compared Unfavorably
with U.S. Indicators and with the Median of the Peer Counties*
Saginaw River and Bay AOC**

	Mecosta	Midland	Montcalm	Ogemaw	Osceola
Demographic Profile					
Children 6 years and younger	3389	7817	5771	1661	2074
Females aged 15-44	8914	17613	12262	3809	4606
Adults 65 years and older	5339	9975	7421	4064	3284
Infant Mortality (per 1,000 births)					
Infant mortality					
White infant mortality		X		X	
Black infant mortality					
Neonatal infant mortality	X			X	
Post-neonatal infant mortality			X		
Birth Measures (%)					
Low Birth Wt					
Very Low Birth Wt				X	
Premature Births					
Teen Mothers					
Older Mothers					
Unmarried Mothers				X	
No care in 1 st trimester	X		X		X
Death measures (per 100,000)					
Breast cancer (female)		X		X	
Colon Cancer	X	X		X	
Coronary heart disease	X	X		X	X
Homicide					
Lung cancer			X		X
Stroke				X	
	Roscommon	Saginaw	Sanilac	Shiawassee	Tuscola
Demographic Profile					
Children 6 years and younger	1620	20416	4153	6960	5105
Females aged 15-44	3939	44058	8693	15124	11828
Adults 65 years and older	6054	28331	6865	8581	7450
Infant Mortality (per 1,000 births)					
Infant mortality	X	X			X
White infant mortality	X				X
Black infant mortality		X			
Neonatal infant mortality	X	X			X
Post-neonatal infant mortality					X
Birth Measures (%)					
Low Birth Wt		X			
Very Low Birth Wt		X			
Premature Births		X			
Teen Mothers					
Older Mothers					
Unmarried Mothers	X	X			
No care in 1 st trimester			X		
Death measures (per 100,000)					
Breast cancer (female)	X				X
Colon Cancer		X		X	X
Coronary heart disease	X	X	X		X
Homicide		X			
Lung cancer	X				
Stroke	X	X	X	X	

*Sources: 2000 U.S. Census; 2000 HRSA Community Health Status Indicators Reports

X = Indicators that compared unfavorably with both the U.S. and the median of the peer counties X = Indicators that also were above the upper end of the peer county range