



**STATE OF MICHIGAN  
DEPARTMENT OF ENVIRONMENTAL QUALITY  
REMEDATION AND REDEVELOPMENT DIVISION  
CALUMET FIELD OFFICE  
CALUMET, MICHIGAN**

***DRAFT***

***Technical Memorandum for:***

**Compilation and Interpretation of Key Historic Studies  
Abandoned Mining Wastes - Torch Lake non-Superfund  
Site**

**(Site ID # 31000098)**

**Houghton County, Michigan**

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*The Trusted Integrator for Sustainable Solutions*

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## INTRODUCTION

Weston Solutions of Michigan, Inc. (WESTON®) has prepared this Compilation and Interpretation of Key Historic Studies Technical Memorandum to document previous studies and investigations that were used in the development of the *Draft Sampling and Analysis Plan for the Abandoned Mining Wastes Torch Lake Non-Superfund Site, Houghton County, Michigan (SAP)* prepared by WESTON in May 2014.

The technical memorandum has been prepared in accordance with the *Scope of Work, Schedule, and Budget Estimate - Abandoned Mining Wastes – Torch Lake non-Superfund Site, Calumet and Hecla (C&H) Lake Linden Operations Area, Houghton County Michigan, December 16, 2013* and the subsequent *Scope of Work, Schedule, and Budget Estimate for Modification 1 (July 2014)* prepared by WESTON in response to requests from the Michigan Department of Environmental Quality (MDEQ), Remediation and Redevelopment Division, under the Indefinite Scope, Indefinite Delivery (ISID) Professional Services contract between WESTON and the MDEQ (Contract No. 00477).

## PROJECT OBJECTIVES

The Torch Lake Non-Superfund (NS) Site (Site) is characterized by the risks posed by chemical containers and residues historically discarded in or near Torch Lake. These concerns are distinct and separate from the risks historically addressed under the U.S. Environmental Protection Agency's (EPA's) Superfund program. The EPA defines the Torch Lake Superfund Site as the upper six inches of stamp sand and slag in certain areas of Houghton County and any soil cap and vegetative cover applied to such areas.

The remaining concerns at Torch Lake and the surrounding areas identified by the MDEQ include known or suspected impacts to groundwater, surface water, sediments, and upland media that were not addressed under the Superfund program. Environmental impacts that will be evaluated under the Site SAP include, but are not limited to the assessment of the following:

- Unidentified, significant in-lake and/or terrestrial sources of contamination including polychlorinated biphenyls (PCBs);
- Uncharacterized waste deposits, including more than 750 uncharacterized drums, reportedly, on the lake bottom;
- Bulk disposal areas, including stamp sand deposits, slag dumps, and landfills; and,
- Industrial ruins including coal storage areas, underground storage tanks (USTs), suspect asbestos containing materials (SACM), and any other waste materials identified in future investigations.

The risks posed to environmental media, sediment in particular, by these waste deposits and continuing sources of contamination contribute to the limited recovery of the Torch Lake ecosystem. As such, the investigation will be largely driven by documented observations of drum and/or other debris locations in the lake as well as consideration related to historic operations and detected PCB concentrations.

As such, the objectives of the Torch Lake NS project are to support a comprehensive management approach that will guide MDEQ's decision making process in addressing risks present in the C&H Lake Linden Operations Geographic Area presented on **Figure 1**. The primary focus of this portion of the project is to ascertain the source, nature, and extent of contaminants (including PCBs) in all affected



environmental media (soil, groundwater, surface water, waste materials, and sediments) within Torch Lake, including former industrial areas along the shoreline, summarized as follows:

- Traprock Dump;
- Torch Lake Backwater;
- Lake Linden Beach (stamp sands, campground, beach, day park, and boat launch);
- Calumet Stamp Mill;
- C&H Power Plant (exclusive of on-going EPA efforts);
- Hubbell Coal Dock;
- Mineral Building;
- Former Peninsula Copper Industries (PCI) property;
- Hubbell Red Slags; and,
- Hubbell Slag Dump (including beach, marina and the bay).

The former industrial areas summarized above are presented on **Figure 2**.

## **SITE BACKGROUND**

Hard rock mining operations were prevalent throughout Houghton and Keweenaw Counties for nearly a century, primarily spanning an era between the mid-1800's and the mid-1900's. As mining activities declined in the region, a majority of the mine holdings, including surface and underground operations were abandoned, scrapped, and remnants otherwise left in-place.

The Torch Lake NS Site includes properties remote from Torch Lake proper, such as the 270+ acre Centennial Mine just north of Calumet, the Michigan Smelter, Freda/Redridge, the Tamarack City industrial ruins, Mason- Quincy Mill & leach plant, and other areas congruent with the Torch Lake Superfund site where the response action has been limited to the application of the vegetative cover or eliminating the area from further consideration.

The vast distribution of these former mining operations throughout the region (spanning several townships, villages and cities in Houghton County along the Portage Canal, Lake Superior, Slaughterhouse Creek, and Torch Lake) required that operational areas of the mining companies be divided into geographic subsets, allowing for prioritization of the geographic subsets and establishing a phased approach for assessing and addressing environmental concerns regionally.

The C&H Lake Linden Operations Geographic Subset encompasses the former C&H Mining Company copper mining and processing operations in the vicinity of the Lake Linden, Michigan. C&H's operations in the area occurred between 1867 and 1956 and included copper ore processing facilities such as stamp mills, smelters, reprocessing, flotation, and leaching plants, and a laboratory. C&H also reprocessed and smelted scrap metals from surplus World War II munitions, which included lead-containing materials. Over time, mining and plant operation wastes were used as fill material along the shoreline of Torch Lake. The company also used portions of the geographic subset for the direct disposal of industrial wastes. Known waste disposal areas include slag disposal in the northeast and southern portions of the geographic subset, and sludge disposal near Lake Linden's public beach and marina. Wastes were also reportedly buried in the Lake Linden stamp sands deposit, north/northeast of the public beach. The C&H Lake Linden Operations Geographic Area and the conceptual geographic boundaries of each geographic subset are presented on **Figure 2**.



## **SITE LOCATION AND DESCRIPTION**

The C&H Lake Linden Operations Geographic Subset consists of approximately 155 acres of land extending approximately two miles along the shoreline of Torch Lake. The geographic subset also incorporates up to 22 different parcels with multiple property owners. Building on the organization of the Preliminary Assessment completed by the MDEQ in October 2009, the C&H Lake Linden Operations Geographic Subset was divided six smaller conceptual organizational areas based on the historical industrial operations in each area. The investigative areas and their respective former industrial sites are summarized as follows:

- Torch Lake Backwater Area
  - Traprock Dump; and,
  - Torch Lake Backwater.
- Lake Linden Sands Area
  - No Industrial Sites identified;
  - Reported disposal areas; and,
  - Lake Linden Beach (stamp sands, campground, beach, day park, and boat launch).
- Lake Linden Processing Area
  - Calumet Stamp Mill; and,
  - C&H Power Plant (exclusive of on-going EPA efforts).
- Hubbell Coal Dock Area
  - Hubbell Coal Dock.
- Hubbell Smelter Area
  - Mineral Building; and,
  - Former Peninsula Copper Industries (PCI) property.
- Hubbell Slag Dump and Beach Area
  - Hubbell Red Slags; and,
  - Hubbell Slag Dump (including beach, marina and the bay).

## **APPLICABLE REGULATORY CRITERIA**

Evaluation of potential environmental and human health risks present in the C&H Lake Linden Operations Geographic Area requires that analytical results are uniformly compared to analytical results. Previous investigations at the Site had specific goals and objectives that may have placed emphasis on evaluating specific locations, environmental media, or chemical analytes, intentionally narrowing the scope of each investigation. In addition, to the constraint of focused objectives, these investigations are also prone to common limiting factors such as funding, personnel, and equipment resources. As such, the findings of a given investigation are also limited, potentially providing a compartmentalized view of a larger, more prolific problem.



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Similar to limitations identified above, the findings and interpretation of each investigation were also contingent upon the selected regulatory criteria utilized in the evaluation. Over the course of time, regulatory criteria are refined and subject to change, often including criteria revisions and new rule promulgation. As a result, regulatory criteria for a specific exposure pathway and environmental medium evaluated in 2007 may have been evaluated differently using the same regulatory criteria in 2013.

In support of developing a comprehensive approach for evaluating risks, the analytical results from previous investigations summarized herein were compiled and compared to the same regulatory criteria. Consistent with this approach, the same regulatory criteria will be used to evaluate the findings derived from implementation of the SAP. The following provides a summary of the regulatory criteria utilized for evaluating analytical results from surface soil, subsurface soil, groundwater, sediment, and surface water during interpretation of the identified key documents:

- Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA), being Public Act (PA) 451 of 1994, as amended Residential and Non-Residential Cleanup Criteria for Response Activity (December 30, 2013).
  - Surface Soil;
  - Subsurface Soil; and,
  - Groundwater.
- EPA, Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels (ESL) (August 2003).
  - Surface Water; and,
  - Sediment.
- MDEQ – Rule 57 Water Quality Values, Surface Water Assessment Section (February 2014).
  - Surface Water.
- Sediment Quality Guidelines, Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs), MacDonald, et al, 2000.
  - Sediment.

The establishment of baseline criteria is critical to SAP development as well as the future assessment of findings related to the Site. It should be noted that the figures included in this technical memorandum have been prepared using the criteria summarized above; however the conclusions from each investigations summarized in the document narratives have not been modified, thus preserving the objectives and findings of the original documents.

**SAP DEVELOPMENT**

Screening and sample analytical data from previous investigations were incorporated into the sample design. By doing so WESTON was able to identify potential data gaps, while considering the recommendations in each document and available screening and analytical results for soil, groundwater, and sediment from the investigations.



As discussed in the preceding subsection, results derived from individual investigations limit interpretation, particularly as it relates to the presence of potential source areas, localized concentrations of contaminated media, and potential exposure routes. As such, analytical and screening results compiled from the key documents summarized in this document were also integrated into the project database. The result creates a more comprehensive look at the historical findings at the Site while also reducing the potential for redundant sampling activities. The historical analytical and screening results at the Site are presented on multiple figures summarized as follows:

- **Figure 3:** Soil Sample Location Map – Torch Lake Backwater Area;
- **Figure 4:** Soil Screening Location Map – Torch Lake Backwater Area;
- **Figure 5:** Groundwater Sampling Location Map – Torch Lake Backwater Area;
- **Figure 6:** Surface Water and Sediment Sample Location Map – Torch Lake Backwater Area;
- **Figure 7A/B:** Soil Sample Location Map – Lake Linden Sands and Lake Linden Processing Area;
- **Figure 8:** Soil Screening Location Map – Lake Linden Sands and Lake Linden Processing Area;
- **Figure 9:** Groundwater Sample Location Map – Lake Linden Sands and Lake Linden Processing Area;
- **Figure 10:** Surface Water and Sediment Sample Location Map – Lake Linden Sands and Lake Linden Processing Area;
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- **Figure 16:** Soil Screening Location Map – Hubbell Slag Dump and Beach Area;
- **Figure 17:** Surface Water and Sediment Sample Location Map – Hubbell Slag Dump and Beach Area; and,
- **Figure 18:** PCB Congener Detections – SPMD Sampling Locations.

The volume of analytical data derived from the historical documents and presented on the aforementioned figures required the use of graphical and analytical details to simplify the overall presentation of the data. With the exception of **Figure 4**, **Figure 8**, **Figure 12**, and **Figure 16**, the following graphics were used to present the analytical results:

- **Green Dots** – A sample location that is typically unlabeled to reduce overcrowding of the figure, these dots represent a sampling or screening result that was below the figure criteria. Green dots may be derived from any of the historical investigations.
- **Red Dots** – A sample location labeled with a callout box that lists the sample identification, the sample interval, and the sample date. These dots represent an exceedance of figure criteria, a summary of which is presented in the corresponding callout box.



- **Yellow Dot/Ring** – A sample location represented by a yellow dot means that it was analyzed for PCBs and no congeners were detected. A green or red sample location surrounded by a yellow ring, indicates the same; the sample was analyzed for PCBs and no congener was detected.
- **Light Blue Dot/Ring** – A sample location represented by a light blue dot means that it was analyzed for PCBs and at least one congener was detected (recall that if PCBs exceeded criteria the dot would be red). A green or red sample location surrounded by a blue ring, indicates the same; the sample was analyzed for PCBs and at least one congener was detected (if PCBs exceeded criteria they would be listed in the callout box)

## KEY DOCUMENT REVIEW AND INTERPRETATION

This Section provides a summary of the key documents selected for review as well as a synopsis of the investigation and conclusions relevant to the development of the SAP and the performance of current sampling and analysis scope of work at the Site.

### KEY DOCUMENT IDENTIFICATION AND REVIEW

Numerous investigations have been conducted on and along the shoreline of Torch Lake with various purposes, often specific to a particular property or investigative focus. Although often referenced in individual reports, a comprehensive approach consolidating the findings of these investigations has not been completed. In support of the development of the SAP for the Torch Lake NS Site key deliverables were selected to assist in the identification of historic areas of contamination or data gaps requiring further assessment. The following is a summary of the key documents reviewed during preparation of the SAP:

- *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County – March 2006.* Prepared by the Great Lakes Environmental Center.
- *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan – November 2007.* Prepared by WESTON.
- *Summary Report for the Torch Lake Area Assessment, Torch Lake NPL Site and Surrounding Areas, Keweenaw Peninsula, Michigan – December 2007.* Prepared by WESTON.
- *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, MDEQ Water Bureau – February 2008.* Prepared by the MDEQ Water Bureau.
- *PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior - June 2008.* Prepared by the MDEQ Water Bureau.
- *Groundwater Sampling Investigation Report for Village of Lake Linden, Torch Lake Superfund Site, Lake Linden, Michigan - March 2009.* Prepared by the MDEQ-Remediation and Redevelopment Division (RRD), Superfund Section, Geological Support Unit.
- *Aroclor Sediment Investigation, Torch Lake Area of Concern, Houghton County, Michigan – June 2009.* Prepared by the EPA Great Lakes National Program Office (GLNPO).



- *Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945 - March 2013.* Prepared by the MDEQ-RRD, Superfund Section, Pre-remedial Group, Site Evaluation Unit (Pre-remedial Group).
- Correspondence, narratives, and analytical results from other studies including the following:
  - Summary of multi-level monitoring well investigation completed in Lake Linden by the MDEQ;
  - Summary of sediment and groundwater analytical results collected from the former PCI Property located in Hubbell provided by others.

The following subsections summarize the findings of these investigations and the conclusions derived from the performance of each assessment.

### **Final Report, PCB Study Using Semipermeable Membrane Devices (SPMD) in Torch Lake, Houghton County – March 2006**

The MDEQ contracted Great Lakes Environmental Center, Inc. (GLEC) to conduct a contaminant concentration study using SPMDs in Torch Lake, Portage Lake, and the Keweenaw Waterway in Houghton County, and Huron Bay in Baraga County. The intent of the study was to collect data for comparison of PCB residues at the various sites to determine if Torch Lake was a source of PCBs.

SPMDs are passive samplers that can be used as an alternative to the collection and analysis of water samples. One advantage of SPMDs is that they isolate only the truly dissolved portion of these compounds from the water; compound that is adsorbed to particulates, and therefore not bioavailable, is excluded. SPMDs mimic the transfer of dissolved compounds across biological membranes (e.g., gills), effectively concentrating them and allowing the detection of compounds that may be present at concentrations below the analytical method detection level in water samples. At constant temperature and flow velocity, the amount of a particular compound absorbed by an SPMD is linearly proportional to the dissolved concentration of the compound in the water (Booij et al. 2003). The utility of SPMDs for monitoring aqueous residues of PCBs, as well as other low to moderate molecular weight nonpolar organic environmental contaminants, has been repeatedly demonstrated.

SPMDs were deployed at 10 locations (Sites 1-10) in Torch Lake, Portage Lake, and the Keweenaw Waterway in Houghton County, and Huron Bay in Baraga County. PCBs detected at Sites 2, 5, 7, 8, 9, and 10 were very similar in concentration, congener pattern, and number of congeners. Total PCB concentrations at these sites ranged from 22 to 26 µg/L with nearly identical congeners being detected. Of the 13 to 16 congeners detected at these six sites, 12 were detected at all ten sites. Sites 2, 5, 7, 8, 9, and 10 were all located outside the main basin of Torch Lake.

- Site 2 was upstream of Torch Lake, in the Trap Rock River;
- Site 5 was in the southern basin of the lake, connected to the main basin by only a narrow strait, and partially fed by tributaries;
- Site 7 was located in Portage Lake;
- Sites 8 and 9 were in the Keweenaw waterway; and,



- Site 10 was in Lake Superior.

The MDEQ selected Sites 5 and 7 to determine whether the stamp sands or the old mill near Site 5, and the abandoned equipment near Site 7, were sources of PCBs; the results from this study suggest that there were not. Sites 8, 9, and 10 were chosen to demonstrate background levels of PCBs in the Keweenaw waterway and Lake Superior. The similarity of PCB results for these six sites suggests that PCBs at Sites 2, 5, and 7 were also at background levels.

In contrast, the remaining sites within Torch Lake (Sites 1, 3, 4, and 6) had elevated levels of PCBs, with the highest concentrations and the greatest number of congeners detected at Site 4. Sites 3 and 4 were selected because they were near potential PCB sources, which the results support. The fact that Site 1 (without stamp sands) had elevated levels of PCBs, and Site 5 (with stamp sands) had background levels of PCBs indicates that the stamp sands were not a source of PCBs. Site 6 was representative of the discharge from the lake. Overall, the results demonstrated that the surface water in the main basin of Torch Lake contains elevated levels of PCBs.

### **Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan – November 2007**

On 21 June 2007, Michigan Department of Environmental Quality (MDEQ) representatives visited the Site to assess the newly exposed shoreline areas. While at the Site, MDEQ observed and sampled white, clayey waste material on the shoreline. The MDEQ sample (LK Linden Park) was collected along the shoreline west of the Village's swimming beach. The sample contained PCBs at concentrations of 12 milligrams per kilogram (mg/kg) as well as elevated target analyte list (TAL) metals that exceeded MDEQ Residential Direct Contact Criteria (RDCC). In addition, the concentrations of barium, cadmium, chromium, lead, and selenium were indicative of characteristic hazardous waste.

At the request of the MDEQ, Western Upper Peninsula District Health Department, Michigan Department of Community Health (MDCH), and the Village of Lake Linden EPA collected two soil/sediment samples (LLV-Sediment1 and LLV-Sediment2) on 26 July 2007. In addition, EPA collected one surface water sample (LLV-Creek 1) from the creek located west of the Site's swimming beach, and one water sample (LLV-Beach1) from a hole dug in the sandy swimming beach. The samples collected from the creek and the beach contained contaminant concentrations exceeding Residential Drinking Water Criteria, GSI criteria, and MDEQ Rule 57 Human Drinking Water (HDW) value criteria.

On 3 August 2007, EPA initiated an emergency removal action to mitigate the imminent threats to public health, welfare, and the environment posed by the presence of uncontrolled hazardous substances along the shoreline of Torch Lake. Emergency removal activities began on 6 August 2007, and were completed on 3 October 2007. The emergency removal activities completed during this time period include the following:

- EPA delineated Area 1, which had an approximate area of 200 feet by 200 feet. The direct contact threat was projected to be in the top 18 inches of soil/sediment. Excavation of Area 1 began on 7 August 2007 and was completed on 12 August 2007. Two excavators, one standard-reach and one long-reach, were used to excavate the top two to five feet of the area contaminated with clayey waste material. An estimated 905.5 tons of soil were removed and stockpiled for disposal.
- Between 7 August 2007, and 8 August 2007, EPA conducted further investigation and delineation of Area 2. Area 2 was determined to be approximately 3 feet by 200 feet with the direct contact threat determined to be in the top 18 inches of soil/sediment. EPA initiated the soil/sediment



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excavation at Area 2 on 13 August 2007, and completed activities on 15 August 2007. An estimated 64.69 tons of soil was removed and stockpiled for disposal.

- Confirmatory soil samples were collected from the bottom of the excavations. Three samples were collected from Area 1 (LLV-EXC-1, LLV-EXC-2, and LLV-EXC-3) and one sample and one duplicate sample were collected from Area 2 (LLV-2EXC-2 and LLV-2EXC-2 DUP). Analytical results for all samples were below applicable MDEQ criteria with the exception of one sample (LLV-2EXC-2), which exceeded RDCC for arsenic at 20 mg/kg.
- On 15 August 2007, WESTON START collected surface water samples from the creek and along the swimming beach (LLV-Creek1, LLV-Beach1, and LLV-Beach2). All concentrations were below applicable MDEQ criteria.

At the completion of the work the excavation areas were capped with clean soil and rip rap along the shoreline.

**Summary Report for the Torch Lake Area Assessment, Torch Lake NPL Site and Surrounding Areas, Keweenaw Peninsula, Michigan – December 2007**

In September 2007, the EPA at the request of the MDEQ, conducted assessment activities in the vicinity of Torch Lake. The focus of the assessment was on 17 Areas of Investigation (AOI) identified jointly by the EPA and the MDEQ that were impacted by historical copper mining operations in the Keweenaw Peninsula. The Torch Lake Area Assessment included portions of the Torch Lake NPL Site where stamp sands are the primary media of concern.

The primary project objectives of the Torch Lake Area Assessment were to evaluate imminent threats to human health, welfare and the environment, including the identification of areas for additional investigation. The geographical locations specific to Torch Lake, and pathways evaluated during the assessment were:

- Direct-contact hazards associated with exposed stamp sand and the potential presence of other mining-era related waste along the western shoreline of Torch Lake. At the time of the investigation, the evaluated area included recently exposed shoreline between the edge of the EPA-installed vegetative cover and the water's edge as a result of the significantly lower surface-water levels in Lake Superior and its contiguous water bodies. These previously shallow water areas had not been investigated; and,
- Limited evaluation of potential environmental concerns at abandoned mining-era related industrial buildings, ruins, and land areas proximal to the western shoreline of Torch Lake.

The list of targeted AOIs relevant to the Torch Lake NS Site included in the Torch Lake Area Assessment are summarized as follows:

- AOI 21 – Hubbell Beach and Slag Dump;
- AOI 22 – Hubbell Docks, Mineral Building, and the C&H Smelter;
- AOI 12 – Lake Linden Sands;
- AOI 23 – C&H Power Plant;
- AOI 24 – Backwater Area of Torch Lake;
- AOI 27 – Drums on Lake Bottom.



A comprehensive assessment of all environmental hazards known to affect historical industrial properties and structures was not within the scope of the assessment; however, the EPA's report provided specific recommendations by AOI for further investigation, maintenance, and or no further action.

### **A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, MDEQ Water Bureau – February 2008**

The objective of this investigation was to conduct a chemistry survey of the sediment in Torch Lake in part, because of elevated levels of PCBs in fish tissue. The investigation was completed by the MDEQ Water Bureau together with the EPA GLNPO. At the time of the investigation, the EPA listed Torch Lake, as a Great Lakes Area of Concern. MDCH also restricted consumption of northern pike, smallmouth bass, and walleye caught in Torch Lake.

Previous investigations had indicated that a potential source of PCBs was present within the northern portion of Torch Lake. The objective of this study was to evaluate sediments in this area, including several previously identified drum disposal areas, as a potential source of PCBs to the lake. In general, the study included the following findings:

- Seventy-one discrete sediment samples were collected from 36 location in Torch Lake and analyzed for PCBs, silver, arsenic, barium, cadmium, chromium, copper, mercury, lead, selenium, zinc, and percent total solids;
- The metals analysis demonstrated elevated concentrations of copper and lead consistent with the historical sampling activities;
- PCBs were detected in 16 of the 71 discrete samples, with quantified concentrations ranging from 130 micrograms/kilogram ( $\mu\text{g}/\text{kg}$ ) to 8,900  $\mu\text{g}/\text{kg}$ . PCBs were also detected at 11 of the 36 surficial sampling locations. The highest concentrations of PCBs were detected in deeper sediments near Lake Linden.
- Surficial sediments near Hubbell in Torch Lake appear to have low levels (1,000  $\mu\text{g}/\text{kg}$  or less) of PCB concentrations. PCB concentrations in the deeper sediments, except at the very northern end of the sample area, were predominantly below reporting limits.

The MDEQ Water Bureau concluded that it was possible that a low level upland source of PCBs to Torch Lake near Hubbell due to historical industrial operations. A detailed upland source identification study was not conducted at the time of the study to verify the presence of such a source area. The sediment sample results contained elevated concentrations of PCB in the deeper sediment intervals of Torch Lake in the north end sample area and low concentrations of PCB in surficial sediment of Torch Lake in the Hubbell area; however, the MDEQ Water Bureau did not recommend remedial actions to address the contaminants in sediments at the time of the study.

### **PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior - June 2008**

Torch Lake, Houghton County, is currently listed as a Great Lakes Area of Concern by the EPA, in part because of elevated levels of PCBs in fish. The PCB concentrations in fish collected from Torch Lake have been consistently higher than in fish found in nearby surface water bodies. A fish consumption advisory due to elevated levels of PCBs was first issued for Torch Lake fish by the MDCH in 1998.



The Torch Lake watershed contains elevated levels of PCBs, but the question remained as to whether the watershed is the cause of elevated concentrations in fish. It had been postulated that the elevated concentrations of PCBs in fish caught in Torch Lake may actually represent exposure to the contaminant in Lake Superior since PCBs are elevated in several species in Lake Superior, and there are no barriers to fish movement between the two water bodies. The elevated PCB concentration in Lake Superior fish is believed to be due primarily to atmospheric deposition.

Prior to this study, no walleye from Lake Superior in the vicinity of Torch Lake had been analyzed for chemical contamination. The goal of this study was to compare concentrations of total PCBs in walleye collected from Torch Lake (Houghton County) with concentrations in walleye collected from Portage Lake and Huron Bay, Lake Superior. The null hypothesis was that PCB concentrations within Torch Lake fish were no different than in fish collected from Portage Lake and nearby waters of Lake Superior. Walleye were collected from Huron Bay, Lake Superior, in April 2006 and from Torch Lake and Portage Lake in April 2007. In general, the study included the following findings:

- The length ranges of walleye collected from all three locations were equivalent.
- Total PCB and lipid-normalized total PCB concentrations in Torch Lake walleye collected in 2007 were equivalent to the concentrations in walleye collected in 2000.
- Total PCB and lipid-normalized total PCB concentrations in walleye collected from Torch Lake were higher than concentrations in walleye collected from Huron Bay, and the data suggest that walleye from the two areas represent distinct groups.
- Total PCB concentrations in Portage Lake walleye appear similar to the concentrations in walleye collected from Huron Bay, but the comparisons are weak due to a small Portage Lake sample.
- The MDCH fish consumption advisories for Torch Lake and Portage Lake walleye are unlikely to be relaxed based on the total PCB concentrations measured in the 2007 samples.

The higher total PCB concentrations and different congener composition in the Torch Lake walleye as compared to the Huron Bay walleye are consistent with the sediment and surface water studies indicating that there is a source of PCBs in the Torch Lake watershed. It seems likely that the walleye collected in Torch Lake are in the lake for extended periods of time and that the elevated concentrations of PCBs measured in those fish are a result of sources within the Torch Lake watershed over and above atmospheric inputs.

### **Groundwater Sampling Investigation Report for Village of Lake Linden Torch Lake Superfund Site, Lake Linden, Michigan - March 2009**

The objective of this investigation was to further evaluate groundwater exposure pathways in stamp sand deposits along Torch Lake and to provide additional site characterization data for future EPA and MDEQ site assessment efforts. This sampling effort was designed to screen for likely groundwater discharge locations along stamp sand deposits in Lake Linden and to collect samples of groundwater prior to its discharge into the Torch Lake surface water body.

The investigation identified zones of groundwater discharge using potentiometric head measurements. There were heterogeneities in some of the potentiometric head measurements. For instance, one location had both upward and downward potentiometric head measurements at different depths, reportedly



indicating inconsistencies in the flow regime of the stamp sands and other buried wastes. At the majority of the locations, the stamp sands were determined to be highly transmissive.

The investigation was intended to improve the understanding of the interaction between surface water and groundwater interaction in the shallow stamp sand aquifer (Lake Linden stamp sands). The data indicates that contaminated materials, primarily metals, present in the mining wastes adjacent to Lake Linden are being transported to the surface water through shallow groundwater pathways. The study identified areas of preferential shallow groundwater flow from terrestrial areas on the Lake Linden water front towards Torch Lake and concluded that generally, all the groundwater from the Lake Linden stamps and aquifer discharges into Torch Lake.

There were also two tiers of analytical scans for sampling at analytical sampling locations, and some locations were sampled for inorganic constituents and metals. Some locations were also selected for a full analytical scan. Some groundwater samples were analyzed for volatile organic, semi-volatile organic, pesticide, PCBs, and full inorganic parameters by the MDEQ laboratory.

The report identified the former C&H Power Plant as a potential contaminant source. The facility contained water in the basement that was potentially in hydraulic communication with the lake via former process piping or utility conduits. Samples of sediment and water were collected from the basement of the former C&H Power Plant for laboratory analysis. PCBs were detected in the basement sediments.

### **Aroclor Sediment Investigation Torch Lake Area of Concern, Houghton County, Michigan – GLNPO - 2009**

The objective of this study was to evaluate surficial sediments throughout Torch Lake to determine if there are areas of higher PCB concentrations that might indicate a terrestrial and/or aquatic source of PCBs. The report summarizes the results of the 2008 sediment sampling event and provides some context for those results. In addition, the data evaluation presented incorporated the results of the 2007 sampling efforts completed by the MDEQ and the EPA GLNPO.

Eighty surficial sediment samples, along with 9 duplicate samples were collected between 26 and 28 August 2008. All sample locations were randomly selected prior to mobilization of the EPA's research vessel, *Mudpuppy*, to the lake. The locations were reviewed and discussed with both MDEQ and the Torch Lake Public Advisory Council (TLPAC).

Of the eighty nine samples collected and analyzed, only two had detectable concentrations of PCBs, sample TL08-75 (90 µg/kg) and TL08-76 (26 µg/kg). Both TL08-75 and TL08-76 are in the vicinity of the samples collected in 2007 that had detectable concentrations of PCBs in the top 1-2 inches of sediment. The 2007 data from this area ranged from a low of 130 µg/kg to 1,100 µg/kg (MDEQ 2008a). The 2007 sampling event did identify subsurface concentrations of PCBs ranging from 180 µg/kg to 8,900 µg/kg in samples ranging from 6 inches to 64 inches below the sediment surface. Combining the two data sets results in a detectable range of PCB concentrations from a low of 26 µg/kg to a high of 1,100 µg/kg.

### **MDEQ Pre-remedial Group - Draft SI Report for C&H Lake Linden Operations – 2013**

Under the authority of a cooperative agreement between the MDEQ and the EPA, the MDEQ's Pre-Remedial Group conducted assessment activities at the Site in October 2011. The MDEQ completed the assessment activities under an approved work plan dated 7 October 2011. The SI field work was completed



at the Site between 10 and 13 October 2011. The findings were documented in a draft report prepared by the MDEQ that details the completed investigative activities, analytical findings, and demographics from the C & H Lake Linden Operations Site.

The investigation was prompted by historical findings of elevated levels of metals and asbestos in surface soils; lead and arsenic in sludges; semi-volatile organic compounds (SVOC) and PCBs in waste materials; and volatile organic compounds (VOC) venting into Torch Lake from contaminated groundwater; and metals, in groundwater.

The scope and objectives of the SI were designed to meet the investigative requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 105 to provide sufficient data for National Priorities List (NPL) or No Further Remedial Action Planned (NFRAP) decisions and/or to support the need for time-critical or non-time-critical actions. The performance of the SI included interviews with local residents; reconnaissance inspections of the properties; installation of temporary groundwater monitoring wells; collection of soil, groundwater, surface water, and sediment samples; and documentation of Site conditions. Four migration pathways of concern were discussed in the report and included groundwater, surface water, soil, and air.

### **Groundwater**

Groundwater analytical results from the SI investigation were compared to Michigan's Cleanup Criteria Requirements for Response Activity (Formerly the Part 201 Generic Cleanup Criteria and Screening Levels) for Residential Drinking Water Criteria, Groundwater Surface Water Interface Criteria (GSIC), and Groundwater Contact Criteria (*Note: Groundwater Contact Criteria is not a relevant criterion under Michigan's Cleanup Criteria Requirements for Response Activity*). Inorganic contaminants detected in groundwater exceeded criteria and generally determined to be attributable to wastes observed in source areas at the Site. Inorganic contaminants observed in wastes documented in surficial soils at the Mineral Building property and wastes also documented in subsurface soils at the Lake Linden Village Park were detected in groundwater samples collected from near these "source areas". The MDEQ concluded that the potential remains for continued migration of contaminants from soils and waste deposits at the Site.

### **Surface Water**

The MDEQ determined that risks to surface water were present due to waste deposits located along the shoreline as well as the potential for venting groundwater to cause impacts in the surface water pathway. The MDEQ noted that the topography adjacent to the Site is at higher elevations directing surface runoff flow across the Site and into surface waters. In the vicinity of the Village of Lake Linden, the village is immediately uphill of the Site, and any surface runoff in this area flows across village properties before flowing across the Site and into Torch Lake. The northern part of the Site is part of the Trap Rock River watershed, and the topography is less steep than west of the Site. However, the slope in this area is still toward Torch Lake. Thus, surface runoff in this area will also flow across the Site and into the Torch Lake backwater or possibly into the Trap Rock River. Historical documentation of surface soil contamination across the C & H Lake Linden Operations Site makes Torch Lake susceptible to the contaminants documented in the shallow soils. The surface water samples collected from areas adjacent to documented source areas indicate an observed release of contaminants into Torch Lake at these source areas. A limited number of inorganic analytes were found to exceed both RDWC and GSIC. No exceedances of direct contact criteria were identified.



## ***Sediment***

Similar to surface water, sediment samples collected from areas adjacent to documented source areas indicate an observed release of contaminants into Torch Lake at these source areas. The concentrations of 12 inorganic contaminants exceeded at least one more of the applicable criteria. Of these 12 contaminants, 10 exceeded Groundwater Surface Water Interface Protection Criteria (GSIPC) and 7 exceeded Residential Drinking Water Protection Criteria (RDWPC). Since no public water intakes are present within the 15-Mile target distance limit, the exceedances of RDWPC were determined to be insignificant. Arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, and zinc exceeded GSIPC.

## ***Soil***

The MDEQ utilized x-ray fluorescence to screen surface soils during the implementation of the SI. XRF screening documented many areas where inorganic contaminant concentrations exceeded applicable criteria. Nine or more of the 20 surface soil samples collected during the SI also exceeded RDWPC for arsenic, copper, and lead. Deeper soil was also determined to pose a direct contact risk, but such soil would become a risk only during excavation.

The Site is located in an area of residential and commercial uses and little fencing is present in the northern half of the Site to restrict access to areas where surface contamination is present. Approximately 2,523 people live within a one-mile radius of the Site.

## ***Air***

A release of potential contaminants to the air was not documented during the investigation of the Site; however, the MDEQ believes that potential releases to air exist. Significant surface waste and soil contamination have been documented at the Lake Linden Village Park, at the Historical Society property, at the former Power Plant property, at the Coal Docks property, and at the Mineral Building property. Some of these areas are only minimally vegetated, making the surface soil subject to wind erosion potentially allowing particulates to become airborne and respirable.

The findings of the SI determined that significant quantities of waste are present at the Site; and shallow and subsurface soils, groundwater, and sediments have become contaminated with heavy metals, especially arsenic, chromium, copper, and lead.

## **Correspondence, Narratives, and Analytical Results from Other Studies**

In addition, to the findings of the investigations summarized above, WESTON also considered the results derived from other investigations that may have been provided in the form of narrative accounts of the sampling events and partial data sets. This information, although not necessarily provided in a complete and final report format, was valuable nonetheless. The following subsections summarize the analytical results and project narratives considered as during SAP preparation.

### ***Historical Archive Research and Mapping, Michigan Technological University - May 2014***

As a preliminary component to a broader scope of work, Michigan Technological University (Michigan Tech) provided background historical information associated with C&H's Lake Linden and Hubbell operations. Geo-referenced Sanborn Fire Insurance Maps and structure coordinates were provided and



incorporated into the project database. In addition to geo-referenced maps, Michigan Tech also provided archival blueprints for several of the facilities within the proposed investigation area. These references to historical structures and operations were incorporated into the SAP, allowing the investigation to target specific operations and potential sources, minimizing the amount of approximation needed to locate a given structure. Coordinates and/or structural and operational details related to the following structures were provided by Michigan Tech:

- Hubbell Coal Dock Area
  - Mineral Building;
  - Coal Pulverization Plant;
  - Coal Storage Building;
  - Coal Dock Electrical Substation; and,
  - Unidentified Structure.
- Lake Linden
  - Regrinding Plant No. 1;
  - Regrinding Plant No. 2;
  - Leaching Plant;
  - Flotation Plant;
  - Electrical Substation; and,
  - Calumet Mill.

### ***Multi-Level Groundwater Monitoring Wells, Lake Linden, MDEQ - 2013***

The objective of this study was to build upon efforts previously completed at the Site, including the following:

- EPA Emergency Removal Action, Lake Linden, August 2007;
- Torch Lake Area Assessment, EPA, 2007;
- Lake Linden Groundwater Investigation MDEQ, 2008; and,
- Response to citizen reports of blue water present along the Lake Linden Beach.

The investigation was designed to identify likely groundwater discharge locations along stamp sand deposits in Lake Linden. The investigative activities were conducted in accordance with a Work Plan prepared by the MDEQ Remediation Division, Superfund Section. This groundwater investigation included the installation of 12 multi-level sampling systems at various locations in the stamp sand deposit that would be used to collect samples of groundwater prior to discharging into the Torch Lake surface water body. The intent of installing multi-level sampling systems was to determine if contaminants associated with mining waste had infiltrated the shallow groundwater aquifer and were discharging to Torch Lake.

Multi-level sampling locations were strategically placed in the vicinity of the following areas of interest in Lake Linden:

- Lake Linden sands, the Lake Linden beach;
- The unnamed creek west of the Lake Linden Beach;
- The former emergency removal action excavation area; and,
- Along the shoreline of Torch Lake extending from Lake Linden to Hubbell.



Multi-level sampling systems were selected to characterize and monitor the groundwater as part of the long term monitoring for the Torch Lake. Multi-level wells provide long term discrete groundwater monitoring data from specific vertical intervals in the subsurface. This data is necessary to delineate and characterize spatial variations in hydraulic conductivity and groundwater chemical concentrations. Groundwater adjacent to Torch Lake is discharging into Torch Lake and its tributaries.

### **Groundwater Analytical Results – PCI Property, MDEQ - 2013**

Field investigations completed in 1990 as part of the Operational Unit II Remedial Investigation (OU II RI) identified "hot spot" contamination offshore from the former C&H smelter at Hubbell (Donohue, 1992). Subsequent investigative activities attempted to delineate the extent of contamination in the vicinity of the property. This area of sediment contamination has since been better defined offshore from the location of the former smelter. Although not specifically associated with submerged drum/barrel reports, drums/barrels and debris have been documented on the lake bottom in this area. The area can be defined as extending approximately 400 feet south-southwest from the former PCI Property (currently Koppers) outfall along the shoreline of Torch Lake, and approximately 200 feet offshore, and covering approximately 3 acres of lake bottom sediment. Sediment samples collected from the area have the highest concentrations of arsenic, chromium, copper, and lead of any sediment samples collected as part of the OU II RI.

In addition to known waste deposits and sediment contamination at the Site, ongoing sampling activities at the former PCI Property include regular groundwater monitoring from the existing monitoring well network at the property. Historical sediment analytical results in conjunction with groundwater analytical results indicate that the property and the nearshore environment east of the property is potentially and ongoing source of environmental contaminants.

### **DATA INTERPRETATION AND LINES OF EVIDENCE**

The investigative findings summarized in the preceding section individually provide relevant information related to various aspects of the health and long-term management of Torch Lake. The following subsections provide a summary of the how the specific findings were incorporated into the *Draft Sampling and Analysis Plan for the Abandoned Mining Wastes, Torch Lake Non-Superfund Site, Houghton County, Michigan* dated May 2014.

#### **Final Report, PCB Study Using SPMD in Torch Lake, Houghton County – March 2006**

Analytical results from the SPMD study were not directly incorporated into the SAP for the Site. The analytical results were evaluated and compared to the analytical results from the other studies summarized herein. The SPMD results confirm the presence of PCBs in surface waters; however, the study was inconclusive in identifying a specific PCB source within Torch Lake. Further, concentrations of PCBs measured in the SPMD samples were consistent with historical data; demonstrating higher concentrations of PCB congeners in Torch Lake with the highest concentrations being measured in the vicinity of the Site. Analytical results for SPMD samples collected from Torch Lake are presented on **Figure 18**.

#### **Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan – November 2007**

The Lake Linden Emergency Response was used to evaluate surface soil and sediment conditions that might be indicative of mining wastes. The assessment included a substantial number of surface and



subsurface soil screening and sampling results from the Lake Linden Village Park and Public Beach. Soil sampling locations presented on **Figure 7A** and **Figure 7B** were used to evaluate the potential presence of terrestrial mining wastes that would be represented by elevated levels of inorganic contaminants and PCBs.

The report also included a limited number of surface water and sediment samples that were included in the evaluation of contaminants. Surface water and sediment sampling locations and contaminant concentrations are presented on **Figure 10**.

The removal action conducted at the Site resulted in the excavation and disposal of contaminated soil and near shore sediment. The limits of the removal and the related terrestrial and offshore sampling program were used to establish previously investigation/removal limits to minimize the duplication of previous work conducted in this location. Further, the removal action contributed to a comprehensive understanding of disposal practices and potential waste distribution along the shoreline and lake bottom of Torch Lake.

### **Summary Report for the Torch Lake Area Assessment, Torch Lake NPL Site and Surrounding Areas, Keweenaw Peninsula, Michigan – December 2007**

The Torch Lake Area Assessment was used to evaluate surface soil conditions that might be indicative of mining wastes. The assessment included a substantial number of surface soil screening results, recorded using an x-ray fluorescence hand held analyzer, across the entire Site. Soil screening locations presented on **Figure 4**, **Figure 8**, **Figure 12**, and **Figure 16** were used to evaluate the potential presence of terrestrial mining wastes that would be represented by elevated levels of inorganic contaminants.

The report also included a limited number of soil and groundwater samples that were composited with the results from other investigations to evaluate the presence of contaminants. Soil sample locations and contaminant concentrations are presented on **Figure 6**, **Figure 10**, **Figure 15**, and **Figure 17**. Similarly, groundwater sampling locations and contaminant concentrations are presented on **Figure 5**, **Figure 9**, and **Figure 14**.

The resulting offshore sampling program was then developed to minimize the duplication of previous investigative activities, while also providing results that contribute to a comprehensive understanding of waste and contaminant distribution along the shoreline and lake bottom of Torch Lake.

### **A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, MDEQ Water Bureau – February 2008**

The objective of the investigation, to conduct a chemistry survey of the sediment in Torch Lake, partially due to elevated levels of PCBs in fish tissue along with historical industrial land use, tied directly to the objectives of the current investigative activities. Similar to the 2009 GLNPO investigation, this report supported the development of both terrestrial and offshore investigative locations.

The sediment chemistry survey completed by the MDEQ Water Bureau was significant in the development of the SAP for the Site. The horizontal and vertical location of the sediment analytical results was critical in the development of both the terrestrial and lakeward sampling programs. Sample locations and contaminant concentrations from this investigation are presented on **Figure 6**, **Figure 10**, **Figure 15**, and **Figure 17**. The results of the investigation were used to evaluate the presence of existing contamination and determine where data gaps may be present. In addition, land use was also considered



to determine where potential unidentified terrestrial sources of contamination may be present or where potential exposure risks were greatest.

The resulting sampling program was developed to minimize the duplication of previous investigative activities, while also providing results that contribute to a comprehensive understanding of potential terrestrial sources of PCBs as well as waste and contaminant distribution along the lake bottom.

### **PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior - June 2008**

Analytical results from this study were not directly incorporated into the SAP for the Site. Concentrations of PCBs in fish collected from Torch Lake were considered evidence of an ongoing source of PCBs present in or along the shoreline of Torch Lake. Analytical results for fish tissue samples collected from Walleye taken from Torch Lake in 2000 and 2007 are summarized on **Figure 18**. (*Note: Sample coordinates for tissue samples were not reported, tissue samples were reported by water body only.*)

The resulting offshore sampling program was developed with an emphasis in evaluating historical industrial operations at the Site. The investigative sampling locations were positioned to further evaluate environmental conditions along the lake bottom and shoreline of Torch Lake.

### **Groundwater Sampling Investigation Report for Village of Lake Linden Torch Lake Superfund Site, Lake Linden, Michigan - March 2009**

Analytical results and groundwater flow conditions discussed in this document were used to support the selection of terrestrial and offshore sampling locations. The 2009 investigation was largely focused on the shoreline of Torch Lake in the Lake Linden Sands and C&H Processing geographic areas of the Site. The evaluation provided insight related to the groundwater flow regime and assisted in the placement of temporary monitoring wells in the vicinity of potential historical sources of PCBs at the Site. In addition, review of the sampling locations and data, although not specifically incorporated into this technical memorandum, were used to eliminate proposed monitoring wells along the shoreline of the lake that would have been focused on evaluating the groundwater/surface water interface.

Groundwater sampling locations and contaminant concentrations presented on **Figure 5**, **Figure 9**, and **Figure 14** were used to evaluate the presence of existing contamination and determine where data gaps may be present.

### **Aroclor Sediment Investigation Torch Lake Area of Concern, Houghton County, Michigan, EPA –GLNPO - 2009**

Sediment analytical results summarized in this document were used to establish baseline conditions in the sediment of Torch Lake. The objective of the investigation, determining whether areas of elevated PCB concentrations may indicate a terrestrial and/or aquatic source of PCBs, tied directly to the objectives of the current investigative activities. The conclusions derived from the report supported the development of both terrestrial and offshore investigative locations. Sample locations and contaminant concentrations presented on **Figure 6**, **Figure 10**, **Figure 15**, and **Figure 17** were used to evaluate the presence of existing contamination and determine where data gaps may be present. In addition, land use was also considered to determine where potential unidentified terrestrial sources of contamination may be present or where potential exposure risks were greatest.



The resulting offshore sampling program was then developed to minimize the duplication of previous investigative activities, while also providing results that contribute to a comprehensive understanding of waste and contaminant distribution along the lake bottom.

## **MDEQ Pre-remedial Group - Draft SI Report for C&H Lake Linden Operations – 2013**

The geographic areas established in the SAP were generally based on the same geographic areas established during the Pre-Remedial Group's investigation. Specific boundaries, naming conventions, and areas were modified to fully incorporate the goals and objectives established in the SAP, but the overall intent was to maintain consistency with the previous investigation to allow for uniform discussion of results and impacts in across the defined limits of the Site. The conceptual geographic boundaries of the Site are presented on **Figure 1**.

In addition to incorporating the SI's organizational structure, the analytical and screening results collected from soil, sediment, surface water, and groundwater were also incorporated into the sample design. Sample locations and contaminant concentrations presented on **Figure 4** through **Figure 15** were used to evaluate the presence of existing contamination and determine where data gaps may be present.

## **CONCLUSIONS AND RECOMMENDATIONS**

The evaluation and interpretation of analytical results and findings from previous key investigations was completed to create a baseline understanding of conditions at the Site. The incorporation of these findings into the SAP minimizes redundancies while also creating a more comprehensive approach for assessing potential environmental impacts across the Site.

### **Conclusions**

The properties in the C&H Lake Linden Operations Geographic Area feature vacant land, historical and recreational parks, in mixed residential/non-residential areas within the villages of Lake Linden and Hubbell. The contaminants attributable to the Site include VOCs, PNAs, PCBs, and inorganic contaminants. Concerns at Torch Lake and the surrounding areas identified by the MDEQ include known or suspected impacts to groundwater, surface water, sediments, and upland media that were not addressed under the Superfund program. Further, the analytical and screening results indicate that inorganic contaminants are present in environmental media in excess of Part 201 of Michigan's NREPA, being PA 451 of 1994, as amended Residential and Non-Residential Cleanup Criteria for Response Activity.

The analytical results from these key investigations were used in the characterization of the conceptual geographic areas of the Site, but also contributed to the horizontal and vertical placement of the proposed sampling locations included in the SAP.

During 2014, the activities, operations, and wastes related to the former industrial areas identified at the Site will be researched and documented. Terrestrial and underwater surveys will be conducted to identify drum and waste deposits. Representative sediment, surface water, groundwater, soil, and waste samples in the vicinity of these previously uncharacterized debris and waste deposits will be collected and analyzed. Further, the sample intervals will be spaced horizontally and vertically to accurately characterize the extent of any identified contamination in the vicinity of the identified wastes.



## Recommendations

The review and evaluation of the summarized reports resulted in the preparation of a SAP that builds upon existing analytical results and focuses on potential environmental impacts, including the following:

- Unidentified, significant in-lake and/or terrestrial sources of contamination including PCBs;
- Uncharacterized waste deposits, including more than 750 uncharacterized drums, reportedly, on the lake bottom;
- Bulk disposal areas, including stamp sand deposits, slag dumps, and landfills; and,
- Industrial ruins including coal storage areas, USTs, SACM, and any other waste materials identified in future investigations.

The risks posed to environmental media, sediment in particular, by these waste deposits and continuing sources of contamination contribute to the limited recovery of the Torch Lake ecosystem. As such, the investigation will be largely driven by documented observations of drum and/or other debris locations in the lake as well as consideration related to historic operations and detected PCB concentrations.

## REFERENCES

1. Booij, K, H.E. Hofmans, C.V. Fischer, and E.M. Van Weerlee. *Temperature-Dependent Uptake Rates of Nonpolar Organic Compounds by Semipermeable Membrane Devices and Low-Density Polyethylene Membranes*. Environmental Science and Technology, pp 37, pp 361-366. 2003.
2. Donahue & Associates. *Final Remedial Investigation Report OU II, Volume 1*. January 1992.
3. Donahue & Associates. *Final Investigation Report OU II, Addendum 1*. March 1992.
4. Great Lakes Environmental Center. *Final Report, PCB Study Using Semipermeable Membrane Devices in Torch Lake, Houghton County, MDEQ Project Number 05-25*. March 2006.
5. Great Lakes National Program Office. *Aroclor Sediment Investigation, Torch Lake Area of Concern, Houghton County, Michigan*. June 2009.
6. Michigan Department of Environmental Quality (MDEQ), Remediation and Redevelopment Division (RRD) Superfund Section, Pre-remedial Group, Site Evaluation Unit (Pre-remedial Group), *CERCLA Draft Site Inspection (SI) Report for C&H Lake Linden Operations, Lake Linden, Michigan, 49945, U.S. EPA ID No: MIN000510619*, 2013.
7. MDEQ, RRD, Superfund Section, Geological Support Unit. *Groundwater Sampling Investigation Report for Village of Lake Linden, Torch Lake Superfund Site, Lake Linden, Michigan*, March 2009.
8. MDEQ, Water Bureau. *PCB Concentrations in Walleye Collected from Torch Lake (Houghton County) and Lake Superior*, June 2008.
9. MDEQ, Water Bureau, Alexander, M., *A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2007*, Editor 2008: Lansing, Michigan.



**TECHNICAL MEMORANDUM**

10. United States Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO). *Aroclor Sediment Investigation, Torch Lake Area of Concern, Houghton County, Michigan*. June 2009.
11. Weston Solutions of Michigan, Inc. (WESTON). *Letter Report for Lake Linden Emergency Response Site, Lake Linden, Houghton County, Michigan*. November 2007.
12. WESTON. *Summary Report for the Torch Lake Area Assessment, Torch Lake NPL Site and Surrounding Areas, Keweenaw Peninsula, Michigan*. December 2007.



## FIGURES



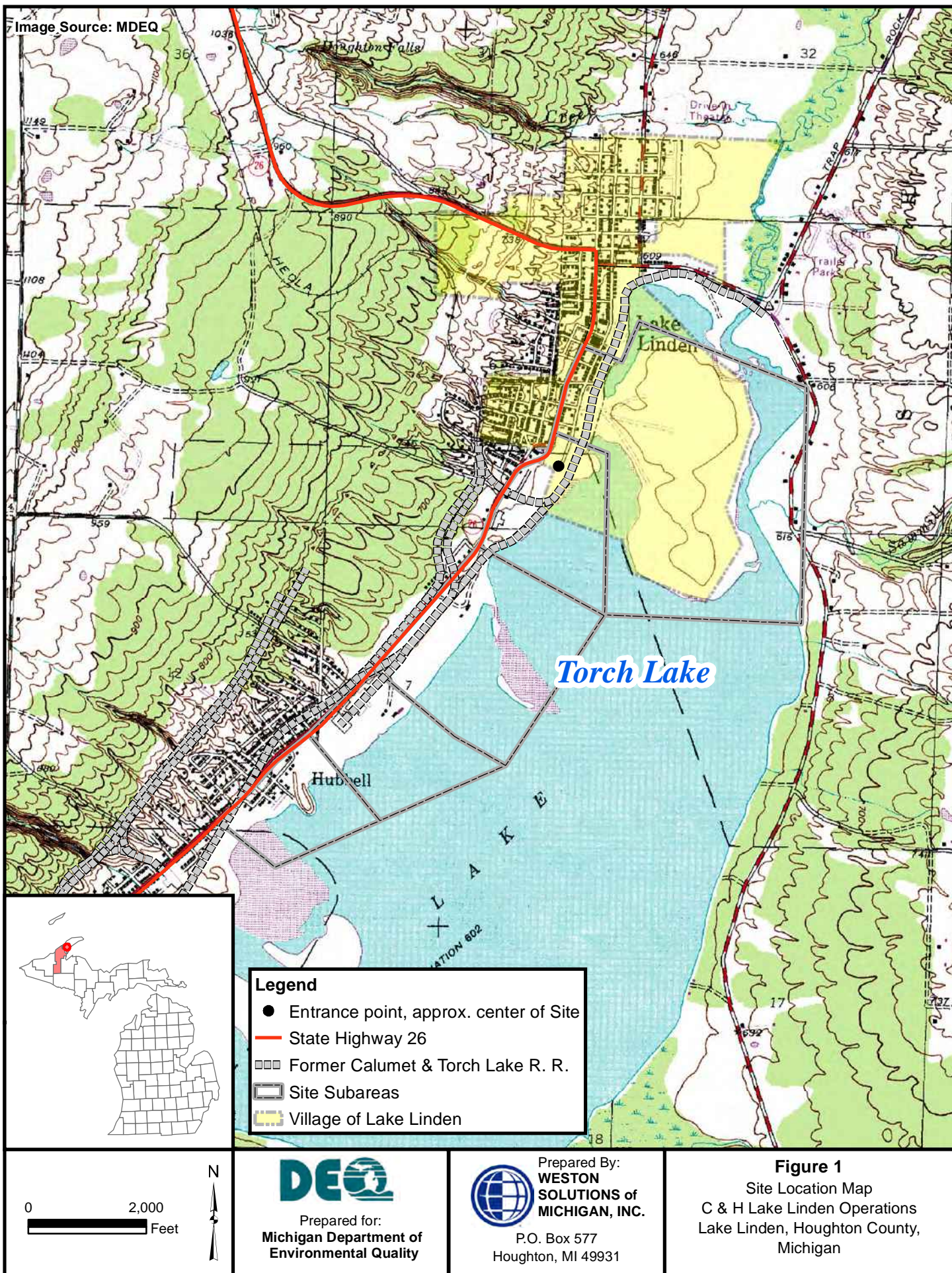




Image Source: ESRI World Imagery

**Torch Lake Backwater Area**  
-Traprock Slag Dump  
-Torch Lake Backwater

**Lake Linden Sands Area**  
-Lake Linden Beach (stamp  
sands, campground, beach, day  
park, and boat launch)

**Lake Linden Processing Area**  
-Calumet Stamp Mill  
-C&H Power Plant (Exclusive of ongoing EPA efforts)

**Hubbell Coal Dock Area**  
-Hubbell Coal Dock

**Hubbell Smelter Area**  
-Mineral Building  
-Peninsula Copper Industries (PCI) property

**Hubbell Slag Dump and Beach Area**  
-Hubbell Slag Dump  
-Hubbell Red Slags

#### Legend

- Identified Industrial Areas of Interest
  - Conceptual Site and Geographic Area Boundaries
  - Historical Buildings
- 0 1,500  
Feet



Prepared for:  
**Michigan Department of  
Environmental Quality**



Prepared By:  
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**Figure 2**  
Geographic Area Map  
C & H Lake Linden Operations  
Lake Linden, Houghton County,  
Michigan



Image Source: ESRI World Imagery

Lake Linden S2-8 09/12/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ALUMI NUM	11000	J MG/KG	[1, 4, 11]	
0-6	COBALT	14	J MG/KG	[1, 2, 4, 11]	
0-6	COPPER	2100	J MG/KG	[1, 2]	
0-6	NICKEL	34	J MG/KG	[1, 2]	
0-6	SILVER	1.3	J MG/KG	[1, 2]	
0-6	ZINC	130	J MG/KG	[1, 2]	

TraprockB-12 09/11/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ALUMI NUM	13000	J MG/KG	[1, 4, 11]	
0-6	COPPER	47	J MG/KG	[1, 2]	
0-6	LITHIUM	11	J MG/KG	[1, 2, 4, 11]	

SB-03 10/10/11					
Depth	Parameter	Result	Units	Criteria	
64-79	COPPER	34.5	J MG/KG	[1, 2]	

TraprockB-8 09/11/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ALUMI NUM	9800	J MG/KG	[1, 4, 11]	
0-6	COBALT	9.4	J MG/KG	[1, 2, 4, 11]	
0-6	COPPER	360	J MG/KG	[1, 2]	
0-6	LEAD	48	J MG/KG	[1]	
0-6	NICKEL	30	J MG/KG	[1, 2]	
0-6	SILVER	1.7	J MG/KG	[1, 2]	
0-6	ZINC	95	J MG/KG	[1, 2]	

BootjackB-17 09/11/07					
Depth	Parameter	Result	Units	Criteria	
0-6	COPPER	110	J MG/KG	[1, 2]	
0-6	LEAD	23	J MG/KG	[1]	

SS-02 10/10/11					
Depth	Parameter	Result	Units	Criteria	
0-3	ARSENIC	7	J MG/KG	[1, 2, 4, 11]	
0-3	ARSENIC	8	J MG/KG	[1, 2, 4, 10, 11]	DUP
0-3	BARIUM	76.3	J MG/KG	[1]	
0-3	BARIUM	90.1	J MG/KG	[1]	DUP

SS-03 10/10/11					
Depth	Parameter	Result	Units	Criteria	
0-4	ALUMI NUM	11400	J MG/KG	[1, 4, 11]	
0-4	ANTIMONY	1.5	J MG/KG	[2]	
0-4	ARSENIC	13.9	J MG/KG	[1, 2, 4, 10, 11]	
0-4	BARIUM	1090	J MG/KG	[1, 2]	
0-4	CADMIUM	4	J MG/KG	[1, 2]	
0-4	COPPER	234	J MG/KG	[1, 2]	
0-4	CYANIDE	1.9	J MG/KG	[1, 2]	
0-4	IRON	16400	J MG/KG	[1, 4, 11]	
0-4	LEAD	506	J MG/KG	[1, 10]	
0-4	MANGANESE	2920	J MG/KG	[1, 2, 4, 11, 16]	
0-4	SELENIUM	0.95	J MG/KG	[1, 2]	
0-4	ZINC	563	J MG/KG	[1, 2]	

MDEQ Part 201 Cleanup Criteria for Response Action

- 1=Statewide Default Background Level
- 2=Groundwater Surface Water Interface Protection Criteria
- 3=Soil Saturation Concentration Screening Levels
- 4=Residential Drinking Water Protection Criteria
- 5=Residential Soil Volatilization to Indoor Air Inhalation Criteria (VSIC)
- 6=Residential Infinite Source Volatile Soil Inhalation Criteria
- 7=Residential Finite VSIC for 5 Meter Source Thickness
- 8=Residential Finite VSIC for 2 Meter Source Thickness
- 9=Residential Particulate Soil Inhalation Criteria
- 10=Residential Direct Contact Criteria
- 11=Nonresidential Drinking Water Protection Criteria
- 12=Nonresidential Soil Volatilization to Indoor Air Inhalation
- 13=Nonresidential Infinite Source Volatile Soil Inhalation Criteria
- 14=Nonresidential Finite VSIC for 5 Meter Source Thickness
- 15=Nonresidential Finite VSIC for 2 Meter Source Thickness
- 16=Nonresidential Particulate Soil Inhalation Criteria
- 17=Nonresidential Direct Contact Criteria

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/KG = milligrams per kilogram  
UG/KG = micrograms per kilogram  
Sample depths shown in inches below ground surface.

0 400  
Ft



Prepared for:  
**Michigan Department of Environmental Quality**



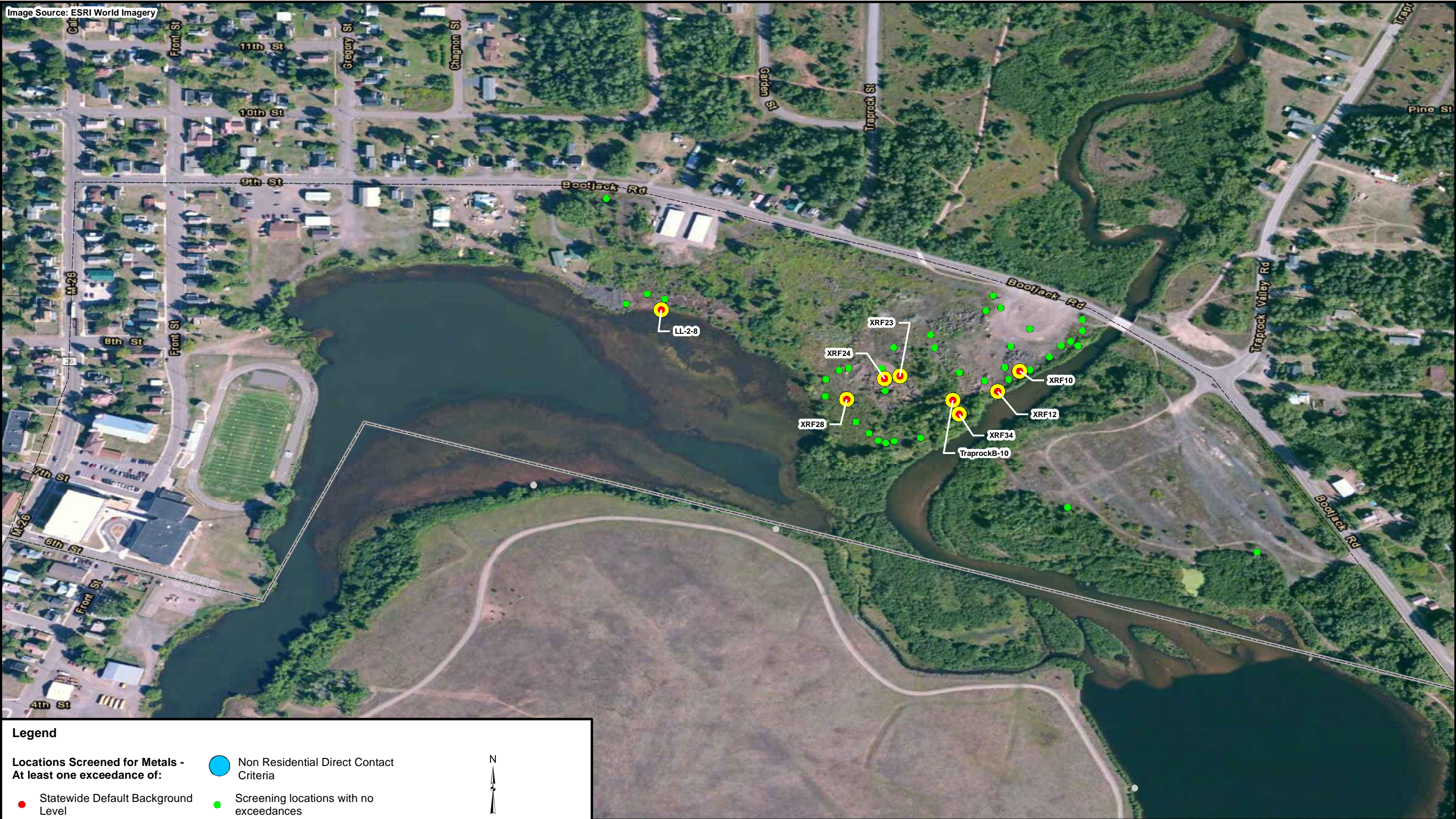
Prepared By:  
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Figure 3

Soil Sample Location Map - Torch Lake Backwater Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

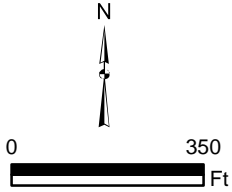


**Legend**

**Locations Screened for Metals -  
At least one exceedance of:**

- Statewide Default Background Level
- Residential Particulate Soil Inhalation Criteria
- Residential Direct Contact Criteria

- Non Residential Direct Contact Criteria
- Screening locations with no exceedances
- Locations are included within a different geographical area boundary
- Conceptual Site and Geographic Area Boundaries



Xray Fluorescence screening results are from surface soils unless otherwise specified.



Prepared for:  
**Michigan Department of  
Environmental Quality**



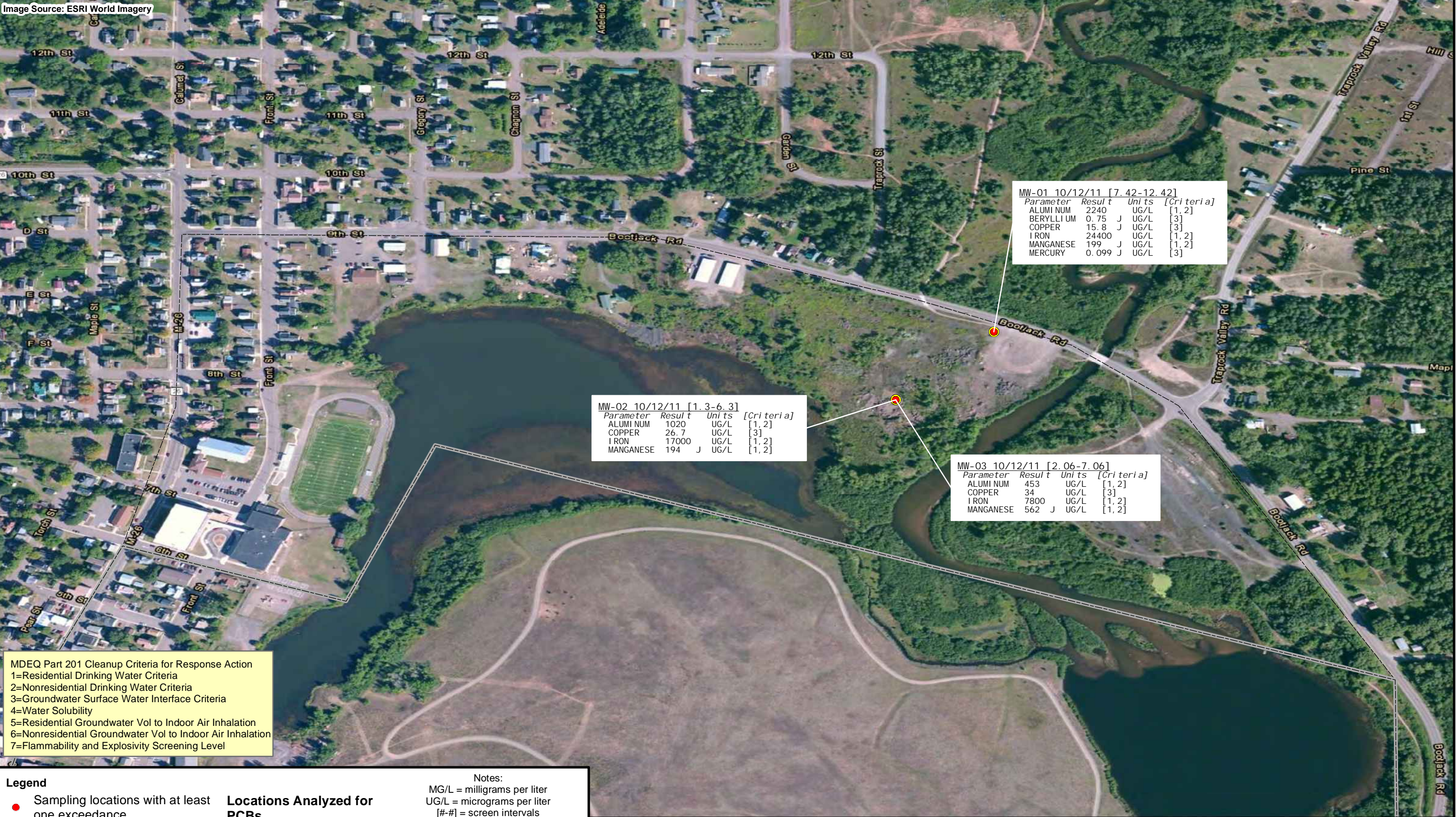
Prepared By:  
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Houghton, MI 49931

**Figure 4**

Soil Screening Location Map - Torch Lake Backwater Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery



MW-01 10/12/11 [7.42-12.42]

Parameter	Result	Units	Criteria
ALUMI NUM	2240	UG/L	[1, 2]
BERYLLIUM	0.75	J UG/L	[3]
COPPER	15.8	J UG/L	[3]
IRON	24400	UG/L	[1, 2]
MANGANESE	199	J UG/L	[1, 2]
MERCURY	0.099	J UG/L	[3]

MW-02 10/12/11 [1.3-6.3]

Parameter	Result	Units	Criteria
ALUMI NUM	1020	UG/L	[1, 2]
COPPER	26.7	UG/L	[3]
IRON	17000	UG/L	[1, 2]
MANGANESE	194	J UG/L	[1, 2]

MW-03 10/12/11 [2.06-7.06]

Parameter	Result	Units	Criteria
ALUMI NUM	453	UG/L	[1, 2]
COPPER	34	UG/L	[3]
IRON	7800	UG/L	[1, 2]
MANGANESE	562	J UG/L	[1, 2]

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Residential Drinking Water Criteria  
2=Nonresidential Drinking Water Criteria  
3=Groundwater Surface Water Interface Criteria  
4=Water Solubility  
5=Residential Groundwater Vol to Indoor Air Inhalation  
6=Nonresidential Groundwater Vol to Indoor Air Inhalation  
7=Flammability and Explosivity Screening Level

**Legend**

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

**Locations Analyzed for PCBs**

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

**Notes:**  
MG/L = milligrams per liter  
UG/L = micrograms per liter  
[#-#] = screen intervals (feet below ground surface)

0 400 Ft

N



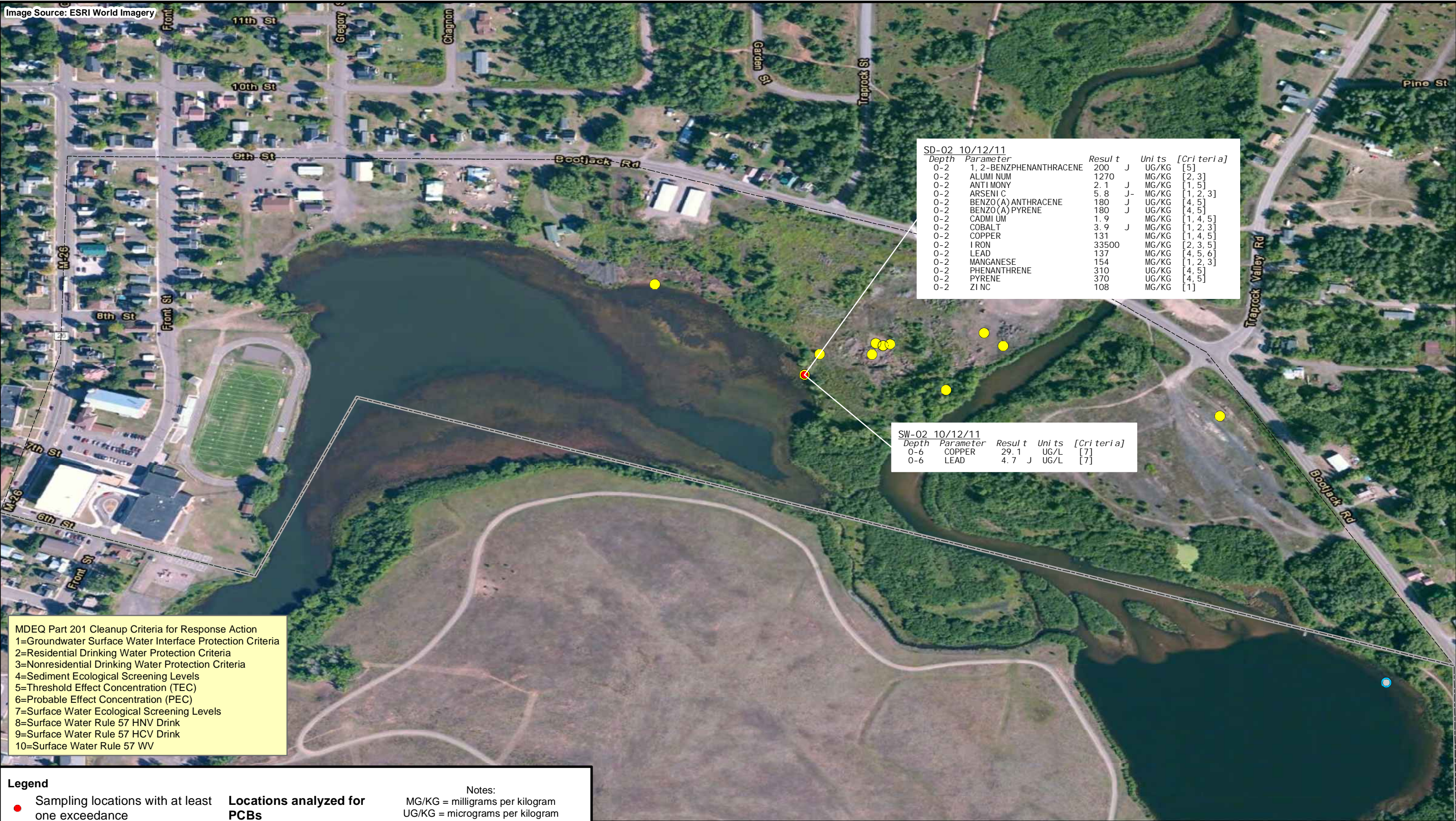
Prepared for:  
**Michigan Department of Environmental Quality**



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**WESTON SOLUTIONS of MICHIGAN, INC**  
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**Figure 5**  
Groundwater Sample Location Map - Torch Lake Backwater Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan





**DEQ**

Prepared for:  
**Michigan Department of  
Environmental Quality**



Prepared By:  
**WESTON  
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**Figure 6**  
Surface Water and Sediment Sample Location Map  
Torch Lake Backwater Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

CalumetB-16 09/07/07				
Depth	Parameter	Result	Units	Criteria
0-0	ALUMI NUM	13000 J	MG/KG	[1, 4, 11]
0-0	ARSENI C	36	MG/KG	[1, 2, 4, 10, 11]
0-0	COBALT	18	MG/KG	[1, 2, 4, 11]
0-0	COPPER	10000	MG/KG	[1, 2, 4, 11]
0-0	LEAD	1100	MG/KG	[1, 4, 10, 11, 17]
0-0	MANGANESE	740	MG/KG	[1, 2, 4, 11]
0-0	MERCURY	0.23	MG/KG	[1, 2]
0-0	NI CKEL	49	MG/KG	[1, 2]
0-0	SI LVER	2.4	MG/KG	[1, 2]
0-0	ZI NC	420 J	MG/KG	[1, 2]

SS-11 10/12/11				
Depth	Parameter	Result	Units	Criteria
0-8	ARSENI C	18.9	MG/KG	[1, 2, 4, 10, 11]
0-8	COPPER	3440 J	MG/KG	[1, 2]
0-8	CYANI DE	0.51 J	MG/KG	[1, 2]
0-8	IRON	12900 J	MG/KG	[1, 4, 11]
0-8	LEAD	171	MG/KG	[1]
0-8	MERCURY	0.17 J-	MG/KG	[1, 2]
0-8	NI CKEL	20.9	MG/KG	[1]
0-8	PHENANTHRENE	2300	UG/KG	[2]
0-8	SELENI UM	0.81 J	MG/KG	[1, 2]
0-8	ZI NC	126 J	MG/KG	[1, 2]

SS-12 10/12/11				
Depth	Parameter	Result	Units	Criteria
0-8	ALUMI NUM	24300 J	MG/KG	[1, 4, 11]
0-8	ALUMI NUM	26900 J	MG/KG	[1, 4, 11] DUP
0-8	ANTI MONY	7.8	MG/KG	[2, 4, 11]
0-8	ANTI MONY	11	MG/KG	[2, 4, 11] DUP
0-8	ARSENI C	307	MG/KG	[1, 2, 4, 10, 11, 17]
0-8	ARSENI C	312	MG/KG	[1, 2, 4, 10, 11, 17] DUP
0-8	BARI UM	566 J	MG/KG	[1, 2]
0-8	BARI UM	537 J	MG/KG	[1, 2] DUP
0-8	CADMI UM	12	MG/KG	[1, 2, 4, 11]
0-8	CADMI UM	11.1	MG/KG	[1, 2, 4, 11] DUP
0-8	COBALT	14.7	MG/KG	[1, 2, 4, 11]
0-8	COBALT	15.2	MG/KG	[1, 2, 4, 11] DUP
0-8	COPPER	7010 J	MG/KG	[1, 2, 4, 11]
0-8	COPPER	7540 J	MG/KG	[1, 2, 4, 11] DUP
0-8	IRON	93400 J	MG/KG	[1, 4, 11]
0-8	IRON	92600 J	MG/KG	[1, 4, 11] DUP
0-8	LEAD	838	MG/KG	[1, 4, 10, 11]
0-8	LEAD	1130	MG/KG	[1, 4, 10, 11, 17] DUP
0-8	MANGANESE	656 J	MG/KG	[1, 2, 4, 11]
0-8	MANGANESE	645 J	MG/KG	[1, 2, 4, 11] DUP
0-8	MERCURY	0.14 J-	MG/KG	[1, 2] DUP
0-8	NI CKEL	31.6	MG/KG	[1, 2]
0-8	NI CKEL	35.6	MG/KG	[1, 2] DUP
0-8	SI LVER	14.9	MG/KG	[1, 2, 4, 11]
0-8	SI LVER	18	MG/KG	[1, 2, 4, 11] DUP
0-8	VANADI UM	140 J	MG/KG	[4]
0-8	VANADI UM	134 J	MG/KG	[4] DUP
0-8	ZI NC	583 J	MG/KG	[1, 2]
0-8	ZI NC	664 J	MG/KG	[1, 2] DUP

SS-08 10/10/11				
Depth	Parameter	Result	Units	Criteria
0-6	ALUMI NUM	10800 J	MG/KG	[1, 4, 11]
0-6	ANTI MONY	45.4 J	MG/KG	[2, 4, 11]
0-6	ARSENI C	11	MG/KG	[1, 2, 4, 10, 11]
0-6	BARI UM	219 J	MG/KG	[1, 2]
0-6	CADMI UM	1.5	MG/KG	[1]
0-6	COBALT	9.2	MG/KG	[1, 2, 4, 11]
0-6	COPPER	3710 J	MG/KG	[1, 2]
0-6	CYANI DE	0.23 J	MG/KG	[2]
0-6	IRON	18000 J	MG/KG	[1, 4, 11]
0-6	LEAD	6940	MG/KG	[1, 2, 4, 10, 11, 17]
0-6	MERCURY	0.22 J-	MG/KG	[1, 2]
0-6	NI CKEL	29.8	MG/KG	[1, 2]
0-6	SI LVER	1.7	MG/KG	[1, 2]
0-6	ZI NC	175 J	MG/KG	[1, 2]

SS-09 10/10/11				
Depth	Parameter	Result	Units	Criteria
0-2	ALUMI NUM	7190 J	MG/KG	[1, 4, 11]
0-2	CADMI UM	1.7	MG/KG	[1, 2]
0-2	COBALT	10.9	MG/KG	[1, 2, 4, 11]
0-2	COPPER	2480 J	MG/KG	[1, 2]
0-2	IRON	17200 J	MG/KG	[1, 4, 11]
0-2	LEAD	39.1	MG/KG	[1]
0-2	NI CKEL	31.5	MG/KG	[1, 2]
0-2	SI LVER	1.4	MG/KG	[1, 2]
0-2	ZI NC	139 J	MG/KG	[1, 2]

SS-07 10/10/11				
Depth	Parameter	Result	Units	Criteria
9-12	ARSENI C	7.6	MG/KG	[1, 2, 4, 11]
9-12	COBALT	9.4	MG/KG	[1, 2, 4, 11]
9-12	COPPER	16500 J	MG/KG	[1, 2, 4, 11]
9-12	IRON	13400 J	MG/KG	[1, 4, 11]
9-12	NI CKEL	23.3	MG/KG	[1]
9-12	SI LVER	8.1	MG/KG	[1, 2, 4]
9-12	ZI NC	144 J	MG/KG	[1, 2]

SB-13 10/11/11				
Depth	Parameter	Result	Units	Criteria
21-30	ANTI MONY	8.5 J	MG/KG	[2, 4, 11]
21-30	ARSENI C	17.5 J-	MG/KG	[1, 2, 4, 10, 11]
21-30	BARI UM	108000	MG/KG	[1, 2, 4, 10, 11]
21-30	CADMI UM	8.4	MG/KG	[1, 2, 4, 11]
21-30	COPPER	9940	MG/KG	[1, 2, 4, 11]
21-30	IRON	23800	MG/KG	[1, 4, 11]
21-30	LEAD	16100	MG/KG	[1, 2, 4, 10, 11, 17]
21-30	NI CKEL	24.3	MG/KG	[1]
21-30	SI LVER	3.2	MG/KG	[1, 2]
21-30	ZI NC	607	MG/KG	[1, 2]

SB-10 10/11/11				
Depth	Parameter	Result	Units	Criteria
10-24	COPPER	1030	MG/KG	[1, 2]
10-24	LEAD	41.2	MG/KG	[1]
10-24	SI LVER	1.1	MG/KG	[1, 2]

SS-04 10/11/11				
Depth	Parameter	Result	Units	Criteria
0-5	ALUMI NUM	7540 J	MG/KG	[1, 4, 11]
0-5	COBALT	11.1	MG/KG	[1, 2, 4, 11]
0-5	COPPER	788 J	MG/KG	[1, 2]
0-5	CYANI DE	0.12 J	MG/KG	[2]
0-5	IRON	16000 J	MG/KG	[1, 4, 11]
0-5	LEAD	31.5	MG/KG	[1]
0-5	NI CKEL	29.2	MG/KG	[1, 2]
0-5	ZI NC	69.7 J	MG/KG	[1, 2]

SB-05 10/10/11				
Depth	Parameter	Result	Units	Criteria
33-48	COPPER	5130	MG/KG	[1, 2]
33-48	LEAD	83.4	MG/KG	[1]
33-48	SI LVER	7	MG/KG	[1, 2, 4]
33-48	ZI NC	79.3	MG/KG	[1, 2]

SB-04 10/10/11				
Depth	Parameter	Result	Units	Criteria
96-144	ALUMI NUM	6940	MG/KG	[1, 4, 11]
96-144	ALUMI NUM	7050	MG/KG	[1, 4, 11] DUP
96-144	COBALT	10.3	MG/KG	[1, 2, 4, 11]
96-144	COBALT	9.8	MG/KG	[1, 2, 4, 11] DUP
96-144	COPPER	1190	MG/KG	[1, 2]
96-144	COPPER	1220	MG/KG	[1, 2] DUP
96-144	IRON	18500	MG/KG	[1, 4, 11]
96-144	IRON	18700	MG/KG	[1, 4, 11] DUP
96-144	NI CKEL	31.7	MG/KG	[1, 2]
96-144	NI CKEL	31.7	MG/KG	[1, 2] DUP
96-144	SI LVER	2.3	MG/KG	[1, 2]
96-144	SI LVER	2.4	MG/KG	[1, 2] DUP
96-144	ZI NC	61.6	MG/KG	[1]
96-144	ZI NC	65.6	MG/KG	[1, 2] DUP

SS-05 10/11/11				
Depth	Parameter	Result	Units	Criteria
2-10	COPPER	989 J	MG/KG	[1, 2]
2-10	IRON	15400 J	MG/KG	[1, 4, 11]
2-10	LEAD	134	MG/KG	[1]
2-10	SI LVER	2.5	MG/KG	[1, 2]
2-10	ZI NC	60.5 J	MG/KG	[1]

SB-06 10/11/11				
Depth	Parameter	Result	Units	Criteria
18-33	COBALT	6.9	MG/KG	[1, 2, 41, 1]
18-33	COPPER	411	MG/KG	[1, 2]
18-33	IRON	14400	MG/KG	[1, 4, 11]
18-33	NI CKEL	21.3	MG/KG	[1]
18-33	ZI NC	50.6	MG/KG	[1]

SB-07 10/11/11				
Depth	Parameter	Result	Units	Criteria
30-42	COBALT	8.5	MG/KG	[1, 2, 4, 11]
30-42	COPPER	1170	MG/KG	[1, 2]
30-42	IRON	14500	MG/KG	[1, 4, 11]
30-42	LEAD	43	MG/KG	[1]
30-42	MERCURY	0.58	MG/KG	[1, 2]
30-42	NI CKEL	26.7	MG/KG	[1]
30-42	SI LVER	3.2	MG/KG	[1, 2]
30-42	ZI NC	68.1	MG/KG	[1, 2]

SB-08 10/11/11				
Depth	Parameter	Result	Units	Criteria
22-36	COBALT	9.3	MG/KG	[1, 2, 4, 11]
22-36	COPPER	1460	MG/KG	[1, 2]
22-36	IRON	14900	MG/KG	[1, 4, 11]
22-36	LEAD	111	MG/KG	[1]
22-36	NI CKEL	27.5	MG/KG	[1]
22-36	SI LVER	4.3	MG/KG	[1, 2]
22-36	ZI NC	147	MG/KG	[1, 2]

SS-06 10/11/11				
Depth	Parameter	Result	Units	Criteria
0-1	ANTI MONY	4.5 J	MG/KG	[2, 4, 11]
0-1	ARSENI C	46.8	MG/KG	[1, 2, 4, 10, 11, 17]
0-1	BARI UM	76.2 J	MG/KG	[1]
0-1	CADMI UM	8.9	MG/KG	[1, 2, 4, 11]
0-1	COBALT	15	MG/KG	[1, 2, 4, 11]
0-1	COPPER	53700 J	MG/KG	[1, 2, 4, 10, 11]
0-1	CYANI DE	0.17 J	MG/KG	[2]
0-1	IRON	153000 J	MG/KG	[1, 4, 11]
0-1	MERCURY	1.4 J-	MG/KG	[1, 2]
0-1	NI CKEL	35.7	MG/KG	[1, 2]
0-1	SI LVER	40.9	MG/KG	[1, 2, 4, 11]
0-1	ZI NC	81.7 J	MG/KG	[1, 2]

SB-09 10/11/11				
Depth	Parameter	Result	Units	Criteria
33-48	COBALT	10.4	MG/KG	[1, 2, 4, 11]
33-48	COPPER	877	MG/KG	[1, 2]
33-48	IRON	14400	MG/KG	[1, 4, 11]
33-48	NI CKEL	30.3	MG/KG	[1, 2]
33-48	SI LVER	2.2	MG/KG	[1, 2]
33-48	ZI NC	61.5	MG/KG	[1]

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Statewide Default Background Level  
2=Groundwater Surface Water Interface Protection Criteria  
3=Soil Saturation Concentration Screening Levels  
4=Residential Drinking Water Protection Criteria  
5=Residential Soil Volatilization to Indoor Air Inhalation Criteria (VSIC)  
6=Residential Infinite Source Volatile Soil Inhalation Criteria  
7=Residential Finite VSIC for 5 Meter Source Thickness  
8=Residential Finite VSIC for 2 Meter Source Thickness  
9=Residential Particulate Soil Inhalation Criteria  
10=Residential Direct Contact Criteria  
11=Nonresidential Drinking Water Protection Criteria  
12=Nonresidential Soil Volatilization to Indoor Air Inhalation  
13=Nonresidential Infinite Source Volatile Soil Inhalation Criteria  
14=Nonresidential Finite VSIC for 5 Meter Source Thickness  
15=Nonresidential Finite VSIC for 2 Meter Source Thickness  
16=Nonresidential Particulate Soil Inhalation Criteria  
17=Nonresidential Direct Contact Criteria

#### Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

#### Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/KG = milligrams per kilogram  
UG/KG = micrograms per kilogram  
Sample depths shown in inches below ground surface.

0 700  
Ft

See figure 7b for exceedance results not displayed on this figure.



Prepared for:  
Michigan Department of  
Environmental Quality



Prepared By:  
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#### Figure 7a

Soil Sample Location Map -  
Lake Linden Sands Area & Lake Linden Processing Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



- MDEQ Part 201 Cleanup Criteria for Response Action
- 1=Statewide Default Background Level
  - 2=Groundwater Surface Water Interface Protection Criteria
  - 3=Soil Saturation Concentration Screening Levels
  - 4=Residential Drinking Water Protection Criteria
  - 5=Residential Soil Volatilization to Indoor Air Inhalation Criteria (VSIC)
  - 6=Residential Infinite Source Volatile Soil Inhalation Criteria
  - 7=Residential Finite VSIC for 5 Meter Source Thickness
  - 8=Residential Finite VSIC for 2 Meter Source Thickness
  - 9=Residential Particulate Soil Inhalation Criteria
  - 10=Residential Direct Contact Criteria
  - 11=Nonresidential Drinking Water Protection Criteria
  - 12=Nonresidential Soil Volatilization to Indoor Air Inhalation
  - 13=Nonresidential Infinite Source Volatile Soil Inhalation Criteria
  - 14=Nonresidential Finite VSIC for 5 Meter Source Thickness
  - 15=Nonresidential Finite VSIC for 2 Meter Source Thickness
  - 16=Nonresidential Particulate Soil Inhalation Criteria
  - 17=Nonresidential Direct Contact Criteria







**Legend**

**Locations Screened for Metals - At least one exceedance of:**

- Statewide Default Background Level
- Residential Particulate Soil Inhalation Criteria
- Residential Direct Contact Criteria

Non Residential Direct Contact Criteria


Screening locations with no exceedances

Locations are included within a different geographical area boundary


Conceptual Site and Geographic Area Boundaries

0 600 Ft

Xray Fluorescence screening results are from surface soils unless otherwise specified.



Prepared for:  
**Michigan Department of Environmental Quality**



Prepared By:  
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**Figure 8**  
Soil Screening Location Map -  
Lake Linden Sands Area & Lake Linden Processing Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

CENTRAL PIT #2 10/14/08 [0-6]

Parameter	Result	Units	Criteria
BI S(2-ETHYLHEXYL)PHTHALATE	16	UG/L	[1, 2]
FLUORANTHENE	3.6	UG/L	[3]

MW-12 10/13/11 [7.73-12.73]

Parameter	Result	Units	Criteria
ALUMI NUM	8500	UG/L	[1, 2]
AMMONI A	28	MG/L	[1, 2]
ARSENI C	220	UG/L	[1, 2, 3]
BARI UM	26000	UG/L	[1, 2, 3]
COPPER	1200	UG/L	[1, 2, 3]
I RON	4000	UG/L	[1, 2]
LEAD	310	UG/L	[1, 2, 3]
MANGANESE	290	UG/L	[1, 2]
SI LVER	1.1	UG/L	[3]
VANADI UM	29	UG/L	[1, 3]

MW-07 10/11/11 [2.28-7.28]

Parameter	Result	Units	Criteria
ALUMI NUM	9020	UG/L	[1, 2]
ANTI MONY	7.5	J	UG/L [1, 2, 3]
ARSENI C	136	J	UG/L [1, 2, 3]
BARI UM	587	J	UG/L [3]
BERYLLI UM	1.5	J	UG/L [3]
CADMI UM	3.7	J	UG/L [3]
CHROMI UM	46.1	J+	UG/L [3]
COPPER	24700	UG/L	[1, 2, 3]
I RON	22900	UG/L	[1, 2]
LEAD	282	UG/L	[1, 2, 3]
MANGANESE	744	J	UG/L [1, 2]
MERCURY	0.7	UG/L	[3]
NI CKEL	65.1	UG/L	[3]
SI LVER	75.4	UG/L	[1, 3]
ZI NC	404	UG/L	[3]

3RD BAY 10/14/08 [0-6]

Parameter	Result	Units	Criteria
AROCLOR-1262	32	UG/L	[1, 2, 3]
BI S(2-ETHYLHEXYL)PHTHALATE	1000	UG/L	[1, 2, 3, 4]

CENTRAL PIT 10/14/08 [0-6]

Parameter	Result	Units	Criteria
BI S(2-ETHYLHEXYL)PHTHALATE	21	UG/L	[1, 2]

MW-08 10/12/11 [7.34-12.34]

Parameter	Result	Units	Criteria
ALUMI NUM	384	UG/L	[1, 2]
AMMONI A	23	MG/L	[1, 2]
COPPER	480	UG/L	[3]
I RON	2500	UG/L	[1, 2]
LEAD	21.9	UG/L	[1, 2, 3]
MANGANESE	470	J	UG/L [1, 2]
MERCURY	0.19	J	UG/L [3]

MW-09 10/12/11 [12.23-17.23]

Parameter	Result	Units	Criteria
ALUMI NUM	1970	UG/L	[1, 2]
AMMONI A	28	MG/L	[1, 2]
BARI UM	257	J	UG/L [3]
COPPER	71.7	UG/L	[3]
I RON	1800	UG/L	[1, 2]
MANGANESE	369	J	UG/L [1, 2]

MW-04 10/11/11 [4.54-9.54]

Parameter	Result	Units	Criteria
ALUMI NUM	541	UG/L	[1, 2]
ARSENI C	15.3	UG/L	[1, 2, 3]
BARI UM	1580	J	UG/L [3]
COPPER	415	UG/L	[3]
I RON	5350	UG/L	[1, 2]
LEAD	51.3	UG/L	[1, 2, 3]
MANGANESE	624	J	UG/L [1, 2]

MW-05 10/11/11 [2.9-7.9]

Parameter	Result	Units	Criteria
ALUMI NUM	78.4	J	UG/L [1, 2]
BARI UM	738	J	UG/L [3]
BARI UM	742	J	UG/L [3] DUP
COPPER	614	UG/L	[3]
COPPER	457	UG/L	[3] DUP
I RON	985	UG/L	[1, 2]
I RON	880	UG/L	[1, 2] DUP
LEAD	60.8	UG/L	[1, 2, 3]
LEAD	32	UG/L	[1, 2, 3]
MANGANESE	167	J	UG/L [1, 2]
MANGANESE	163	J	UG/L [1, 2] DUP
MERCURY	0.22	UG/L	[3] DUP

MW-06 10/11/11 [2.47-7.47]

Parameter	Result	Units	Criteria
ALUMI NUM	69.4	J	UG/L [1, 2]
BARI UM	778	J	UG/L [3]
COPPER	210	UG/L	[3]
MANGANESE	104	J	UG/L [1, 2]
SI LVER	1.1	J	UG/L [3]

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Residential Drinking Water Criteria  
2=Nonresidential Drinking Water Criteria  
3=Groundwater Surface Water Interface Criteria  
4=Water Solubility  
5=Residential Groundwater Vol to Indoor Air Inhalation  
6=Nonresidential Groundwater Vol to Indoor Air Inhalation  
7=Flammability and Explosivity Screening Level

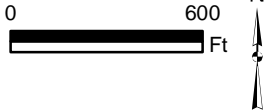
Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Monitoring Well
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/L = milligrams per liter  
UG/L = micrograms per liter  
[#-#] = screen intervals (feet below ground surface)



Prepared for:  
Michigan Department of Environmental Quality



Prepared By:  
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**Figure 9**  
Groundwater Sample Location Map -  
Lake Linden Sands Area & Lake Linden Processing Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



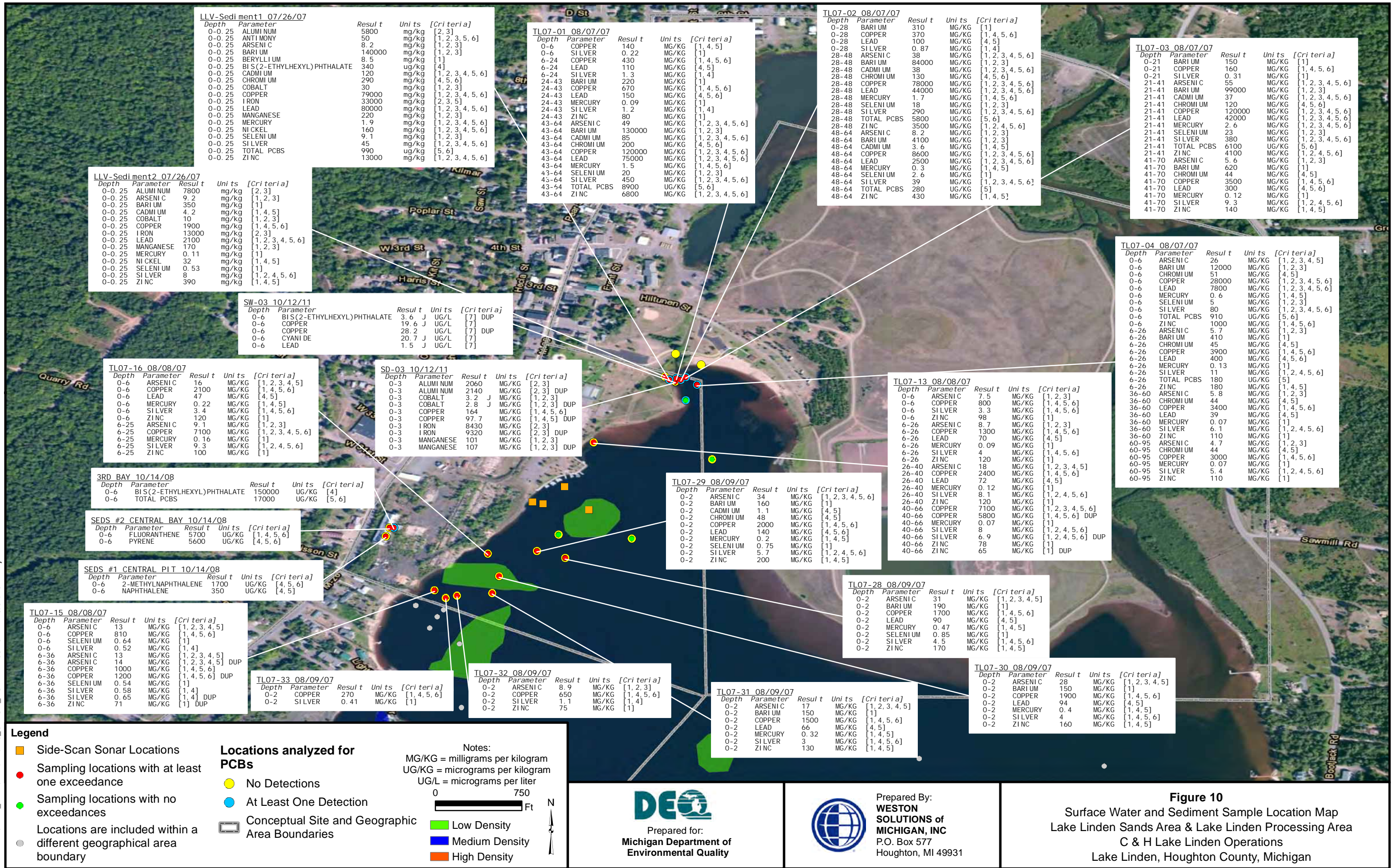




Image Source: ESRI World Imagery

SS-17 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-8	ANTIMONY	5.1	MG/KG	[2, 4, 11]	
0-8	ARSENIC	134	MG/KG	[1, 2, 4, 10, 11, 17]	
0-8	CADMIUM	1.5	MG/KG	[1]	
0-8	COBALT	12	MG/KG	[1, 2, 4, 11]	
0-8	COPPER	24500	J	MG/KG [1, 2, 4, 10, 11]	
0-8	CYANIDE	0.36	J	MG/KG [2]	
0-8	IRON	12500	J	MG/KG [1, 4, 11]	
0-8	LEAD	267	MG/KG	[1]	
0-8	NICKEL	102	MG/KG	[1, 2, 4, 11]	
0-8	SELENIUM	0.74	J	MG/KG [1, 2]	
0-8	SILVER	2.6	MG/KG	[1, 2]	
0-8	ZINC	2310	J	MG/KG [1, 2]	

SS-14 10/12/11					
Depth	Parameter	Result	Units	[Criteria]	
0-10	ANTIMONY	9.5	MG/KG	[2, 4, 11]	
0-10	ARSENIC	31.4	MG/KG	[1, 2, 4, 10, 11]	
0-10	BARIUM	285	J	MG/KG [1, 2]	
0-10	CADMIUM	3.9	MG/KG	[1, 2]	
0-10	COPPER	5080	J	MG/KG [1, 2]	
0-10	IRON	49400	J	MG/KG [1, 4, 11]	
0-10	LEAD	578	MG/KG	[1, 10]	
0-10	MERCURY	0.38	J-	MG/KG [1, 2]	
0-10	NICKEL	26.6	MG/KG	[1]	
0-10	SELENIUM	0.98	J	MG/KG [1, 2]	
0-10	SILVER	3.2	MG/KG	[1, 2]	
0-10	ZINC	399	J	MG/KG [1, 2]	

SS-13 10/12/11					
Depth	Parameter	Result	Units	[Criteria]	
1-10	ALUMINUM	8980	J	MG/KG [1, 4, 11]	
1-10	ARSENIC	16	MG/KG	[1, 2, 4, 10, 11]	
1-10	CADMIUM	1.3	MG/KG	[1]	
1-10	COBALT	14.2	MG/KG	[1, 2, 4, 11]	
1-10	COPPER	10400	J	MG/KG [1, 2, 4, 11]	
1-10	IRON	17400	J	MG/KG [1, 4, 11]	
1-10	LEAD	47.2	MG/KG	[1]	
1-10	NICKEL	54.5	MG/KG	[1, 2]	
1-10	SILVER	3.2	MG/KG	[1, 2]	
1-10	ZINC	126	J	MG/KG [1, 2]	

Minneral B-11 09/07/07					
Depth	Parameter	Result	Units	[Criteria]	
0-6	ARSENIC	52	MG/KG	[1, 2, 4, 10, 11, 17]	
0-6	COBALT	6.9	MG/KG	[1, 2, 4, 11]	
0-6	COPPER	17000	MG/KG	[1, 2, 4, 11]	
0-6	LEAD	280	MG/KG	[1]	
0-6	NICKEL	24	MG/KG	[1]	
0-6	SILVER	5	MG/KG	[1, 2, 4]	
0-6	ZINC	490	J	MG/KG [1, 2]	

SB-14 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-14	ANTIMONY	1.4	J	MG/KG [2]	
0-14	ARSENIC	41.5	J	MG/KG [1, 2, 4, 10, 11, 17]	
0-14	COPPER	14300	J	MG/KG [1, 2, 4, 11]	
0-14	CYANIDE	0.15	J	MG/KG [2]	
0-14	LEAD	83	MG/KG	[1]	
0-14	SELENIUM	0.44	J-	MG/KG [1, 2]	
0-14	SILVER	3.9	MG/KG	[1, 2]	
0-14	ZINC	181	MG/KG	[1, 2]	

SS-15 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-6	ALUMINUM	11500	J	MG/KG [1, 4, 11]	
0-6	ARSENIC	40.9	MG/KG	[1, 2, 4, 10, 11, 17]	
0-6	CADMIUM	3	MG/KG	[1, 2]	
0-6	COBALT	15.3	MG/KG	[1, 2, 4, 11]	
0-6	COPPER	132	J	MG/KG [1, 2]	
0-6	IRON	45100	J	MG/KG [1, 4, 11]	
0-6	NICKEL	57.9	MG/KG	[1, 2]	
0-6	SELENIUM	1.4	J	MG/KG [1, 2]	
0-6	SILVER	2.8	MG/KG	[1, 2]	

Minneral B-6 09/07/07					
Depth	Parameter	Result	Units	[Criteria]	
0-6	ARSENIC	230	MG/KG	[1, 2, 4, 10, 11, 17]	
0-6	COBALT	48	MG/KG	[1, 2, 4, 11]	
0-6	COPPER	44000	MG/KG	[1, 2, 4, 10, 11]	
0-6	LEAD	1900	MG/KG	[1, 4, 10, 11, 17]	
0-6	NICKEL	540	MG/KG	[1, 2, 4, 11]	
0-6	SILVER	9	MG/KG	[1, 2, 4]	
0-6	ZINC	5400	J	MG/KG [1, 2, 4, 11]	

SS-20 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-0.75	ALUMINUM	8260	MG/KG	[1, 4, 11]	
0-0.75	ANTIMONY	4.8	J	MG/KG [2, 4, 11]	
0-0.75	ARSENIC	66.9	J	MG/KG [1, 2, 4, 10, 11, 17]	
0-0.75	BARIUM	434	MG/KG	[1, 2]	
0-0.75	CADMIUM	11.4	MG/KG	[1, 2, 4, 11]	
0-0.75	COBALT	9	MG/KG	[1, 2, 4, 11]	
0-0.75	COPPER	20300	J	MG/KG [1, 2, 4, 10, 11]	
0-0.75	CYANIDE	0.14	J	MG/KG [2]	
0-0.75	IRON	92200	MG/KG	[1, 4, 11]	
0-0.75	LEAD	1010	MG/KG	[1, 4, 10, 11, 17]	
0-0.75	MANGANESE	596	MG/KG	[1, 2, 4, 11]	
0-0.75	MERCURY	1.7	MG/KG	[1, 2]	
0-0.75	NICKEL	31.5	MG/KG	[1, 2]	
0-0.75	SILVER	11.8	MG/KG	[1, 2, 4]	
0-0.75	ZINC	3050	MG/KG	[1, 2, 4]	

SS-16 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-2	ANTIMONY	26	MG/KG	[2, 4, 11]	
0-2	ARSENIC	48.8	MG/KG	[1, 2, 4, 10, 11, 17]	
0-2	BARIUM	4060	J	MG/KG [1, 2, 4, 11]	
0-2	CADMIUM	4.9	MG/KG	[1, 2]	
0-2	COPPER	37300	J	MG/KG [1, 2, 4, 10, 11]	
0-2	HEXACHLOROBENZENE	380	UG/KG	[2]	
0-2	IRON	23700	J	MG/KG [1, 4, 11]	
0-2	LEAD	3680	MG/KG	[1, 2, 4, 10, 11, 17]	
0-2	MERCURY	0.52	J-	MG/KG [1, 2]	
0-2	NICKEL	27.7	MG/KG	[1]	
0-2	SELENIUM	3.1	J	MG/KG [1, 2]	
0-2	SILVER	5.7	MG/KG	[1, 2, 4]	
0-2	ZINC	19100	J	MG/KG [1, 2, 4, 11]	

SB-12 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
6-12	ARSENIC	8.6	J-	MG/KG [1, 2, 4, 10, 11]	
6-12	COPPER	3660	MG/KG	[1, 2]	
6-12	CYANIDE	0.13	J	MG/KG [2]	

SS-19 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-4	ALUMINUM	8660	MG/KG	[1, 4, 11]	
0-4	ANTIMONY	13.2	MG/KG	[2, 4, 11]	
0-4	ARSENIC	5600	J	MG/KG [1, 2, 4, 9, 10, 11, 16, 17]	
0-4	BARIUM	212	MG/KG	[1, 2]	
0-4	CADMIUM	96.3	MG/KG	[1, 2, 4, 11]	
0-4	COPPER	199000	J	MG/KG [1, 2, 4, 9, 10, 11, 16, 17]	
0-4	CYANIDE	0.24	J	MG/KG [2]	
0-4	HEXACHLOROBENZENE	850	UG/KG	[2]	
0-4	LEAD	1610	MG/KG	[1, 4, 10, 11, 17]	
0-4	MERCURY	20.8	MG/KG	[1, 2, 4, 11]	
0-4	NICKEL	95.3	MG/KG	[1, 2]	
0-4	SELENIUM	69.3	MG/KG	[1, 2, 4, 11]	
0-4	SILVER	45.5	MG/KG	[1, 2, 4, 11]	
0-4	ZINC	14800	MG/KG	[1, 2, 4, 11]	

SB-11 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-16	ANTIMONY	1.5	J	MG/KG [2]	
0-16	ARSENIC	27.1	J-	MG/KG [1, 2, 4, 10, 11]	
0-16	COPPER	6600	MG/KG	[1, 2, 4, 11]	
0-16	LEAD	54.7	MG/KG	[1]	
0-16	SILVER	1.7	MG/KG	[1, 2]	
0-16	ZINC	78.7	MG/KG	[1, 2]	

SS-18 10/11/11					
Depth	Parameter	Result	Units	[Criteria]	
0-6	ALUMINUM	10600	J	MG/KG [1, 4, 11]	
0-6	ANTIMONY	80.2	MG/KG	[2, 4, 11]	
0-6	ARSENIC	1220	MG/KG	[1, 2, 4, 9, 10, 11, 16, 17]	
0-6	BARIUM	291	J	MG/KG [1, 2]	
0-6	CADMIUM	5.8	MG/KG	[1, 2]	
0-6	COBALT	8.8	MG/KG	[1, 2, 4, 11]	
0-6	COPPER	26900	J	MG/KG [1, 2, 4, 10, 11]	
0-6	CYANIDE	1.9	MG/KG	[1, 2]	
0-6	IRON	31500	J	MG/KG [1, 4, 11]	
0-6	LEAD	715	MG/KG	[1, 4, 10, 11]	
0-6	MERCURY	0.21	J-	MG/KG [1, 2]	
0-6	NICKEL	49.4	MG/KG	[1, 2]	
0-6	PHENANTHRENE	4400	UG/KG	[2]	
0-6	SILVER	9.5	MG/KG	[1, 2, 4]	
0-6	ZINC	1310	J	MG/KG [1, 2]	

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Statewide Default Background Level  
2=Groundwater Surface Water Interface Protection Criteria  
3=Soil Saturation Concentration Screening Levels  
4=Residential Drinking Water Protection Criteria  
5=Residential Soil Volatilization to Indoor Air Inhalation Criteria (VSIC)  
6=Residential Infinite Source Volatile Soil Inhalation Criteria  
7=Residential Finite VSIC for 5 Meter Source Thickness  
8=Residential Finite VSIC for 2 Meter Source Thickness  
9=Residential Particulate Soil Inhalation Criteria  
10=Residential Direct Contact Criteria  
11=Nonresidential Drinking Water Protection Criteria  
12=Nonresidential Soil Volatilization to Indoor Air Inhalation  
13=Nonresidential Infinite Source Volatile Soil Inhalation Criteria  
14=Nonresidential Finite VSIC for 5 Meter Source Thickness  
15=Nonresidential Finite VSIC for 2 Meter Source Thickness  
16=Nonresidential Particulate Soil Inhalation Criteria  
17=Nonresidential Direct Contact Criteria

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

Locations Analyzed for PCBs

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/KG = milligrams per kilogram  
UG/KG = micrograms per kilogram  
Sample depths shown in inches below ground surface.

0 700  
Ft



Prepared for:  
Michigan Department of  
Environmental Quality



Prepared By:  
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**Figure 11**  
Soil Sample Location Map -  
Hubbell Coal Dock Area & Hubbell Smelter Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

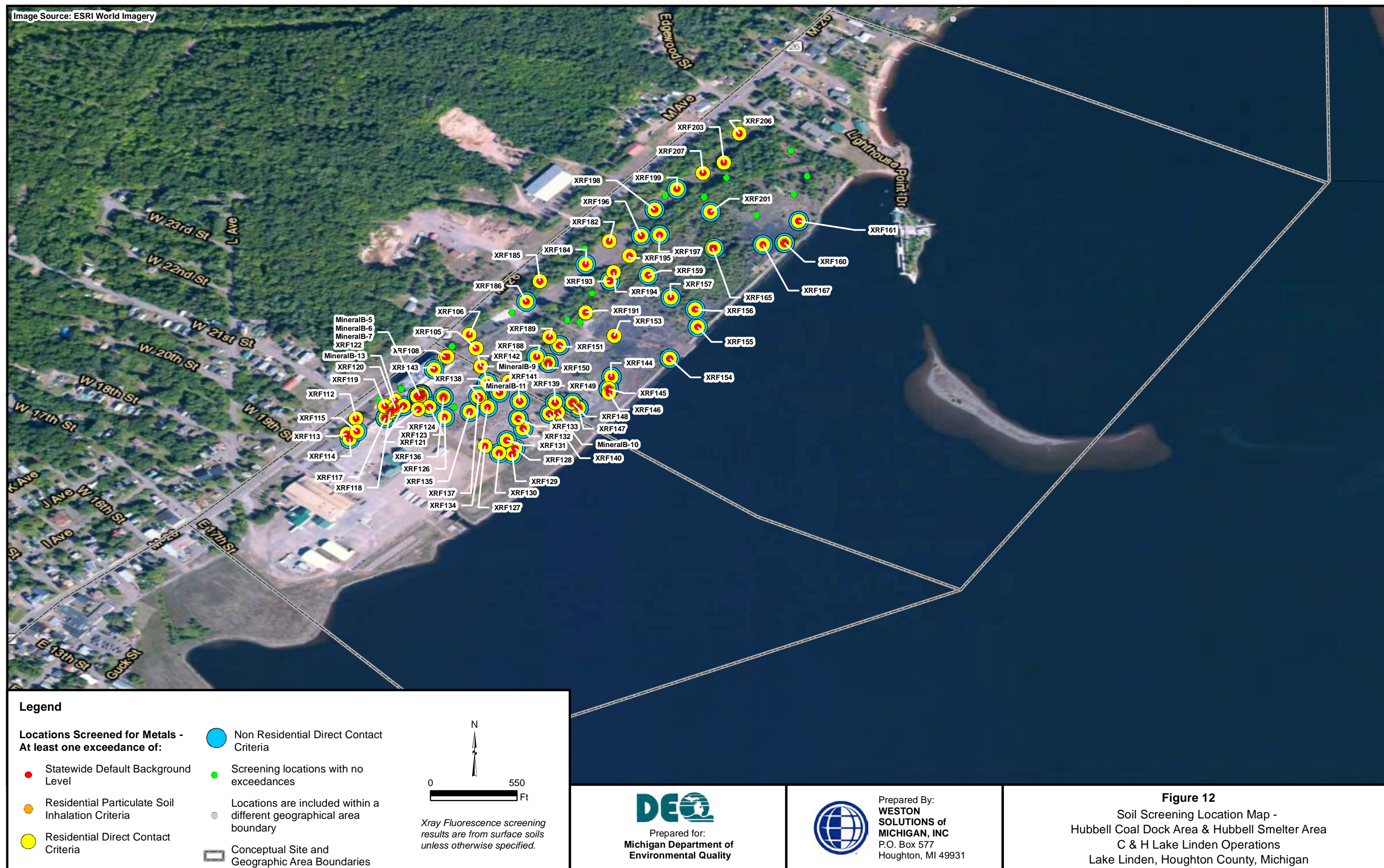




Image Source: ESRI World Imagery

SD-04 10/12/11					
Depth	Parameter	Result	Units	Criteria	
0-3	1,2-BENZPHENANTHRACENE	11000	J	UG/KG	[5, 6]
0-3	ACENAPHTHENE	3900	J	UG/KG	[4, 5, 6]
0-3	ACENAPHTHYLENE	780	J	UG/KG	[4, 5, 6]
0-3	ALUMI NUM	13800	J	MG/KG	[2, 3]
0-3	ANTHRACENE	3800	J	UG/KG	[4, 5, 6]
0-3	ANTI MONY	2.3	J	MG/KG	[1, 5]
0-3	ARSENI C	27.3	J	MG/KG	[1, 2, 3, 4, 5]
0-3	BENZO(A)ANTHRACENE	11000	J	UG/KG	[4, 5, 6]
0-3	BENZO(A)PYRENE	8800	J	UG/KG	[4, 5, 6]
0-3	BENZO(B)FLUORANTHENE	9500	J	UG/KG	[5]
0-3	BENZO(G, H, I)PERYLENE	4300	J	UG/KG	[4, 5, 6]
0-3	BENZO(K)FLUORANTHENE	9100	J	UG/KG	[5]
0-3	CADMI UM	3.2	J	MG/KG	[1, 4, 5]
0-3	COBALT	14.8	J	MG/KG	[1, 2, 3]
0-3	COPPER	2340	J	MG/KG	[1, 4, 5, 6]
0-3	DI BENZO(A, H)ANTHRACENE	1400	J	UG/KG	[4, 5, 6]
0-3	FLUORANTHENE	43000	J	UG/KG	[1, 4, 5, 6]
0-3	FLUORENE	1500	J	UG/KG	[4, 5, 6]
0-3	I NDENO(1, 2, 3-CD)PYRENE	4100	J	UG/KG	[4, 5, 6]
0-3	I RON	45300	J	MG/KG	[2, 3, 5, 6]
0-3	LEAD	223	J	MG/KG	[4, 5, 6]
0-3	MANGANESE	233	J	MG/KG	[1, 2, 3]
0-3	MERCURY	0.19	J	MG/KG	[1, 4, 5]
0-3	NAPHTHALENE	1400	J	UG/KG	[1, 4, 5, 6]
0-3	NI CKEL	42.1	J	MG/KG	[1, 4, 5]
0-3	PHENANTHRENE	11000	J	UG/KG	[1, 4, 5, 6]
0-3	PYRENE	30000	J	UG/KG	[4, 5, 6]
0-3	SI LVER	1.7	J	MG/KG	[1, 4, 5]
0-3	TOTAL PCBS	92	J	UG/KG	[5]
0-3	ZI NC	210	J	MG/KG	[1, 4, 5]

TL07-14 08/08/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ARSENI C	12	MG/KG	[1, 2, 3, 4, 5]	
0-6	COPPER	3800	MG/KG	[1, 4, 5, 6]	
0-6	LEAD	47	MG/KG	[4, 5]	
0-6	SELENI UM	0.45	MG/KG	[1]	
0-6	SI LVER	2	MG/KG	[1, 4, 5]	
0-6	ZI NC	140	MG/KG	[1, 4, 5]	
6-35	COPPER	8000	MG/KG	[1, 2, 3, 4, 5, 6]	
6-35	SI LVER	7.3	MG/KG	[1, 2, 4, 5, 6]	
6-35	ZI NC	100	MG/KG	[1]	
35-49	COPPER	9800	MG/KG	[1, 2, 3, 4, 5, 6]	
35-49	SI LVER	7.9	MG/KG	[1, 2, 4, 5, 6]	
35-49	ZI NC	97	MG/KG	[1]	

TL07-34 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	13	MG/KG	[1, 2, 3, 4, 5]	
0-2	COPPER	1200	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	38	MG/KG	[4, 5]	
0-2	MERCURY	0.11	MG/KG	[1]	
0-2	SI LVER	1.2	MG/KG	[1, 4]	
0-2	ZI NC	68	MG/KG	[1]	

TL07-35 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	14	MG/KG	[1, 2, 3, 4, 5]	
0-2	ARSENI C	16	MG/KG	[1, 2, 3, 4, 5]	DUP
0-2	COPPER	1200	MG/KG	[1, 4, 5, 6]	
0-2	COPPER	1300	MG/KG	[1, 4, 5, 6]	DUP
0-2	LEAD	47	MG/KG	[4, 5]	
0-2	LEAD	50	MG/KG	[4, 5]	DUP
0-2	MERCURY	0.2	MG/KG	[1, 4, 5]	
0-2	MERCURY	0.22	MG/KG	[1, 4, 5]	DUP
0-2	SELENI UM	0.43	MG/KG	[1]	
0-2	SI LVER	1.7	MG/KG	[1, 4, 5]	
0-2	SI LVER	1.7	MG/KG	[1, 4, 5]	DUP
0-2	ZI NC	96	MG/KG	[1]	
0-2	ZI NC	100	MG/KG	[1]	DUP

TL07-36 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	19	MG/KG	[1, 2, 3, 4, 5]	
0-2	COPPER	2200	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	71	MG/KG	[4, 5]	
0-2	MERCURY	0.31	MG/KG	[1, 4, 5]	
0-2	SI LVER	2.4	MG/KG	[1, 4, 5, 6]	
0-2	ZI NC	120	MG/KG	[1]	

TL07-27 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	30	MG/KG	[1, 2, 3, 4, 5]	
0-2	COPPER	1600	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	120	MG/KG	[4, 5]	
0-2	MERCURY	0.39	MG/KG	[1, 4, 5]	
0-2	SELENI UM	0.94	MG/KG	[1]	
0-2	SI LVER	3.2	MG/KG	[1, 4, 5, 6]	
0-2	ZI NC	150	MG/KG	[1, 4, 5]	

TL07-26 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	40	MG/KG	[1, 2, 3, 4, 5, 6]	
0-2	BARI UM	170	MG/KG	[1]	
0-2	CADMI UM	1.2	MG/KG	[4, 5]	
0-2	CHROMI UM	46	MG/KG	[4, 5]	
0-2	COPPER	1700	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	120	MG/KG	[4, 5]	
0-2	MERCURY	0.49	MG/KG	[1, 4, 5]	
0-2	SELENI UM	0.85	MG/KG	[1]	
0-2	SI LVER	4.5	MG/KG	[1, 4, 5, 6]	
0-2	ZI NC	200	MG/KG	[1, 4, 5]	

SW-04 10/12/11					
Depth	Parameter	Result	Units	Criteria	
0-6	BI S(2-ETHYLHEXYL)PHTHALATE	3.5	J	UG/L	[7]

TL07-25 08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENI C	42	MG/KG	[1, 2, 3, 4, 5, 6]	
0-2	BARI UM	220	MG/KG	[1]	
0-2	CADMI UM	1	MG/KG	[4, 5]	
0-2	CHROMI UM	45	MG/KG	[4, 5]	
0-2	COPPER	1800	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	120	MG/KG	[4, 5]	
0-2	MERCURY	0.55	MG/KG	[1, 4, 5]	
0-2	SELENI UM	0.98	MG/KG	[1]	
0-2	SI LVER	4.3	MG/KG	[1, 4, 5, 6]	
0-2	ZI NC	200	MG/KG	[1, 4, 5]	

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Groundwater Surface Water Interface Protection Criteria  
2=Residential Drinking Water Protection Criteria  
3=Nonresidential Drinking Water Protection Criteria  
4=Sediment Ecological Screening Levels  
5=Threshold Effect Concentration (TEC)  
6=Probable Effect Concentration (PEC)  
7=Surface Water Ecological Screening Levels  
8=Surface Water Rule 57 HNV Drink  
9=Surface Water Rule 57 HCV Drink  
10=Surface Water Rule 57 WV

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

Locations analyzed for PCBs

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
mg/kg = milligrams per kilogram  
ug/kg = micrograms per kilogram  
ug/l = micrograms per liter  
0 600 Ft  
Low Density  
Medium Density  
High Density



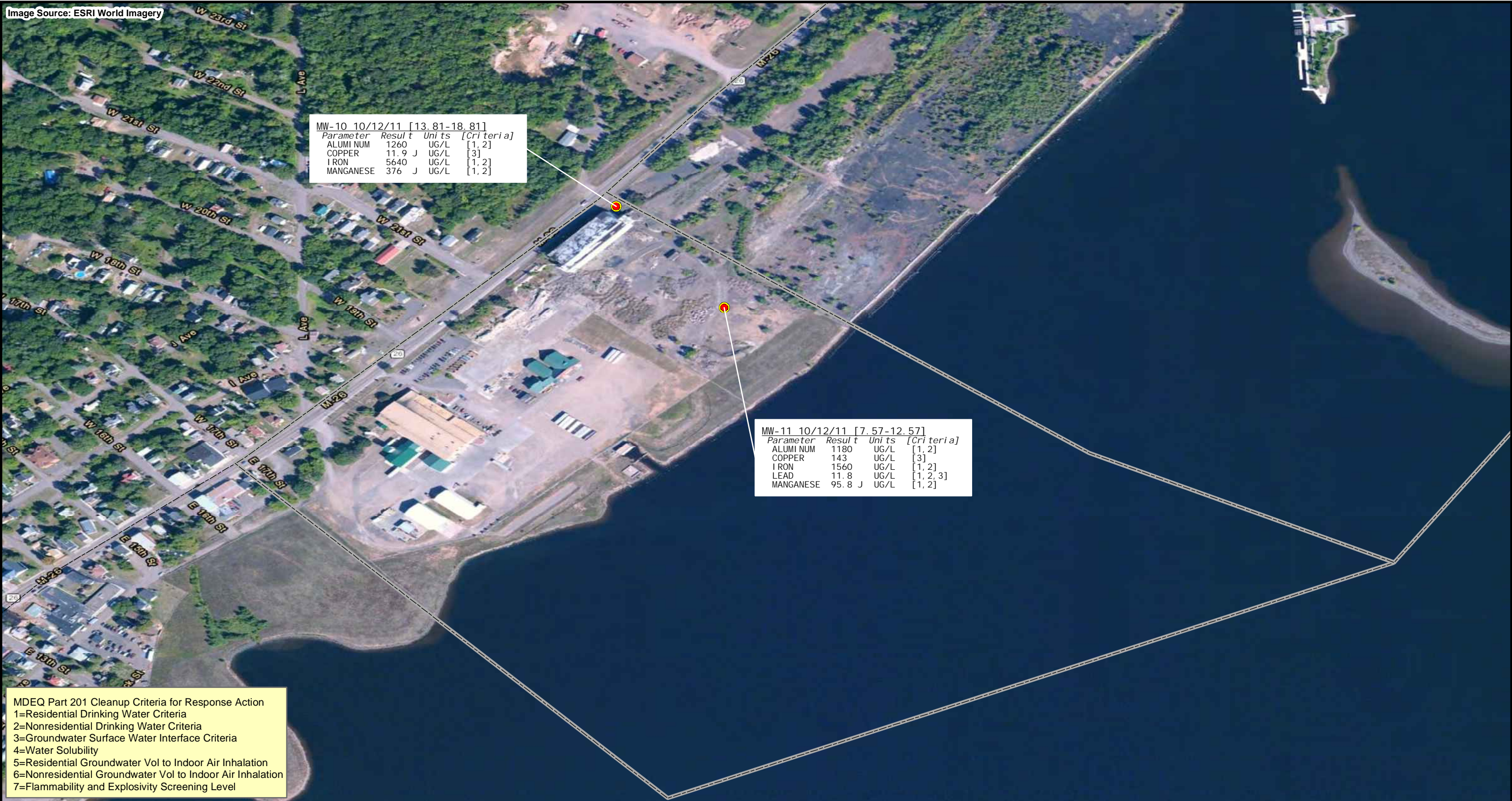
Prepared for:  
Michigan Department of  
Environmental Quality



Prepared By:  
WESTON  
SOLUTIONS of  
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P.O. Box 577  
Houghton, MI 49931

**Figure 13**  
Surface Water and Sediment Sample Location Map  
Hubbell Coal Dock Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan





**Legend**

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

**Locations Analyzed for PCBs**

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/L = milligrams per liter  
UG/L = micrograms per liter  
[#-#] = screen intervals (feet below ground surface)

0 400 Ft

N



Prepared for:  
**Michigan Department of Environmental Quality**



Prepared By:  
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**Figure 14**

Groundwater Sample Location Map - Hubbell Smelter Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

TL07-07 08/07/07				
Depth	Parameter	Result	Units	Criteria
0-6	ARSENIC	40	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	CADMIUM	1.3	MG/KG	[4, 5]
0-6	CHROMIUM	96	MG/KG	[4, 5]
0-6	COPPER	4300	MG/KG	[1, 4, 5, 6]
0-6	LEAD	320	MG/KG	[4, 5, 6]
0-6	MERCURY	0.21	MG/KG	[1, 4, 5]
0-6	SILVER	6.4	MG/KG	[1, 2, 4, 5, 6]
0-6	TOTAL PCBS	320	UG/KG	[5]
0-6	ZINC	670	MG/KG	[1, 4, 5, 6]
6-36	ARSENIC	13	MG/KG	[1, 2, 3, 4, 5]
6-36	CHROMIUM	92	MG/KG	[4, 5]
6-36	COPPER	2900	MG/KG	[1, 4, 5, 6]
6-36	MERCURY	0.43	MG/KG	[1, 4, 5]
6-36	SILVER	4.3	MG/KG	[1, 4, 5, 6]
6-36	ZINC	240	MG/KG	[1, 4, 5]
36-72	CHROMIUM	51	MG/KG	[4, 5] DUP
36-72	COPPER	1900	MG/KG	[1, 4, 5, 6]
36-72	COPPER	2700	MG/KG	[1, 4, 5, 6] DUP
36-72	MERCURY	0.13	MG/KG	[1]
36-72	MERCURY	0.19	MG/KG	[1, 4, 5] DUP
36-72	SILVER	2	MG/KG	[1, 4, 5]
36-72	SILVER	3	MG/KG	[1, 4, 5, 6] DUP
36-72	ZINC	120	MG/KG	[1]
36-72	ZINC	160	MG/KG	[1, 4, 5] DUP

TL07-06 08/07/07				
Depth	Parameter	Result	Units	Criteria
0-6	ARSENIC	32	MG/KG	[1, 2, 3, 4, 5]
0-6	CADMIUM	2.4	MG/KG	[1, 4, 5]
0-6	CHROMIUM	98	MG/KG	[4, 5]
0-6	COPPER	4000	MG/KG	[1, 4, 5, 6]
0-6	LEAD	160	MG/KG	[4, 5, 6]
0-6	MERCURY	0.39	MG/KG	[1, 4, 5]
0-6	SILVER	10	MG/KG	[1, 2, 4, 5, 6]
0-6	TOTAL PCBS	130	UG/KG	[5]
0-6	ZINC	430	MG/KG	[1, 4, 5]
6-36	ARSENIC	15	MG/KG	[1, 2, 3, 4, 5]
6-36	CHROMIUM	64	MG/KG	[4, 5]
6-36	COPPER	2700	MG/KG	[1, 4, 5, 6]
6-36	MERCURY	0.46	MG/KG	[1, 4, 5]
6-36	SILVER	3.9	MG/KG	[1, 4, 5, 6]
6-36	ZINC	190	MG/KG	[1, 4, 5]
36-72	CHROMIUM	74	MG/KG	[4, 5]
36-72	COPPER	3000	MG/KG	[1, 4, 5, 6]
36-72	MERCURY	0.33	MG/KG	[1, 4, 5]
36-72	SILVER	2.4	MG/KG	[1, 4, 5, 6]
36-72	ZINC	220	MG/KG	[1, 4, 5]

TL07-21 08/09/07				
Depth	Parameter	Result	Units	Criteria
0-2	ARSENIC	59	MG/KG	[1, 2, 3, 4, 5, 6]
0-2	BARIUM	150	MG/KG	[1]
0-2	CADMIUM	1.8	MG/KG	[1, 4, 5]
0-2	CHROMIUM	89	MG/KG	[4, 5]
0-2	COPPER	3200	MG/KG	[1, 4, 5, 6]
0-2	LEAD	250	MG/KG	[4, 5, 6]
0-2	MERCURY	0.48	MG/KG	[1, 4, 5]
0-2	SELENIUM	0.76	MG/KG	[1]
0-2	SILVER	5.1	MG/KG	[1, 2, 4, 5, 6]
0-2	TOTAL PCBS	340	UG/KG	[5]
0-2	ZINC	270	MG/KG	[1, 4, 5]

TL07-10 08/08/07				
Depth	Parameter	Result	Units	Criteria
0-6	ARSENIC	23	MG/KG	[1, 2, 3, 4, 5]
0-6	CHROMIUM	85	MG/KG	[4, 5]
0-6	COPPER	3400	MG/KG	[1, 4, 5, 6]
0-6	LEAD	100	MG/KG	[4, 5]
0-6	MERCURY	0.44	MG/KG	[1, 4, 5]
0-6	SILVER	4.7	MG/KG	[1, 2, 4, 5, 6]
0-6	ZINC	260	MG/KG	[1, 4, 5]
6-36	ARSENIC	7.7	MG/KG	[1, 2, 3]
6-36	CHROMIUM	84	MG/KG	[4, 5]
6-36	COPPER	2600	MG/KG	[1, 4, 5, 6]
6-36	LEAD	39	MG/KG	[4, 5]
6-36	MERCURY	0.32	MG/KG	[1, 4, 5]
6-36	SILVER	2.7	MG/KG	[1, 4, 5, 6]
6-36	ZINC	220	MG/KG	[1, 4, 5]
36-72	ARSENIC	4.9	MG/KG	[1, 2, 3]
36-72	BARIUM	140	MG/KG	[1]
36-72	CHROMIUM	57	MG/KG	[4, 5]
36-72	COPPER	2100	MG/KG	[1, 4, 5, 6]
36-72	MERCURY	0.28	MG/KG	[1, 4, 5]
36-72	SELENIUM	0.46	MG/KG	[1]
36-72	SILVER	2.2	MG/KG	[1, 4, 5]
36-72	ZINC	180	MG/KG	[1, 4, 5]

SD-05 10/12/11				
Depth	Parameter	Result	Units	Criteria
0-3	2-METHYLNAPHTHALENE	700	J	UG/KG [4, 5, 6]
0-3	ALUMINUM	9540	J	MG/KG [2, 3]
0-3	ANTIMONY	9.7	J	MG/KG [1, 2, 3, 5, 6]
0-3	ARSENIC	96.6	J-	MG/KG [1, 2, 3, 4, 5, 6]
0-3	CADMIUM	2.8	J	MG/KG [1, 4, 5]
0-3	CHROMIUM	60.2	J	MG/KG [4, 5]
0-3	COBALT	11.7	J	MG/KG [1, 2, 3]
0-3	COPPER	14800	J	MG/KG [1, 2, 3, 4, 5, 6]
0-3	CYANIDE	0.57	J	MG/KG [1, 4]
0-3	IRON	33700	J	MG/KG [2, 3, 5]
0-3	LEAD	963	J	MG/KG [2, 3, 4, 5, 6]
0-3	MANGANESE	285	J	MG/KG [1, 2, 3]
0-3	MERCURY	0.28	J	MG/KG [1, 4, 5]
0-3	NAPHTHALENE	400	J	UG/KG [4, 5]
0-3	NICKEL	50.5	J	MG/KG [1, 4, 5, 6]
0-3	PHENANTHRENE	630	J	UG/KG [4, 5]
0-3	SILVER	4.2	J	MG/KG [1, 4, 5, 6]
0-3	TOTAL PCBS	890	J	UG/KG [5, 6]
0-3	ZINC	2170	J	MG/KG [1, 4, 5, 6]

TL07-09 08/08/07				
Depth	Parameter	Result	Units	Criteria
0-6	ARSENIC	38	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	CHROMIUM	79	MG/KG	[4, 5]
0-6	COPPER	6300	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	LEAD	160	MG/KG	[4, 5, 6]
0-6	MERCURY	0.29	MG/KG	[1, 4, 5]
0-6	SILVER	6.6	MG/KG	[1, 2, 4, 5, 6]
0-6	ZINC	570	MG/KG	[1, 4, 5, 6]
6-36	ARSENIC	12	MG/KG	[1, 2, 3, 4, 5]
6-36	CHROMIUM	90	MG/KG	[4, 5]
6-36	COPPER	3800	MG/KG	[1, 4, 5, 6]
6-36	MERCURY	0.39	MG/KG	[1, 4, 5]
6-36	SILVER	3.2	MG/KG	[1, 4, 5, 6]
6-36	ZINC	200	MG/KG	[1, 4, 5]
36-72	CHROMIUM	77	MG/KG	[4, 5]
36-72	COPPER	3400	MG/KG	[1, 4, 5, 6]
36-72	MERCURY	0.31	MG/KG	[1, 4, 5]
36-72	SILVER	2.5	MG/KG	[1, 4, 5, 6]
36-72	ZINC	210	MG/KG	[1, 4, 5]

TL08-75 08/28/08				
Depth	Parameter	Result	Units	Criteria
0-0	TOTAL PCBS	90	J	UG/KG [5]

TL07-12 08/08/07				
Depth	Parameter	Result	Units	Criteria
0-6	ARSENIC	93	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	CADMIUM	3.6	MG/KG	[1, 4, 5]
0-6	CHROMIUM	73	MG/KG	[4, 5]
0-6	COPPER	7600	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	LEAD	280	MG/KG	[4, 5, 6]
0-6	MERCURY	0.19	MG/KG	[1, 4, 5]
0-6	SILVER	6.3	MG/KG	[1, 2, 4, 5, 6]
0-6	TOTAL PCBS	510	UG/KG	[5]
0-6	ZINC	860	MG/KG	[1, 4, 5, 6]
6-36	ARSENIC	11	MG/KG	[1, 2, 3, 4, 5]
6-36	CHROMIUM	59	MG/KG	[4, 5]
6-36	COPPER	4200	MG/KG	[1, 4, 5, 6]
6-36	MERCURY	0.29	MG/KG	[1, 4, 5]
6-36	SILVER	3.4	MG/KG	[1, 4, 5, 6]
6-36	ZINC	220	MG/KG	[1, 4, 5]
36-71	COPPER	90	MG/KG	[1, 4, 5]
36-71	SILVER	0.17	MG/KG	[1]

TL07-24 08/09/07				
Depth	Parameter	Result	Units	Criteria
0-2	ARSENIC	47	MG/KG	[1, 2, 3, 4, 5, 6]
0-2	BARIUM	140	MG/KG	[1]
0-2	CADMIUM	1.3	MG/KG	[4, 5]
0-2	CHROMIUM	56	MG/KG	[4, 5]
0-2	COPPER	2200	MG/KG	[1, 4, 5, 6]
0-2	LEAD	180	MG/KG	[4, 5, 6]
0-2	MERCURY	0.48	MG/KG	[1, 4, 5]
0-2	SELENIUM	0.96	MG/KG	[1]
0-2	SILVER	5	MG/KG	[1, 2, 4, 5, 6]
0-2	ZINC	240	MG/KG	[1, 4, 5]

TL07-17 08/09/07				
Depth	Parameter	Result	Units	Criteria
0-2	ARSENIC	150	MG/KG	[1, 2, 3, 4, 5, 6]
0-2	CADMIUM	1.9	MG/KG	[1, 4, 5]
0-2	CHROMIUM	64	MG/KG	[4, 5]
0-2	COPPER	4400	MG/KG	[1, 4, 5, 6]
0-2	LEAD	430	MG/KG	[4, 5, 6]
0-2	MERCURY	0.57	MG/KG	[1, 4, 5]
0-2	SELENIUM	0.78	MG/KG	[1]
0-2	SILVER	6.8	MG/KG	[1, 2, 4, 5, 6]
0-2	TOTAL PCBS	1100	UG/KG	[5, 6]
0-2	ZINC	340	MG/KG	[1, 4, 5]
0-6	ARSENIC	37	MG/KG	[1, 2, 3, 4, 5, 6]
0-6	CHROMIUM	73	MG/KG	[4, 5]
0-6	COPPER	3200	MG/KG	[1, 4, 5, 6]
0-6	LEAD	170	MG/KG	[4, 5, 6]
0-6	MERCURY	0.17	MG/KG	[1]
0-6	SILVER	4.3	MG/KG	[1, 4, 5, 6]
0-6	TOTAL PCBS	160	UG/KG	[5]
0-6	ZINC	460	MG/KG	[1, 4, 5]
6-36	ARSENIC	18	MG/KG	[1, 2, 3, 4, 5]
6-36	ARSENIC	17	MG/KG	[1, 2, 3, 4, 5] DUP
6-36	CHROMIUM	69	MG/KG	[4, 5]
6-36	CHROMIUM	66	MG/KG	[4, 5] DUP
6-36	COPPER	3100	MG/KG	[1, 4, 5, 6]
6-36	COPPER	3200	MG/KG	[1, 4, 5, 6] DUP
6-36	MERCURY	0.38	MG/KG	[1, 4, 5]
6-36	MERCURY	0.4	MG/KG	[1, 4, 5] DUP
6-36	SILVER	4.7	MG/KG	[1, 2, 4, 5, 6]
6-36	SILVER	4.9	MG/KG	[1, 2, 4, 5, 6] DUP
6-36	ZINC	230	MG/KG	[1, 4, 5]
6-36	ZINC	210	MG/KG	[1, 4, 5] DUP
36-72	CHROMIUM	48	MG/KG	[4, 5]
36-72	COPPER	3000	MG/KG	[1, 4, 5, 6]
36-72	MERCURY	0.23	MG/KG	[1, 4, 5]
36-72	SILVER	1.9	MG/KG	[1, 4, 5]
36-72	ZINC	170	MG/KG	[1, 4, 5]

TL07-23 08/09/07				
Depth	Parameter	Result	Units	Criteria
0-2	ARSENIC	70	MG/KG	[1, 2, 3, 4, 5, 6] DUP
0-2	ARSENIC	79	MG/KG	[1, 2, 3, 4, 5, 6] DUP
0-2	BARIUM	160	MG/KG	[1]
0-2	BARIUM	160	MG/KG	[1] DUP
0-2	CADMIUM	1.1	MG/KG	[4, 5]
0-2	CADMIUM	1.4	MG/KG	[4, 5] DUP
0-2	CHROMIUM	52	MG/KG	[4, 5]
0-2	CHROMIUM	53	MG/KG	[4, 5] DUP
0-2	COPPER	3800	MG/KG	[1, 4, 5, 6]
0-2	COPPER	3900	MG/KG	[1, 4, 5, 6] DUP
0-2	LEAD	240	MG/KG	[4, 5, 6]
0-2	LEAD	260	MG/KG	[4, 5, 6] DUP
0-2	MERCURY	0.54	MG/KG	[1, 4, 5]
0-2	MERCURY	0.69	MG/KG	[1, 4, 5] DUP
0-2	SELENIUM	0.89	MG/KG	[1]
0-2	SELENIUM	0.89	MG/KG	[1] DUP
0-2	SILVER	5.2	MG/KG	[1, 2, 4, 5, 6]
0-2	SILVER	5.5	MG/KG	[1, 2, 4, 5, 6] DUP
0-2	TOTAL PCBS	620	UG/KG	[5]
0-2	TOTAL PCBS	730	UG/KG	[5, 6] DUP
0-2	ZINC	210	MG/KG	[1, 4, 5]
0-2	ZINC	240	MG/KG	[1, 4, 5] DUP

TL07-22 08/09/07				
Depth	Parameter	Result	Units	Criteria
0-2	ARSENIC	310	MG/KG	[1, 2, 3, 4, 5, 6]
0-2	BARIUM	210	MG/KG	[1]
0-2	CADMIUM	1.8	MG/KG	[1, 4, 5]
0-2	CHROMIUM	57	MG/KG	[4, 5]
0-2	COPPER	2500	MG/KG	[1, 4, 5, 6]
0-2	LEAD	550	MG/KG	[4, 5, 6]
0-2	MERCURY	0.6	MG/KG	[1, 4, 5]
0-2	SELENIUM	0.93	MG/KG	[1]
0-2	SILVER	6.4	MG/KG	[1, 2, 4, 5, 6]
0-2	TOTAL PCBS	450	UG/KG	[5]
0-2	ZINC	270	MG/KG	[1, 4, 5]

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Groundwater Surface Water Interface Protection Criteria  
2=Residential Drinking Water Protection Criteria  
3=Nonresidential Drinking Water Protection Criteria  
4=Sediment Ecological Screening Levels  
5=Threshold Effect Concentration (TEC)  
6=Probable Effect Concentration (PEC)  
7=Surface Water Ecological Screening Levels  
8=Surface Water Rule 57 HNV Drink  
9=Surface Water Rule 57 HCV Drink  
10=Surface Water Rule 57 WV

**Legend**

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

**Locations analyzed for PCBs**

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

**Notes:**  
MG/KG = milligrams per kilogram  
UG/KG = micrograms per kilogram  
UG/L = micrograms per liter

0 650 Ft

Low Density  
Medium Density  
High Density

DEQ  
Prepared for:  
Michigan Department of  
Environmental Quality

Prepared By:  
WESTON  
SOLUTIONS of  
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H





**Legend**

**Locations Screened for Metals - At least one exceedance of:**

- Statewide Default Background Level
- Residential Particulate Soil Inhalation Criteria
- Residential Direct Contact Criteria

- Non Residential Direct Contact Criteria
- Screening locations with no exceedances
- Locations are included within a different geographical area boundary
- Conceptual Site and Geographic Area Boundaries

0 300 Ft

Xray Fluorescence screening results are from surface soils unless otherwise specified.

Prepared for:  
**Michigan Department of Environmental Quality**

Prepared By:  
**WESTON SOLUTIONS of MICHIGAN, INC**  
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**Figure 16**  
Soil Screening Location Map - Hubbell Slag Dump and Beach Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

TL07-05_08/07/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ARSENIC	22	MG/KG	[1, 2, 3, 4, 5]	
0-6	ARSENIC	19	MG/KG	[1, 2, 3, 4, 5]	DUP
0-6	BARIUM	190	MG/KG	[1]	
0-6	BARIUM	200	MG/KG	[1]	DUP
0-6	CADMIUM	1.1	MG/KG	[4, 5]	
0-6	CADMIUM	1.2	MG/KG	[4, 5]	DUP
0-6	CHROMIUM	200	MG/KG	[4, 5, 6]	
0-6	CHROMIUM	220	MG/KG	[4, 5, 6]	DUP
0-6	COPPER	3300	MG/KG	[1, 4, 5, 6]	
0-6	COPPER	3800	MG/KG	[1, 4, 5, 6]	DUP
0-6	LEAD	180	MG/KG	[4, 5, 6]	
0-6	LEAD	190	MG/KG	[4, 5, 6]	DUP
0-6	MERCURY	1.2	MG/KG	[1, 4, 5, 6]	
0-6	MERCURY	0.37	MG/KG	[1, 4, 5]	DUP
0-6	SELENIUM	0.42	MG/KG	[1]	
0-6	SELENIUM	0.6	MG/KG	[1]	DUP
0-6	SILVER	3.4	MG/KG	[1, 4, 5, 6]	
0-6	SILVER	3.1	MG/KG	[1, 4, 5, 6]	DUP
0-6	TOTAL PCBs	290	UG/KG	[5]	
0-6	TOTAL PCBs	230	UG/KG	[5]	DUP
0-6	ZINC	330	MG/KG	[1, 4, 5]	
0-6	ZINC	340	MG/KG	[1, 4, 5]	DUP
6-22	ARSENIC	18	MG/KG	[1, 2, 3, 4, 5]	
6-22	BARIUM	340	MG/KG	[1]	
6-22	CHROMIUM	500	MG/KG	[4, 5, 6]	
6-22	COPPER	3400	MG/KG	[1, 4, 5, 6]	
6-22	MERCURY	0.11	MG/KG	[1]	
6-22	SILVER	5.6	MG/KG	[1, 2, 4, 5, 6]	
6-22	ZINC	260	MG/KG	[1, 4, 5]	

TL07-11_08/08/07					
Depth	Parameter	Result	Units	Criteria	
0-6	ARSENIC	20	MG/KG	[1, 2, 3, 4, 5]	
0-6	CHROMIUM	180	MG/KG	[4, 5, 6]	
0-6	COPPER	2800	MG/KG	[1, 4, 5, 6]	
0-6	LEAD	85	MG/KG	[4, 5]	
0-6	MERCURY	0.14	MG/KG	[1]	
0-6	SILVER	2.2	MG/KG	[1, 4, 5]	
0-6	ZINC	400	MG/KG	[1, 4, 5]	
6-36	ARSENIC	16	MG/KG	[1, 2, 3, 4, 5]	
6-36	CHROMIUM	130	MG/KG	[4, 5, 6]	
6-36	COPPER	1800	MG/KG	[1, 4, 5, 6]	
6-36	MERCURY	0.22	MG/KG	[1, 4, 5]	
6-36	SILVER	6.1	MG/KG	[1, 2, 4, 5, 6]	
6-36	ZINC	260	MG/KG	[1, 4, 5]	
36-72	BARIUM	180	MG/KG	[1]	
36-72	CHROMIUM	180	MG/KG	[4, 5, 6]	
36-72	COPPER	2400	MG/KG	[1, 4, 5, 6]	
36-72	MERCURY	0.3	MG/KG	[1, 4, 5]	
36-72	SILVER	2.4	MG/KG	[1, 4, 5, 6]	
36-72	ZINC	180	MG/KG	[1, 4, 5]	

TL07-19_08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENIC	40	MG/KG	[1, 2, 3, 4, 5, 6]	
0-2	ARSENIC	38	MG/KG	[1, 2, 3, 4, 5, 6]	DUP
0-2	BARIUM	160	MG/KG	[1]	
0-2	BARIUM	160	MG/KG	[1]	DUP
0-2	CADMIUM	1	MG/KG	[4, 5]	
0-2	CADMIUM	1	MG/KG	[4, 5]	DUP
0-2	CHROMIUM	60	MG/KG	[4, 5]	
0-2	CHROMIUM	61	MG/KG	[4, 5]	DUP
0-2	COPPER	2400	MG/KG	[1, 4, 5, 6]	
0-2	COPPER	2200	MG/KG	[1, 4, 5, 6]	DUP
0-2	LEAD	190	MG/KG	[4, 5, 6]	
0-2	LEAD	180	MG/KG	[4, 5, 6]	DUP
0-2	MERCURY	0.45	MG/KG	[1, 4, 5]	
0-2	MERCURY	0.39	MG/KG	[1, 4, 5]	DUP
0-2	SELENIUM	0.89	MG/KG	[1]	
0-2	SELENIUM	0.82	MG/KG	[1]	DUP
0-2	SILVER	4	MG/KG	[1, 4, 5, 6]	
0-2	SILVER	3.9	MG/KG	[1, 4, 5, 6]	DUP
0-2	ZINC	290	MG/KG	[1, 4, 5]	
0-2	ZINC	270	MG/KG	[1, 4, 5]	DUP

TL07-20_08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENIC	39	MG/KG	[1, 2, 3, 4, 5, 6]	
0-2	BARIUM	170	MG/KG	[1]	
0-2	CADMIUM	1.1	MG/KG	[4, 5]	
0-2	CHROMIUM	110	MG/KG	[4, 5]	
0-2	COPPER	2300	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	160	MG/KG	[4, 5, 6]	
0-2	MERCURY	0.5	MG/KG	[1, 4, 5]	
0-2	SELENIUM	0.81	MG/KG	[1]	
0-2	SILVER	4.7	MG/KG	[1, 2, 4, 5, 6]	
0-2	ZINC	260	MG/KG	[1, 4, 5]	

TL07-18_08/09/07					
Depth	Parameter	Result	Units	Criteria	
0-2	ARSENIC	32	MG/KG	[1, 2, 3, 4, 5]	
0-2	CADMIUM	11	MG/KG	[1, 2, 3, 4, 5, 6]	
0-2	CHROMIUM	77	MG/KG	[4, 5]	
0-2	COPPER	2500	MG/KG	[1, 4, 5, 6]	
0-2	LEAD	520	MG/KG	[4, 5, 6]	
0-2	MERCURY	0.23	MG/KG	[1, 4, 5]	
0-2	SILVER	2.5	MG/KG	[1, 4, 5, 6]	
0-2	ZINC	430	MG/KG	[1, 4, 5]	

MDEQ Part 201 Cleanup Criteria for Response Action  
1=Groundwater Surface Water Interface Protection Criteria  
2=Residential Drinking Water Protection Criteria  
3=Nonresidential Drinking Water Protection Criteria  
4=Sediment Ecological Screening Levels  
5=Threshold Effect Concentration (TEC)  
6=Probable Effect Concentration (PEC)  
7=Surface Water Ecological Screening Levels  
8=Surface Water Rule 57 HNV Drink  
9=Surface Water Rule 57 HCV Drink  
10=Surface Water Rule 57 WV

Legend

- Sampling locations with at least one exceedance
- Sampling locations with no exceedances
- Locations are included within a different geographical area boundary

Locations analyzed for PCBs

- No Detections
- At Least One Detection
- Conceptual Site and Geographic Area Boundaries

Notes:  
MG/KG = milligrams per kilogram  
UG/KG = micrograms per kilogram  
UG/L = micrograms per liter

0 450 Ft

Low Density  
Medium Density  
High Density



Prepared for:  
Michigan Department of  
Environmental Quality



Prepared By:  
WESTON  
SOLUTIONS of  
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Houghton, MI 49931

**Figure 17**  
Surface Water and Sediment Sample Location Map  
Hubbell Slag Dump and Beach Area  
C & H Lake Linden Operations  
Lake Linden, Houghton County, Michigan



Image Source: ESRI World Imagery

PCB Congener Data for Walleye in Torch Lake				
Sample ID	Collection Date	Length (cm)	Weight (g)	TOTAL PCBC (ppm)
2000096-S10	5/3/2000	43.4	760	0.040
2000096-S11	5/3/2000	46	1000	0.030
2000096-S12	5/3/2000	46.7	900	0.036
2000096-S13	5/3/2000	47	940	0.020
2000096-S14	5/3/2000	47.8	980	0.046
2000096-S15	5/3/2000	52.1	1180	0.373
2000096-S16	5/3/2000	54.1	1480	0.183
2000096-S17	5/3/2000	55.9	1640	0.184
2000096-S18	5/3/2000	55.4	1930	0.039
2000096-S19	5/3/2000	54.1	1620	0.029
2007257-S21	4/25/2007	39.37	520	0.011
2007257-S22	4/25/2007	39.116	620	0.051
2007257-S23	4/25/2007	44.196	680	0.016
2007257-S24	4/25/2007	45.212	860	0.010
2007257-S25	4/25/2007	45.212	710	0.026
2007257-S26	4/25/2007	47.752	1060	0.125
2007257-S27	4/25/2007	50.038	900	0.021
2007257-S28	4/25/2007	52.832	1350	0.077
2007257-S29	4/25/2007	53.086	1180	0.052
2007257-S30	4/25/2007	54.61	1760	0.235
2007257-S31	4/25/2007	54.61	1710	0.039
2007257-S32	4/25/2007	57.912	1770	0.469
2007257-S33	4/25/2007	54.864	1550	0.212
2007257-S34	4/25/2007	58.928	1980	0.206
2007257-S35	4/25/2007	59.69	1920	0.176
2007257-S36	4/25/2007	60.198	1840	0.161
2007257-S37	4/25/2007	61.722	2180	0.271
2007257-S38	4/25/2007	61.722	2180	0.183
2007257-S39	4/25/2007	63.246	2100	0.346
2007257-S40	4/25/2007	63.246	2570	0.206

SPMD Site #8 11/17/05	
Parameter	Result
PCB 028	3
PCB 031	2.2
PCB 033	1.6
PCB 037-042	1.8
PCB 044	1.6
PCB 049	3.7
PCB 052	2.2
PCB 066-095	1.8
PCB 070	1.3
PCB 077a-110	1.5
PCB 090-101	0.9
PCB 118a	0.5
PCB 138a-163	0.6
PCB 151	0.9
PCB 153	0.8
PCB 174	0.9
TOTAL PCBC	10

SPMD Site #3 11/18/05	
Parameter	Result
PCB 018	1.3
PCB 028	3.3
PCB 031	2.4
PCB 033	1.9
PCB 037-042	2.5
PCB 044	2.7
PCB 049	6.5
PCB 052	5.3
PCB 056-060	1.1
PCB 064	1.5
PCB 066-095	5.2
PCB 070	2.8
PCB 074	1.1
PCB 077a-110	8.5
PCB 084	0.9
PCB 087	2.3
PCB 090-101	4.9
PCB 091	0.6
PCB 092	0.7
PCB 097	1.4
PCB 099	2.2
PCB 105a	1.3
PCB 118a	3.6
PCB 128	0.6
PCB 132	1
PCB 138a-163	3.3
PCB 149	0.7
PCB 151	0.7
PCB 153	2.5
PCB 158a	0.6
PCB 170	0.2
PCB 174	1
PCB 180	0.5
TOTAL PCBC	74

SPMD Site #2 11/18/05	
Parameter	Result
PCB 028	2.6
PCB 031	1.9
PCB 033	1.4
PCB 037-042	1.3
PCB 044	1.5
PCB 049	3.7
PCB 052	2
PCB 066-095	1.8
PCB 070	1.3
PCB 077a-110	1.7
PCB 090-101	0.9
PCB 118a	0.6
PCB 138a-163	0.5
PCB 153	0.8
PCB 174	0.7
TOTAL PCBC	22

SPMD Site #1 11/18/05	
Parameter	Result
PCB 028	2.5
PCB 031	1.7
PCB 033	1.4
PCB 037-042	2.2
PCB 044	3
PCB 049	10.3
PCB 052	6.2
PCB 056-060	1.9
PCB 064	1.4
PCB 066-095	5.9
PCB 070	2.9
PCB 077a-110	9.7
PCB 084	1.5
PCB 087	2.3
PCB 090-101	5.2
PCB 091	0.5
PCB 092	1.5
PCB 097	1.5
PCB 099	2.3
PCB 105a	1.2
PCB 118a	3.4
PCB 128	0.5
PCB 132	0.7
PCB 138a-163	2.9
PCB 149	0.6
PCB 151	0.9
PCB 153	2.3
PCB 170	0.3
PCB 174	0.9
PCB 180	0.5
TOTAL PCBC	77

SPMD Site #6 11/18/05	
Parameter	Result
PCB 028	2.8
PCB 031	1.9
PCB 033	1.3
PCB 037-042	1.8
PCB 044	2.4
PCB 049	8.1
PCB 052	5.3
PCB 064	1.2
PCB 066-095	5.1
PCB 070	2.8
PCB 077a-110	7.9
PCB 084	0.7
PCB 087	1.9
PCB 090-101	4
PCB 092	0.7
PCB 097	1.2
PCB 099	1.8
PCB 105a	0.9
PCB 118a	2.7
PCB 132	0.6
PCB 138a-163	2.5
PCB 149	0.5
PCB 151	0.7
PCB 153	2.1
PCB 158a	0.5
PCB 170	0.2
PCB 174	1
PCB 180	0.5
TOTAL PCBC	62

SPMD Site #4 11/18/05	
Parameter	Result
PCB 017	1.2
PCB 018	1.6
PCB 022	1
PCB 028	4.4
PCB 031	3.2
PCB 037-042	3.9
PCB 044	5.9
PCB 047	1.2
PCB 049	13.2
PCB 052	13.5
PCB 056-060	2.4
PCB 064	3
PCB 066-095	12
PCB 070	6.3
PCB 071	1
PCB 074	1.9
PCB 077a-110	17.5
PCB 082	0.7
PCB 084	2.6
PCB 087	4.2
PCB 090-101	9.7
PCB 091	1.4
PCB 092	2.2
PCB 097	2.7
PCB 099	4.3
PCB 105a	2.2
PCB 118a	5.8
PCB 128	0.9
PCB 132	1.5
PCB 135-144	0.9
PCB 138a-163	5.1
PCB 141	0.8
PCB 146	0.6
PCB 149	1.3
PCB 151	1.5
PCB 153	4.1
PCB 158a	1
PCB 170	0.4
PCB 174	1.3
PCB 179	0.4
PCB 180	1.1
PCB 182-187	0.9
TOTAL PCBC	150

SPMD Site #9 11/17/05	
Parameter	Result
PCB 028	2.9
PCB 031	2.2
PCB 033	1.5
PCB 037-042	1.5
PCB 044	1.5
PCB 049	5.6
PCB 052	2
PCB 066-095	1.8
PCB 070	2.3
PCB 077a-110	1.5
PCB 090-101	0.8
PCB 118a	0.5
PCB 153	0.7
PCB 174	0.8
TOTAL PCBC	25

SPMD Site #5 11/18/05	
Parameter	Result
PCB 028	2.4
PCB 031	1.7
PCB 033	1.1
PCB 037-042	1.8
PCB 044	1.3
PCB 049	3.4
PCB 052	2.2
PCB 066-095	1.8
PCB 070	1.2
PCB 077a-110	2.2
PCB 087	0.6
PCB 090-101	1.2
PCB 118a	0.8
PCB 138a-163	0.7
PCB 153	0.9
PCB 174	0.9
TOTAL PCBC	23

SPMD Site #7 11/18/05	
Parameter	Result
PCB 028	2.1
PCB 031	1.5
PCB 033	1.2
PCB 044	1
PCB 049	8.4
PCB 052	1.5
PCB 066-095	1.3
PCB 070	1.1
PCB 077a-110	1.3
PCB 090-101	0.7
PCB 118a	0.5
PCB 153	0.6
PCB 174	0.5
TOTAL PCBC	21

Legend

- Locations with at least one detection
- Locations with no detections
- Conceptual Site and Geographic Area Boundaries

Notes:  
All SPMD results presented in ug/l  
ug/l = micrograms per liter  
PCBC - PCB Congeners



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**Figure 18**  
PCB Congener Detections  
SPMD Sampling Locations  
Lake Linden, Houghton County, Michigan